Developing Country Studies
ISSN 2224-607X (Paper) ISSN 2225-0565 (Online)
Vol.8, No.2, 2018

Technical Efficiency Analysis of Wildlife Parks in Punjab

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Abstract
The purpose of this research is to examine the relative performance wildlife parks which are working under Punjab Wildlife and Parks Department (PWPD) Punjab. The data has been directly obtained from the respective controlling office of PWPD for the years 2011-14. To measure the relative efficiency of wildlife parks, this study incorporated the DEA technique. The finding showed that the total factor productivity of wildlife in Lahore showed productivity improvement. Finally, the finding suggested means of improvement in terms of cost, productivity and visitors satisfaction level.
Keywords: Outdoor recreation, wildlife parks, Data Envelopment Analysis, Management Efficiency

1. INTRODUCTION

Wildlife parks are not only a good source of recreation but also have a socio-economic function such as to creates miscellaneous jobs, support the local economy through purchasing of products and services, educate visitors on the importance of biodiversity conservation, habitat preservation and sustainable living, provide academic and vocational training, and support conservation, research and science. Wildlife parks often work in networks of partnerships and collaborations which further broaden and deepen the impact of their work.
Punjab is the most fertile province of Pakistan and Punjabis are enterprising people. They worked

hard to bring about agricultural and industrial revolution. Population growth rate is about 2.13% annually (Statistics, 2017). All these things have put a large pressure on natural resources. Natural forest and naturally vegetated areas are cleared rapidly to grow more food crops, to feed human being and their live stocks. Cash crops are also growing on large scales to fill in the gaping mouth of industrial complexes. Wildlife shooting is also one of the most favorite recreations of the feudal lords, aristocracy and wild lands dwellers of Punjab. All these pressures have severely affected the wildlife. Wildlife species have been reduced in numbers in most of the areas in Punjab. Wild life parks have been established by the government of Punjab to maintain endangered species in captivity in state as close to nature as possible. These wildlife parks are also opened for general public for recreational purposes. These parks also provide opportunities for students to get both formal and informal education through study or park trips and provide research opportunities for students of various fields such as ecological management, environmental tourism, wildlife management, and conservation etc. These parks are also good source of providing possible indirect benefit to the local economy.

In Punjab, the wildlife parks are managed by the Punjab Wildlife and Parks Department with the vision to conserve the endangered species and their natural habitat. For this purpose, they have established some wildlife parks, breeding centers and zoos for ex-situ conservation and public recreation. To achieve its objective, the department is spending a significant amount every year, the detail of wildlife department budget is given in figure 1.

By realizing the social and economic significant of wildlife Parks, this study is an effort to illustrate better method and model to estimate decision making units' (DMU) efficiency in the case of Punjab's wildlife parks. The main purpose of this research is to recommend a familiar benchmarking methodology, which would help to construct a very cautious measurement of DMUs of organization. Data envelopment analysis is considered one of the top flexible and suitable techniques for calculating the efficiency of DMU relative to parallel DMUs (in present case national parks management offices) and consequently to measures a best practice frontier. Anywhere efficiency in this research is an estimate of special features associated to ecological, economic and social impact of wildlife parks.

1.1. Statement of the Problem

It is less frequent in Punjab to measure the efficiency of recreation units yet. By measuring the efficiency of wildlife parks, the administration can take action to develop the inefficient DMU in that way which will definitely make it possible to improve the overall performance of organization.

1.2. Objective of the Study

The objective of this study is to evaluate the relative efficiency performance of public wildlife parks under the administration of Punjab Wildlife and Parks Department Punjab by using non- parametric approach.

1.3. Significance of the Study

This study would also provide guidance to the management of each DMU in the institution to make improvement in the use of resources and providing services. It would also highlight the weak aspects of the management of institutions through comparative inputs/outputs analysis and provide proposition to make changes in quantity and quality of inputs and outputs variables in order to achieve high rank of efficiency.

