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Relative Efficiency of Rural Saving and Credit Cooperatives: An Application of Data Envelopment Analysis

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Saving and Credit Cooperatives (SACCOs) have been playing a distinct and important role in rural areas of Ethiopia in terms of outreach, volume of operation and the purpose they serve. The performance of rural financial cooperatives in the mobilization of savings and provision of credit has been inadequate. Therefore, greater degrees of efficiency among rural SACCOs would result in greater access to finance, higher profitability and increased financial services to rural people. In this study we apply the Data Envelopment Analysis (DEA) method to evaluate the relative efficiency of SACCOs in Tigrai region of Ethiopia. Data were collected from 329 rural SACCOs during the year 2012. The result showed that the extent of technical efficiency varies across geographical location and scale size of the cooperatives. From the total of 329 SACCOs, compared to their respective peers, only 18 (5.5%) were identified as relatively efficient with the maximum efficiency score of one. The remaining SACCOs were found to be relatively inefficient with efficiency score of less than one. The average efficiency was 21.3% which indicates that there is substantial amount of inefficiency among rural SACCOs in the study area. Technical efficiency was high for larger SACCOs. In terms of geographical location, the highest mean efficiency has been observed in southern and western zones of the region with a mean score of 0.276 and 0.259 respectively. The most interesting aspect of this study was that most of the efficient rural SACCOs are the ones that received reward from the regional government for their best performance, during the year 2012.

Keywords: data envelopment analysis, technical efficiency, saving and credit cooperatives

Introduction

The financial service sector in Ethiopia is composed of formal, semi formal and informal sectors. The formal/organized sector comprises diverse range of financial service institutions such as commercial banks and other finance companies. However, the semi formal and informal sector mainly comprises small financial institutions such as saving and credit cooperatives and *iqqub* and *iddir* respectively. The formal financial service sector regulated by National Bank of Ethiopia (NBE) comprises licensed commercial banks, insurance companies and microfinance. Licensed commercial banks have been permitted to provide all banking services. Hence, they play a central role within the financial services sector. They have the capacity to provide liquidity, and are also responsible for payment services, thereby facilitating for all entities to carry out their financial transactions.

In addition, the emergence of member based financial institutions has also been recognized for the provision of banking services in Ethiopia. These specialized institutions provide only certain financial services, such as saving and credit services to members. Cooperatives such as saving and credit cooperative (SACCOs) have an extensive network throughout the country. In 1991/1992, SACCOs, which were only 495 (with membership of 119,799), reached 10,270 in the year 2012, currently constituting the first most common type of coops in the country in terms of both number and membership. As coops, SACCOs are expected to play their share in bringing about broad based development and poverty alleviation. SACCOs are permitted to take deposit from the members and grant loan under the cooperative proclamation No. 147/1998. These proclamation, failed to recognize that SACCOs are financial institutions despite the fact that they accept deposits and grant loans. They are not subjected to the regulation and supervision that other formal financial intermediaries are subjected to (Kifle, 2012). Although SACCOs are not regulated or supervised by the National Bank of Ethiopia (NBE), they play a vital role for the development of small and microcredit, particularly in the rural parts of the country.

The only available comprehensive economic analysis of the semi formal sector is that of Mauri

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(1987), Begashaw (1987) and Aredo (1993),which brought to light the nature and relative economic importance of this sector in Ethiopia. However, there are still different aspects of the sector which need further investigation. For example, no attempt has been made to investigate the efficiency of semiformal sectors (i.e., saving and credit cooperatives). The literature to date has focused only on the formal sector (bank) and has neglected the semiformal sector of SACCOs. Little empirical evidence has been generated to measure the efficiency of SACCOs.

Table 1 presents the status of SACCO in Ethiopia in terms of number, membership, savings and loan dispersed in 2012. The table reveals that despite the importance of commercial banks, organizations based on cooperative model remained the dominant financial product/service provider. Moreover, SACCOs compete with other institutions in saving markets as well as lending markets.

Table 1. Status of SACCOs in terms of number, membership, savings and loan dispersed.

Type of SACCO	Number of SACCO	Membership Size	Saving	Loan dispersed
Urban	3573	381212	994,960,169	73,185,994
Rural	6134	529063	211,358,991	179,509,934
Total	10270	910275	1,206,319,160	252,695,928

Source: FCA (2012).

Though the purposes of financial cooperatives in Ethiopia are distinct, the soundness of every organization is important as these institutions contribute towards maintaining confidence in the system. Hence, providing efficient financial services can be a critical element of an effective poverty reduction and rural development strategy and also contributes to the development of the overall financial system through integration of financial markets (ADB, 2000). Although significant progress has been made in recent years, many rural financial institutions generally have insufficient capital, reach, and capacity to provide agricultural cooperatives with services at the scale they need. The provision of efficient financial products and services plays a key role in developing a robust sector and in enhancing outreach which in turn will lead to greater economies of scale, thereby improving profitability and enhancing sustainability (Sebhatu, 2012). Given this background, the SACCO sector in Ethiopia needs structural changes for diversification of its activities to enhance self-sufficiency and provide access for rural people. For the SACCOs to perform, grow and achieve sustainability while at the same time proving to be the instruments of development and poverty alleviation by mobilizing small savings from the members and diversify them to the productive use in the agricultural sector, it is relevant and appropriate to study the relative efficiency of SACCOs in Tigrai region.

