Determinants of banks' cost efficiency: a case study of selected commercial banks, Ethiopia

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Abstract

This study examines the determinants of cost efficiency commercial banks' in Ethiopian using balanced panel data with a sample of 13 commercial banks over the period 2010-2017 by paying a translog stochastic cost frontier approach. The identification and selection of inputs and outputs variables was based on the intermediation approach. Accordingly, three input variables (cost of labor, cost of capital, and cost of fund) and two output variables (total loans and other earning assets) are used in the study. Furthermore, five banks specific and one macroeconomic variable are included to examine their effect on cost efficiency. So as to examine the effect of determinant variables which are associated with banks efficiency, a single stage maximum likelihood estimation method is applied to stochastic frontier cost function. The empirical estimations were accomplished by Appling a single stage maximum likelihood function assimilated into Stata software. The estimation is based on conditional mean model concepts. The finding shows that from bank specific factors, return on assets (ROA), and intermediation ratio have positive and significant for intermediation (IR) and insignificant for ROA with cost inefficiency. On the other hand, Bank size (lnTA), Credit risk (CR) and capital adequacy ratio (CAR) have a significant negative coefficient with cost inefficiency. GDP also has negative but insignificant with inefficiency. Therefore, banks are recommended to improve and sustain their efficiency by maintaining available proportion of capital adequacy ratio and attract high value, low interest-bearing demand deposits.

Key Words: *Bank, Cost efficiency, Stochastic cost frontier*

JEL Classification: G21, G32, G33, O16

INTRODUCTION

Modern Banking in Ethiopia was started in 1905, for the period of Minelik II, with the establishment of the Bank of Abyssinia (Rama & Tekeste, 2012). The bank of Abyssinia was owned by the Ethiopian government in partnership with the National Bank of Egypt formerly under British rule. However, a sound banking system started to develop in the early of 1940s-after the Italian departure. A government preserved bank which is the State Bank of Ethiopia-was established in 1942, and a number of foreign bank branches and a private bank were working in opposition with the government possessed commercial bank up to they were nationalized and merged into one government owned

mono-bank in 1976. Due to their dynamic role, banks as financial intermediaries play unlimited role in the economy of a country being as a major resource allocator of a state. Moreover, financial institutions help the government in formulating and evaluating monetary and economic policies, and also make accessible a wide diversity of economic services such as transfer of money, foreign exchange, simplify international trade, market stabilization and other related activities (Scott & Timothy, 2006).

Commercial banks collect deposits from depositors and use the proceeds to provide credit to businesses, individuals, as well as government agencies. Hence, they support investors who demand to invest their surplus funds in the form of deposits. Commercial banks use the deposited moneys to bid commercial loans to businesses and personal loans to individuals. Correspondingly, commercial banks make invest in debt securities issued by firms as well as government agencies. As banks are financial intermediaries, they should have to do in economically or efficiently so as to facilitate economic development of a country through of transfer of economic resources Efficiency is a crucial notion for financial institutions, and it is measured in respect to an organization's objective and goals. It can be measured regarding maximization of output, maximization of profits, or minimization of costs (Mester & Allen, 2003). The efficiency of commercial banks is usually measured in terms of minimization of inputs to produce a specific level of outputs or in terms of maximization of outputs given a specific level of inputs (Wang, 2008).

Banks are the primary sources of external funds for businesses throughout the world. So the data suggests that banks have the most important role in financing business activities in both industrialized and under developing countries. Although banks are even more important in developed countries, they play the more important role in the financial system of under industrialized countries (Frederic, 2004). Therefore, commercial banks are the primary financial intermediaries in Ethiopia as Ethiopia is one of the developing sub-Sahara African countries. They constitute a significant part of the financial sector. According to (Beck, 2006), global financial background has been changing rapidly in the last two decades as a result of regulatory changes and technological development. Therefore, in a dynamic and reasonable banking system, only strong, technically efficient and profitable banks can promise a realistic return to their stakeholders and reduce the probability of bankruptcy (Adusei, 2016).

