# EVALUATING THE OPERATIONAL EFFICIENCY OF ASSAM GRAMIN VIKASH BANK BRANCHES

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## Abstract:

Efficiency analysis can easily depict an organisation's ability to utilize its resources to generate business transactions. The main objective of the paper is to measure the level of efficiency (in terms of operating efficiency) of seventy Assam Gramin Vikash Bank. An attempt has also been made to explore the influential determinants that affect the level of efficiency. The paper which is empirical in nature is based on primary data and the efficiency is measured for the year 2016-2017 by using Data Envelopment Analysis under Technical Efficiency (Constant Return to Scale) and Pure Technical Efficiency (Variable Return to Scale). The findings reveal that there is variance in the efficiency score among the AGVB branches. There are certain key areas of weaknesses which need quick or immediate redresses by the policy makers, branch manager. According to empirical findings the inefficient use of scarce resources, managerial irregularities and regional offices are found to be the major causes of concern in emerging technical inefficiency among seventy branches of AGVB. The result also shows that Lakhimpur regional office has performed well as compared to its counterparts in regards to input and output oriented approaches.

**Key words:** AGVB, Branch, Data Envelopment Analysis, Operational efficiency

**INTRODUCTION:**

Bank performance is an important issue particularly in developing countries. This is due to the vital role of commercial banks and regional rural banks (RRB) in the economy, due to the fact that these banks are the dominant financial institutions in these countries and they are the major sources of financial intermediation. Evaluation of their overall performance and financial condition is meaningful for their owners, potential investors, depositors, managers and, of course, regulators. Hence, it is essential for a bank to know the efficiency of its branches. Once the efficiency of each branch is known, the management of the bank will be in a position to rank the branches according to their efficiencies, to see where the inefficiency is coming from, and to suggest measures for improving the performance. Among a network of branches, a branch is said to be efficient relative to another branch if it produces the same level of output with fewer inputs, or if it produces more output with the same level of inputs.

The RRBs were established in India with a vision to improve rural economy by providing rural credit to agricultural laborers, farmers, artisans and small entrepreneurs. The RRBs were raised by the mutual efforts of the central government, state government and commercial banks. The 2012-2013 annual report of NABARD shows that there are 56 Regional Rural Banks in India. In Assam, there are two RRBs namely, Assam Gramin Vikash Bank and Langpi Dehangi Rural Bank. The present study considers only the AGVB branches.

AGVB came into existence on 12th January, 2006. It is sponsored by the United Bank of India. At present, there are 413 branches all over Assam except three districts (AGVB, Annual Report, 2017).

**SIGNIFICANCE OF THE STUDY:**

Efficiency studies throw light on the proper utilization of inputs and give a direction on minimisation of cost and allocation of resources. Such studies help the organization to formulate policies to improve their level of outputs by cost minimisation. The present study is based on AGVB branches. It finds out the efficient branches amongst themselves by using Data Envelopment Analysis (DEA) and analyses the factors responsible for inefficiency of branches. Such studies are highly significant today; because, in the competitive market, the efficient organisations can easily face the challenges. The AGVB branches in Assam would be able to challenge the competition only if they are efficient.

**REVIEW OF LITERATURE:**

This section provides an overview of literature on branch level of efficiency studies published during the period from 1985 to 2017. There are a number of studies conducted with regard to efficiency of banks and branches by using Data Envelopment Analysis (DEA) technique to find out level of efficiency of branches; some of them are Sherman *et al*. (1985), Oral *et al*. (1990), Giokas (1991), Sherman *et al*. (1995), Schaffnit *et al*. (1997), Soteriou *et al*. (1999), Camanho *et al*. (1999), Athanassopoulos (2000), Cook *et al*. (2001), Hartman *et al*. (2001), Manandhar *et al*. (2002), Stanton (2002), Paradi *et al*. (2004), Camanho *et al*. (2005), Camanho *et al*. (2006), Valami (2009), Wu *et al*. (2006), Yang *et al*. (2006), Howland *et al*. (2006), Pastor *et al*. (2006), McEachern *et al*. (2007), Al-Tamimi *et al*. (2007), Portela *et al*. (2007), Camanho *et al*. (2008), Noulas *et al*. (2008), Lotfi *et al*. (2010), Paradi *et al*. (2010), Tsolas (2010), Deb, J. (2011), Minh, *et al*. (2012), Singh, H. (2013), Zarinkamar *et al*. (2014), Azarbad *et al*. (2015), Chanu *et al*. (2016) and Das *et al*. (2017).