Objectives of the Study

The main objective of this research is to examine the overall efficiency of rural SACCOs in Tigrai region (Ethiopia). A comparative analysis is undertaken to identify the relative levels of SACCOs with controls for size and geographical areas of operations. The next section reviews the literature related to efficiency in financial institutions and relates this literature to develop methodology and the measurement of efficiency of SACCOs.

Research Questions

Based on the above facts, this study seeks to address the following research questions:
-Do the SACCOs in Tigrai region operate efficiently in providing financial products/services?
-Does the size of the SACCOs affect their efficiency?
-Does the location of the SACCOs affect their efficiency?

Overview of SACCO in Tigrai Region

The primary beneficiaries of financial services offered by SACCOs are agricultural cooperatives and small enterprises. These SACCO do not exclusively target the rural or define their mission as serving the poor. Their long term strategic direction is to ensure source of financing capital to agricultural cooperatives, financial products and services that effectively address agricultural cooperatives key financial needs (i.e., input credit, investment, insurance, etc.) and to diversify the membership income and wealth base in order to build a heterogeneous and stable core of membership. The large difference across institutions suggests that SACCOs have the potential to serve a wide range of

households, primarily farmers and microenterprises in rural areas of Tigrai region (Kifle, 2012).

The members rely on their own capital (shares) to foster their economic development through access to financial services-savings and credit. Since 2002, several rural SACCOs have been established in the region in collaboration with development organizations such as VOCA. Their appeal to rural people is spreading rapidly; while demand is evidenced by rapid growth rates in membership and average sizes of loans dispersed and deposits.

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Table 2. Depth of outreach rural SACCOs.

Indicators	2012
No of SACCO	793
Number of members	120,607
Percent of women members	38.8%
Saving (Million Birr)	41.4
Capital /Share (Million Birr)	11.4
Loan disbursed (Million Birr)	70.8
Total Asset (Million Birr)	113.8

Source**:** Regional Cooperative Agency (2012).

As of June 2012, the number of rural SACCOs has reached 793 with active total membership of 120,607 of which the percentage of women members were 38.8 %(n= 46,796). These SACCOs pulled a saving amount of 41.4 Million Birr (2.36 Million USD), with 11.4 Million Birr (64,7648USD) in share capital. Their share capital and savings are invested in a 70.8Million Birr (4.03Million USD) loan portfolio that finances their microenterprises and agricultural activities. However, the SACCOs provide less than one percent of the country's total financing, and many struggle with low-capacity management and governance (Kifle, 2012).

Literature Review

The two principal method of studying comparative efficiency are parametric and non-parametric methods. Stochastic Frontier Analysis (SFA) is a parametric method which determines comparative efficiency levels by hypothesizing a functional form. Data Envelopment Analysis (DEA), conversely, is a non-parametric method which employs mathematical programming /linear programming model (Coelli et al., 1998). The popularity of DEA rests on its capability to consider multiple inputs and outputs for calculating relative efficiency. DEA comes up with a single scalar value as a measure of efficiency and does not requires any specification of functional forms as is required under parametric models.

DEA is a linear programming model used to measure technical efficiency. It comes up with a single scalar value as a measure of efficiency. Efficiency of any firm can be defined in terms of either output maximization for a set of inputs or input minimization for a given output. In DEA, relative efficiencies of a set of decision-making units (DMUs) are calculated. Each DMU is assigned the highest possible efficiency score by optimally weighing the inputs and outputs. DEA constructs an efficient frontier composed of those firms that consume as little input as possible while producing as much output as possible. Those firms that comprise the frontier are efficient, while those firms below the efficient frontier are inefficient. For every inefficient DMU, DEA identifies a set of corresponding benchmark efficient units (Coelli et al., 1998). Generally, DEA evaluates the efficiency of a given firm, in a given industry, compared to the best performing firms in that industry by considering many inputs and outputs. Thus, it is a relative measurement.

Many efficiency studies related to banks and financial institutions using DEA method have been carried out in different countries, in different contexts. Studies by Taylor et al., (1997) of Mexican banks, Brockett et al., (1997) of American banks, Schaffnit, Rosen and Parade (1997) of large Canadian banks, Soteriou and Zenios (1999) of Cyprus Commercial banks, Kao and Liu,(2004) of Taiwanese Commercial banks, Portela and Thanassoulis (2007) of Portuguese banks and Jayamaha and Mula (2011) of cooperative rural banks in Sri Lanka are a few of the efficiency studies in the banking sector.

Overview of the Study Area

The Tigrai region of Ethiopia located between in 12^0 15'N and 14^0 57'N latitude and 36^0 27'E and 39^0

59'E longitude. The region is bordered with Eritrea to the north, to the west by the Sudan, to the south by the Amhara national regional state, and to the east by the afar national regional state. Mekelle city is the capital of the national state of Tigray region, which is the political and commercial center of the region.