There are numerous studies which considered the determinants of the banking sector by using both parametric and non-parametric approaches in different parts of the world. For example, Tecles & Tabak (2010) studied the determinants of bank efficiency in Brazil by using stochastic frontier analysis. Fries & Taci (2005), studied the efficiency of banks across 15 East European countries.

Regarding to Ethiopian commercial banks, Muluneh (2006), examined the cost efficiency of six privately owned banks through a stochastic frontier analysis using quarterly data covering the year 1994-2001. Similarly, Eskindir (2013), applied the stochastic frontier approach so as to examine the cost efficiency of 10 commercial banks during the period 2007-2012 and to determine whether ownership has an impact on the cost efficiency of banks and found that private commercial banks are more cost efficient than the state-owned banks.) Tesfay (2016) examined the determinants of commercial Banks efficiency in Ethiopia over the period 2003–2012 using Tobit model. The study results revealed that deposit liquidity is found to have positive and significant effect on bank efficiency, while bank size has negative and significant effect on bank efficiency.

Mohana & Tekeste (2012), examined the relationship between cost efficiency and ownership structure of commercial banks in Ethiopia using data envelopment analysis (DEA). Moreover, they made try to discover the key causes that affect the cost efficiency

of the commercial banks using the Tobit model. Emishaw (2016), analyzed the determinants of Ethiopian commercial banks' cost efficiency using unbalanced sample of 12 commercial banks over the period 2000-2013 by employing a translog stochastic cost frontier approach. In order to examine bank specific factors which, influence in (efficiency), a single stage maximum likelihood estimation procedure is applied to a stochastic cost frontier function.

However, the aforementioned studies listed differently for the factors of commercial banks in Ethiopia that are contributed for different efficiency score over different time. Therefore, it is vital to study the determinant factors behind over time. Most of the studies are focused on technical as well as allocative efficiency only. Moreover, they have focused on non-parametric approaches that preset the inefficiency components differently than parametric approaches. Thus, this study includes the current data which enables the researcher to examine the current actual situations and efficiency performance of commercial banks. Furthermore, it includes bank specific determinant variables as well as macroeconomic factor that are affecting efficiency of banks positively or negatively.

Henceforth, assessing the determinants of commercial banks' efficiency is a vital owner so as to check benchmarks of their business, for depositors to make decisions about their savings, and it is essential for government to assess a particular sector of the economy. Therefore, this study was conducted with the objective of examining determinants of cost efficiency of commercial banks as well as the factors that are associated with cost efficiency of commercial banks using stochastic frontier approach to analysis the relative cost efficiency of commercial banks in Ethiopia based on an intermediation approach. The study used recent data from published and audited annual financial reports of commercial banks in Ethiopia during the period of 2010-2017 G.C.

METHODS

Target population

The target populations of this study were all of commercial banks of Ethiopia both the private and state-owned banks which are on operating for the described time periods.

Data types and sources

For this study we used panel data sourced from secondary sources so as to achieve the stated objectives. To do so, bank specific data which are audited financial statements (i.e. Balance Sheet and Profit & Loss Accounts) of each selected commercial bank included in the sample and macroeconomic data were collected from National Bank of Ethiopia. The collected data covers the time period from year 2010 to 2017 (for eight years data).

Sampling design and size

Non-probability sampling technique is applied in this study. Because, since the data used for this study includes the period of 2010-2017, some banks which are established after 2010 and have no data for the required period of time. Therefore, the sample of the study was based on judgmental sampling technique and incorporated thirteen commercial banks. The sample banks were awash international bank, Dashen bank, Bank of Abyssinia, Wogagen bank, united bank, Nib international bank, Cooperative bank of Oromia, Lion international bank, Zemen bank Sc, Oromia international bank, Bunna bank Sc, Berhan international bank Sc, and Commercial bank of Ethiopia. All these sample banks are on working since prior to 2010 G.C and they have the required data for this study.

