Sufficiency Analysis of Local Production Capacity in Punjab for the requirement of CPEC

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Abstract

China Pakistan Economic Corridor (CPEC) is most significant project in the history of Pakistan. The total investment volume of CPEC is about US $46 billion out of which US $9.79 have been allocated to transport infrastructural projects. Successful implementation of CPEC requires fulfillment of construction and infrastructural needs that depend greatly on three major sectors: cement, stone crushing and steel. Keeping in view the importance of these three sectors, present study endeavors to assess whether these sectors have sufficient capacity to meet the infrastructural investment regarding CPEC. We use latest CMI 2010-11 data of Punjab province and employ DEA bootstrap technique in order to measure capacity utilization for the three sectors. The results reveal that Steel, Stone and Cement sectors are utilizing 35%, 50% and 60% capacity respectively. Conversely, there is un-utilized capacity of 65%, 50% and 40% in steel, stone crushing and cement industry respectively. It may be concluded that there is enough un-utilized capacity in these sectors to fulfill the rising demand for the completion of CPEC. Furthermore, on the basis of regression results, we recommend that Government may implement policies that ensure smooth provision of energy in order to enhance capacity utilization. It is also recommended that there is no need of further expansion of firms in current scenario.

Key words: CPEC, Punjab, Capacity utilization, DEA bootstrap

I. Introduction

Pakistan china economic corridor is a very ambitious effort by the two countries that will lead to greater investment and rapid industrialization of Pakistan. Successful implementation of it will be a game-changer for the people of Pakistan in terms of new economic opportunities leading to higher incomes and significant improvements in the living standards for ordinary Pakistanis. The China-Pakistan Economic Corridor (CPEC) is more than just a US $46 billion investment. It will not only improve Pakistan's current situation, but promises to improve the lives of nearly three billion people across the region as part of the larger Chinese vision of a grand Silk Road Economic Belt, which stretches across Asia through the Middle East and connects to Europe. Pakistan will become the most strategically important country in the region because it will improve trade and economic connectivity between Asia, Middle East and Europe.

In today's world the globe consists of the borderless economy and each and every entity such as industries, firms; small or big and organizations should be prepared to accept the challenges of this change if they want to play a major role in businesses and also want to be on safe side. An entity should be efficient and should know its potential and capacity utilization if it wants to stay in businesses. So it is necessary for every firm to know about its potential and utilization of capacity to get the actual information about its plant regarding scenario of the economy. Because to know about its potential and capacity utilization is the only criteria to know that is there any need to install further capacity or not regarding the demand of the economy. It is essential for firms, organizations or industries to reach at their optimal level in order to compete with their business competitors all over the world. It is also the requirement of every country and every state to know that how much is the potential of its industries and what is their current production level (capacity utilization) to cope with the economic conditions.

Capacity utilization plays significant role in the evaluation of economic activity, contributing to explain the behavior of investment, inflation, productivity and output (see for example Greenwood et al., (1988)). Basically the level of capacity utilization in industry (or individual firm) is defined as the ratio of its existing output to its potential output. Malgarini and Paradiso (2010) said that potential output may be estimated on the basis of some hypothesis on the technology in use. On the other hand, Johansen (1968) explained the concept of Potential output that it refers to the sustainable maximum output that could be produced by an existing (installed) manufacturing plant and machinery; however, sometimes other factors such as labour are taken into account. One of the byproducts of the determination of capacity and utilization is a measure of productive efficiency for each plant (Fare et al., (1989)).

There is meaningful debate about either Pakistan especially Punjab is able to cater the requirement for the expected investment from china in form of China Pakistan Economic Corridor (CPEC) or not. The purpose of this study is to assess the existing production capacity and utilization of different sectors regarding infrastructural investment. There are four CPEC transport infrastructural projects estimated US $9790 million, detail is given below in table 1.1.

Table 1.1-CPEC-TRANSPORT INFRASTRUCTURE SECTOR PROJECTS

Sr.No	Project	Length (km)	Cost (US$ M)
1.	KKH Phase II (Railkot-Islamabad Section)	440	3,500
2.	Peshawar-Karachi Motorway (Multan-Sukkur Section)	392	2600
	RAIL SECTOR PROJECT		
1.	Expansion and Reconstruction of existing Line ML-1	1736	3,650
2.	Havelian Dry Port (450 M, Twenty-Foot Equivalent Units)		40
	TOTAL		**9,790**

Source: Ministry of Planning, Development and Reform

So three main sectors; steel, cement and stone crushing, regarding infrastructural scenario are selected to assess the capacity utilization and existing production capacity. Assessment of production capacity is the sole criteria to know that how much investment is needed regarding the demand of steel or cement after achieving the potential. This study will be helpful for the Government of Punjab in order to get the real information about the production capacity and Government of Punjab will able to take the decision either there is need to increase the current capacity or not regarding infrastructural investment.

Data envelopment analysis (DEA) is one of the approach that is used to measure the capacity utilization in term of technology as discussed by Johansen (1968). DEA is the most popular technique which is widely used to measure the capacity utilization in different sectors. Many studies utilized the DEA as a measure of capacity utilization for example Fare et al., (1989) assessed the capacity, capacity utilization and technical change of industrial sector. Fare et al., (2000) utilized the DEA approach to assessed the capacity of fisheries. Kang and Kim (2015) measured the capacity utilization of public sector hospitals by using the DEA. Yu, Chang and Chen (2016) used the input-oriented data envelopment analysis model to estimate the physical capacity utilization and cost gap in airlines sector.

In this study, a nonparametric (linear programming) framework is developed in which capacity, as defined above, and a measure of the utilization of this capacity can be determined from data on observed inputs and outputs. The method we use is closely related to that used to measure productive efficiency as popularized by Farrell (1957). Since this method constructs a best practice frontier and gives information on how far a given observation is from that frontier, we can easily derive "maximum" frontier output as required by the definition of capacity above. As a result, one of the byproducts of the determination of capacity and utilization is a measure of productive efficiency for each plant.

