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EFFICIENCY OF FOOD SECTOR OF PAKISTAN – A DEA ANALYSIS

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ABSTRACT

We used DEA to examine the efficiency of the food sector of Pakistan for the period 2007-2010. The year-wise technical efficiency scores show that the performance of the food producing companies improved over the past four years. The overall efficiency analysis suggests that the industry level technical efficiency scores ranged between 0.5 and 0.8 in the year 2007 which increased to 0.9 in the year 2010. The food industry is most efficient (90.7%) in the year 2010 when the technical efficiency score assuming VRS with output orientation was considered. In the second stage analysis based on OLS, the Model IV was found to be the most feasible one in which the size, age and labor to capital ratio and dummy have significant impact on the technical efficiency. Performance of food sector of Pakistan will improve significantly if modern technology in food production and processing is used that is likely to promote exports.

Keywords: Food sector, DEA, Technical efficiency, Determinants, Pakistan

INTRODUCTION

After air food is the most basic need of human being to keep the body and soul together. Fixed supply of land acts as the binding constraint to raise the production of food in order to cater to the growing needs of the population. Malthus predicted a dismal future of the humanity because the population growth outstrips the production of food that brings misery to the mankind. Technological discoveries increased the food production but gave rise to health hazards due to increasing use of fertilizers, pesticides and insecticides with a view to increase the crops yield. Urbanization and industrialization increased vigorously after the Second World War which also

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affected the agricultural sector. The rising level of urbanization increased the rural-urban migration. The massive migration required the increased supply of water, transport, health and education facilities besides food. Agriculture also became an industry to meet the mounting needs of the population. Many agro-based industries like textile, sugar, fertilizers, and flour mills were set up that had multi-faceted effects. The industries used various agricultural inputs as intermediate goods to produce the final products like garments, sweets, biscuits, cakes, cold drinks and many others. In addition to agro-based industries, many other different kinds of industries were also established. The increased industrialization has boosted the demand for eggs and poultry which besides being used as the final products, are also used as raw material (input) for various products like bakery products. Poultry, eggs and chicken are not free from the health hazards. Especially the hormones fed chicken pose many serious problems for the humanity especially the females.

Being an agricultural country, the food sector of Pakistan largely depends on the agricultural yield. The raw material comes from the seasonal crops which are processed properly. A large number of multinational companies have invested in the food sector utilizing the potential and the fertile resources of the country. The most noticeable groups are Bawany, Crescent, Habib, Fecto, Premier, Lakson, Burma Oil Brooke Bond, Clover Foods, Lever Brothers, Nestle and National Foods. Unlike developed countries the food processing usually involves the traditional procedures. In most of the developing countries, the food crops are harvested and the traditional processes of cooking are used to make them ready for eating.

The food and its allied products industry is considered Pakistan's largest industry and is believed to account for 27% of its value-added production, and 16% of the total employment by the manufacturing sector. It is estimated that in Pakistan there are 80,000 small businesses and more than 2 million micro-enterprises, many of which are food manufacturers. SMEs (small and medium enterprises) and micro-enterprises are located in rural areas and fall into the category of food processors, depending heavily on agricultural raw materials and poorly skilled non-farm labor. Due to lack of education and technological advancement, the standards of hygiene are not maintained by these small businesses. However, these come under the category of food manufacturers and processors. The types of crops grown in Pakistan can be categorized into commodity crops (wheat, rice), industrial crops (sugarcane, oilseeds) and the horticulture crops. The livestock is another type of raw material used in the food production besides agricultural crops. Oilseed being an industrial crop is used both as an additive as well as a final product. Despite considerable yield of oilseed, Pakistan could not become self-sufficient in vegetable oil. Horticulture crops are also important because the climate of the country is favorable for the production of a variety of fruits and vegetables. The main fruits which contribute towards the economy of the country are mango and oranges. Various varieties of oranges are grown in Punjab.

Sargodha is known for the production of *kino*. Mango is the second largest produced fruit of Pakistan. Both fruits are extensively being used in the manufacturing of juices and beverages. As far as vegetables are concerned, potatoes are the most notable one. The limited supply of horticulture crops for the production and processing of food in Pakistan is attributed to various factors which include old practices of cultivation, lack of modern technology and poor pest management.

Yet another element of food processing in Pakistan is the use of livestock. There are 30.8 million buffalo, 34.3 million cattle, 59.9 million goat and 27.8 million sheep in Pakistan which accounts for the better availability of milk and eggs. The poultry business is well established in the country since chicken is used both as an ingredient as well as the final product. Animal husbandry is a relatively less expensive business in the country. The food and allied industries are developing in Pakistan. The agricultural sector contributes 21 percent towards GDP employing the 45 percent of the total population. Almost 62 percent of population of the country resides in rural areas and is associated with farming (Government of Pakistan (GOP) 2009-10). There are over 50 food producing companies listed on the Karachi Stock Exchange (KSE) of Pakistan. The food processing sector of Pakistan mainly consists of the grain and flour mills, hydrogenated vegetable oil, dairy plants, fruit juice units, beverage bottling plants, snack foods, confectionery units and tea blending plants. In addition, there are some small vegetable dehydration, spice and salt packaging, and cereal facilities. The meat and vegetable processing industry is not well developed.

Food industry problems

1. Rise in energy prices and acute shortage of supply, alarming law and order situation, precarious economic situation, labor unrest due to rampant inflation are the common problems faced by the industry in Pakistan. However, food sector faces many peculiar problems .Traditional processes of production, little use of the latest technology, delayed production processes, low quality of the processed food items and infrastructure are the prominent food sector problems. Consequently the food industry is labor-intensive that is not highly skilled and receives low wage culminating in low productivity.
2. The supply chain management is another factor that adversely affects the efficiency of the food producers **i**n Pakistan. Farmer plays a primary role in the whole supply chain right from the time of harvest till the food reaches the consumer after processing. But it is clearly observed that there is a big gap between the two most important players – farmers and the consumers which frustrates the realization of the objectives of the whole process. Farmers lack the information that helps them in assessing the demand of the market while the consumers always want the quality for which they are paying. The

performance of the food producers, being the intermediate players, suffers at the end of the day due to the lack of integration along the supply chain.