2. Literature Review

DEA is known as a multi-site mathematical technique which is often used to calculate the relative efficiency of homogenous production units of private and public organization and institutions. DEA also gives the direction of potential advancement at what time a particular production unit is found to be inefficient. DEA is a nonparametric method to measure the relative efficiency of decision making units seeing that it can evaluate the relationship among data of inputs and outputs variables exclusive of forming any assumption as regards the form of production function under study. The DEA methodology has not only been applied in various benchmarking studies of governmental profit institutions such as banks, (Charnes, Cooper, & Rhodes, 1978) but it has also applied on many non-profit organizations for example, public transportation (Barnum, McNeil, & Hart, 2007), hospitals (Moshiri, Aljunid, Amin, Dahlui, & Ibrahim, 2011), schools Aminarh, E. S. (2017). However, the DEA methodology to calculate and evaluate the efficiency of environment and resource management is least found. However, DEA has been used to measure the efficiency of national parks by Bosetti, V., & Locatelli, G. (2006), while the relative efficiency of environmental behavior of coal-fired power plants in china can be found in Wu, Y., Ke, Y., Xu, C., Xiao, X., & Hu, Y. (2018). Some more application of DEA technique can be cited in the table 1

Table 1: Application of DEA in existing Literature

Application	Author
DEA approach for unified efficiency measurement: assessment of Japanese fossil fuel power generation	Sueyoshi, T., & Goto, M. (2011).
A DEA approach for estimating the agricultural energy and environmental efficiency of EU countries	Vlontzos, G., Niavis, S., & Manos, B. (2014)
The economic and environmental efficiency assessment in EU cross-country: Evidence from DEA and quantile regression approach.	Moutinho et al. (2017)
The Effects of Environmental Factors on the Efficiency of Clinical Commissioning Groups in England: A Data Envelopment Analysis	Takundwa et al. (2017)

3. METHODOLOGY

3.1 Conceptual Framework

The DEA has been pioneered by Charnes in 1978. The DEA model given by Charnes was known as CCR model. The CCR model was initially applied only on those technologies distinguished by constant return to scale. Some extensions were made in CCR model by Banker, Charnes and Cooper (BCC) in 1984, to address the technologies categorized by variable return to scale. Until now, the significant developments in DEA were acknowledged by Seiford & Thrall (1990). At the present time, the usage of DEA methodology to compute the relative efficiency of homogenous decision-making units of profit and non-profit organization, for example universities, schools, police stations, public and private libraries, agricultural farms, hospitals, insurance companies, commercial banks, national parks have become very common. DEA model is also known as frontier based model. The technical frontier demonstrates the performance of the productive unit. The measurement of performance is defined via efficiency score ranging between 0-100%. This efficiency score is unit free measure because it is not affected by the measurement unit in which outputs and inputs are measured.

3.2. Model Formulation

DEA model in mathematical form can be written as following

If all decision-making units are expressed by N, every DMU has m inputs and n outputs. The technical efficiency score of every DMU can be measured by solving the following model proposed by Charnes et al. (1978):

$$for \quad each \quad DMU_p \qquad P = 1, 2, 3.....$$

$$\max imize \qquad E_p = \frac{\sum_{j=i}^{n} u_j y_{jp}}{\sum_{k=1}^{m} v_k x_{kp}}$$

$$subject\ to \quad \frac{\sum_{j=1}^{n} u_j y_{j_i}}{\sum_{k=1}^{m} v_k x_{k_i}} \le 1 \qquad \forall \quad i$$

$$u_{j,} v_k \ge 0 \qquad \forall \quad k, j \qquad (1)$$

Where
K = 1, 2, 3…….*n*
J = 1, 2, 3……..*m*
I = I, 2, 3……..*N*

y_{ji} = the amount of output j produced by *i*th unit,

x_{ki} = the amount of inputs k utilized by *i*th unit,

u_j = weights given to output *j*

v_k = weights given to inputs

The problem set shown in 1 can be transformed into linear programming as following;

$$\max \quad \sum_{j=1}^{n} u_j \, y_{jp}$$

$$s.t \quad \sum_{k=1}^{m} v_k \, x_{kp} = 1$$

$$\sum_{j=1}^{n} u_j y_{ji} - \sum_{k=1}^{m} v_k x_{ki} \le 1 \qquad \forall i$$

$$u_j, v_k \ge 0 \qquad \forall \qquad k, j. \qquad (2)$$

Decision variables

u_j *weight of output j (unitless)*

v_k *weight of inputs k (unitless)*

The weights are unidentified as priory. The unknown weights of outputs u_j and weights of inputs v_k are calculated via DEA software, by using the data set of variables, as a method of measuring the relative efficiency of each DMU. These unknown weights are estimated individually for each unit of organization so that the level of highest efficiency score can be attained. Furthermore, these inputs and outputs weights should be categorically positive so that the chance that some inputs or outputs might be omitted in the process of measuring the efficiency of each DMU can be avoided.