DEA seems appropriate technique to assess the capacity and capacity utilization in this study but Simar and Wilson (1998, 2000) have identified the severe restrictions with the Data Envelopment Analysis (DEA) approach. They explained a number of limitations in their study such as:

1. Efficiency scores are serially correlated when it is calculated by DEA.
2. DEA does not give any interpretation of data- generating process (DGP).
3. Having uncertainty about what is being estimated in the DEA.
4. Conventional inference methods used in the DEA are inconsistent and invalid.

So due to these severe limitations, it is preferred to utilize DEA bootstrapped approach of Simar and Wilson (1998, 2000) in this study to assess the capacity utilization. Because DEA bootstrap technique estimates and explains the technical efficiency (capacity utilization) score and also produces confidence intervals for individual production efficiency scores.

The objectives of the study are:

1. Assessment of existing production capacity of steel, cement and stone crushing sectors.
2. Identification of output gap in concerned sectors.
3. To provide some policy implications on the base of empirics.

The remaining of the study is designed as follows: Section II contains on review of related literature in the context of this study. Section III consists on methodological framework and describes sources of data. Section IV provides Empirical results of concerned sectors. Section V concludes this study and provides recommendations.

II. Review of Literature

Many studies have been done to assess the potential level of output and capacity utilization by using the different approaches but common usage approach is DEA. Few studies are enlisted here regarding capacity utilization.

Yang et al., (2014) measured regional technical efficiency of Chinese steel sector based on a network DEA model during the period of 2006-2010. They utilized both traditional DEA method and network DEA method and concluded that network DEA method had the advantages over the traditional DEA method that it did not demand model assumptions on input/output orientation and avoid the dilemma on the choice of input/output indicators. The comparison analysis showed that network DEA model produced more reasonable efficiency results than the traditional DEA model. It is indicated by empirical analysis that there was a steady increase in technical efficiency of Chinese steel sector. In addition, the technical efficiency of Chinese industry sector in eastern area, central area and western area are unbalanced, with a lower efficiency in the west and a higher one in the east.

Ray et al., (2005) measured the capacity output of a firm by using the given inputs (quasi-fixed input) and outputs as the maximum producible amount and they had to face the expenditure constraints regarding choice of variable inputs. The indirect capacity utilization is estimated in this study for the overall manufacturing sector of US over the period of 1970 to 2001 and the same approach is utilized for disaggregated industries. They utilized the DEA non-parametric technique to assess the capacity utilization. They found that there was extensive change in capacity utilization over the period of time within industries and cross industries. They concluded that expenditure constraint was binding, especially in periods of high interest rates.

Fare et al., (1989) developed measures of plant capacity, plant capacity utilization, and technical change based on observed best practice performance by using the data set of coal fired steam electric generating plants in 1978. These measures were calculated as solutions to linear programming problems which were closely related to those used to calculate Farrell-type efficiency measures.

Prior and Filimon (2002) evaluated the inefficiency of chemical industry in Romania for the period of 1996-1997 by using the insufficient fixed inputs structure and it was not easy to adjust in short run. They applied DEA approach (which is famous for frontier evaluation) to assess the capacity utilization by using the data of inputs and outputs. It was found in this study that less capacity utilization was the major source of inefficiency in chemical industry.

Yang and Choi (2013) explored the performance and efficiencies of the five international steel manufacturers in order to help other supply chain members of steel manufacturing to evaluate across various companies using publically available data over the period of 2008 to 2011. They employed DEA approach by using the appropriate input and output variables. They found that Ampco Pittsburgh had high pure managerial efficiency in case of assets DEA model while in expenses model, all companies had high efficiency. They concluded that their study would help supply chain managers in steel manufacturing in terms of evaluating large not-so-transparent companies as either a supplier or a buyer for their strategic alliance decisions.

Sahinoz and Atabek (2016) proposed capacity utilization gap as an alternative measure of the output gap in the Turkish economy. They utilized the firm-level micro data of Turkish manufacturing sector consisting of an unbalanced panel of 3,165 firms with a total of 97,824 observations from the Business

Tendency Survey (BTS) over the period of 2007 to onward. They found that there were supporting evidence for the suitability of a capacity utilization gap as an alternative indicator for assessing the overall state of the business cycle and inflation pressures. They concluded that capacity utilization gap did not have "end of sample" problem because it was directly calculated from firm-level survey data.

Malgarini and Paradiso (2010) made a comparison between survey and time series-based estimates of capacity utilization for the Italian manufacturing sector over the period of 1970 to 2009 based on actual economic crisis. They found that there was ability of the series to correctly track cyclical turning points and their contribution in explaining CPI inflation while ISAE survey measures results to be lagging, especially at troughs. Further, they found that time series-based measures generally outperformed the survey in explaining inflation. They also highlighted the reason of weakening the survey that "the difficulty with surveys is that they do not specify any explicit definition of what is meant by "capacity". Thus the respondents are free to choose between various measures of capacity and misperceive the effective utilization rate"

It can be observed by mentioned above literature that there is broad usage of DEA technique in measuring the potential level of output, capacity utilization and technical efficiency. There are number of studies which tried to assess the capacity utilization by keeping in view the potential output through different techniques i.e. survey analysis, time series analysis and DEA approach but DEA is preferred in literature because it incorporates the technological concept. Basically assessment of potential level of output is technological concept as Johannsen (1968) briefly discussed it. After referencing different studies, it seems preferable to use DEA technique but there are some deficiencies in conventional DEA technique as it will be discussed in methodological framework. So DEA bootstrapped approach will be utilized in this study to assess the bias corrected capacity utilization of steel, cement and stone crushing sectors.