233

Method of data analysis and presentation
To test the proposed hypotheses, statistical analyses were carried out using econometric analysis which is Stochastic Cost Frontier Model was used to test the relationships among variables

Description and operational definition of variables
Dependent variable
According to Fries & Taci (2004), Cost efficiency is determined by how close a banks costs lie to the efficient cost frontier for a given technology. The efficient frontier is determined by both technical efficiency and a locative efficiency. The absence of either technical or allocative efficiency or both necessarily leads to a departure from cost minimization and creates inefficiency. As the dependent variables represent the output or outcome whose variation is being studied, the dependent variable in this study is cost efficiency of commercial banks in Ethiopia.
Independent Variable
The independent variables represent inputs or causes, that is, potential reasons for variation. In this study, the independent variables include the input variables which are price of labor (W1), price of deposit (W2), and price of capital (W3), the output variables include total outstanding loans (Y1), deposits in NBE and other banks plus total investments in securities and other investment opportunities (Y2). In addition to the input and output variables, six banks specific and one macroeconomics determinant variables are also incorporated in the study.
Stochastic cost frontier model specification
This study intended to use the stochastic frontier approach. According to Battese and Coelli, (1995) stochastic frontier approach estimates a border function by taking into account the distributional assumptions for both components of random error and inefficiencies. The stochastic frontier approach assumes that bank inefficiency components have a truncated normal distribution which is independently and identically distributed across different banks, an assumption which is violated in the second step of the estimation procedure. This procedure permits cost efficiencies and their determinants to be estimated using a one-step maximum likelihood estimates (MLE) procedure (Fries &Taci, 2004).
According to Shen & Jones (2008), cost efficiency provides a measure of how close a bank's actual cost is to what a best practice institution's cost would be for producing the same output bundles under the same conditions. The measure is derived from a cost function in which total cost depends on the prices of inputs (W), the output quantities (Y), bank specific variables (Z) and an error term (ε). Thus the general form for the stochastic cost frontier function specified as follows:

$$C_i t = f(W_{it}, Y_{it}, Z_{it}; +\beta) + \mathcal{E}_{it} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (1)$$

Where C measures the total cost, W is a vector of the input prices, Y is a vector of the output quantities, Z is a bank specific efficiency determinants, β's are parameters and to be estimated, ε is preserved as a composite error term which is given in the form of $\varepsilon_{it} = \mu_{it}+v_{it}$, v_{it} symbolize the random component or error term which follows a normal symmetric distribution around the border, N $(0, \sigma 2_v)$ and integrates measurement error and break that could consequences for high or low costs for banks. The other component, μ_{it}, arrests the inefficiency term which follows a truncated normal asymmetric distribution or a half-normal distribution. Additionally, μ_{it} and v_{it} are should be independently and identically distributed. Therefore, the inefficiency component, (μ_{it}) is assumed to be the

function of a set of bank specific variables (Z_{it}) that may affect performance, a vector of coefficients to be estimated (∂) and random error (W_{it}).

$$\mu_{it} = Z_{it}\,\partial + W_{it} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots . (2)$$

Where, the random variable W_{it} has a half normal distribution with zero mean and variance $\sigma\mu^2$. To make things easier the measurement of efficiency, a functional form has to be chosen given the multiplicity of bank functions. Thus, to estimate the cost frontier function the trans-logarithmic functional form is looks to be best adapted compared to other functional forms because it takes into account the various complementarities between explanatory variables and it does not impose any restriction on the functional form. Moreover, panel data is used because observing banks at several points in time allows for possibly better estimates. For instance, assumptions relating to the stochastic frontier analysis can be relaxed, allowing for more flexibility in the handling of the model. Consequently, according to Kumbhakar & Lovell (2000) the estimation of banks relative efficiency using panel data is obtained by estimating a translog cost function of the general form as follows:

$$\ln C_{it} = \ln C_{it}(Y_{it}, W_{it}, Z_{it}; \beta) + \mathcal{E}it \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