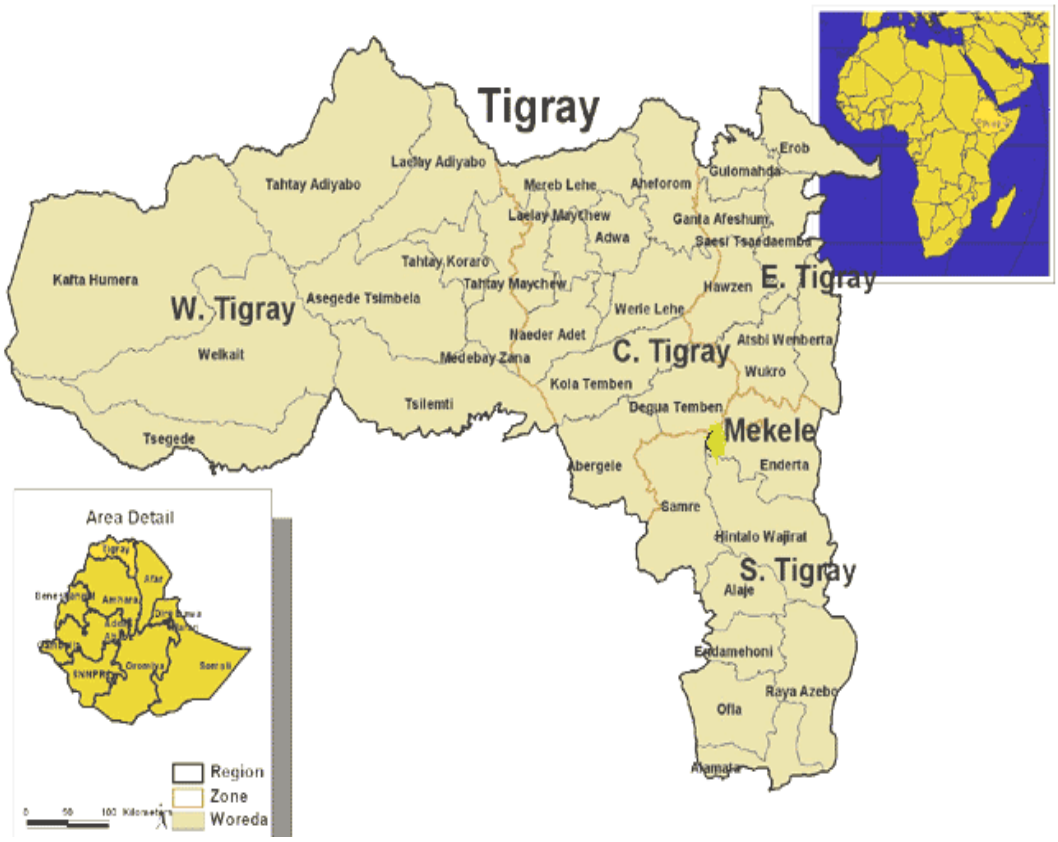

Figure 1**.** Map of Tigrai region.

Sample and Data of the Study

As discussed previously, saving and credit cooperatives (SACCOs) remained the dominant financial service providers in rural areas of the country in terms of financial services, number and membership. As of June 2012, there were 793 rural SACCOs operating throughout the Tigrai region. However, due to lack of completed data, this study considered only 329 SACCOs operating in all 36 districts of the region. Secondary data are used to analyze the efficiency of SACCOs. Data are obtained from the annual financial statements and annual reports of the Federal Cooperative Agency (FCA) and Regional Cooperative Promotion Agency for the year 2012. Other relevant data are obtained from various internal reports and other official documents of SACCOs.

Inputs and Outputs

There is considerable debate in the banking literature about what constitute input and output of banking industry (Casu, 2002; Sathye, 2003). Two different approaches appear in the literature regarding the measurement of inputs and outputs of the bank. These approaches are the 'intermediation approach' and 'production approach' (Humphrey, 1985). The intermediation approach views financial institutions mainly as mediators of funds between savers and investors (Banker etal., 1984). Outputs are measured in monetary values and total costs include all operating and interest expenses (Sealey & Lindley, 1977). In contrast, the production approach view banks as using purchased inputs to produce deposits and various categories of bank assets. Both loans and deposits are, therefore, treated as outputs and

measured in terms of the number of accounts. This approach considers only operating costs and excludes the interest expenses paid on deposits since deposits are viewed as outputs. Although the intermediation approach is most commonly used in the empirical studies, neither approach is completely satisfactory, largely because the deposits have both inputs and output characteristics which are not easily disaggregated empirically.

Berger and Humphrey (1997) suggested that the intermediation approach is best suited for analyzing bank level efficiency, whereas the production approach is well suited for measuring branch level efficiency. This is because, at the bank level, management will aim to reduce total costs and not just non-interest expenses, while at the branch level a large number of customer service processing take place and bank funding and investment decisions are mostly not under the control of branches. Also, in practice, the availability of data required by the production approach is usually rare. Therefore, following Berger and Humphrey (1997), we have selected intermediation approach as opposed to the production approach for selecting input and output variables in the present study.