III. Methodological Framework

Farrell (1957) was the first who introduced that how to measure the efficiency of producing units technically. A lot of work is done on Farrell's (1957) classic technical efficiency. It is obvious that there are two basic techniques for the measurement capacity utilization or technical efficiency: parametric and non-parametric. Meeusen and Van den Broeck (1977) and Aigner et al. (1977) initiated the parametric technique which is known as Stochastic Frontier Analysis (SFA). The SFA technique demands specification of functional form and estimates the cost frontier such as parametric approaches require some assumptions. The main quality of this technique is to incorporate the stochastic error in the specification of the model. The main problem of this technique is the enforcement of the distributional assumption of the error term and SFA technique is sensitive with the respect of the parametric functional form. Further, Mahadevan (2002) said that "Different specifications of the production function under the parametric approach provide different results and this is a serious methodological problem".

The analysis of capacity utilization is developed within the framework of non-parametric (linear programming) frontier evaluation known as Data Envelopment Analysis (DEA) in which a measure of capacity utilization is determined from data on observed inputs and outputs. Many times the concept of capacity is closely related to the technological characteristics of the production process. For this reason, DEA has the great advantage that it doesn't require any a priori specification about a particular functional form and this ensures the sufficient flexibility to adapt to the specific characteristics of the observed unit.

Charnes et al.'s (1978) and Fare et al.'s (1985) linear programming models provided the base for the production efficiency analysis which is now used to assess the capacity utilization. Where the convexity assumption is adopted in the literature, those techniques are known as DEA. Charnes, Cooper, and Rhodes (1978) developed the DEA and further modified by Banker et al. in 1984 which based on the frontier efficiency concept first defined by Farrell (1957). It is a non-parametric technique and used for measuring the efficiency of decision making units (DMUs). It does not demand assumption of any specific functional form with respect to the inputs and outputs or the setting of weights for the various factors. DEA creates an efficient frontier for every observation. There are two approaches are used to measure the efficiency by using the DEA 1) Input oriented i.e. to produce the given level of output by utilizing the minimum inputs and 2) Output oriented i.e. to produce the maximum level of output by using the given set of inputs. We are not going to take general overview of DEA here, for this see Coelli et al. (2005).

In 1998 and 2000 Simar and Wilson identified the severe restrictions with the DEA approach. They explained a number of limitations in their studies such as:

1. Efficiency scores are serially correlated when it is calculated by DEA.
2. DEA does not give any interpretation of data- generating process (DGP).
3. Having uncertainty about what is being estimated in the DEA.

4. Conventional inference methods used in the DEA are inconsistent and invalid.

Because of these limitations we use Simar and Wilson (1998, 2000) DEA bootstrap technique that will give reliable and statistically significant results within DEA models. DEA bootstrap technique estimates the efficiency scores/capacity utilization and confidence intervals for individual production efficiency scores by Simar and Wilson (1998). We are employing DEA bootstrap technique to measure the bias corrected estimates of production level for steel, cement and stone crushing sectors of Punjab.

Here, the output oriented variable returns to scale (VRS) model is used for getting the efficiency scores because constant returns to scale (CRS) is employed where industries or firms operate at their optimal scale. In the scenario of this study, there is considerable evidence that firms are not working at their optimal scale due to the inclusion of varying size of firms, imperfect competition and financial constraints. The output-oriented DEA efficiency estimator $\hat{\Theta}_{ivrs}$ for any data set (x_i, y_i) for each firm can be obtained by solving the following linear programing equation.

$$\hat{\Theta}_{ivrsi} = max(\Theta > 0 | \Theta i Y i \leq \sum_{i=1}^{n} \Upsilon i Y i; X i \geq \sum_{i=1}^{n} \Upsilon i X i; \sum_{i=1}^{n} \Upsilon i = 1; \Upsilon i \geq 0, i = 1, \ldots . n) \quad (1)$$

Where;

$\hat{\theta}_i$ = efficiency estimator of θ; efficiency score or capacity utilization for *i*th firm.

x_i = vector of inputs for the *i*th firm.

y_i = vector outputs for the *i*th firm.

$\boldsymbol{\lambda_i}$ = vector of intensity variable

In equation (1) x and y are observed inputs and outputs and i=1….,n is the specific firm. The $\Theta i Y i$ is the efficient level of output or it can be coded as capacity utilization, Θ is the scalar and Υi is the non-negative vector of constant defining the optimal weights of inputs to outputs. The obtained value of $\hat{\Theta}_{ivrsi}$ is the technical efficiency estimate or capacity utilization for ith firm. In case of output oriented, where $\hat{\Theta}_{ivrsi}$=1 means that the firm is considered fully efficient or working on its potential while $\hat{\Theta}_{ivrsi}$<1 means that the firm is inefficient and it needs to increase the output for reducing the inefficiencies or to reach on its potential level.

There are two things to be noted relating to the above equation (1). First, in this linear program, variable returns to scale (VRS) is assumed and second, Simar and Wilson (2000) observed that $\hat{\Theta}_{\mathbf{vrsi}}$ is the downward biased estimator, as industrial frontier can be underestimated. Due to limitations of

DEA, the smooth bootstrap technique of Simar and Wilson (1998, 2000) is applied in this study for getting the bias-corrected efficiencies and their confidence intervals accompanied by the DEA with bootstrapping approach.

There are seven steps to perform the DEA bootstrap as described here.

(a) Solve the equation (1) and obtain $\hat{\Theta}_{1....}\hat{\Theta}_n$
(b) Produce a sample $\beta_1\tilde{}....,\beta_n\tilde{}$ from $\hat{\Theta}_{1....}\hat{\Theta}_n$
(c) Sample values will be smoothed by using the formula as given:

$$\Theta\tilde{}i* = (\beta\tilde{i} + h\dot{\varepsilon}i \; if \; \beta\tilde{i} + h\dot{\varepsilon}i \geq 1 \; or \; 2 - \beta\tilde{i} - h\dot{\varepsilon}i \; if \; \beta\tilde{i} + h\dot{\varepsilon}i < 1)$$

Where h is the bandwidth of a standard kernel density and $\dot{\varepsilon}$i is a random error.