3. Proper marketing strategies may have positively contributed towards the performance of food producers. The implementation of marketing techniques has not been done. Consequently the quality food cannot be produced.
4. Food industry receives step-motherly treatment from the financial institutions and commercial banks. The industry is not facilitated with a timely and low-cost credit that certainly affects the production potential and quality of the products.
5. The financial institutions and banks are reluctant to understand the precarious position of a food producer. The production of food primarily depends on the natural environment and the food processors have to suffer if the yield is not up to the mark due to lack of rainfall. In such situation, the banks do not extend the credit limit even for a limited period of time. The performance of the food processing companies gets adversely affected by this practice.
6. Consequently the food sector on the whole experiences the worst situation. The export of Pakistani fish and seafood to the European Union countries was banned on account of allegation of producing the unhygienic products. Similarly other non-tariff barriers significantly affect the efficiency of the food sector.
7. The mindset and buying practices of consumers also play an important role. Because of financial instability and poverty, consumers do not want to spend more on the food products. They demand high quality food at low prices which exposes the food producing firm to an awkward situation. Consequently, the quality is sacrificed and the substandard food is offered to the consumer at a much lower price. Lack of government support aggravates the situation.

Efficiency

Efficiency refers to the optimum utilization of inputs and production of maximum possible output. There are different types of efficiencies (technical, cost, allocative, and scale) which have been identified, explained and measured by using various techniques**.** A firm is said to be technically efficient if it produces a given amount of output by using the minimum inputs while cost efficiency is the ratio between the minimum cost at which it is possible to attain a given volume of production and the cost actually incurred. The allocative efficiency is equal to the ratio of the cost efficiency to the technical efficiency as discussed in a study on European banks (Maudos *et. al*., 1999).

Efficiency measurement is one of the dimensions of the modern world. Various industries have been evaluated so as to identify the loopholes. Despite extensive research on the manufacturing and banking sectors of Pakistan, there is no study on the food industry of Pakistan for

performance evaluation. This study aims at filling the gap in the literature by considering the food producing companies of Pakistan. Most of the studies have concentrated on the financial sector like banking and insurance for the efficiency measurement. Although there are some studies on the manufacturing sector of Pakistan but none of these to the best of our knowledge has examined the efficiency of the food producers of Pakistan**.** The main objective of the study is to evaluate the technical and scale efficiency of food producing companies listed on the Karachi Stock Exchange (KSE) for the period 2007 - 2010. We use DEA (Data Envelopment Analysis) to achieve the objective. Furthermore, the study also aims at identifying the determinants of technical efficiency of food sector of Pakistan. This study is the pioneering one to evaluate the efficiency of the food sector of Pakistan using the DEA.

REVIEW OF STUDIES

A number of studies have been done on the efficiency and its various forms. An important aspect of these studies is their concentration on the banking sector using DEA and SFA (Stochastic Frontier Analysis). Very few studies have been done on the manufacturing sector particularly food industry. Banker and Morey (1986) evaluated the efficiency of the restaurant networks considering the relative nature of the DEA when the input and output variables are not under the control of the managers. Banker and Thrall (1990) study contributed to the literature by developing a linkage between the various returns to scale with the most efficient scale size especially where there are multiple inputs and outputs used. Gregorian and Manole (2002) calculated an appropriate measure of commercial bank efficiency in a multiple-input/output framework and evaluated the effects of policy framework on the performance of commercial banks in seventeen transition countries for the period 1995-1998. The inputs used were the labor, fixed assets and interest expenditure while they considered two sets of outputs. First set consisted of revenues, net loans and liquid assets whereas the second set comprised deposits, net loans and liquid assets. Countries that produced the best outcome in terms of a revenue-based index (DEA-l) were Czech Republic (1995, 1998), Slovak Republic (1996), and Croatia (1997). The list of service-based index (DEA-2), winners consisted of Czech Republic (1995), Slovenia (1996, 1998), and Latvia (1997). It was found that the rules and regulations regarding banking operations, ownership structure and consolidation are the critical factors that affect the efficiency scores of the banking sector.

Mahdevan (2002) studied the Malaysian manufacturing sector taking into account 28 sub-sectors for the evaluation of productivity growth performance and Malmquist Index to calculate the total productivity growth. The change in technical and scale efficiencies was also studied as an outcome of the productivity growth of the industry. The results showed that the Malaysian manufacturing industry had a low productivity growth leading to a negative effect on the

technical and scale efficiency change. Mahmood *et. al*., (2002) used SFA to analyze the large-scale manufacturing sector of Pakistan for 1995-96 and 2000-01. They considered the contribution towards GDP as an output while the inputs were taken to be capital, labor, industrial cost and non-industrial cost. The sample of the study analyzed the data of all the important manufacturing sectors (tobacco, petroleum, food, drugs, iron and steel). They conclude that some sectors are technically efficient.

Zahid *et. al*., (1992) examined seventeen industry groups in order to analyze the technical change and efficiency in Pakistan for the period 1960-1986. It was concluded that in the long-term, the capital production techniques can be replaced by the labor-intense approach. The results show that various industries of Pakistan (sugar, rubber products, textiles, fertilizers and non-ferrous metals) reveal constant returns to scale while the remaining industries represent the decreasing returns to scale. Using DEA, Mukherjee and Ray (2004) studied the effect of reforms on the efficiency of the firms in different states of India for the periods 1986-87 and 1999-2000. The inputs used for the analysis included production workers, non-production workers, capital, fuels, and materials while the gross-value of manufacturing production in a state was taken as the sole output. The study did not identify any effect of the reforms on the efficiency of the manufacturing sector. Burki and Khan (2005) studied the impact of allocative inefficiency on the resource allocation in manufacturing industry of Pakistan for the period 1969- 91 and concluded that the allocative inefficiency had a negative effect on the allocation of resources. The results confirm that the strict regulatory regime is one of the factors leading to the high allocative inefficiency.