Where $\varepsilon_{it} = v_{it} + \mu_{it}$ for every bank i = 1,.., N; C_{it} is total cost of bank i, Y_{it} is outputs' vector of bank i, W_{it} is inputs' vector of bank i, Z_{it} is bank specific variables, β is vectors of parameters to be estimated, μ_{it} is the measure of inefficiency of bank i and is determined by a set of bank specific variables. Staikouras & Schmiedel (2007), estimate the specific cost efficiency frontier using the specification of Tran slog as follows:

$$
\begin{aligned}
\ln C_{it} = a_0 &+ \sum_j \alpha jl\, n W_{jit} + \sum_k \beta k \ln Y k_{it} + 0.5 \sum_h \sum_j \alpha hj\, \ln W h_{it} \ln W j_{it} \\
&+ 0.5 \sum_k \sum_1 \beta k1 \ln Y k_{it} \ln Y1_{it} + \sum_h \sum_k \delta hk\, \ln W h_{it} \ln Y k_{it} \\
&+ \sum_m \varphi m \ln Z m_{it} + V_{it} + \mu_{it} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots . \dots\dots\dots\dots (4)
\end{aligned}
$$

Where i = (1,…….,13) refers to number of banks ,t = years of study (2010-2017), h and j= (1,….,3) are parameters of input prices, k and l = (1,2) are outputs, m refers to number of bank specific variables; β, δ and φ are parameters to be estimated. To decrease the number of parameters and consequently, to win in terms of degrees of freedom, the following limitations must be imposed:

$$\alpha hj = \alpha jh \text{ and } \beta k1 = \beta 1k \dots\dots\dots\dots\dots\dots\dots (Symmetric\ \ constraints)$$

Furthermore, any function of cost must be homogeneous of degree 1 in input prices. So, a proportional increase in input prices increases the total cost in the same proportion without affecting the factors request. The linear homogeneity conditions were imposed during the estimation by normalizing the cost and inputs prices by the input price of capital. This condition of homogeneity is translated by the following limitations:

$$\sum_j \alpha j = 1; \sum_j \alpha hj = 0; \sum_j \delta hk = 0 \dots\dots\dots\dots\dots (Homogeniety\ \ constraints)$$

These constraints of symmetry and homogeneity reduce significantly the number of parameters to be estimated.

RESULTS AND DISCUSSION

Estimation results of the stochastic cost frontier analysis

The empirical result of the cost frontier estimation throughout in this paper is accomplished by maximum likelihood cost function incorporated into Stata 14.0. Supplementary assumptions about the distribution of the one-sided error term were also tried. Specially, a more restrictive half-normal distribution of the inefficiency effect (Bottasso & Sembenelli, 2004) was estimated. Therefore, the result of this estimation is not reported. In contrast, convergence of the single stage frontier estimation and cost inefficiency model assuming a truncated normal distribution is achieved only after 14 numbers of iterations. Accordingly, the reported results are based on the selected specification taking into account the assumptions made about the inefficiency error component. In this manner, a general unrestrictive truncated normal distribution is assumed. According to Fujii (2001), the main advantage of this truncated normal distribution is that it allows for a simultaneous estimation of the stochastic frontier function and analysis of the determinants of the inefficiency effects under very general conditions.

Since, the conditional mean model approach allows for single step estimation of maximum likelihood estimates (MLE) of the parameters of the stochastic cost frontier function and the inefficiency model, the estimation result of the translog function is based on the conditional mean model approach of SFA method, using Strata software. In this paper, all the summary statistics and regression reports are generated using the software STATA.

The Table 1 presents the empirical results of the stochastic cost frontier model found through using Maximum Likelihood Estimation (MLE) method.

Table 1. Empirical results of the stochastic cost frontier model

Variables	Coefficients	Std. Erors	p-value
Lnw1	0.3071 *	0.0522	0.000
Lnw2	0.1522 *	0.0335	0.000
Lnw3	-0.00896	0.0243	0.713
Lny1	0.9124 *	0.0287	0.000
Lny2	0.0383	0.0294	0.193
Constant	0.0837	0.2533	0.741
Mu	-0.27077	17.2605	0.997
lnsigma2	-4.0127 *	1.0150	0.000
ilgtgamma	-4.0885	61.4261	0.947

*Log likelihood function= 61.946926 and the notations *represents the level of significant at 1%.*