**RESEARCH GAP:**

Though there are many studies on efficiency studies, the efficiency analysis of AGVB branches in Assam lack in the existing literature. Dev. J. (2011) employed DEA in evaluating the performance and factors of (in)efficiency of the bank branches in North East India. The present study is an attempt to fill the existing research gap.

**OBJECTIVES:**

1. To measure the level of efficiency of the selected AGVB branches;
2. To measure the scale of efficiency of the selected AGVB branches; and
3. To measure the level of efficiency of the regional offices of AGVB branches.

**HYPOTHESES:**

1. $H_{01}$= There is no significant difference in relation to level of efficiency amongst the AGVB branches; and
2. $H_{01}$= There is no significant difference in relation to level of efficiency amongst the AGVB regional offices.

**METHODOLOGY:**

**Type of study** : Theoretical and empirical in nature.
**Type of data** : The present study is based on primary data.
**Sources of data** : Data are collected from primary sources that are unpublished reports of selected AGVB branches in Assam.
**Population Size** : 97 (Total number of AGVB branches which were installed CBS system in the financial year 2010-2011).
**Sample Size** : 70 branches. Based on the Proportional distribution (70 percent branches from the seven regional offices).
**Period of Study** : The present study covers one financial year i.e. April 2016- March 2017.
**Software Used** : Data is analyzed by using the DEA Excel Solver, Zhu (2003) software.

**LIMITATION OF THE STUDY**:

The study is limited to only 70 branches from AGVB. The study period is limited to only one year due the availability of the data which is collected from the AGVB branch offices.

**SELECTION OF INPUT AND OUTPUT VARIABLES:**

In empirical studies on efficiency of banking sector, an important and controversial issue is selection of inputs and outputs. According to Berger and Humphrey (1997), there are two main approaches – the production approach and the intermediation approach. In the present study production approach is used to measure the efficiency and on the basis of this approach following inputs and outputs variables are chosen. Table 1 shows different input and output variables and their explanations respectively.

**Table 1: Details of input & output Variables**

| | | |
|---|---|---|
| Inputs | Interest Expended | Interest on deposits |
| | Operating Expenditure | Payments to employees, printing and stationary, Advertisement and publicity, Law charges etc. |
| Outputs | Loans and Advances | Bills purchased and discounted, Cash credits, Overdrafts and loans repayable on demand, Term loans, Secured by tangible assets, Unsecured. |
| | Interest Earned | Interest on Advance, interest on loan. |
| | Other Income | Commission, exchange, brokerage etc. |
| | Deposits | Current Account, Saving Bank Deposits, Term Deposits |

Source: Researchers' Compilations

In the present study input oriented and output oriented measures are taken to analyse the level of efficiency. Efficiency measures can be broadly estimated with two types of approaches, they are parametric and non-parametric approaches. However, in the present study non-parametric- Data Envelopment Analysis is used under Technical Efficiency (constant return to scale) and Pure Technical Efficiency (variable return to scale).

**MODEL USED FOR THE STUDY:**

**DATA ENVELOPMENT ANALYSIS (DEA):**

DEA is a linear programming-based technique to measure the level of efficiency of organizational units like bank and its branches. Here, branches are known as Decision Making Unit (DMU). The performance of DMUs is assessed in Data Envelopment Analysis by using the concept of efficiency which is the ratio of weighted outputs (virtual output) to weighted inputs (virtual inputs). The best performing DMU is assigned an efficiency score of unity (or 100 percent) and the performance score of a DMU vary between 0 and 1. The operating units of branches have multiple inputs such as staff size, locations, operating expenses and NPA of operation, advertising budget as well as multiple outputs such as profit, total deposits, loans and advances, interest earned and other income. In this situation, it is often difficult for a manager to determine which operating units are inefficient in converting their inputs into outputs.