Halkos and Tzeremes (2010) studied the twenty three manufacturing industries of Greek including food and used DEA, the ratio analysis and Bootstrapping technique in order to evaluate the sensitivity of their data. The used, total assets, total equity and the distribution costs as the input variables and the ratios of net profit**,** return on equity and return on assets as the output variables. The results show that the efficiency scores considerably improved after application of Bootstrapping technique. Gopinath *et. al*., (1996) conducted a unique study on the food sector of USA in which the efficiency gains from the agriculture and the food processing were inter-related in a different manner. They maintain that the efficiency gains from the agriculture are more important than those by the processing of food materials. Jayanthi *et al*., (1996) analyzed the efficiency of 20 manufacturing plants used in the food processing sector of USA. The results suggest that the small sized food processing units are competitive while for the plant infrastructure it was concluded that the competitiveness depends on the factors like equipment maintenance, quality management programs, packaging supplies inventory, workforce training and product variety.

Hamilton and Sunding (1997) suggested that the increasing trend towards the food processing is inversely proportional to the market power. This implies that when the farm supply curve shifts outwards, the decrease in the market power causes the increased focus on the food processing. Fontana and Wobst (2001) studied the impact of macro policies on the food sector in Bangladesh in the backdrop of trade liberalization in the early 1990s and the depreciation of the local currency. The results suggest that the impact of the policies on the average households is different depending on whether it is headed by a woman or a man. Using DEA for the period 1997-1999, Palomares (2002) investigated the efficiency and productivity change in the food distribution industry of Spain. They used SFA along with the output-oriented DEA model for the measurement of efficiency. A multi-stage DEA was also applied to study the role of inefficient units in the sample. A total of 22 food distribution units were considered and their data were analyzed for the measurement of scale, technical and pure technical efficiency of the sector. It was concluded that there is a margin of improvement in the sales efficiency as far as the technical and pure technical efficiencies are concerned. Using DEA, Chapelle and Plane (2002) analyzed the technical efficiency of the Ivorian manufacturing sectors including the textile and garment, metal products, wood and furniture, food processing. The results showed that the managerial performance is higher in the small and informal companies.

Abedullah *et. al*., (2007) analyzed the rice production of Punjab province of Pakistan with special reference to future investment in the country. The technical efficiency of the farmers of Punjab was evaluated using the SFA. It was revealed that more investment in machinery used in farming could boost the technical efficiency scores of the farmers and that the low inefficiency score implies that there is a possibility of improvement in the efficiency scores. Bayyurt and Duzu (2008) carried out a comparative analysis of the manufacturing firms of Turkey and China. They employed the DEA technique in order to have a comparative data for the two countries. It was concluded that Chinese manufacturing industry is a way ahead of the Turkish manufacturing industry as far as the efficiencies of the firms are concerned. Wilkinson (2004) conducted a descriptive study reviewing the literature on the factors of export earnings, dietary issues and domestic restructuring of the food processing companies in the developed countries.

Kumar and Basu (2008) studied the impact of technological change and technical efficiency change on the scale efficiency of food processing industry in India for the periods 1998-99 and 2004-05. It is found that the industry is not utilizing its agricultural resources up to the optimal level due to which the food processing sector of India is not working efficiently. Lopez (2008) studied the Canadian food processing sector. The results suggest that the market was very sensitive to the change in prices and reported that labor and energy are more elastic inputs and raw food materials and capital do not respond as much to a change in the market prices.

Tektas and Tosun (2010) used DEA analysis and considered the supply chain costs, inventory costs and employee strength as the inputs while the profits, revenues and the exports were taken as the outputs for efficiency analysis of food and beverages sector in Turkey. They also observed the impact of volume of exports on the supply chain efficiency of the food and beverage sector of Turkey. The results confirmed that there is a positive relationship between the exports and the supply chain efficiency. Mohamad and Said (2010) considered the Malaysian food manufacturing sector and evaluated the companies for the period 2002- 2007. DEA is used to compute and analyze the decomposition of Malmquist index TFP into technological change, technical efficiency change and scale efficiency change by utilizing an output-oriented DEA model under the assumptions of constant and variable returns to scale.

METHODOLOGY AND DATA

DEA is a methodology that measures the relative performance and efficiency of multiple decision making units (DMU_s) when the production process presents a difficult structure of multiple inputs and outputs. DEA effectively estimates the frontier by finding a set of linear segments that binds or envelops the observed data. The DEA is a linear programming based technique for measuring the relative efficiency and management performance of firms where presence of multiple inputs and outputs makes comparison difficult (Banker and Morey 1986).

The definition of a DMU is generic and flexible. DEA has been used extensively in evaluating the performances of many different kinds of entities like hospitals, universities, cities, business firms, banks, regions etc since it is based on very few assumptions. Charnes, Cooper and Rhodes (1978) proposed a model that had an input-orientation and assumed constant returns to scale (CRS). Later studies have considered alternative sets of assumptions. Banker, Charnes and Cooper (1984) first introduced the assumption of variable returns to scale (VRS). The CRS assumption is only appropriate when all DMU_s are operating at an optimal scale. However, factors like imperfect competition and constraints on finance may cause a DMU not to be operating at optimal scale. Consequently the use of the CRS specification when some DMU_s are not operating at optimal scale will result in measures of technical efficiency which are mystified by scale efficiencies. The VRS specification has been the most commonly used specification in the 1990s (Coelli 1998).

The literature shows that different studies have used various models of DEA to analyze efficiency. However, these models are either input-oriented or output-oriented. When the linear programming model is modified such that the inputs used by a firm are reduced to the maximum level to achieve the same required quantity of outputs, it takes the form of input-oriented DEA.

There is evidence that the model can be used in the capacity estimation but that is rare. Mostly it has been employed in studying the efficiency of the firms.

Suppose there are n DMU_s who use *m* inputs and produce *s* outputs. The quantities of the outputs may be different for each DMU. More precisely the DMU_j uses an m-dimensional input vector x_{ij} (i= 1, 2…m) to produce an s-dimensional output vector y_{rj} (r=1, 2…s). A particular DMU is represented by DMU_0 and rest is denoted by DMU_j. In the ratio form, the ratio of weighted sum of outputs to weighted sum of inputs is used to measure the relative efficiency. For each DMU following optimization problem is formed (Pyu 1992):

$$\textbf{Max } \sum_r u_r y_{r0} / \sum_i v_i x_{i0} \quad (1)$$

Subject to the constraint

$$\sum_r u_r y_{rj} / \sum_i v_i x_{ij} \leq 1 \quad u_r \geq 0 \quad v_i \geq 0$$

Where i= 1, 2…m, r=1, 2…s; j = 1, 2… n

Both output weight (u_r) and inputs weight (v_i) are required to be non-negative.