As indicated from the regression table above, the input prices for labor and price of capital is positive and significant. This implies that increases in banks labor costs and other operating costs are directly reflected in higher total operating cost of the banks. As regression coefficient indicates, the unit labor cost coefficient is higher than that of the unit cost of capital. This implies that the amount of expenditure used as a labor wages, salaries and other benefits has a significant effect on total cost than that of expenditures relating to unit cost of capitals. When other things being constant and the unit labor cost increase by 1%, total operating expenditure of banks leads to increase by 0.307. This implies that from total expenditure of commercial banks, personnel or labor cost consists about 30.7%. Similarly, keeping other things constant and the price of capital increases by 1%, it leads to increase in total operating cost by 15.2%. In fact, both labor cost and cost of capital contribute the largest portion of banks operation expenses. This result is similar as expected value before regression.

The result also shows that the price of deposits is statistically insignificant with a negative sign. This implies that the contribution of cost of deposit has not high effect over total operating costs. Furthermore, this negative indicates the effect of interest rate margin over the cost of deposits. The presence of interest rate margins consequently may contributes to increase the levels of efficiency. This negative and insignificant sign of price of fund is deferent from the finding of Emishaw (2016) with positive and significant sign of cost of deposits.

The coefficients of both loans and other earning assets (out puts) are positive but significant for the first one and insignificant for the second one. The positive and significant sign of loans implying that production of loans followed with higher transaction costs because of the possibility related to risk assessment of loan applicants and checking of repayments. The higher estimated coefficient loans than that of the coefficient of other earning assets implies that in Ethiopian banks focus to invest on short term, medium term, and long-term loans as revenue generating activities. It is also indicating that Ethiopian banks are main sources of funds for business, individuals, as well as investors. This result is consistence with finding of Musonda (2008) when he was investigated the determinants of cost efficiency in Zambian banking sector. However, it is different from the finding of Emishaw (2016) when he examined the determinants of cost efficiency of banks in Ethiopian. The proportion or percentage of cost of output (loan) is higher and about 0.912. This means that the largest portion of labor cost is related to loan assessment and related activities. Furthermore, since banks are financial intermediaries, they collect time deposit, demand deposits and fixed deposits from customers and convert these deposits in to loans by incurring additional cost of customer analysis. Therefore, the cost of customers' analysis and cost of default loans increases the total cost of operations in banks. Consequently, this may lead to cost inefficiency of banks.

The positive but insignificant sign for other earning assets implying that, since these assets include investments on government and other corporate securities, deposits in national bank, and other banks, as well as deposit in foreign banks, these out puts(investments) are performed with low transaction costs. This result is inconsistent with the finding of (Emishaw, 2016).

Determinants of banks cost efficiency

Since the purpose of this study is to investigate the determinants of cost efficiency of commercial banks in Ethiopia. The researcher has more emphasized on bank specific and macroeconomic factors that are affecting cost efficiency level of commercial banks. Therefore, the estimated outcomes regarding to the determinants of bank cost efficiency are performed based on the conditional mean model approach of SFA method. Because, conditional mean model allows the single step estimation of maximum likelihood estimates (MLE) of the parameters of the stochastic cost frontier function and the inefficiency variables. The empirical results have presented in the Table 2.

As the regression coefficient indicates from the Table 2, Bank size (lnTA) which is the natural logarithms of total assets has a negative and significant coefficient. This negative and significant sign implies that there is appositive relationship between this variable and cost efficiency, but negatively related with cost inefficiency. Since large banks have capable of mobilizing large amount of funds in the economy, they can generate high returns for depositors as well as the equity holders. Therefore, larger banks have cost advantages over other smaller counterparts. Furthermore, larger banks could be able to finance large volume of profitable investment prospects and acquire better access to investment activities. This negative and significant relationship between bank size and

inefficiency model implies that large size enables banks to have economies of scope and consequently leads to cost efficiency.