There are a number of DEA models. In the present study, $TE_{CRS}$ and $PTE_{VRS}$ models are used. The main difference between the two models lies in their treatment of the issue of returns to scale. $TE_{CRS}$ assumes that each DMU operates with constant returns to scale while $PTE_{VRS}$ allows for variable returns to scale (Al-Tamimi *et al.* 2007).

The model used in this study namely, DEA operating efficiency model. The DEA operating efficiency model was run with employee expenses and other operating expenses as the two input variables and the value of total loans, total deposits, and number of transactions as the three output variables. This model was used by the Al-Tamimi *et al.* 2007 in their branch level study.

In the study, input oriented approach and output oriented approach are used. Input minimization is defined as minimising the level of inputs controllable in the same or no more favourable operating environment. Output maximization is defined as maximising the level of outputs for the given inputs controllable in the equal or no more favourable operating environment (Avkiran, 2006).

**EMPIRICAL RESULTS:**

**Efficiency results under Input and Output Oriented Approaches in $TE_{CRS}$, $PTE_{VRS}$ and SE Models for the Financial Year 2016-2017:**

**Table: 2 Statistical Summaries of Efficiency Scores for 2016-2017**

| Particulars | Input Oriented | | | Output Oriented | | |
|---|---|---|---|---|---|---|
| | $TE_{CRS}$ | $PTE_{VRS}$ | SE | $TE_{CRS}$ | $PTE_{VRS}$ | SE |
| Total number of DMUs | 70 | 70 | 70 | 70 | 70 | 70 |
| Number of fully efficient DMUs | 6 | 12 | 6 | 6 | 12 | 6 |
| Number of inefficient DMUs | 64 | 58 | 64 | 64 | 58 | 64 |
| Max efficiency score | 1 | 1 | 1 | 1 | 1 | 1 |
| Min efficiency score | 0.34404 | 0.45352 | 0.7586 | 0.34404 | 0.37736 | 0.9117 |
| Std. dev of efficiency | 0.12559 | 0.12718 | 0.05921 | 0.12559 | 0.14077 | 0.0575 |
| Average of efficiency M | 0.78165 | 0.8266 | 0.94562 | 0.78165 | 0.81032 | 0.87413 |
| Average of inefficiency | 0.21835 | 0.1734 | 0.05438 | 0.21835 | 0.18968 | 0.1258 |
| Percentage of the DMU in 1 | 9.00% | 17.00% | 9.00% | 9.00% | 17.00% | 9.00% |
| Return To Scale (RTS) | Numbers | | | Percentage | | |
| Increasing Return To Scale(IRS) | 48 | | | 68% | | |
| Decreasing Return To Scale (DRS) | 16 | | | 23% | | |
| Constant Return To Scale(CRS) | 6 | | | 9% | | |

Source: Researcher's calculations

Table: 2 presents statistical summary of efficiency score of seventy AGVB branches under $TE_{CRS}$, $PTE_{VRS}$ and SE models under input and output oriented approaches for the financial year 2016-2017.