In Charnes, Cooper, and Rhodes (1978) model the reduction of the multiple-output /multiple-input situation is reduced (for each DMU) to that of a single virtual output ($\sum_r u_r y_{rj}$) and virtual input ($/\sum_i v_i x_{ij}$) .

This ratio which is to be maximized forms the objective function in mathematical programming language for the particular DMU being evaluated. This ratio is non-linear and can be transformed to a linear form as given below:

$$\textbf{Max } \sum_r u_r y_{rj} \quad (2)$$

subject to $v_i x_{ij} = 1$

$$\sum_r u_r y_{rj} - v_i x_{ij} \leq 0$$

$$u_r \geq 0 \quad v_i \geq 0$$

Data

In the DEA variables are termed as the outputs and inputs. Literature shows that diverse inputs and outputs have been used by the studies. This study considers the capital, salaries, materials and energy as the inputs while net sales is taken to be the output variable. The cost of capital was calculated considering the depreciation and interest costs while the net sales were deflated using the GDP deflator for each year. The choice of these variables was made on the basis of the fact that being the neo-classical technique the DEA considers only the variable inputs. Since the measure of efficiency can be best expressed in terms of sales of the firm, it was considered as the output. The relevant data from annual reports of 22 food producing companies were gathered from the Karachi Stock Exchange for the period 2007-2010. Data on GDP deflator were gathered from GOP, Economic Survey (various issues).

Determinants of technical efficiency

A second stage analysis using the OLS is also carried out in order to see the robustness of the efficiency scores of the firms. We use four models of technical efficiency where each model represents a different combination of two orientations and the returns to scale. The technical efficiency score for each of the firm under CRS with input orientation (Y_1) is taken as the dependent variables while the size, age and labor to capital ratio are the independent variables. A number factors could be identified that are expected to influence the efficiency of a firm like political and economic stability, cheap and regular energy supply, cordial labor and management relations, absence of security threats, efficient skilled labor and competent management etc. Keeping in view of data limitations, we presume that the size of a firm, age and labor to capital ratio are the important factors influencing the efficiency of a firm. The natural log of the input variables reduces the chances of error in the estimates (Angelidis and Lyroudi 2006). Therefore, the natural logs are used for the size of a firm, age and labor to capital ratio.

Larger firms are usually considered more efficient than smaller firms because the former are thought to have superior organization or technical knowledge. Older firms are usually regarded more efficient than younger firms because the former gain experience from past operations and their survival per se may reflect their superior efficiency. Therefore we take square of the age. Efficiency may also be related to local participation in ownership. Local participation may improve efficiency since foreign owners are generally less familiar with the local environment; local shareholders can help in that respect. On the other hand, local participation may hurt efficiency if the local owners, because of a lack of knowledge or experience or simply for cultural reasons, resist adoption of new and more efficient techniques. Considering this background, we specify the models as follows:

Model I: CRS (Input-Orientation)

$$Y_1 = \alpha_0 + \alpha_1 lnX_{1it} + \alpha_2 (lnX_{1it})^2 + \alpha_3 lnX_{2it} + \alpha_4 (lnX_{2it})^2 + \alpha_5 lnX_{3it} + D + \mu_{it} \quad (3)$$

Where

Y_1 = technical efficiency score under CRS with input orientation

ln = natural log

t = time (number of years)

X_{1it} = age of the firm i in the year t

X_{2it} = size of the firm i in year t measured by number of employees

X_{3i} = ratio of labor to capital

Dummy Variable =1 if the firm is locally owned

= 0 if the firm is foreign owned

μ = error term that follows the classical linear regression assumptions

It is difficult to predict exactly the expected signs of the coefficients

Model II: VRS (Input-Orientation)

Model II represents the technical efficiency score under the VRS assumption with input orientation (Y_2).

$$\mathbf{Y_2 = \beta_0 + \beta_2 lnX_{1it} + \beta_3 (lnX_{1it})^2 + \beta_3 lnX_{2it} + \beta_4 (lnX_{2it})^2 + \beta_5 lnX_{3it} + D + \mu_{it}} \quad (4)$$

Where

Y_2 = technical efficiency score under VRS with input orientation

Model III CRS (output-orientation)

Model III was developed in order to examine the technical efficiency score under CRS assumption with output-orientation (Y_3)

$$\boldsymbol{Y_3 = \lambda_0 + \lambda_1 lnX_{1it} + \lambda_2 (lnX_{1it})^2 + \lambda_3 lnX_{2it} + \lambda_4 (lnX_{2it})^2 + \lambda_5 lnX_{3it} + D + \mu_{it}} \quad (5)$$

Where

Y_3 = technical efficiency score under CRS with output-orientation

Model IV: VRS (output-orientation)

This model represents the technical efficiency score under VRS with output-orientation.

$$\boldsymbol{Y_4 = \varphi_0 + \varphi_1 lnX_{1it} + \varphi_2 (lnX_{1it})^2 + \varphi_3 lnX_{2it} + \varphi_4 (lnX_{2it})^2 + \varphi_5 lnX_{3it} + D + \mu_{it}} \quad (6)$$

Where

Y_4 = technical efficiency score under VRS with output-orientation

EMPIRICAL RESULTS

DEA results

The data on the food producing companies listed on the KSE have been analyzed using the DEA. The efficiency scores were calculated by using the DEA software version 2.1. The efficiency scores for each of the 22 companies were calculated for the period 2007 – 2010. The empirical results have been given in the Appendices A, B, C and D.