The efficiency scores are estimated for individual SACCOs and mean efficiency scores are calculated for the sample as a whole. In terms of size and geographical location estimated efficiencies are also examined with mean estimated scores over the study year. Moreover, correlation coefficients for inputs and outputs variables are estimated. Thus, a total of 329 observations were used for DEA efficiency analysis in this study. Savings, and total expenses have been identified as inputs and loans and total income have been identified as outputs. The following table presents the input-output specifications. These inputs and outputs are identified from prior studies suitable of this study.

Table 3. Input-output specifications.

Intermediation Approach		
Variables	Definition	Input/ Output
Total expenses	Amount paid as interest on deposits, wages and other benefits to employees, and expenses incurred on others.	Input
Saving s	Deposit mobilized from the members and includes share capital, voluntary, and compulsory savings.	Input
Loans	Amount of loan dispersed to the members.	Output
Total income	Income received on income generating activities and investments as interest.	Output

Discussion and Analysis

The correlation coefficients show all variables have positive and significant relationship with each other. In regard to the estimated coefficients all output variables (loans and income) are positively and significantly correlated with deposits and expense. In particular, the association has a very high correlation of over 0.80 in some cases. These statistically significant and positive correlations among the variables provide further support for the appropriateness of the selected variables in the DEA model in this research. Overall, the correlation results show that change in one variable can be expected to impact the overall efficiency of the SACCOs. The reminder of this section discusses the efficiency of SACCOs based on estimated DEA scores.

Table 4. Descriptive statistics of inputs and outputs in DEA models.

Input/output	Savings	Loans	Income
Loans	0.870		
	(0.000)		
Income	0.284	0.353	
	(0.000)	(0.000)	
Expense	0.224	0.312	0.442
	(0.000)	(0.000)	(0.000)

*Correlation is significant at the 0.01 level.

Efficiency Score

The efficiency measures computed in our study are relative in nature. The performance of a SACCO is not assessed in an absolute manner but is compared with the best in the industry. The sources of inefficiency can be determined by comparing the relative sizes of various efficiency measures. The estimated efficiency scores for each DMU and the estimated mean efficiency scores are in the appendix.

To estimate the performance and efficiency of the financial cooperatives, several models with different variables are estimated. The DEA model under variable return to scale (VRS) can provide a better indication of the relative performance of the SACCOs. TE represents technical efficiency in the Charnes, Cooper and Rhodes's (CCR) model in VRS and SE represents scale efficiency with VRS. The summary of estimated results for efficiency is presented in Table 5.

Table 5. Summary of efficiency scores.

				Descriptive Statistics			
Description	No of DMUs evaluated	Efficient	Inefficient	Mean	Max	Min	SD
VRS	329	18	311	0.213	1.000	0.008	0.256
SE	329	7	322	0.770	1.000	0.053	0.256

TE = Technical efficiency SE = Scale efficiency.

The results for the DEA run with variable returns to scale indicate that the average technical relative efficiency is 0.213, which means that overall technical inefficiency of SACCOs is to the tune of 79% in the year 2012. Of 329 SACCOs, 18 SACCOs are identified as "relatively efficient" with technical efficiency score equal to one. The remaining 311 SACCOs have been found to be "relatively inefficient" with efficiency score less than one in the same year. The inefficient SACCOs can improve their efficiency by decreasing resource inputs and increasing outputs. In other words, it implies that the SACCOs will be maximizing the output at given inputs or minimizing the inputs at given out put level depending on the amount of resource utilized.

As can be seen from the annexed table, most of the SACCOs are inefficient with a very low overall efficiency score of 0.213. This indicates that there is huge possibility for the SACCOs to improve their efficiency through improved utilization of their inputs and outputs. It should be clear that there are only 18 SACCOs which are efficient, and these are, in fact, efficient in relative terms. More specifically, the DEA result clearly shows the targets for the inefficient SACCOs. For instance, if we take SACCO No. 10, it was compared against SACCO No. 252, 233, and 300. If SACCO No. 10 is to be as relatively efficient as its peers (which are listed in the appendix), it has to reduce its expenses by 61% and increase its loan amount and income 6.4times the current level. The same analysis could be made about the other relatively inefficient ones too.

Efficiency analysis by size

Only one metric is used to measure the size of the sample SACCOs; i.e., amount of capital. A three tier size classification system is defined in Table 6. The percentage of the sample for the small, medium and large categories are also shown.

Table 6. Size metric of the sample.

Size	Large	Medium	Small	Scale
Capital	19%	18%	63%	Large = More than 200 thousand Birr, Medium=100 thousand to 200 thousand Birr, Small=below 100 thousand Birr

As shown in Table 6 specific size categories have been determined at the researchers' discretion. Based on the capital size of the DMUs, majority (63%) of the sample are below 100,000 Birr capital balances and are considered as small scale. DMUs with Capital balances over 200,000Birr are grouped as large scale and account for 19% of the total. 18% of the DMUs have capital balances ranging from 100,000 to 200,000 Birr and are put as medium scale. The efficiency scores also are analyzed for the size categories. The mean DEA scores for each DMU are considered for this analysis. Figure1 present technical efficiency (TE) of the sample by size.