(d) Adjusting the smoothed sample value by utilizing the following formula for getting the value of Θ_i*:

$$\Theta_i* = \beta\tilde{} * + \frac{\Theta\tilde{}i* - \beta\tilde{}*}{\sqrt{1 + h^2/\varphi 2\Theta}}$$

Where $\beta\tilde{} * = (1/n) \sum_{i=1}^{n} \beta i\tilde{}$ and $\varphi 2\Theta$ is the sample variance of $\hat{\Theta}_{1....}\hat{\Theta}_n$

(e) Estimate the pseudo data set using by $\hat{\Theta}i/\Theta i*$

(f) By solving the equation (1), calculate the bootstrap estimate $\hat{\Theta}_i$*vrs.
(g) Repeat these 5 steps “b-f” 2500 times to provide a set of estimates.

Source and Selection of Data

There are three inputs and one output is selected for analyzing the capacity utilization and to assess the potential because the difference between actual output and potential output is known as inefficiency. The inefficiency tells us in this case that after reducing the inefficiency the specific firm will attain its potential level. So DEA is the best technique in existing techniques by using the available data as a measure of capacity utilization. Different studies used different inputs and outputs to assess the technical efficiency or inefficiency or broadly we can say capacity utilization. There are a lot of studies relating to inputs and outputs but data about inputs and outputs of few studies is presented in the following table 3.1.

Table 3.1 Summary of Different Inputs and Outputs Used in Various Studies

Author	location and Period	Inputs	Outputs
Ramli and Munisamy (2013)	Malaysia/2001 to 2010	Operating expenditure Capital	Sales as desirable output CO_2 emission as undesirable output
Arocena and Oliveros (2012)	Spain/1994 to 2002	Labor Capital	Value added
Memon and Tahir (2012)	Pakistan/2008 to 2010	Raw materials Staff expenses Plant and machinery	Net sale Earnings after tax
Haron and Chellakumar (2012)	Kenya/2009 to 2011	Raw material Staff expenses Plant and machinery	Net sale Earnings after tax
Keramidou et al. (2011)	Greek/1994 to 2007	Cost of capital Cost of raw material Number of full time employees	Total sale
Abokaresh and Kamaruddin (2011)	Libya/2000 to 2008	Labor Capital Total assets	Sales Net income
Mohamad and Said (2010)	Malaysia/2008-2009	Total operating expenditure	Rate of change of revenue Rate of change of net profit Rate of change of assets Return on revenue Return on equity Return on assets
Barros and Assaf	Angola/2002 to 2007	Operational cost	Production of oil

(2009)		Investment premium Taxes	
Din et al. (2007)	Pakistan/1995-96 and 2000-01	Capital Labor Industrial cost Non-industrial cost	Contribution to GDP
Watanabe and Tanaka (2007)	China/1994 to 2002	Capital Labor Materials (coal)	Desirable output is industrial products Undesirable output is sulfur dioxide
Balteiro et al. (2006)	Spain/1998-2001	Labor Shareholder's funds Loans	Sales Profit before tax
Baten et al. (2006)	Bangladesh/1981/1982 to 1999/2000	Capital Labor	Value added

There are three inputs utilized in this study after analyzing the literature carefully i.e. fixed assets, number of employees and the value of raw material and one output i.e. value added is utilized. The data is in "000" R.s for all variables except for labour. The whole data for inputs and output is collected from the Census of Manufacturing industries (CMI) Punjab for the period of 2010-2011. There are three sectors are selected for the purpose of analysis i.e. Steel, Stone and Cement sector. These sectors will be analyzed individually because one thing will be taken into account that homogeneity of each sector remain stable and one sector's firms are selected on the base of same activity from whole province which are available in CMI 2010-2011 of Punjab. So 83 firms of steel sector are selected on the base of same activity and availability of data,12 firms of Stone sector are selected and 12 firms of Cement sector also taken for the purpose of analysis from CMI 2010-2011 of Punjab.

The bias-corrected technical efficiency scores (capacity utilization), which will be estimated through DEA bootstrap, will be taken as dependent variable to find out the determinants for enhancing the capacity utilization. In the second step of estimations, a single OLS regression will be employed for regressing these capacity utilization of all firms against a set of explanatory factors in the following regression model:

$$\hat{\hat{\theta}}_i = \beta 0 + \beta 1 LnAWi + \beta 2 LnSZi + \beta 3 LnEi + \beta 4 LnESQRi + \varepsilon it \quad (2)$$

$\hat{\hat{\theta}}_i$ is the estimated technical efficiency scores (capacity utilization) based on the assumption of the variable returns to scale.

Where AW represents the average wage which is calculated by the total cost of salaries divided by number of employees, which is counted as the employee's skill and human capital (for example see Kravtsova, 2008).

SZ is the industry size which is calculated by taking the logarithm of total fixed assets of the firm, which is considered as a proxy for the economies of scale of the firm in this study (for example see Lin *et al.,* 2009; Yusuf and Malomo, 2007).

E is for energy intensity i.e. measures the extent of energy usage for production. It is derived by dividing the value of energy by value of production.

ESQR is the square of LnE, which is used to check the impact of increase in provision of energy to the firms on capacity utilization.

IV. EMPIRICAL ANALYSIS

The results of variable returns to scale technical efficiency (VRS T.E) of Steel, Stone and Cement firms are presented in the table 4.1, 4.2 and 4.3 respectively for the period of 2010-11. Firms are analyzed after 2500 bootstrapped iteration. Firms' names are given in the first column, results of original DEA efficiency scores, which are represented by DEA, are shown in second column, biased corrected efficiency scores, which are represented by the B.C, are given in the third column while lower bound and upper bound of confidence interval are presented with the name of L.B and U.B in fourth and fifth column respectively.