Table 2. Empirical results of the determinants of banks cost efficiency

Variables	Parameters	Coefficients	Std. Errors
lnTA	β_1	-0.5839**	0.1068352
CAR	β_2	-0.1396**	0.0212513
CR	β_3	-0.1489**	0.0264674
IR	β_4	0.1205**	0.115208
ROA	β_5	0.0578**	0. 0585492
GDPGR	β_6	-0.03091	0.0622785
Constant	α_0	14.51369	3.359176
lnsigma^2		-0.6762146	0.1386752
Ligtgamma		-1.905811	6.049789
Sigma		0.50853	0.0705217
Gamma($_\gamma$)		0.129452	0.6817768
Sigma_u^2		0.065831	0.3467807
Sigma_v^2		0.442707	0.3524286

The symbolizations ***,**,* shows the level of significance at 1%, 5%, and 10% respectivily.

The presence of Economies of scope also enables banks to enjoy operational efficiencies, it is driven by product or services diversification. In the banking sector, economies of scope could be economical to diversify into different areas of financial services such as investment banking, commercial banking, leasing, and life insurance rather than focusing on traditional commercial banking only. This result is similar with of (Rohana & Tekeste, 2012). They found that bank size has appositive relationship with cost efficiency. But, it is different from the finding of Sanderson and Prier (2016) when they were investigated Zimbabwean banks sector. It is also similar with the conventional economics efficiency theory and findings of previous researchers (such as Rozzani & Rahman, 2013) it is hypothesized that larger banks would acquire better efficiency, since these banks would have more resources to be allocated for better services to its customers).

The capital adequacy ratio (CAR), with negative and significant coefficient also shows that, there is a negative relationship between inefficiency and this variable and implies that positively related with cost efficiency. High level of capital reduces the risk of insolvency and the cost of borrowed capital. Since car is measured by the ratio of bank's capital over total assets, it is an indicator of the coverage ratio of banks assets by owners' fund. Furthermore, it is as a measure of bank's financial strength and stability. Since then, the positive and significant coefficient of CAR with cost efficiency implies that well capitalized banks can provide better banking products and services in stabilized manner. Furthermore, higher amount of capital enables banks to invest without raising additional deposits as source of funds with cost of funds (interests). This situation enables banks to reduce cost of funds relating to raising additional deposits to finance their activities. This outcome is consistent with the finding of Frimpong, Gan & Hu (2014) that evaluate cost efficiency Gana's banking sector and found that appositive relationship between CAR and efficiency. Whereas, it is different from the finding of Emishaw (2016) found appositive and significant relationship between this variables and total costs and contributes to lower cost efficiency and Sanderson & Pierre (2016) evaluated the cost and revenue efficiency of the Zimbabwean banking sector during the period of 2009- 2014. The result showed that capital adequacy has a negative and significant relationship with cost efficiency.

The intermediation ratio (IR) has a positive and significant coefficient with cost inefficiency. This implies that negatively affects cost efficiency of commercial banks. The positive and significant coefficient indicates that an increase in the proportion of interest-bearing deposits (time and savings deposits and interbank liabilities) to gross loans, the higher the intermediation costs and by extension, the higher the operating expenses. In order to decrease the costs associated with deposit mobilization and interbank funds, banks should be encouraged to attract high value, low interest-bearing demand deposits. Furthermore, the positive coefficient indicates that the major sources of funds for commercial banks of Ethiopia are from interest bearing customer deposits rather than equity capitals. Therefore, the cost of funds (interest expense) positively affects total operating costs and then negatively affect cost efficiency of banks. This result is similar with the finding of Joshua (2011) stated that intermediation ratio has positive relation with total cost and negatively related with cost efficiency. However, it is not similar with the finding of Nitoi & Spulbar (2015) when they evaluate cost efficiency of central and Eastern Europe by using heteroskedastic frontier model (Pancurova & Lyocsa,2013).

The profitability indicator variable ROA has a positive and insignificant coefficient with cost inefficiency. This implying that it affects negatively but insignificantly cost efficiency of commercial banks. The negative coefficient indicates that when ROA of banks increase by 1% the total cost of banks as can increase by 0.21% and then leads to increase cost inefficiency of banks. Furthermore, the positive sign of ROA with cost inefficiency shows that banks finance their business activities through customer's interest-bearing time and saving deposit. This cost of funds can positively affect the amount of total operation costs of banks and while cost efficiency of banks. This result is conformity with the result of Sanderson & Pierre (2016) when they have evaluated the cost and revenue efficiency of the Zimbabwean banking sector and found that cost efficiency is negatively related with ROA. However, the result is not conformity with the finding of Emishaw (2016) and Mohana & Tekeste (2012), who were evaluated cost efficiency of commercial banks in Ethiopia.