2007

The results for 2007 (Appendix A) show that there are some companies which have the highest efficiency score of 1 when the input orientation and output orientation are considered. The technical efficiency scores of Wazir Ali Industries, Al-Abbas Sugar Mills, JDW Sugar Mills and

Rafhan Maize demonstrate that these firms are 100 percent efficient. On the other hand, Sakrand Sugar Mills is approaching the efficient frontier with 88 percent efficiency when the input orientation is considered under VRS assumption. The scale efficiency scores show that the firms which were technically efficient were also scale efficient as Wazir Ali Industries, Al-Abbas Sugar Mills, JDW Sugar Mills and Rafhan Maize scored the maximum efficiency score 1 under both types of orientations. The companies which are following the frontier include Shakarganj Sugar Mills and Colony Sugar Mills with 93 percent and 92 percent efficiency respectively when input orientation is considered. While in case of output orientation, Faran Sugar Mills, Shakarganj Sugar Mills, Mehran Sugar Mills and Noon Pakistan showed inadequately efficient performance.

2008

A variable trend is observed in the year 2008 (Appendix B) regarding the efficiency of the firms. Only few companies showed 100 percent efficiency. As far as technical efficiency is concerned, Wazir Ali, Al-Abbas Sugar, J.D.W. Sugar and Rafhan Maize are technically efficient with both orientations and returns to scale. While Mitchell's Fruits, S.S Oil, Mirza Sugar, National Foods Limited, Nestle Pakistan and Pangrio sugar are technically efficient under the VRS assumption. Appendix B shows that the scale efficiency scores differed from the technical efficiency. Wazir Ali, Al-Abbas Sugar, J.D.W. Sugar and Rafhan Maize were 100 percent scale efficient with the maximum efficiency score of 1 in both types of orientation. The scale efficiency scores of all other firms in the sample are lower and none of them can be regarded as working efficiently.

2009

2009 (Appendix C) results show that Wazir Ali could not maintain its efficient performance and showed a lower technical efficiency of 26.4 percent and 94 percent under the different assumptions. On the other hand, there is a considerable improvement in the performance of some companies like S.S Oil and Pangrio Sugar as they were 100 percent efficient under CRS and VRS with both types of orientations. Accordingly S.S Oil, Pangrio Sugar, Al-Abbas Sugar and J.D.W. Sugar are technically efficient for the year and Mitchell's Fruits, Thal Industries, Unilever Pakistan, Nestle Pakistan and Noon Sugar Limited attained maximum technical efficiency score 1 under the VRS assumption with the input and output orientation. The scale efficiency scores of the sample firms followed the trend of preceding years and Wazir Ali, Al-Abbas Sugar, J.D.W. Sugar and Rafhan Maize again showed 100 percent scale efficiency.

2010

The year 2010 (Appendix D) can be regarded as the most successful year as far as the performance of the food producing companies is concerned. Although few companies which had shown influential performance in the previous years could not keep up the pace but many other companies joined the group of technically efficient companies which include Adam Sugar and Thal Industries. Other technically efficient companies for 2010 are S.S.Oil, Al-Abbas Sugar, J.D.W sugar, Rafhan Maize, Murree Brewery and Wazir Ali. All these companies showed both technical and scale efficiencies.

OLS results

Four models were developed in order to determine the effect of different factors like age, size and labor to capital ratio on the technical efficiency of the sample firms. We get results for age (experience) against expectations in the four models which are even significant in Model III and Model IV (Table I). These results are not sustainable keeping in view the infant industry argument for domestic industry protection. However, except Model I other models results are according to expectations (age^2) as supported by economic theory. Model I shows poor results. Size variable is negative and significant for Model II only suggesting that increase in the size of the firm will diminish technical efficiency and is negative and insignificant in Model III and Model IV. As the firm size increases ($size^{2)}$, it has significant impact on technical efficiency except Model I. This means that larger firms are more technically efficient under CRS with output orientation. Labor-capital ratio seems to have no impact on the technical efficiency suggesting that firms use labor-intensive technology because Pakistan is a labor-abundant country and this factor is used intensively. Dummy is significant only in model IV implying that foreign or local ownership carries insignificant role in other models.

Table 1: OLS Results

Variables	Model I	Model II	Model III	Model IV
C	0.78 (0.84)	4.72 (0.10)	6.5 (0.14)	7.78 (0.01)
$X_{1\ age}$	-0.99 (-0.55)	-0.22 (- 0.85)	-2.9 (0.08)	-2.5 (0.03)
$(X_1)^2$	0.14 (0.53)	0.02 (0.001)	0.40 (0.09)	0.33 (0.03)
$X_{2\ size}$	0.21 (0.72)	-0.77 (0.06)	-0.42 (0.56)	-0.78 (0.11)
$(X_2)^2$	-0.005 (0.89)	0.04 (0.09)	0.03 (0.02)	0.05 (0.07)
$X_{3\ L/K}$	-0.105 (0.15)	0.003 (0.94)	0.03 (0.46)	-0.03 (0.59)
D	0.23 (0.47)	-0.03 (0.87)	0.50 (0.19)	0.37 (0.08)
R^2	0.13	0.19	0.11	0.29
DW	1.89	2.04	1.86	2.00

Note: The figures in parenthesis are the p-values

CONCLUSIONS

We used DEA to examine the financial data of food producing companies listed on the KSE for the period 2007 -2010. The year-wise technical efficiency scores of the food sector show that the performance of the food producing companies has improved over the past four years. The overall

efficiency analysis of the food industry suggests that the industry level technical efficiency scores ranged between 0.5 and 0.8 in the year 2007 which increased to 0.9 in the year 2010. The food industry is most efficient (90.7%) in the year 2010 when the technical efficiency score assuming VRS with output orientation was considered. This trend shows that the industry as a whole is improving. However, the fact that the efficiency never reached the maximum of 100% in the past 4 years indicates that proper policy making and implementation is needed so as to make the industry fully efficient. Similarly, if the results from the scale efficiency analysis are considered there is an increasing trend since 2007. Although, the scale efficiency scores of the industry are not as encouraging as the technical efficiency ones are. The range is 0.5 to 0.7 for the sample period. Therefore, there is a margin of improvement as far as the scale efficiency of the food industry is concerned.