As it can be seen in following tables that original efficiency scores or capacity utilization of each firm, which is denoted by DEA, overestimate the results, same as described in the limitations of DEA by Simar and Wilson (2000). Bias-corrected efficiencies (which are denoted by B.C in the following tables) are estimated after 2500 iterations, correct the T.E scores and eliminate the bias of exaggeration from the results. The main importance of these estimations is that they also fall in the confidence intervals while DEA scores does not fall in confidence interval because it underestimates the frontier and it assumes to reach the frontier before touching to the real one.

In this study, output oriented DEA Bootstrap technique is applied, so if the efficiency score is 1 that means firm is efficient and producing at its potential level while if the estimated efficiency score is less than 1then it will show that specific firm is inefficient and not operating on its potential level i.e. it has the capacity to produce more by using the same inputs or equipment and this firm is facing the scenario of underutilization. In case of output oriented model, different set of output is produced by utilizing same set of inputs. So, for minimizing the inefficiencies or to attain the potential level, maximum level of output should be obtained with the same set of inputs.

First of all, efficiency/capacity utilization of 83 firms of steel sector is estimated by using the three inputs and one output and all firms perform the same activity of producing steel because it will not hurt the assumption of homogeneity. The results of capacity utilization of 83 firms are mentioned in table 4.1. It is found that there are nine firms are working on its potential in case of DEA while there is not any firm is fully efficient or working on its potential in case of DEA Bootstrap. Firm number 18 is less efficient and it is just working with 4.4% capacity utilization and firm number 49 is most efficient and working with 78% capacity utilization in case of DEA Bootstrap. So 22% production can be increased by using the same level of inputs or we can say that 22% inputs can be reduced for producing the same level of output. It can be noted that over all steel sector is working with 35% capacity utilization. So there is more space in this sector to produce 65% more with the same level of inputs. So if there is any increase in the demand of steel due to the CPEC then this sector will be able to cope with the increasing demand.

This analysis has much importance even in 2015-16 as it can be observed that Mughal steel raised its sales 105% in 2014-15 in one year even by using just its 50% installed capacity that means it can produce further by using the existing capacity. On the other hand, if we look at the condition of installed capacity of re-rolled steel in Punjab, it is in very miserable condition because it is reduced over the period of time 2007-8 to 2013-14 from 500000 M. Tons to 350000 M. Tons (Punjab Development Statistics 2015). The reason behind this reduction of installed capacity is the cheap imports from China and Ukraine which has damaged the local production of iron and steel, which fell 8.6 per cent during first half of FY16 compared to a growth of 31pc during the same period of FY15 (State Bank of Pakistan (SBP)).

Table 4.1 Efficiency/ Capacity utilization of Steel Firms

SR #	Name of Firms	DEA	B.C	L.B	U.B
1	**CAPITAL SAFE & ENGG CO. (PVT) LTD**	**0.37942**	**0.266441**	**0.223653**	**0.356129**

2	**KHURRAM STEEL.**	**0.189559**	**0.150526**	**0.130836**	**0.178646**
3	**NATIONAL TECHNO COMMERCIAL SERVICES (PVT.) LTD.**	**0.617132**	**0.467374**	**0.404967**	**0.574239**
4	**PAKISTAN METAL FINISHING CENTRE**	**0.765638**	**0.554183**	**0.468178**	**0.72605**
5	**SUFI STEEL INDUSTRIES (PVT.) LTD.**	**0.049341**	**0.041352**	**0.036291**	**0.046811**
6	**AF STEEL MILLS**	**0.315428**	**0.28205**	**0.253842**	**0.30818**
7	**HAFIZ STEEL CORPORATION**	**1**	**0.66418**	**0.556943**	**0.947963**
8	**HAROON STEEL INDUSTRIES**	**0.461936**	**0.386661**	**0.333909**	**0.444359**
9	**BROTHERS ENGINEERING (PVT.) LTD.**	**0.247967**	**0.197666**	**0.166503**	**0.240004**
10	**KARIM AZIZ INDUSTRIES (PVT.) LTD.**	**0.331697**	**0.242923**	**0.204077**	**0.307477**
11	**MUGHAL STEELS (PVT.) LTD.**	**1**	**0.650488**	**0.543787**	**0.929034**
12	**MADINA STEEL RE ROLLING MILLS**	**0.326926**	**0.264027**	**0.223458**	**0.314071**
13	**RAUF STEEL**	**0.5449**	**0.461841**	**0.407318**	**0.523618**
14	**PAKISTAN ENGINNEERING COMPANY LTD.**	**0.126411**	**0.094827**	**0.078826**	**0.121684**
15	**BBJ - NKK STEEL PIPE (PVT.) LTD.**	**1**	**0.637498**	**0.524877**	**0.93188**
16	**KAMRAN STEEL MILLS (PVT.) LTD.**	**0.184935**	**0.144114**	**0.121551**	**0.175066**
17	**F. F. STEEL (PVT.) LTD.**	**0.371085**	**0.319663**	**0.284691**	**0.35901**
18	**TAYYAB BROTHERS (PVT.) LTD.**	**0.058387**	**0.044694**	**0.038124**	**0.055542**
19	**MODEL STEEL ENTERPRISES (PVT.) LTD.**	**0.11153**	**0.081485**	**0.0692**	**0.104567**
20	**ABDUL HAQ INDUSTRIES (PVT) LTD**	**0.125053**	**0.094026**	**0.078452**	**0.120327**
21	**MADINA ENTERPRISES LTD.**	**0.344721**	**0.254448**	**0.209529**	**0.328659**
22	**PAKISTAN STEEL**	**0.608606**	**0.444664**	**0.372561**	**0.577034**
23	**AL MADINA STEEL**	**1**	**0.657476**	**0.558518**	**0.9419**
24	**ALLAH TAWAKAL STEEL MILL**	**0.712352**	**0.561844**	**0.48236**	**0.672216**
25	**EZAZ STEEL**	**0.174404**	**0.151337**	**0.134475**	**0.169655**
26	**GHULAM RASOOL STEEL**	**0.30722**	**0.265298**	**0.234495**	**0.295105**
27	**HAROON BROTHERS STEEL**	**0.390046**	**0.334863**	**0.292821**	**0.376749**
28	**L.D STEEL**	**0.596267**	**0.449084**	**0.389212**	**0.561185**
29	**NADEEM STEEL MILL**	**0.384084**	**0.285612**	**0.24755**	**0.364442**
30	**NAWAZ STEEL**	**0.320811**	**0.274074**	**0.243933**	**0.306246**
31	**SALEEM AKHTAR STEEL**	**0.617093**	**0.514486**	**0.445097**	**0.592697**
32	**CHAUDHARY STEEL**	**0.117833**	**0.097993**	**0.087666**	**0.111754**