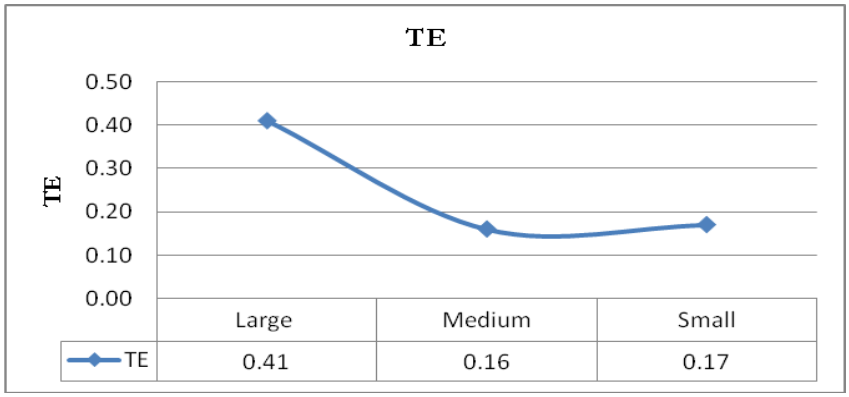

Figure 2: TE and size.

The TE efficiency score of large scale categories was 41%, during the year 2012. Small scale and medium scale DMUs had TE scores of 17% and 16% respectively. The estimated overall mean of TE score were higher for larger DMUs compared to medium and small size DMUs (see Figure 2).

Efficiency analysis by location

Efficiency scores are examined to see whether geographical disparity affects the efficiency of the SACCOs. Table below presents the mean efficiency scores by zone calculating the overall mean efficiency of each DMU.

Table 7. Mean efficiency by location

S/No	Zone	Mean TE	No of efficient SACCOs	No inefficient SACCOs	%age of Efficient SACCOs
1	South	0.276	4	65	6.15%
2	South East	0.221	0	35	0%
3	Eastern	0.137	2	69	2.9%
4	Central	0.201	7	104	6.73%
5	Western	0.259	5	38	13.16%

As can be seen from the table above, the Eastern and South East zones had the lowest proportion of relatively efficient SACCOs. In fact, though South East zone had none of its SACCOs with a relative efficiency score of one, its overall mean efficiency score was greater than that of Eastern zone. In relative terms, the other three zones had better number of efficient SACCOs. It looks like the location factor has effect on efficiency but this requires further investigation taking different approaches.

Findings and Conclusion

The primary objective in this study was to assess overall efficiency of SACCOs in Tigrai region by taking 329 rural SACCOs which were operating in the year 2012. It was found that majority of SACCOs were less efficient over the study year and did not use their inputs efficiently. However, it is found that there were significant differences in the efficiency of SACCOs by geographical locations and size. It is noted that size really matters when it comes to efficiency of SACCOs.

This efficiency study is much important for policy makers and managers, the reason that, after the year 2008 many new microfinance entered the rural finance market in the region and many commercial banks diversified their activities to include microfinance services. Hence, it is important to assess that pioneers of the microfinance activities in the region, SACCOs, operate their activities in different market segments especially as changing macroeconomic conditions. Moreover, the findings of this study may convince the sector decision makers to establish more comprehensive policy setting for promoting SACCOs activities in the Ethiopian rural financial sector and

survival of the institutions. Further work could extend our research in various directions not considered in this study. First, the efficiency of SACCOs could be compared with that of microfinance. Second, subject to data availability over a longer period that would result in a higher sample, one could examine the technical efficiency using stochastic frontier analysis.

Limitations of the Study

This study is based on secondary data collected from annual reports of Regional Cooperative Promotion Agency. These are compiled from SACCOs' financial statements; even if audited, they may not be strictly accurate and comparable. This could somehow affect the findings. The level of variation in disclosure across the sample is also a limitation. Hence, the sufficiency, reliability, and validity of data are subject to the above limitations. Further, this study focused on only one type of cooperative, namely SACCOs'. No attempt has been made to assess the efficiency of different types of cooperative operating in Tigrai region. Other types of cooperatives such as Multipurpose, agricultural marketing cooperatives may or may not have similar issues, but this study does not attempt to provide evidence for other cooperatives. In general, subject to the data limitations discussed above, the analysis of efficiency in this study is based on SACCOs and different to generalize for the whole cooperative society so the results obtained must be treated with caution.

References

Aredo, D. (1993). *The informal and semi-formal financial sectors in Ethiopia: A study of the Iqqub, Iddir, and Savings and Credit Co-operatives*: African Economic Research Consortium.

Banker, R., Charnes, A., & Cooper, W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science,30*(9),1078-1092.