**Efficiency Results under Input Oriented Approach:**

Table: 2 indicates that out of seventy branches, there are 6, 12 and 6 fully efficient branches that is their score is equal to one and 64, 58 and 64 are not fully efficient branches because their score is less than one under $TE_{CRS}$, $PTE_{VRS}$ and SE models respectively. The table also shows that the lowest score stands at 0.34404, 0.45352 and 0.7586 under $TE_{CRS}$, $PTE_{VRS}$ and SE models respectively. Jorhat branch scored the lowest under $TE_{CRS}$, $PTE_{VRS}$ and SE models. Average efficiency score of seventy branches is 0.78165, 0.8266 and 0.94562 under $TE_{CRS}$, $PTE_{VRS}$ and SE models respectively; and their average *inefficiency* score is 0.21835, 0.1734 and 0.05438 under the same models respectively. The result implies that inputs could be decreased proportionately without decreasing the level of outputs. All the selected branches in average are not fully efficient under any model. Further, inside into efficiency scores then we find that pure technical inefficiency rather than scale inefficiency is the main cause of technical inefficiency of the branches. Standard deviation stands at 0.12559, 0.12718 and 0.05921 under $TE_{CRS}$, $PTE_{VRS}$ and SE models respectively. Large dispersion is noticed under $TE_{CRS}$ and $PTE_{VRS}$ models.

**Efficiency Results under Output Oriented Approach:**

Table: 2 indicates that out of seventy branches, there are 6, 12 and 6 fully efficient branches that is their score is equal to one and 64, 58 and 64 are not fully efficient branches under $TE_{CRS}$, $PTE_{VRS}$ and SE models respectively. The table also shows that the lowest score stands at 0.34404, 0.37736 and 0.9117 under $TE_{CRS}$, $PTE_{VRS}$ and SE models respectively. Jorhat branch had scored the lowest under $TE_{CRS}$ and $PTE_{VRS}$ and Nalbari branch had scored the lowest among them under SE model. Average efficiency score of seventy branches is 0.76165, 0.81032 and 0.874135 under $TE_{CRS}$, $PTE_{VRS}$ and SE models respectively; and their average *inefficiency* score is 0.21835, 0.18968 and 0.12587 under the same models respectively. The result implies that output variable could be proportionately increased without introducing the additional inputs. Further all the selected branches in average are not fully efficient under the output oriented approach. Standard deviation score stands at 0.12559, 0.14077 and 0.05756 under $TE_{CRS}$, $PTE_{VRS}$ and SE models respectively. Large dispersion is measured under $TE_{CRS}$ and $PTE_{VRS}$ models. The above table also shows that efficiency scores under $PTE_{VRS}$ model is lower than the SE model. Therefore, pure technical inefficiency rather than scale inefficiency is the main cause of technical inefficiency of the branches.

The returns to scale (RTS) results are presented in Table 2. The majority of the branches that is forty eight in number are considered to operate under increasing return to scale (IRS), therefore, the result of the analysis indicates that about sixty eight percent of the branches are operating below their optimal scale. There are sixteen branches classified as decreasing return to scale (DRS), it means twenty three percent of the branches are above their optimal scale and hence could increase their technical efficiency by decreasing their size. Lastly, there are only six branches working on constant return to scale (CRS); therefore, nine percent are operating at their optimal scale.

**Regional office wise Mean Efficiency scores under $TE_{CRS}$ and $PTE_{VRS}$ Model under Input and Output Oriented Approaches in the year 2016-2017:**

Table 3 presents summary of efficiency scores and hypothetical results under seven regional offices of seventy AGVB branches under $TE_{CRS}$ and $PTE_{VRS}$ models under input and output oriented approaches for the period 2016-2017.

**Table 3 Level of Efficiency and Hypothesis Testing under Regional Offices**

| RO | Input Oriented | | Output Oriented | |
|---|---|---|---|---|
| | $TE_{CRS}$ | $PTE_{VRS}$ | $TE_{CRS}$ | $PTE_{VRS}$ |
| Dibrugarh | 0.78842 | 0.83420 | 0.78842 | 0.83539 |
| Golaghat | 0.73174 | 0.81832 | 0.73174 | 0.78684 |
| Guwahati | 0.81365 | 0.86238 | 0.81365 | 0.85187 |
| Kokrajhar | 0.73630 | 0.78519 | 0.73630 | 0.78726 |
| Lakhimpur | 0.85928 | 0.88127 | 0.85928 | 0.88068 |
| Nalbari | 0.81119 | 0.85433 | 0.81119 | 0.82661 |
| Silchar | 0.65093 | 0.73141 | 0.65093 | 0.68982 |
| Hypothesis testing- different level of efficiency scores under seven regional offices | | | | |

| (Kruskal-Wallis test) | | | | |
|---|---|---|---|---|
| $H_{calculated}$ | 21.7866 | 21.7666 | 21.7766 | 15.5891 |
| P=(0.05) | 0.0013 | 0.0138 | 0.0013 | 0.0163 |
| Inference | Rejected $H_0$ | Rejected $H_0$ | Rejected $H_0$ | Rejected $H_0$ |