33	MULTI WORKS	0.86798	0.714275	0.616341	0.821889
34	PRIME ENGINEERING WORKS – III	0.311439	0.24122	0.208353	0.293671
35	NAWAZ STEEL INDUSTRY	0.50984	0.385189	0.327721	0.479938
36	SHUJA STEEL INDUSTRY	0.404924	0.320647	0.268933	0.390718
37	KASHMIR PIPE MILL	0.541771	0.460652	0.40929	0.526217
38	A.S STEEL MILL	0.337906	0.297276	0.269583	0.326275
39	ASHRAF BILLA STEEL INDUSTRY	1	0.740707	0.636378	0.929634
40	FAROOQ STEEL MILL,	0.220887	0.194615	0.175082	0.215126
41	HASHIR STEEL INDUSTRY	0.39968	0.320804	0.281792	0.372944
42	JAMSHEED STEEL PHATTA NO. 20	0.374392	0.321928	0.281184	0.362018
43	MEHBOOB STEEL MILLS	0.268521	0.226016	0.202733	0.25446
44	MUGHAL STEEL INDUSTRY – II	0.658285	0.590062	0.53354	0.643281
45	KHAWAJA STEEL MILLS	0.862589	0.684708	0.570471	0.832311
46	RASHID FOUNDRY	0.596979	0.509053	0.454732	0.568478
47	SIDRA STEEL MILLS	0.614024	0.439508	0.36647	0.579312
48	SUPER STEEL MILLS	0.368473	0.317403	0.285261	0.354645
49	PAK REHMAN STEEL	1	0.787987	0.693679	0.950986
50	PAN ISLAMIC INDUSTRIES (PVT.) LTD.	0.25215	0.19156	0.163462	0.238256
51	ROYAL STEEL MILLS	0.235156	0.184568	0.155976	0.220698
52	M. M. STEEL	0.222385	0.183431	0.164046	0.212375
53	MUSHTAQ ENGINEERING WORKS	0.516556	0.40754	0.349762	0.485327
54	RACK MASTER	1	0.714993	0.609093	0.929416
55	ZAHID & COMPANY	0.46644	0.39125	0.346516	0.452643
56	ALFASAL INDUSTRIES	0.447888	0.399459	0.359461	0.436129
57	AYUB INDUSTRIES	0.459495	0.373606	0.32709	0.430296
58	FIRAND ALI STEEL MILLS	0.502892	0.403157	0.35009	0.476428
59	KHALID INDUSTRY – II	1	0.66383	0.555048	0.932738
60	QUALTY STEEL MILLS	0.333478	0.291521	0.263949	0.321114
61	SANGUM STEEL MILLS	0.484707	0.429138	0.38668	0.4694
62	GUJRANWALA STEEL INDUSTRIES	0.235577	0.205746	0.184949	0.22732
63	REHMAN STEEL (PVT.) LTD.	0.313038	0.277785	0.250371	0.303293
64	SECO PAK (PVT.) LTD.	0.205808	0.156562	0.13758	0.192606
65	ITTEFAQ SONS (PVT.) LTD.	0.227164	0.159215	0.131492	0.213472
66	AHMAD INDUSTRIES (PVT.) LTD.	0.340785	0.278378	0.247715	0.321984

67	**MUGHAL IRON & STEEL INDUSTRIES LTD.**	**0.20086**	**0.15837**	**0.13319**	**0.190823**
68	**HAMEED STEEL**	**0.517706**	**0.394902**	**0.328912**	**0.487942**
69	**G.R.STEEL**	**0.384025**	**0.340405**	**0.307147**	**0.374727**
70	**SUPERA STEEL**	**0.19809**	**0.163231**	**0.145417**	**0.186774**
71	**H.K.S STEEL MILLS**	**0.209013**	**0.186486**	**0.168712**	**0.203115**
72	**DATA STEEL INDUSTRIES**	**0.616789**	**0.509488**	**0.435426**	**0.588531**
73	**HASNAIN USMAN STEEL INDUSTRIES**	**0.486145**	**0.402505**	**0.345198**	**0.464367**
74	**LUCKY ENTERPRISES**	**0.253408**	**0.192925**	**0.168004**	**0.238053**
75	**ILYAS STEEL MILLS**	**0.459664**	**0.395682**	**0.347086**	**0.444073**
76	**IBRAHIM STEEL**	**0.509113**	**0.415663**	**0.36736**	**0.477791**
77	**M/S MADINA STEEL MILL,**	**0.514562**	**0.408397**	**0.348748**	**0.48427**
78	**MALIK TAJ STEEL**	**0.259323**	**0.209303**	**0.18487**	**0.242679**
79	**HABIB INDUSTRIES.**	**1**	**0.633886**	**0.516816**	**0.932498**
80	**MAQSOOD STEEL**	**0.305111**	**0.263211**	**0.236523**	**0.2927**
81	**M/S MUSLIM INDUSTRY**	**0.958222**	**0.750073**	**0.650179**	**0.909103**
82	**JAHAGEER & BROTHER STEEL**	**0.4561**	**0.400979**	**0.363147**	**0.438701**
83	**SHAHBAZ STEEL MILLS**	**0.17744**	**0.148581**	**0.129158**	**0.170045**