Begashaw, G. (1978). The economic role of traditional savings and credit institutions in ethiopia/le role economique des institutions traditionnelles d'epargne et de credit en ethiopie. *Savings and Development*, 249-264.

Berger, A., & Humphrey, D. (1997). Efficiency of financial institutions: International survey and directions for future research. *European Journal of Operational Research, 98*(2), 175-212.

Brockett, P., Charnes, A., Cooper, W., Huang, Z., & Sun, D. (1997). Data transformations in DEA cone ratio envelopment approaches for monitoring bank performances. *European Journal of Operational Research, 98*(2), 250-268.

Casu, B., Girardone, C., & Molyneux, P. (2004). Productivity change in European banking: A comparison of parametric and non-parametric approaches. *Journal of Banking and Finance, 28*(10), 2521-2540.

Coelli, T., Rao, D., O'Donnell, C., & Battese, G. (2005). *An introduction to efficiency and productivity analysis*: Springer.

Delis, M., & Papanikolaou, N.(2009). Determinants of bank efficiency: evidence from a semi-parametric methodology. *Managerial Finance, 35*(3), 260-275.

Goddard, J., Molyneux, P., Wilson, J., & Tavakoli, M. (2007). European banking: An overview. *Journal of Banking & Finance, 31*(7), 1911-1935.

Humphrey, D.(1985). Cost and scale economies in bank intermediation. *Handbook for Banking Strategy, New York: John Wiley and Sons*, 745-783.

Jackson, P., & Fethi, M.(2000). Evaluating the efficiency of Turkish commercial banks: An application of DEA and Tobit Analysis.

Jayamaha, A., & Mula, J.(2011). Best Financial Practices Analysis and Efficiency of Small Financial Institutions: Evidence from Cooperative Rural Banks in Sri Lanka. *Journal of Emerging Trends in Economics and Management Sciences (JETEMS), 2*(1), 22-31.

Kao, C., & Liu, S.(2004). Predicting bank performance with financial forecasts: A case of Taiwan commercial banks. *Journal of Banking & Finance, 28*(10), 2353-2368.

Mostafa, M. (2007). Benchmarking top Arab banks' efficiency through efficient frontier analysis. *Industrial Management and Data Systems, 107*(6), 802-823.

Mukherjee, A., Nath, P., & Pal, M.(2002). Performance benchmarking and strategic homogeneity of Indian banks. *International Journal of Bank Marketing, 20*(3), 122-139.

Portela, M., & Thanassoulis, E. (2007). Comparative efficiency analysis of Portuguese bank branches. *European Journal of Operational Research, 177*(2), 1275-1288.

Sathye, M. (2003). Efficiency of banks in a developing economy: the case of India. *European Journal of Operational Research, 148*(3), 662-671.

Schaffnit, C., Rosen, D., & Paradi, J.(1997). Best practice analysis of bank branches: an application of DEA in a large Canadian bank. *European Journal of Operational Research, 98*(2), 269-289.

Sealey, C., & Lindley, J.(2012). Inputs, outputs, and a theory of production and cost at depository financial institutions. *The Journal of Finance, 32*(4), 1251-1266.

Sebhatu, K. (2012a). Determinants of saving Behaviour of cooperative members survey evidence from Tigrai region, Ethiopia. *Journal of Research in Economics and International Finance (JREIF) 1*, 150-158.

Sebhatu, K. (2012b). The Impact of Savings and Credit Cooperatives in Ofla Wereda Tigray Region of Ethiopia. *European Journal of Business and Management, 4*(3), 78-90.

Sebhatu, K.(2012c). Management of Savings and Credit Cooperatives from the Perspective of Outreach and Sustainability: Evidence from Southern Tigrai of Ethiopia. *Research Journal of Finance and Accounting, 2*(7-8), 10-23.

Soteriou, A., & Zenios, S. (1999). Using data envelopment analysis for costing bank products. *European Journal of Operational Research, 114*(2), 234-248.

Taylor, W., Thompson, R., Thrall, R. , & Dharmapala, P. (1997). DEA/AR efficiency and profitability of Mexican banks a total income model. *European Journal of Operational Research, 98*(2), 346-363.

Appendix 1. Efficiency Score.