Credit risk (CR), with negative and significant coefficient indicates the indirect relation between this variable and cost inefficiency but has a direct relationship with cost efficiency. The negative and significant sign implies that on average 1% increase in the proportion of total loan to total assets leads to increase cost efficiency of banks while decrease cost inefficiency of by 0.137. This result is similar with the finding of Niţoi & Spulbar (2015), when they have investigated the commercial banks cost efficiency differences in six emerging countries from Central and Eastern Europe. They found that the ratio of loans in total assets and an increased lending-focused activity of the banks lead to a higher efficiency for the banks. Furthermore, Sufiana (2008), also found similar result stating that the proportion of total loan to total asset, has positive and statistically significance with efficiency.

Gross Domestic Product (GDP), with negative but insignificant coefficient indicates that there is inverse relationship between GDP and cost inefficiency but has direct relation with cost efficiency. This is similar with finding of Phan, Anwar, & Alexander (2014). They found positive and significant with the variable GDP when they had assessed cost efficiency of Hong Kong banking sector. Impact of this variable on total cost inefficiency is low. It is different from the finding of Phan, Anwar, & Alexander (2014). They found positive and significant with the variable GDP when they had assessed cost efficiency of Hong Kong banking sector. Tesfaye (2014), finds that the real GDP growth rate which measures the economy growth of Ethiopia has not impacted significantly on the performance of commercial banks.

239

Analysis of average bank level efficiency scores

Table 3. presents the average cost efficiency scores and their ranks of each banks estimated from the translog frontier cost function. As estimation shows, the banking sector as a whole, operated with a mean cost efficiency of 0.998. Accordingly, the mean inefficiency of commercial banks in Ethiopia is about 0.002% on average. This implies that commercial banks in Ethiopia could improve their efficiency performance by saving up to 0.002% in their expenditures per year when they were all utilizing the best practice technology over the sample period.

Table 3. Average levels of cost efficiency and ranks of banks

Bank	Mean efficiency	Std. deviation	Rank
CBE	0.9989134	8.70e-06	4
AIB	0.9989065	3.80e-06	8
DB	0.9989086	4.89e-06	7
BOA	0.9989042	7.54e-06	11
WB	0.9989093	7.40e-06	6
UB	0.9988998	7.76e-06	13
NIB	0.9989003	6.17e-06	12
CBO	0.9989166	8.18e-06	3
LIB	0.9989096	7.42e-06	5
OIB	0.9989181	5.01e-06	1
BuIB	0.9989062	5.71e-06	9
BRIB	0.9989051	7.0e-06	10
ZB	0.9989174	0.0001	2

The estimated cost efficiency of individual bank shows the relative average cost efficiency of each bank from the relative best performance common frontier. As the estimated coefficient of each bank shows, all commercial banks of Ethiopia have relatively the same cost efficiency performance relative to common frontier. This implies that the effect of technology and working environment have the same impact over all commercial banks in Ethiopia. Moreover, the relative similarity performance of each bank indicates that commercial banks in Ethiopia follow the same strategies, use the same technology and there is sharing of technology and experience. It also indicates that no one has competitive advantage in terms of technology, in terms of labor specialization as well as in the working environment over the others. Correspondingly, the effort or straggle of each bank for cot minimization enables them to have relatively the same efficiency performance regardless of size and capital.

CONCLUSIONS AND RECOMMENDATION

Conclusions

The estimation of the parameters was performed based on Maximum likelihood cost function frontier model. With respect to the determinant variables, the estimation of the parameters was performed based on maximum likelihood cost function frontier model by assuming conditional mean model.