The second stage analysis based on OLS shows that Model IV (technical efficiency scores assuming CRS with the output-orientation) is the most feasible one in which the size, age and labor to capital ratio and dummy have some significant impact on the technical efficiency. Whereas the Model I is not feasible since none of the independent variables tend to have any significant effect on the technical efficiency when the CRS is assumed with input-orientation. In the light of the overall results, we come up with the following policy implications which if implemented are expected to enhance the efficiency of the food sector of Pakistan.

1. Being an agricultural country, proper attention should be given to the modern approaches of producing and processing the agricultural yield. This includes the use of highly equipped machinery and infrastructure in addition to the general awareness in the farmer community.
2. Since the DEA shows that the food industry is not scale efficient which means that the resources are not being appropriately exploited due to which the returns are not up to the desired mark. Ultimately the scale efficiency of the whole industry is suffering.
3. The OLS results show that the technical efficiency scores under CRS and VRS assumption of input orientation is effected by the age of the firm. This implies that the new firms are more efficient. Consequently there is a gap between the efficiency of the new and old firms, the older firms may also achieve the benchmark if they improve their organizational practices. This will in turn trigger the efficiency of the overall performance of the industry.
4. There is a big potential in the food sector of Pakistan which may contribute towards the exports of the country. As for instance, if the cereal grain production is increased and proper steps are taken in the right direction, the productivity of cereals may be improved. Since the South Asian and Middle Eastern countries are not self-sufficient, the exports may be targeted to such countries. This may be done by improving the technological

facilities available to the farmers and the more refined processes to make the yield available for exports.

5. Since Pakistan is blessed with ample natural resources, appropriate steps in the right direction may lead the country towards prosperity. The exploitation of water resources in this regard needs immediate attention. Being an agricultural country, the performance of food sector of Pakistan heavily relies on the annual yield. Therefore, the quality of agricultural yield may be improved if the canal system is further developed employing the modern technological advancements. Proper policy making and exploitation of water resources may in turn enhance the performance of the overall food industry of the country.

REFERENCES

Abedullah, Kouser, S. and Mushtaq, K. (2007). Analysis of Technical Efficiency of Rice Production in Punjab (Pakistan) - Implications for Future Investment Strategies, *Pakistan Economic and Social Review*, Vol. 45, No. 2, pp. 231-244.

Angelidis, D. and Lyroudi, K. (2006). Efficiency in the Italian Banking Industry: Data Envelopment Analysis and Neural Networks, *International Research Journal of Finance and Economics*, Vol. 5, pp. 155-165.

Banker, R., Charnes, A. & Cooper, C. (1984). Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis, *Management Science*, Vol. 30, pp. 1078–1092.

Banker, R. D. and Morey, R. C. (1986). Efficiency Analysis for Exogenously Fixed Inputs And Outputs, *Operations Research*, Vol. 34, No. 4, pp. 113-120.

Banker, R. D. and Thrall, R. M. (1990). Estimation of Returns to Scale using Data Envelopment Analysis, *European Journal of Operational Research*, pp. 74-84.

Bayyurt, N. and Duzu, G. (2008). Performance Measurement of Turkish and Chinese Manufacturing Firms: A Comparative Analysis, *Eurasian Journal of Business and Economics*, Vol. 1, No. 2, pp. 71-83.

Burki, A. A. and Khan, M. H. (2005). Effects of Allocative Inefficiency on Resource Allocation and Energy Substitution in Pakistan's Manufacturing. *Center for Management and Economic Research (CMER), Lahore University of Management Sciences (LUMS)*, Working Paper No. pp. 04-30.

Chapelle, K. and Plane, P. (2002). Technical Efficiency Measurement within the Ivorian Manufacturing Sector: A Data Envelopment Analysis Approach. *Centre D'etudes Et De Recherches Sur Le Developpement International*.

Charnes, A., Cooper, W., & Rhodes. E. (1978), Measuring the efficiency of decision-making units, *European Journal of Operational Research*, Vol. 2, pp. 429–444.

Coelli, T. (1998). A Guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer) Program. *CEPA, Working Paper 96/0*8.

Eling, M. and Luhnen, M. (2008). Frontier Efficiency Methodologies to Measure Performance in the Insurance Industry: Overview and New Empirical Evidence. *Institute of Insurance Economics, University Of St. Gallen*, Working Papers on Risk Management and Insurance No. 56.

Eling, M. and Luhnen, M. (2009). Efficiency in the International Insurance Industry: A Cross-Country Comparison, *Institute Of Insurance Economics, University Of St. Gallen*, Working Papers on Risk Management and Insurance No. 72.

Ferrier, G. D. and V. Valdmanis (1996). Rural Hospital Performance and its Correlates, *Journal of Productivity Analysis*, Vol. 7 pp. 63-80.

Fontana, M. & Wobst, P. (2001). Macro Policies and the Food Sector in Bangladesh: A General Equilibrium Analysis. *Trade and Macroeconomics Division International Food Policy Research Institute.*

Gregorian, D. A. and Manole, V. (2002). Determinants of Commercial Bank Performance in Transition - An Application Of Data Envelopment Analysis, *Policy Research Working Paper 2850 - The World Bank*.

Gopinath, M., Roe, L. & Shane, D. (1996). Competitiveness of US Food Processing: Benefits from Primary Agriculture, *American Journal of Agricultural Economics*, Vol. 78, No. 4, pp. 1044-1055.

Government of Pakistan, *Economic Survey* (various issues), Islamabad, Ministry of Finance, Economic Advisor Wing.

Halkos, G. and Tzeremes, N. (2010). Performance Evaluation Using Bootstrapping DEA Techniques: Evidence from Industry Ratio Analysis. *MPRA*, 25072.

Halkos, G. E. and Salamouris, D. S. (2001). Efficiency Measures of The Greek Banking Sector: A Non-Parametric Approach For The Period 1997-1999, *Munich Personal Repec Archiv.*

Hamilton, F. & Sunding, L. (1997). The Effect of Farm Supply Shifts on Concentration and Market Power in the Food Processing Sector, *American Journal of Agricultural Economics*, Vol. 79, No. 2, pp. 524-531.