The capacity utilization of 12 firms of stone sector is shown in table 4.2. It can be seen that there are three firms are operating on its potential in case of DEA while there is not any firm is fully efficient or working on its potential in case of DEA Bootstrap in this sector. Here, it can be noted that DEA scores do not fall in confidence interval and these values are beyond the interval which shows that DEA has exaggerated the numeric values of capacity utilization while DEA Bootstrap eliminated the bias and exaggeration after 2500 times simulations which corrected the numeric values of capacity utilization. It can also be observed that these bootstrapped values lie in confidence interval. There are 12 firms are selected in this sector on the base of same activity because the assumption of homogeneity may not hurt in this sector. It is found that firm 1 is less efficient with the score of 0.15 i.e. this firm is working on its just 15% capacity. So it can be said that this firm has the capacity to produce 85% more by using the same inputs or equipment and this firm is facing the scenario of underutilization. Firm 5 is most efficient or working with highest capacity utilization with the numeric value of 0.717 i.e. it is producing 71.7% output with the existing level of inputs but still this firm has the space to produce more with the same plant and equipment. It is found that seven firms are working more than its 50% capacity. If we see the overall performance of this sector, then it can be observed that overall capacity utilization of this sector is 50% which shows that if there is any increase of demand in this sector due to the CPEC then it will be able to fulfill the increasing demand by utilizing the available capacity in this sector which is almost 50%.

Table4.2 Efficiency and Capacity of Stone Firms

SR #	Name of Firms	DEA	B.C	L.B	U.B
1	ABUZAR GRINDING MILLS (PVT.) LTD.	0.193237	0.152482	0.123527	0.188732
2	ENGINEERING WORKS	0.264711	0.208091	0.176028	0.256637
3	MESH PAK PROCESSING PVT LTD	0.652273	0.510565	0.400502	0.633093
4	WELCOME INDUSTRIES	1	0.715532	0.553491	0.97077
5	FAISAL GRINDING INDUSTRY	1	0.71791	0.567817	0.9751
6	ASLAM CHINA WORKS	0.511797	0.426761	0.364833	0.497611
7	CL1AY MASTER CERAMICS	0.483092	0.393776	0.33245	0.471443
8	MALIIK MUHAMMAD ASLAM WORKS	0.533817	0.449031	0.383826	0.521641
9	SUPER STAR CHINA	0.731582	0.603585	0.515907	0.71579
10	ZIA STONE GRINDING (PVT.) LTD.	1	0.714894	0.553418	0.972705
11	MUGHAL CRUSHING MILLS (STONE)	0.662778	0.51459	0.43431	0.643081
12	REHNIAT NIARBLE INDUSTRIES	0.757748	0.593215	0.470868	0.740587

There are 12 firms selected from the Cement Sector of Punjab on the base of same activity and availability of data. The assumption of homogeneity is not affected due the same activity of the firms. There are three inputs and one output is utilized also in this sector to assess the capacity utilization. The result of this sector is presented in table 4.3 after estimation of 12 firms. It can be seen again in this sector that values of DEA do not fall in confidence interval and they are beyond the confidence interval which shows the exaggeration in the results of capacity utilization in case of DEA. There are five firms which are fully efficient or working on its potential in case of DEA while there is not a single firm is utilizing its capacity in case of DEA Bootstrap. It can be seen that firm 1 in table 4.3 is less efficient and it is working just with its 16% capacity and firm 10 in the same table is most efficient technically or working with 82% capacity utilization with highest score among these firms in case of DEA Bootstrap. The overall capacity utilization of this sector is 60% which shows that this sector can produce more 40% by using the same level of inputs and equipment. If there is any increase in demand of this sector due to the CPEC then it will be able to cope with the increasing demand of cement. So there will be no issue of the deficiency of cement regarding CPEC.

The above analysis of cement sector is done by using the data on inputs and outputs of CMI 2010-11 Punjab. If we look at the installed capacity of cement sector in Punjab for the period of 2010-11 that was 25128000 M. tons and production was 14686000 M. tons which indicates that capacity utilization was just 58.4%. It is the rough estimate of capacity utilization because it does not consider the other inputs. The capacity utilization of cement sector in Punjab is 68.3% for the period of 2014-15 (Punjab Development Statistics 2015). The reason of enhancing capacity utilization is that installed capacity remained same over the period of time from 2010-11 to onward.

Table 4.3 Efficiency and Capacity utilization of Cement Firms

SR #	Name of Firms	DEA	B.C	L.B	U.B
1	ASKARI CEMENT LTD.	0.201824	0.165483	0.138328	0.197916
2	D. G. KHAN CEMENT COMPANY LTD.	1	0.741363	0.556763	0.976978
3	MAPLE LEAF CEMENT FACTORY LTD.	0.942863	0.754466	0.593671	0.925989
4	BESTWAY CEMENT LTD. (UNIT 1 & 2)	1	0.754587	0.592762	0.977791
5	LAFARGE PAKISTAN CEMENT LTD.	0.368664	0.303638	0.255891	0.36212
6	ALAM ENGINEERING	0.604851	0.505501	0.41157	0.598246
7	BROTHERS ENGINEERING WORKS	1	0.73924	0.55479	0.978228
8	CATKO ENGINEERING	0.531208	0.443726	0.370399	0.523287
9	MISTRY GHULAM NABI ENGG. WORKS	1	0.758499	0.616868	0.980836
10	ARS INTERNATIONAL	1	0.820055	0.688895	0.984106
11	ITTEHAD WORKS	0.646538	0.539659	0.445564	0.635359
12	ASIF ENGG. WORKS	0.727061	0.593454	0.477662	0.715157

There will not be any shortage of cement if demand is enhanced due to the CPEC because there is enough capacity in cement sector to fulfill the raising demand. Along with, Cement Industry has a plan to invest US $1 billion to enhance its capacity while Cherat, Attock, Lucky and DG Khan Cement have all formally announced plans to raise their annual manufacturing capacity by 1.3m tons, 1.1m tons, 2.6m tons and 2.7m tons, respectively.