Source: Researcher's Calculations

In order to get an insight whether regional offices matters in the level of efficiency of AGVB branches, the study analyzes the efficiency differences among branches belonging to different regions and their efficiency scores. The branches of AGVB are classified into seven distinct regional offices. To test whether the observed differences in the efficiency scores across different regional offices are statistically significant or not, the non-parametric Kruskal-Wallis test is performed at 5% level of significance. Table 3 also highlights the results of non-parametric Krushal-Wallis H statistics test for seven regional office wise categories of AGVB branches for the period. Test scores presented in the tables indicate chi-square ($X^2$) values for the observation period.

$H_0$ = There is no significant difference on level of efficiency scores among the seven regional offices of AGVB branches; and

$H_1$ = There is significant difference on level of efficiency scores among the seven regional offices of AGVB branches.

**Under the input oriented Approach:**

Table 3 shows that the average efficiency scores are found to be 0.78842, 0.73174, 0.81365, 0.73630, 0.85928, 0.81119 and 0.65093 for Dibrugarh, Golaghat, Guwahati, Kokrajhar, Lakhimpur, Nalbari and Silchar regional offices respectively under $TE_{CRS}$ model. It is clear that the Lakhimpur regional office performed the best among the other seven regional offices. By using the Kruskal-Wallis test, the null hypothesis is accepted at 5% significance level. The evidence provides that scores of different regional offices matter when they are compared under $TE_{CRS}$ efficiency scores. The average efficiency scores are found to be 0.83420, 0.81832, 0.86238, 0.78519, 0.88127, 0.85433 and 0.73141 for Dibrugarh, Golaghat, Guwahati, Kokrajhar, Lakhimpur, Nalbari and Silchar regional offices respectively under $PTE_{VRS}$ model. It is clear that the Lakhimpur regional office performed the best among the other seven regional offices. By using the Kruskal-Wallis test, the null hypothesis is accepted at 5% significance level. The evidence provides that scores of different regional offices matter when they are compared under $PTE_{VRS}$ efficiency scores.

**Under the output oriented Approach:**

Table 3 shows that the average efficiency scores are found to be 0.78842, 0.73174, 0.81365, 0.73630, 0.85928, 0.81119 and 0.65093 for Dibrugarh, Golaghat, Guwahati, Kokrajhar, Lakhimpur, Nalbari and Silchar regional offices respectively under $TE_{CRS}$ model. It is clear that the Lakhimpur regional office performed the best among the other seven regional offices. By using the Kruskal-Wallis test, the null hypothesis is accepted at 5% significance level. The evidence provides that scores of different regional offices matter when they are compared under $TE_{CRS}$ efficiency scores. The average efficiency scores are found to be 0.83539, 0.78684, 0.85187, 0.78726, 0.88068, 0.82661 and 0.68982 for Dibrugarh, Golaghat, Guwahati, Kokrajhar, Lakhimpur, Nalbari and Silchar regional offices respectively under $PTE_{VRS}$ model. It is clear that the Lakhimpur regional office performed the best among the other seven regional offices. By using the Kruskal-Wallis test, the null hypothesis is accepted null hypothesis under the 5% level of significance. The evidence provides that efficiency scores of different regional offices matter when they are compared under $TE_{CRS}$ and $PTE_{VRS}$ models.

**CONCLUSION:**

In the present study, effort was made to present empirical findings pertaining to seventy AGVB branches for the period 2016-2017. To calculate technical efficiency, a non-parametric data envelopment analysis approach was used by using two inputs and four outputs under the input and output oriented approaches. Here, two DEA models namely, $TE_{CRS}$ and $PTE_{VRS}$ are used.