3.3. Variables and Its Description

3.3.1 Variables

Inputs	Outputs
Infrastructure Cost	Number of People Visit the Park
Variable Cost	Protected Species
	Total Area Which Receive Protection

Source: all the above five variables have been selected after directly discussion with officials of relevant department and after comprehensive review of existing literature

3.3.2. Operational Definition of Variables

Infrastructural Cost is considered as a proxy of fixed cost. This cost is considered to be proportional to cost the area protected by the park.

Variable Cost includes the all employee related expenses and non-employee expenses such as the cost of feed of species, maintenance and repairing cost.

Total Visitors is the first physical output provided by public parks and wildlife parks. It indicates total number of visitors who visit the park daily.

Protected Species means the total number of rare fauna and flora which face a high risk of survival.

Wildlife Park Area is the total measurement of area in acres protected by the park. To assess the environmental efficiency, it is very important variable.

3.4. Results and Discussions

All the wildlife parks in Punjab in 2011 has efficiently transformed their inputs into outputs. Table 1 states the efficiency scores of selected wildlife parks in different cities of Punjab under VRS and CRS for the year 2011-12.all the parks were found efficient because they got 100% efficiency score. The average efficiency scores of

selected wildlife parks in different cities of Punjab under VRS and Scale Efficiency is remained the same for the year 2012-13 (Table 2). The parks which found least efficiency score under CRS was Bansra Gali Murree. All parks were found efficient under VRS during the year. While the efficiency for the year 2013-14 has decreased up to 86%. (table 3). The parks which found least efficiency score under CRS was wildlife park Bahawalnagar. All parks were found efficient under VRS during the year.

3.4.1. Malmquist index summary

Year wise performance of parks can also be measured by output-based Malmquist productivity index. If Malmquist index has the value greater than one then it would have meant that there is gain in productivity, while a result less than one indicates productivity decline and equal to one when productivity unchanged. Malmquist productivity index is decomposed by two efficiencies and can be expressed as:

Malmquist productivity index = technical efficiency× technological change

MPI summary of parks (table 4) indicating that technological change adds less to the TFP growth of parks as its value is less than 1 showing that Punjab "Wildlife and Parks Department "has made insufficient investments in technology. The contribution of scale efficiency change has been decreased. Scale efficiency change has decreased by 5%. The total factor productivity change has also decreased during the period. The pure efficiency remained unchanged. TFP of three wildlife parks is observed to be decrease in year 2013-14. As for as technological efficiency is concerned, three parks got technological efficiency improvement. Mean score for effch, techch, sech and tfpch is less than one which shows the overall decrease in all these efficiencies. On average total factor productivity change is 0.645 for the period 2012-14 which is less than 1. It indicates the TFP declined by 35.5%. techch for the given time period is also 0.703 showing a fall of 29.7%. Scale efficiency is decreased by 8.2%. Moreover, sech > techch which shows that scale efficiency change is adding more to total factor productivity change as compare to technological change. Pure efficiency changes for the years 2012-14 is equal1.000, showing that management efficiency of the parks has remained unchanged during the period. Technological change adds less to the TFP growth of wildlife parks as its value is less than 1(table 5) showing that "Punjab wildlife and parks department" has made insufficient investments in fixed assets during last three years. The contribution of pure efficiency change has remained unchanged. Scale efficiency change has also decreased during the period as its value is less than 1. The decline in total factor productivity change is due to decrease in both technological change and scale efficiency change.

3.5. CONCLUSION

Efficiency analysis of wildlife parks in different cities of Punjab has been conducted by using DEA. The finding based on Malmquist productivity index shows that total factor productivity has increased in wildlife parks in Lahore during the period 2011-14 while the total factor productivity has decreased in all other selected wildlife. This indicates that the wildlife parks in Lahore are well performing units as compare to wildlife parks in other cities of Punjab. Many reasons have been observed behind this fact. One of the reasons is that the wildlife parks are major recreational venues in metropolitan, which are great attraction for tourist and provide people with a pleasant day out. Millions of people visit wildlife parks annually and they pay price before entering in wildlife parks. It is very beneficial in financial term because some of the organizational and developmental expenditures met by management of parks have been created by the authority itself.

Secondly there is a lacks joyful recreational opportunity in most of the cities of Punjab. So usually families from other cities also choose visiting wildlife parks in Lahore for a whole day picnic with their children. People come from different walks of life and irrespective of the age visit the parks. The annual revenue from the wildlife parks is considerable. Thirdly, sufficient amount of budget has been allocated for the wildlife parks situated in capital of Punjab. That is why the wildlife parks in Lahore are well kept and well managed.