This study has found the area of bank efficiency, at which commercial banks can improve their cost efficiency. This area of efficiency was identified by estimating the coefficients of each variable included in the regression model. The input and output variables incorporated in the regression were selected based on the intermediation approach. Based on maximum likelihood cost function frontier model and conditional mean model assumption, on average commercial banks in Ethiopia have performed efficiently almost around the best common efficiency frontier. As the estimated result

shows, all banks which have included in the selected sample have relatively the same efficiency levels. Furthermore, results show that there is no one which has a competitive advantage in terms of technology, interns of working environment, or in terms of skilled man powers.

Since the cost of labor and cost of capital covers a large proportion of banks operation costs, the effort of each banks to minimize their operational expenses enables banks to have relatively similar cost performance regardless of size and capital.

Regarding to the determinants of cost efficiency, bank size (lnTA) which is the natural logarithms of total assets has a negative and significant coefficient with cost inefficiency. This negative and significant sign with inefficiency model implies that there is appositive relationship between this variable and cost efficiency. In other words, there is appositive and significant relationship between the variable bank size and cost efficiency but there is negative relationship between bank size and cost inefficiency. Since large banks have capable of mobilizing large amount of funds in the economy, they can generate high returns for depositors as well as the equity holders. Therefore, larger banks have cost advantages over other smaller counterparts with respect to their size.

The capital adequacy ratio (CAR), with negative and significant coefficient also shows that, there is a negative relationship between inefficiency and this variable and implies that positively related with cost efficiency. Furthermore, it is as a measure of bank's financial strength and stability. Since then, the positive and significant coefficient of CAR with cost efficiency implies that well capitalized banks can provide better banking products and services in stabilized manner. Furthermore, higher amount of capital enables banks to invest without raising additional deposits as source of funds with cost of funds (interests).

Credit risk (CR), which is the measure of total Laos to total assets with negative and significant coefficient indicates the indirect relation between this variable and cost inefficiency but has a direct relationship with cost efficiency. The negative and significant sign implies that on average 1% increase in the proportion of total loan to total assets leads to increase cost efficiency of banks while decrease cost inefficiency of by 0.137. The intermediation ratio (IR) has a positive and significant coefficient with cost inefficiency. This implies that negatively affects cost efficiency of commercial banks. The positive and significant coefficient indicates that an increase in the proportion of interest-bearing deposits (time and savings deposits and interbank liabilities) to gross loans, the higher the intermediation costs and by extension, the higher the operating expenses. Furthermore, the positive coefficient indicates that the major sources of funds for commercial banks of Ethiopia are from interest bearing customer deposits rather than equity capitals. Therefore, the cost of funds (interest expense) positively affects total operating costs and then negatively affect cost efficiency of banks. The profitability indicator variable ROA has a positive and insignificant coefficient with cost inefficiency. This implying that it affects negatively but insignificantly cost efficiency of commercial banks. The positive coefficient of ROA with cost inefficiency implies that when other things constant and banks want to increase ROA by 1%, the total expenditure of banks can increase by 0.21%. Consequently, leads to increase cost inefficiency of banks. Furthermore, the positive sign of ROA with cost inefficiency shows that banks finance their business activities through customer's interest-bearing time and saving deposit.

Gross Domestic Product (GDP), with negative but insignificant coefficient indicates that there is inverse relationship between GDP and cost inefficiency but has direct relation with cost efficiency.

Recommendations

Since large banks have capable of mobilizing large amount of funds in the economy, they can generate high returns for depositors as well as the equity holders. Moreover, firm size also provides another perspective for analyzing Scale economics and economies of scope of the firms. Therefore, banks could drive economies of scale by maintaining large size.

Higher amount of capital enables banks to invest without raising additional deposits as source of funds with cost of funds (interests). Consequently, the presence of high and stable level of capital enables banks to maintain sustainable cost efficiency by reducing cost of funds (interest expense). Therefore, banks could improve and sustain their efficiency by maintaining available proportion of capital adequacy ratio.

Banks which rely more on deposits to finance assets face a higher funding risk than those that hold a relatively higher proportion of equity capital. Therefore, in order to decrease the costs and risks associated with deposit mobilization and interbank funds, it is advisable banks to be encouraged to attract high value, low interest-bearing demand deposits.

Since there is a positive relationship between credit risk and cost efficiency banks could increase their cost efficiency by improving the proportion of total loans to total assets.

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