According to empirical findings, under input oriented approach, there is inefficiency to the tune of 21.835 percent as depicted in $TE_{CRS}$ and 17.34 percent as per model $PTE_{VRS}$. This suggests that, branches can, on an average, minimize their costs by eliminating the elements of inefficiencies with the best practices and still produce the same level of output. Under output oriented approach, there is inefficiency to the tune of 21.83 percent as depicted in $TE_{CRS}$ and 18.96 percent as per model $PTE_{VRS}$. This suggests that, branches can, on an average, increase their output level without increase input level.

Empirical findings pertaining to regional office branch analyses suggest that as per input and output oriented approaches, Lakhimpur regional office has scored highest among the seven regional offices and Khuskal-wallis test showed that there is significant difference among the different regional offices at 5% level of significance.

The policy implication of the aforementioned results is that there are certain key areas of weakness that need quick or immediate redresses by the policy makers and branch manager. According to empirical findings, inefficient use of scarce resources and managerial irregularities and regional offices are the major causes of concern in emerging technical inefficiency among seventy AGVB branches.

**REFERENCES:**

[1] Al-Tamimi, H. A. H., & Lootah, A. M. (2007). Evaluating the operational and profitability efficiency of a UAE-based commercial bank. *Journal of Financial Services Marketing, 11(4),* 333–348. Doi: 10.1057/palgrave.fsm.4760043.

[2] Assam Gramin Vikash Bank. (2017). *12th Annual report 2016-2017*. Guwahati: AGVB

[3] Athanassopoulos, A., D., & Giokas, D. (2000). The Use of Data Envelopment Analysis in Banking Institutions: Evidence from the Commercial Bank of Greece. *Interfaces, 30*(2), 81-95. Retrieved from http://www.jstor.org/stable/250 62582 on 02-06-2017.

[4] Avkiran, N.K. (2006). *Productivity analysis in the services sector with data envelopment analysis.* (3rd ed.), University of Queensland Business School, The University of Queensland, Brisbane. Retrieved from http://www.users.on.net/~necmi/financesite/DEA%20Book%203rd%20Edition%202006_AVKIRAN.pdf on 29-5-2015.