4. Policy Recommendation

On the base of empirical analysis, this study recommends some policies to improve the quality of wildlife parks. The policies are of following.

- The managements of wildlife parks may consider to a small increase in the entry fee of parks. If the visitors pay more than what they are actually paying, it would definitely generate revenue for parks which can be used for the better protection of species. To improve efficiency of other wildlife parks in Punjab, PWPD requires increasing the amount of investment in its fixed assets in small wildlife parks and provide sufficient amount of budget without discrimination.
- Furthermore, PWPD can also motivate the local community of each city for animal adoption, according to which people can symbolically adopt a species of wildlife parks. The adoption donation will help the management of the parks to protect some of the world's most endangered species from extinction.
- The mortality of species is also one of the factors of environmental in-efficiency of wildlife parks. Continuous monitoring is required to identify reasons of environmental in-efficiency. Short and long-term planning by experts is necessary to overcome environmental problems and to decrease the

mortality of species.

- To attract the visitors, beautification the wildlife parks in Punjab is very necessary as the untidiness and bad smell is observed by the people while visiting wildlife parks. Furthermore, awareness campaigns should be run in this perspective to make the visitors understand, how to keep the park clean.

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Table 1: Technical Efficiency Estimates of Wildlife Parks in Year 2011-12

DMUs	Under CRS	Under VRS	Scale
Wildlife Park Jallo Lahore	1.000	1.000	1.000
Lahore Zoo Logical Garden Lahore	1.000	1.000	1.000
Wildlife Park/Zoo Safari Lahore	1.000	1.000	1.000
Wildlife Park Changamanga	1.000	1.000	1.000
Wildlife Park Vehari	1.000	1.000	1.000
Wildlife Park Bahawalnagar	1.000	1.000	1.000
Bahawalpur Zoo Bahawalpur	1.000	1.000	1.000
Wildlife Park Loibher Rawalpindi	1.000	1.000	1.000
Wildlife Park Bansragali Murree	1.000	1.000	1.000
Mean	1.000	1.000	1.000

Source: author's calculation by using DEAP 2.1 software

Table 2: Technical Efficiency Estimates of Wildlife Parks in Year 2012-13

DMUs	Under CRS	Under	Scale
Wildlife Park Jallo Lahore	1.000	1.000	1.000
Lahore Zoo Logical Garden Lahore	1.000	1.000	1.000
Wildlife Park/Zoo Safari Lahore	1.000	1.000	1.000
Wildlife Park Changamanga	1.000	1.000	1.000
Wildlife Park Vehari	1.000	1.000	1.000
Wildlife Park Bahawalnagar	1.000	1.000	1.000
Bahawalpur Zoo Bahawalpur	1.000	1.000	1.000
Wildlife Park Loibher Rawalpindi	0.997	1.000	0.997
Wildlife Park Bansragali Murree	0.958	1.000	0.958
Mean	0.995	1.000	0.995

Source: author's calculation by using DEAP 2.1 software

Table 3: Technical Efficiency Estimates of Wildlife Parks in Year 2013-14

DMUs	Under CRS	Under VRS	Scale Efficiency
Wildlife Park Jallo Lahore	1.000	1.000	1.000
Lahore Zoo Logical Garden Lahore	1.000	1.000	1.000
Wildlife Park/Zoo Safari Lahore	1.000	1.000	1.000
Wildlife Park Changamanga	0.700	1.000	0.700
Wildlife Park Vehari	0.556	1.000	0.556
Wildlife Park Bahawalnagar	0.553	1.000	0.553
Bahawalpur Zoo Bahawalpur	1.000	1.000	1.000
Wildlife Park Loibher Rawalpindi	1.000	1.000	1.000
Wildlife Park Bansragali Murree	1.000	1.000	1.000
Mean	0.868	1.000	0.868

Source: author's calculation by using DEAP 2.1 software

Table 4: Malmquist Index Summary for Year 2012-13

DMUs	Effch	techch	pec	sech	tfpch
Wildlife Park Jallo Lahore	1.000	0.981	1.0	1.000	0.981
Lahore Zoo Logical Garden Lahore	1.000	2.107	1.0	1.000	2.107
Wildlife Park/Zoo Safari Lahore	1.000	2.128	1.0	1.000	2.128
Wildlife Park Changamanga	1.000	0.167	1.0	1.000	0.167
Wildlife Park Vehari	1.000	0.162	1.0	1.000	0.162
Wildlife Park Bahawalnagar	1.000	0.161	1.0	1.000	0.161
Bahawalpur Zoo Bahawalpur	1.000	1.230	1.0	1.000	1.226
Wildlife Park Loibher Rawalpindi	0.997	0.960	1.0	0.997	0.919
Wildlife Park Bansragali Murree	0.958	1.980	1.0	0.958	1.980
Mean	0.995	0.708	1.0	0.995	0.705