Overall Capacity utilization and remaining capacity of each sector is presented in table 4.4. It can be seen that steel sector is working with 35% capacity utilization. Steel sector can produce more 65% output by using the same capacity. Current capacity utilization of stone sector is 50% i.e. this sector can produce more 50% with the existing level of inputs and equipment. Similarly cement sector is working with 60% of capacity utilization i.e. it has the capacity to produce more 40 % output by using the same level of inputs and equipment.

Table 4.4 Capacity utilization and Remaining Capacity of Sectors

SECTORS	Current Level of Utilization	Overall Remaining Production Capacity of Sectors
Steel Sector	**35%**	**65%**
Stone Sector	**50%**	**50%**
Cement Sector	**60%**	**40%**

After measuring the capacity utilization for steel, cement and stone sectors, determinants of capacity utilization have been investigated by applying Ordinary Least Square (OLS) regression. Results of determinants of capacity utilization are presented in Table 4.5.

Table 4.5: Results of OLS Regression Analysis

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	**0.455165****	**0.210425**	**2.163074**	**0.0329**
Energy Usage	**0.124283*****	**0.040405**	**3.075900**	**0.0027**
Fixed Assets	**-0.043581*****	**0.011527**	**-3.780908**	**0.0003**
Average Wage	**0.115589****	**0.051764**	**2.232982**	**0.0278**
Square of Energy Usage	**0.016989*****	**0.005754**	**2.952524**	**0.0039**

***, ** represents the 1% and 5% level of significance respectively.

It is found that all the variables used as the determinants of capacity utilization are significant. It can be seen that energy usage has positive and significant impact on capacity utilization i.e. more usage of energy will help the firms to raise their capacity utilization. Under prevailing circumstances there is shortage of energy supply in the industrial sector and if there is increase in energy supply, capacity utilization can be enhanced. In order to investigate the fact that if there is nonstop and ample supply of energy to industry, what will be its outcome, we have used square of energy use. The results depict that it has positive sign and statistically significant impact which means that if there is ample supply of energy to these sectors, capacity utilization can be enhanced easily.

It is very interesting to note that economies of scale measured by fixed assets have negative and significant impact on capacity utilization.it means that there is no need to expand the existing plant size rather it will result in further dwindling of capacity utilization because it is observed in the results of capacity utilization that there is enough unutilized capacity for all sectors, so it is not rationale for firms' owners to expand the size of the firms while they have already excess capacity. So, if they expand the size of the firm in existing condition then it will lead to decrease further capacity utilization. Average wage which is used as employee's skill and human capital has positive and significant impact on capacity utilization. It means that capacity utilization may be enhanced by employing more technically equipped work force.

V. Conclusion

Cement, stone crushing and Steel sectors are the most indispensable sectors regarding construction and infrastructural needs. So these sectors are very important for fulfilling the infrastructural needs of CPEC. The CPEC is one of the biggest and most significant projects in the history of Pakistan. The total volume of CPEC is estimated about US $46 billion while an estimated investment of US$ 9790 million for transport infrastructural projects. This study has been an attempt to investigate whether the domestic Cement, stone crushing and Steel industry can fulfil the infrastructural input demands of CPEC regarding these sectors. It is also tried to find sources of capacity utilization which lead to enhance the capacity utilization of concerned sectors. For this purpose, existing production and capacity utilization has been taken in to account. The DEA bootstrapped approach is employed to assess the production capacity and capacity utilization of aforementioned sectors by using the latest detailed available data on inputs and outputs of CMI 2010-11 Punjab. First of all, efficiency/capacity utilization of 83 firms of steel sector is estimated by using the three inputs and one output. There are mixed results regarding each individual steel firm and utilization rate varied firm to firm in this sector and it is found that not a single firm is working on its potential. It is observed that over all steel sector is working with 35% capacity utilization. So this sector can produce 65% more with the same level of inputs. So if there is any increase in the demand of steel as per CPEC requirement then this sector will be able to cope with the increasing demand.

The capacity utilization of stone sector is estimated for 12 firms as per availability of data and it is found that there is variation in capacity utilization of each individual firm of this sector. The highest capacity utilization rate is 71.7% of firm 5 in table 4.2. It is observed that overall capacity utilization of this sector is 50% which shows that if there is any increase of demand in this sector due to the CPEC then it will be able to fulfill the increasing demand by utilizing the available capacity in this sector which is almost 50%.

For the Cement Sector capacity utilization has been measured for 12 firms. The results reveal that there is no firm utilizing its full capacity. It is found that firm 1 in table 4.3 is less efficient and it is working just with its 16% capacity and firm 10 is most efficient technically and working with 82% capacity utilization. The overall capacity utilization of this sector is 60 % which shows that this sector can produce more 40% by using the same level of inputs and equipment. If there is any increase in demand for this sector due to the CPEC then it will be able to cope with the increasing demand of cement.

In the second step of analysis, Sources of capacity utilization are also determined in OLS regression. It is found in this study that there is positive impact of energy usage on capacity utilization. Economies of scale have negative impact. Average wage has positive impact on capacity utilization. On the base of results, it is suggested that government should ensure the provision of smooth energy supply for enhancing the capacity utilization as there is positive impact of energy usage on capacity utilization. Secondly, there is no need to install further capacity in the current scenario as there is negative impact of economies of scale on capacity utilization. Thirdly, there is need to establish the technical institutes and government is on right way by doing this as there is positive impact of employee's skill and human capital on capacity utilization.

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