Jayanthi, S., Kocha, B. and Sinha, K. K. (1996). Competitive Analysis of U.S Food Processing Plants, *The Retail Food Industry Center, Working Paper* 96-04.

Kumar, M. and Basu, P. (2008). Perspectives of productivity growth in Indian food industry: a data envelopment analysis, *International Journal of Productivity and Performance Management*, Vol. 57, No. 7, pp. 503 – 522.

Lopez, E. (2008). Measuring Oligopoly Power and Production Responses of the Canadian Food Processing Industry, *Journal of Agricultural Economics*, Vol. 3, No. 2, pp. 219-230.

Mahdevan, R. (2002). A DEA Approach to Understanding the Productivity Growth of Malaysia's Manufacturing Industries, *Asia Pacific Journal of Management*, Vol. 19, No. 4, pp. 587-

600.

Mahmood, T., Ghani, E. and Musleh-Ud Din, (2002). Efficiency of Large-Scale Manufacturing in Pakistan: A Production Frontier Approach, *The Pakistan Development Revie*w, Vol. 45, No. 4, pp. 689-700.

Maudos, J., Pastor, J. M., Pérez, F. and Quesada, J. (1999). Cost and Profit Efficiency in European Banks. IVIE, 12.

Mohamad, N. H. and Said, F. (2010). Decomposing Productivity Growth in Malaysian Food Manufacturing Industry, *Africa Journal of Business Management,* Vol. 4, No. 16, pp. 3522-3529.

Mukherjee, K. and Ray, S. (2004). Technical Efficiency and Its Dynamics In Indian Manufacturing: An Inter-State Analysis. *University Of Connecticut. Working Paper Series*, 18.

Oberholzer, M. and Van Der Westhuizen, G. (2004). An Empirical Study on Measuring Efficiency and Profitability Of Bank Regions, *Meditari Accountancy Research*, Vol. 12, No. 1, pp. 165-178.

Palomares, R. D. (2002). Efficiency and Productivity in the Spanish Food Distribution Sector, Xth EAAE Congress 'Exploring Diversity in the European Agri -Food System.

Pyu Y. (1992). Data Envelopment Analysis and Commercial Bank Performance: A Primer with Applications to Missouri Banks, *Review- Federal reserve Bank St. Louis*, Vol. 74, No. 1, pp. 31-45.

Sharma, S. and Sharma, M. (2010). Analyzing the technical and scale efficiency of small industries in India: state-wise cluster study, *Measuring Business Excellence*, Vol. 14, No. 2, pp. 54-65.

Tektas, A. and Tosun, E. O. (2010). Performance Benchmarking in Turkish Food and Beverage Industry. *IBIMA Publishing.*

Wilkinson, J. (2004). The Food Processing Industry, Globalization and Developing Countries, *Journal of Agricultural and Development Economics,* Vol. 1, No. 2, pp. 184-201.

Yang, Z. (2009). Bank Branch Operating Efficiency: A DEA Approach, *International Multi Conference of Engineers and Computer Scientists*. Hong Kong.

Zahid, S. N., Akbar, M. and Jaffry, S. A. (1992). Technical Change, Efficiency and Capital-Labour Substituiton in Pakistan's Large Scale Manufacturing Sector, *The Pakistan Development Review*, Vol. 31, No. 2, pp. 165-188.

Appendix A

Firm Level Efficiency Scores for 2007

	Technical Efficiency		Scale Efficiency			
	Input	Output	Input	Returns	Output	Returns

	orientation		orientation		orientation		orientation	
	CRS	VRS	CRS	VRS				
Adam Sugar Mills	0.272	0.798	0.272	0.41	0.34	IRS	0.663	IRS
Colony Sugar Mills	0.214	0.231	0.214	0.704	0.925	DRS	0.304	DRS
Faran Sugar Mills	0.287	0.586	0.287	0.291	0.49	IRS	0.988	IRS
Mithchells Fruit	0.437	1	0.437	1	0.437	IRS	0.437	IRS
Shahtaj Sugar	0.428	1	0.428	1	0.482	IRS	0.482	IRS
Shakarganj Mills	0.609	0.65	0.609	0.644	0.938	IRS	0.945	DRS
S.S.Oil	0.542	1	0.542	1	0.542	IRS	0.542	IRS
Thal Industries	0.502	0.582	0.502	0.917	0.863	DRS	0.547	DRS
Unilever Pakistan	0.227	1	0.227	1	0.227	DRS	0.227	DRS
Wazir Ali	1	1	1	1	1	-	1	-
AL-Abbas Sugur	1	1	1	1	1	-	1	-
J.D.W.Sugar	1	1	1	1	1	-	1	-
Mehran SugarXD	0.168	0.587	0.168	0.176	0.286	IRS	0.953	DRS
Mirpurkhas Sugar	0.103	0.491	0.103	0.157	0.209	IRS	0.656	DRS
Mirza Sugar	0.203	1	0.203	1	0.203	IRS	0.203	IRS
Murree Brewery	0.727	1	0.727	1	0.727	IRS	0.727	IRS
National Foods Ltd.	0.782	1	0.782	1	0.782	IRS	0.782	IRS
Nestle Pakistan	0.809	1	0.809	1	0.809	DRS	0.809	
Noon Sugar Mills	0.227	0.629	0.227	0.237	0.361	IRS	0.959	IRS
Pangrio Sugar	0.08	1	0.08	1	0.08	IRS	0.08	IRS
Rafhan Maize	1	1	1	1	1	-	1	-
Sakrand Sugar	0.338	0.888	0.338	0.661	0.38	IRS	0.511	IRS

Appendix B

Firm Level Efficiency Scores for 2008

	Technical Efficiency				Scale Efficiency			
	Input orientation		Output orientation		Input orientation	Returns	Output orientation	Returns
	CRS	VRS	CRS	VRS				
Adam Sugar Mills	0.319	0.84	0.319	0.545	0.379	IRS	0.584	IRS
Colony Sugar Mills	233	0.253	233	0.76	0.919	DRS	0.306	DRS
Faran Sugar Mills	0.322	0.604	0.322	0.333	0.533	IRS	0.966	IRS
Mithchells Fruit	0.325	1	0.325	1	0.325	IRS	0.325	IRS
Shahtaj Sugar	0.347	0.902	0.347	0.494	0.384	IRS	0.702	IRS
Shakarganj	0.653	0.69	0.653	0.746	0.941	IRS	0.876	DRS