Source: author's calculation by using DEAP 2.1 software

Table 5: Malmquist Index Summary for Year 2013-14

DMUs	effch	Techch	pech	sech	Tfpch
Wildlife Park Jallo Lahore	1.000	1.513	1.000	1.000	1.513
Lahore Zoo Logical Garden	1.000	1.434	1.000	1.000	1.434
Wildlife Park/Zoo Safari Lahore	1.000	1.406	1.000	1.000	1.406
Wildlife Park Changamanga	0.700	0.538	1.000	0.700	0.377
Wildlife Park Vehari	0.556	0.654	1.000	0.556	0.364
Wildlife Park Bahawalnagar	0.553	0.635	1.000	0.553	0.351
Bahawalpur Zoo Bahawalpur	1.003	0.378	1.000	1.003	0.379
Wildlife Park Loibher Rawalpindi	1.044	0.404	1.000	1.044	0.422
Wildlife Park Bansragali Murree	1.000	0.376	1.000	1.000	0.376
Mean	0.847	0.698	1.000	0.847	0.591

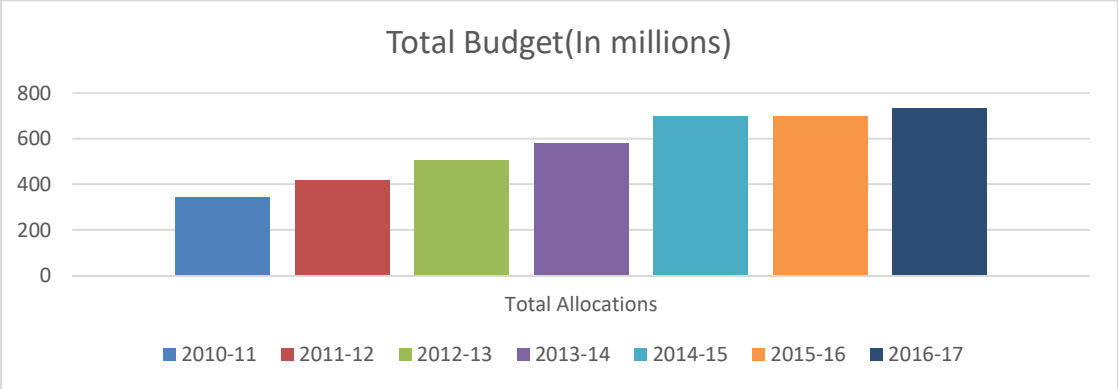
Source: author's calculation by using DEAP 2.1 software

Table 7: Malmquist Index Summary of Wildlife Parks Means

DMUs	effch	Techch	pech	sech	Tfpch
Wildlife Park Jallo Lahore	1.000	1.218	1.000	1.000	1.218
Lahore Zoo Logical Garden Lahore	1.000	1.738	1.000	1.000	1.738
Wildlife Park/Zoo Safari Lahore	1.000	1.730	1.000	1.000	1.730
Wildlife Park Changamanga	0.837	0.300	1.000	0.837	0.251
Wildlife Park Vehari	0.746	0.325	1.000	0.746	0.242
Wildlife Park Bahawalnagar	0.743	0.320	1.000	0.743	0.238
Bahawalpur Zoo Bahawalpur	1.000	0.682	1.000	1.000	0.682
Wildlife Park Loibher Rawalpindi	1.000	0.623	1.000	1.000	0.623
Wildlife Park Bansragali Murree	1.000	0.863	1.000	1.000	0.863
Mean	0.918	0.703	1.000	0.918	0.645