S/No	DMU	Vrste	S/No	DMU	Vrste	S/No	DMU	Vrste	S/No	DMU	Vrste
1	Z/Hiwot	**1.000**	43	Kulu Gizea Lemlem	0.088	86	Lemlem	0.167	128	Kudus- Micheal	0.094
2	Bruh Tesfa	0.194	44	Millinum Hayalo	0.089	87	Sh/Lemlem	0.267	129	Fana	0.027
3	Lemlem Raya	0.300	45	Felege Hiwot	0.075	88	Weini	0.096	130	Fithanegest	0.061
4	Hadash Berhan	0.100	46	Marta	0.140	89	Teabe	0.141	131	Zemenawit	0.373
5	Delit	0.091	47	Awshra	0.131	90	Hayki-Hilet	0.066	132	Kokob	0.077
6	Alem- Berhan	0.274	48	Belay Abera	0.428	91	Gelaw Awhi	0.205	133	Miebale	0.020
7	Berhan	0.117	49	Adis Zemen	0.055	92	Hedasie	0.055	134	Azmera	0.074
8	H/Gezie/ Genet	0.163	50	Shaina	0.543	93	Tembian-Trae	0.297	135	Maebel	0.020
9	Jon-umer	0.083	51	Tsehaynesh	0.101	94	Aedi -Gezaeti	0.310	136	Lewti	0.079
10	Tazma	0.135	52	Lemlemitu Korem	0.104	95	Enda -Korar	0.539	137	Meraya	0.062
11	Hawelti/Weregba	0.072	53	Kidana	0.304	96	Mizan	0.086	138	Fre-Marta	0.035
12	Awet	0.061	54	Berhane sofia	0.118	97	Megeseta	0.139	139	Weini	0.108
13	Fre-Alaje	0.352	55	Embeba Haya	0.846	98	Delit	0.122	140	Fre-Saz	0.102
14	Shewit Betmara	0.061	56	Haftamnesh	0.459	99	Debre Nazret	0.014	141	Welegesa	0.089
15	Hadnet Chelena	0.602	57	Millinum	**1.000**	100	Abeba	0.026	142	Fre-Lemeat	0.073
16	Tirhas Dila	0.181	58	Kulu Gizea Lemlem	0.092	101	Chini	0.016	143	Zemen	0.070
17	Simret	0.229	59	Millinum Hayalo	0.126	102	Adi -Edaga	0.037	144	Lemeat Mama	0.127
18	Selam Seret	0.028	60	Felege Hiwot	0.059	103	Enda ba- Hadera	0.047	145	Sasun	**1.000**
19	Genet Telma	0.231	61	Mulu Berhan	0.387	104	Admas	0.220	146	Shewit	0.294
20	Bruh Tesfa	0.297	62	Lemlem - Sala	0.487	105	Birki	0.116	147	Lemlem	0.288
21	Zewel-Ayba	0.082	63	Tekli- bebizwa	0.298	106	Selam	0.099	148	Tsige Reda	**1.000**
22	Felege Hiwot	0.071	64	Gereb Ayni	0.296	107	Addis Alem	0.047	149	Embeba	0.275
23	Lemlem Tika	0.114	65	Meda Berba	0.135	108	Negash	0.121	150	Hibret	0.192
24	Fre-Sewuat	0.081	66	Berhan- Tsibet	0.444	109	ZaaNa	0.030	151	Meseret	0.033
25	Genet-Kilma	0.073	67	Gedamu	0.228	110	Ezana -Sizana	0.012	152	Alemtsehay	0.076
26	Yekatit	0.092	68	Freweyni	0.273	111	Samra	0.172	153	Millinium	0.267
27	Endodo	**1.000**	69	Hiwot lemlem	0.204	112	Genet	0.234	154	Awet	0.051
28	Meseret	0.763	70	Fre Zemen	0.221	113	Lemeat	0.148	155	Hiwot	0.071
29	Embeba Hashenge	0.420	71	Lemlem Fithawit	0.041	114	Sur-Millinium	0.259	156	Hawelti	0.126
30	Mulu -Berhan	0.349	72	Millinium	0.083	115	Addis Alem	0.162	157	Weini	0.050
31	Berhan Sesela	0.231	73	L/M/Tekli	0.121	116	Selam	0.107	158	Sigem	0.039
32	Gereb Weine	**1.000**	74	Debre Hayla	0.589	117	Ebyet	0.072	159	Andi-Lemeat	0.051
33	Fre-limeat	0.090	75	Samrawit	0.363	118	Fre-Weini	0.130	160	Tesfa	0.055
34	Freweine	0.054	76	Netsanet	0.101	119	Dejen	0.089	161	Selam	0.033
35	Zata Hiwot	0.517	77	Fithawit	0.120	120	Shewit	0.056	162	KidistMariam	0.011
36	Nigsti Zata	0.105	78	Hadnet	0.727	121	Bruh Tesfa	0.122	163	Bruh Tesfa	0.080
37	Addisalem	0.145	79	Lemlem Cheli	0.306	122	Hadnet	0.077	164	Danait	0.102
38	Senay	0.534	80	Kokob1	0.877	123	Kisanet	0.031	165	Marta	0.141
39	Alem Berhan	0.381	81	Maernet	0.521	124	Hiwot	0.057	166	Awlie-Tsero	0.038
40	Lemlem -Ofla	0.150	82	Ahadu	0.076	125	Shewit lemlem	0.032	167	Nestanet	0.124
41	Tsige Reda	0.103	84	Shewit Hintsa	0.476	126	Emnet	0.221	168	Berhan	0.059
42	Fikre- Welda	0.636	85	Yikaal	0.259	127	Simret	0.097	169	Erope	0.606
S/No	DMU	Vrste	S/No	DMU	Vrste	S/No	DMU	Vrste	S/No	DMU	Vrste
170	Selam	0.226	213	Selam	0.046	256	Medhin-Alem	0.145	299	Millinium	0.364
171	Kudus- Gergise	0.071	214	Semhal	0.062	257	May-Nigus	**1.000**	300	Selam	**1.000**
172	Asimba	0.102	215	Fre-Suwaat	0.024	258	Hadnet	0.062	301	Lekatit	0.038
173	Sibagadis	0.110	216	Tsilale_Daero	0.143	259	Man-Sagla	0.050	302	Awet	0.095
174	Halo	0.046	217	Felafel	0.027	260	Fana	0.251	303	Maernet	0.377
175	Daba-Koma	0.158	218	Miebale	0.894	261	Nihbi	0.475	304	Daero	0.358