Mills		5						
S.S.Oil	0.471	1	0.471	1	0.471	IRS	0.471	IRS
Thal Industries	0.475	0.477	0.475	0.85	0.996	IRS	0.559	DRS
Unilever Pakistan	0.23	1	0.23	1	0.23	DRS	0.23	DRS
Wazir Ali	1	1	1	1	1	-	1	-
AL-Abbas Sugur	1	1	1	1	1	-	1	-
J.D.W.Sugar	1	1	1	1	1	-	1	-
Mehran SugarXD	0.12	0.533	0.12	0.152	0.224	IRS	0.788	DRS
Mirpurkhas Sugar	0.075	0.525	0.075	0.122	0.144	IRS	0.615	DRS
Mirza Sugar	0.174	1	0.174	1	0.174	IRS	0.174	IRS
Murree Brewery	0.424	0.584	0.424	0.55	0.726	IRS	0.771	DRS
National Foods Ltd.	0.853	1	0.853	1	0.853	IRS	0.852	IRS
Nestle Pakistan	0.528	1	0.528	1	0.528	DRS	0.528	DRS
Noon Sugar Mills	0.272	0.605	0.272	0.286	0.45	IRS	0.952	IRS
Pangrio Sugar	0.089	1	0.089	1	0.089	IRS	0.089	IRS
Rafhan Maize	1	1	1	1	1	-	1	-
Sakrand Sugar	0.238	0.72	0.238	0.334	0.331	IRS	0.714	IRS

Appendix C

Firm Level Efficiency Scores for 2009

	Technical Efficiency				Scale Efficiency			
	Input orientation		Output orientation		Input orientation	Returns	Output orientation	Returns
	CRS	VRS	CRS	VRS				
Adam Sugar Mills	0.696	0.736	0.696	0.703	0.946	IRS	0.99	DRS
Colony Sugar Mills	0.304	0.729	0.304	0.845	0.417	DRS	0.36	DRS
Faran Sugar Mills	452	0.669	452	0.467	0.676	IRS	0.968	DRS
Mithchells Fruit	0.349	1	0.349	1	0.349	IRS	0.349	IRS
Shahtaj Sugar	0.549	0.781	0.549	0.558	0.704	IRS	0.985	DRS
Shakarganj Mills	0.874	0.953	0.874	0.96	0.917	DRS	0.91	DRS

S.S.Oil	1	1	1	1	1	-	1	
Thal Industries	0.884	1	0.884	1	0.884	DRS	0.884	DRS
Unilever Pakistan	0.417	1	0.417	1	0.417	DRS	0.417	DRS
Wazir Ali	0.264	0.945	0.264	0.264	0.279	IRS	0.999	-
AL-Abbas Sugur	1	1	1	1	1	-	1	-
J.D.W.Sugar	1	1	1	1	1	-	1	-
Mehran SugarXD	0.393	0.396	0.393	0.518	0.993	IRS	0.759	DRS
Mirpurkhas Sugar	0.32	0.619	0.32	0.341	0.517	IRS	0.94	DRS
Mirza Sugar	0.266	1	0.266	1	0.266	IRS	0.266	IRS
Murree Brewery	0.988	1	0.988	1	0.988	IRS	0.988	IRS
National Foods Ltd.	0.537	0.617	0.537	0.625	0.872	IRS	0.861	DRS
Nestle Pakistan	0.886	1	0.886	1	0.886	DRS	0.886	DRS
Noon Sugar Mills	0.606	1	0.606	1	0.606	IRS	0.606	IRS
Pangrio Sugar	1	1	1	1	1	-	1	-
Rafhan Maize	1	1	1	1	1	-	1	-
Sakrand Sugar	0.256	0.68	0.256	0.258	0.377	IRS	0.994	DRS

Appendix D

Firm Level Efficiency Scores for 2010

	Technical Efficiency				Scale Efficiency			
	Input orientation		Output orientation		Input orientation	Returns	Output orientation	Returns
	CRS	VRS	CRS	VRS				
Adam Sugar Mills	1	1	1	1	1	-	1	-
Colony Sugar Mills	0.403	0.468	0.403	0.676	0.862	DRS	0.597	DRS
Faran Sugar Mills	0.731	0.736	0.731	0.746	0.933	DRS	0.981	DRS
Mithchells Fruit	0.676	1	0.676	1	0.676	IRS	0.676	IRS
Shahtaj Sugar	0.719	0.771	0.719	0.745	0.933	IRS	0.966	IRS
Shakarganj Mills	0.639	0.87	0.639	0.885	0.734	DRS	0.722	DRS

S.S.Oil	1	1	1	1	1	-	1	-
Thal Industries	1	1	1	1	1	-	1	-
Unilever Pakistan	0.941	1	0.941	1	0.941	DRS	0.941	DRS
Wazir Ali	1	1	1	1	1	-	1	-
AL-Abbas Sugur	1	1	1	1	1	-	1	-
J.D.W.Sugar	1	1	1	1	1	-	1	-
Mehran SugarXD	0.668	0.7	0.668	0.68	0.954	IRS	0.983	IRS
Mirpurkhas Sugar	0.53	0.581	0.53	0.536	0.911	IRS	0.989	IRS
Mirza Sugar	0.695	1	0.695	1	0.695	IRS	0.695	IRS
Murree Brewery	1	1	1	1	1	-	1	-
National Foods Ltd.	0.873	0.931	0.873	0.903	0.956	IRS	0.966	IRS
Nestle Pakistan	0.895	1	0.895	1	0.895	DRS	0.895	DRS
Noon Sugar Mills	0.878	1	0.878	1	0.878	IRS	0.878	IRS
Pangrio Sugar	0.818	1	0.818	1	0.818	IRS	0.818	IRS
Rafhan Maize	1	1	1	1	1	-	1	-
Sakrand Sugar	0.768	0.795	0.768	0.786	0.965	IRS	0.976	IRS