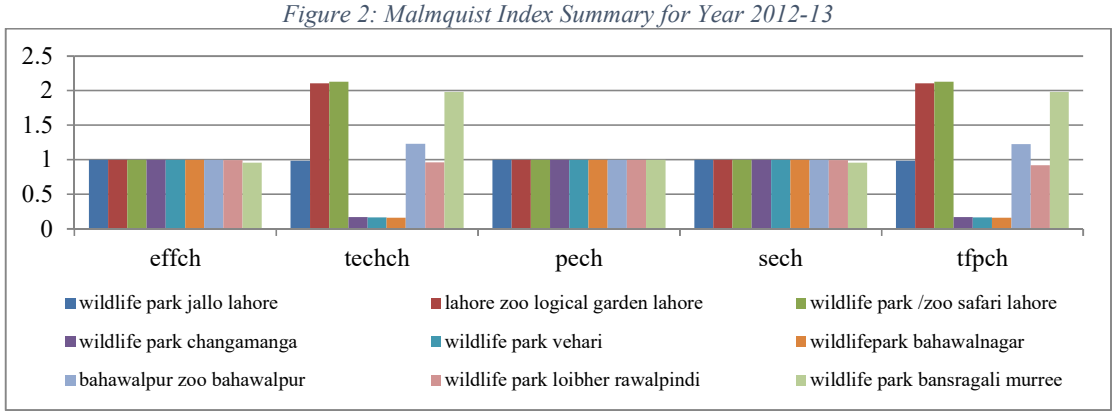
Source: author's calculation

Figure 3: Total Budget of Wildlife Department



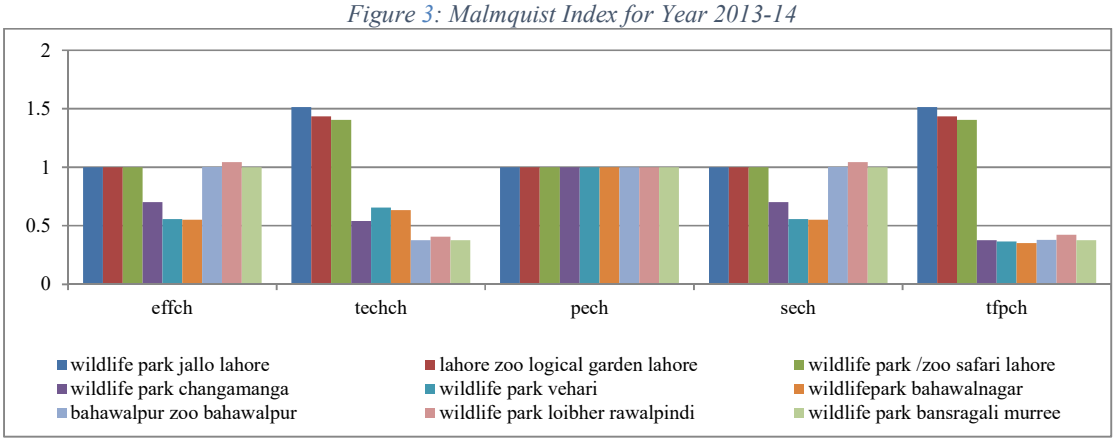
Source: White Paper, Finance Department Punjab

Figure 2: Malmquist Index Summary for Year 2012-13



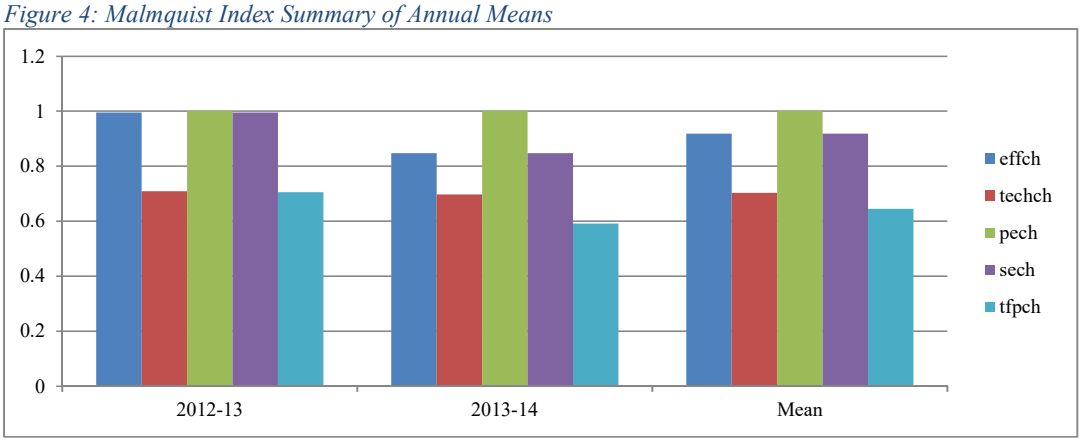
Source: author's calculation

Figure 3: Malmquist Index for Year 2013-14



Source: author's calculation

Figure 4: Malmquist Index Summary of Annual Means



Source: author's calculation