[5] Azarbad, M., Soltani, A & Shojaie, A. (2015). An empirical DEA investigation for development of new bank's branches. *Management Science Letters*, *5*(4), 331-336. Retrieved from http://www.growingscience.com/msl/Vol5/msl_2015_28.pdf on 29-08-2017.
[6] Benston, G. J. (1965). Branch Banking and Economies of Scale. *The Journal of Finance*, 315-331.
[7] Berger, A.N., & Humphrey, D. B. (1997). Efficiency of Financial Institutions: International Survey and Directions for Future Research. *European Journal of Operational Research*, 98, 175-212 Retrieved from http://d1c25a6gwz7q5e.cloudfront.net/papers/67.pdf on 29-5-2015.
[8] Berger, A.N. & Mester, L. (1997). Inside the black box: what explains differences in the efficiency of financial institutions? *Journal of Banking and Finance*, 21(7), 895- 947. Retrieved from http://www.federalreserve.gov/pubs/feds/1997/199710/199710pap.pdf on 29-5-2015
[9] Camanho, A., S., & Dyson, R. G. (2005). Cost Efficiency, Production and Value-Added Models in the Analysis of Bank. *The Journal of the Operational Research Society, 56*(5), 483-494. Retrieved from http://www.jstor.org/stable/4102102 on 07/12/2012.
[10] Camanho AS, & Dyson RG. (2006). Data envelopment analysis and Malmquist indices for measuring group performance. *Journal of Productivity Analysis*, 26, 35–49. DOI 10.1007/s11123-006-0004-8.
[11] Camanho, A. S. & Dyson, R. G. (2008). A generalization of the Farrell cost efficiency measure applicable to non-fully competitive settings. *Omega*, *36*, 147–62. doi:10.1016/j.omega.2005.12.004.
[12] Camanho, A. S., & Dyson, R. G. (1999). Efficiency, size, benchmarks and targets for bank branches: an application of data envelopment analysis. *Journal of the Operational Research Society, 50*, 903-915. Retrieved from http://www.stockton-press.co.uk/jor on 21-6-2017.
[13] Chanu, A.I., & Das. S. (2016). A Study on Efficiency of Select Regional Rural Banks in India. *The Indian Journal of Commerce, 69*(4), 48-59.
[14] Cook, W. D. & Hababou, M. (2001). Sales performance measurement in bank branches. Omega, 29, 299–307. Retrieved from www.elsevier.com/locate/dsw on 15-10-2017.
[15] Das, S., & Chanu, A. I. (2017). Measuring the Efficiency of Regional Rural Banks in India. *International Journal of Business and Administration Research Review, 3*(18), 57-66.
[16] Deb, J. (2011.). Post-Reform bank efficiency in North-East India: a branch level analysis. (Ph.D Thesis, North-Eastern Hill University, India). Retrieved from http://shodhganga.inflibnet.ac.in/handle/10603/5308 on 20-3-2014. (Unpublished)
[17] Giokas, D. (1991). Bank branch operating efficiency: a comparative application of DEA and the log-linear model. *Omega International Journal of Management Science, 19(6)*, 549-57.
[18] Gulati, R. (2011). *Efficiency in Indian Commercial Banks: A Post-deregulation Experience*. (Doctoral Dissertation, Guru Nanak Dev University, Amritsar, India). Retrieved from http://shodhganga.inflibnet.ac.in/handle/10603/10226 on 19-2-2016. (Unpublished).
[19] Hartman, T. E., Storbeck, J. E., & Byrnes, P. (2001). Allocative efficiency in branch banking. *European Journal of Operational Research, 134*, 232–42.
[20] Howland, M., & Rowse, J. (2006). Measuring bank branch efficiency using data envelopment analysis: managerial and implementation issues. *INFOR Journal, 44(1),* 49–63. DOI: 10.1080/03155986.2006.11732739.
[21] Lotfi, F. H., Jahanshahloo, G. R., Ebrahimnejad, A., Soltanifar, M., & Mansourzadeh, S. M. (2010). Target setting in the general combined-oriented CCR model using an interactive MOLP method. *Journal of Computational and Applied Mathematics, 234*, 1–9. doi:10.1016/j.cam.2009.11.045.
[22] Manandhar, R., & Tang, J. C. S. (2002). The evaluation of bank branch performance using data envelopment analysis: a framework. *Journal of High Technology Management Research, 13*, 1–17.
[23] Minh, N. K., Khanh, P. V., & Tuan, P. A. (2012). A New Approach for Ranking Efficient Units in Data Envelopment Analysis and Application to a Sample of Vietnamese Agricultural Bank Branches. *American Journal of Operations Research*, 2(3), 126-136. Retrieved from http://dx.doi.org/10.4236/ajor.2012.21015 on 15-4-2017.
[24] McEachern, D., & Paradi, J. C. (2007). Intra- and inter-country bank branch assessment using DEA. *Journal of Productivity Analysis, 27*, 123–36. DOI 10.1007/s11123-006-0029-z.
[25] Noulas, A. G., Glaveli, N., & Kiriakopoulos, I. (2008). Investigating cost efficiency in the branch network of a Greek bank: an empirical study. *Managerial Finance, 34*, 160–71. DOI 10.1108/03074350810848045.
[26] Oral, M., & Yolalan, R. (1990). An empirical study on measuring operating efficiency and profitability of bank branches. *European Journal of Operational Research*, *46*(3), 282-294.
[27] Paradi, J. C., & Schaffnit, C. (2004). Commercial branch performance evaluation and results communication in a Canadian bank — a DEA application. *European Journal of Operational Research, 156*, 719–35. doi:10.1016/S0377-2217(03)00108-5.
[28] Pastor, J. T., Lovell, C. A. K., & Tulkens, H. (2006). Evaluating the financial performance of bank branches. *Annals of Operations Research, 145*, 321–37. DOI 10.1007/s10479-006-0038-3.
[29] Paradi, J. C., Vela, S., & Zhu, H. (2010). Adjusting for cultural differences, a new DEA model applied to a merged bank. *Journal of Productivity Analysis, 33*, 109–23. DOI 10.1007/s11123-009-0158-2.
[30] Paradi, J. C. & Zhu, H. (2013). A survey on bank branch efficiency and performance research with data envelopment analysis. *Omega*, 41, 61–79. doi:10.1016/j.omega.2011.08.010.
[31] Portela, M. C. A. S., & Thanassoulis, E. (2007). Comparative efficiency analysis of Portuguese bank branches. *European Journal of Operational Research, 177*, 1275–88. doi:10.1016/j.ejor.2006.01.007.
[32] Sathye, M. (2003). Efficiency of Banks in a Developing Economy: The Case of India. *European Journal of Operational Research*, *148*(3), 662-671.