176	Tanqa-Milash	0.681	219	Maebel	0.038	262	Seti-Semhal	0.254	305	Kokob	**1.000**
177	Dalgoa	0.137	220	Meseret	0.027	263	Danabit	0.075	306	Lemlem	0.014
178	Genet	**1.000**	221	Fre-selam	0.025	264	Weini	0.151	307	Wihdet	0.333
179	Millinium	0.548	222	Millinium	0.035	265	Nigste-Saba	0.253	308	Tsiniet	0.271
180	R/mal	0.123	223	Fre-Lemeat	0.060	266	Ebyet	0.106	309	Mihznet	0.126
181	Fre-Tsaeri	0.078	224	Selam	0.042	267	Hadnet	0.161	310	Weini	0.035
182	H/Serawe	**1.000**	225	Fre-Jeganu	0.015	268	Tsilal	0.073	311	Capital	0.444
183	Filfil	0.519	226	Shewit	0.032	269	Lemeat	0.020	312	Filfil	0.008
184	Rahwa	0.078	227	Wihdet	0.039	270	Maydaero	0.097	313	Ruba-Bayta	0.024
185	Kokob-Tsibah	0.490	228	Hiwot-Lemeat	0.122	271	Awet	0.010	314	Bruh-Tesfa	0.083
186	Abzat	0.686	229	Lahmat	0.021	272	Selalwa	0.145	315	Kedawit	0.016
187	N/Berhane	0.264	230	Sesen	0.012	273	Fre-lemeat	0.205	316	Hamlawit	0.091
188	Wegahta	0.231	231	Milyenu	0.032	274	Mariam-Tamba	0.048	317	Fre-Lemaet	0.011
189	Shushayna	**1.000**	232	Hadnet	0.076	275	Genet	0.079	318	Zala-Ambesa	0.038
190	Wer-Reba	0.576	233	Rahwa	**1.000**	276	Madi-Hiwot	0.071	319	Seberom	0.069
191	Almeda	0.217	234	Kokob	0.051	277	Shewit	0.023	320	Ayfa	0.100
192	Enda-ba-Gerima	0.256	235	Kisanet	0.014	278	Kokob3	0.067	321	Marta	0.123
193	May-shingurti	0.243	236	Firyat	0.026	279	Fithawit	0.043	322	Frehiwot	0.101
194	Adi-Berak	0.218	237	Fithawit	0.138	280	Weini	0.104	323	Adi-Awala	0.424
195	Laelay-Legomti	0.041	238	Awet	0.020	281	Haftom	0.033	324	Rahwa	**1.000**
196	Fre-Lemeat	0.116	239	Hibret	0.012	282	Mesert	0.055	325	Wihdet	0.037
197	Mahbre-Selam	0.153	240	Marta	0.038	283	Weini-Selam	0.022	326	Sur	**1.000**
198	Tahtai-Legomti	0.088	241	Tesfa	0.028	284	Kisanet	0.058	327	Walya	**1.000**
199	Miebale	0.065	242	Kedawit	0.030	285	Mayliham	0.533	328	Bahre-Selam	0.897
200	Kokob-Tsibah	0.136	243	Haregeweini	0.068	286	Kewanit	0.119	329	Kebabo4	0.139
201	Erdi-Jeganu	0.065	244	Segem	0.053	287	Taba-Weyane	0.179		**Mean**	**0.213**
202	Tub-Gorzo	0.015	245	Senay	0.063	288	Letencheal	0.215			
203	Finote-Selam	0.099	246	Maernet	0.056	289	Lemlem	0.082			
204	Bruh-Tesfa	0.436	247	Rahwa	0.058	290	Silas	0.036			
205	Maebel	0.149	248	Hadas-Raei	0.110	291	Eleni	0.025			
206	Yiha	0.033	249	Gelila	0.015	292	Arkebet	0.157			
207	Tsediya	0.429	250	Rahwa	0.108	293	Filfil -sene	0.050			
208	Kokob	0.836	251	Lemlem	0.067	294	Fre-Hiwot	0.017			
209	Dejen	0.265	252	Shewit	**1.000**	295	Metkel	0.267			
210	Bruh-Tesfa	**1.000**	253	Daero-Mishilam	0.043	296	Miebale	0.075			
211	Kola-Geble	0.087	254	Kidus-michael	0.174	297	Hadnet	0.246			
	Golgolo	0.049	255	Kokob2	0.118	298	Simret	0.179			