[33] Schaffnit, C., Rosen, D., & Paradi, J. C. (1997). Best practice analysis of bank branches: an application of DEA in a large Canadian bank. *European Journal of Operational Research, 98,* 269–89.
[34] Schaffnit, C., Rosen, D. & Paradi, J. C. (1997). Best practice analysis of bank branches :an application of DEA in a large Canadian bank. *European Journal of Operational Research,* 98, 269–289.
[35] Sherman H. D. & Gold, F. (1985). Bank Branch Operating Efficiency: Evaluation with Data Envelopment Analysis. *Journal of Banking and Finance, 9,* 297-315. Retrieved From Http://Booksc.Org/Book/16211981/13e29c on 26-08-2017.
[36] Sherman, H. D., & Ladino, G. (1995). Managing Bank Productivity Using Data Envelopment Analysis (DEA). *Interfaces, 25*(2), 60-73. Retrieved from http://www.jstor.org/stable/25061993 on 02-06-2017.
[37] Singh, H. (2013). *Efficiency of Indian commercial banks during post reform period*. (Master's thesis, Punjabi University, Amritsar). Retrieved from http://shodhganga.inflibnet.ac.in/handle/10603/25862 on 2-8-2016. (Unpublished).
[38] Soteriou, A. C., & Stavrinides, Y. (1997). An internal customer service quality data envelopment analysis model for bank branches. *International Journal of Operations and Production Management*, 17, 780-789.
[39] Stanton, K. R. (2002). Trends in relationship lending and factors affecting relationship lending efficiency. *Journal of Banking and Finance, 26,* 127–52.
[40] Tsolas, I. E. (2010). Modeling bank branch profitability and effectiveness by means of DEA. *International Journal of Productivity and Performance Management, 59,* 432–51. DOI 10.1108/17410401011052878.
[41] Valami, H. B. (2009). Group performance evaluation, an application of data envelopment analysis. *Journal of Computational and Applied Mathematics, 230,* 485–90. doi:10.1016/j.cam.2008.12.020.
[42] Wu, D., Yang, Z., & Liang, L. (2006). Using DEA-neural network approach to evaluate branch efficiency of a large Canadian bank. Expert Systems with Applications, 31, 108–115. doi:10.1016/j.eswa.2005.09.034.
[43] Yang, Z., & Paradi, J. C. (2006). Cross firm bank branch benchmarking using ''handicapped'' data envelopment analysis to adjust for corporate strategic effects, system sciences. *Proceedings of the 39th Annual Hawaii International Conference.* Hawaii.
[44] Zarinkamara, R. T., & Alam-Tabrizb, A. (2014). Bank branch operating efficiency: evaluation with data envelopment analysis. *Management Science Letters,* 4, 2307-2312. Retrieved from http://www.growingscience.com/msl/Vol4/msl_2014_276.pdf on 2-8-2016.