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RESEARCH ARTICLE

Efficiency and Risk Management in Indian Banks: A Method to Decompose the Risk

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Abstract

A four-stage DEA model proposed to measure the efficiency of Indian commercial banks working in Indian soil. The proposed models have been used to measure and remove the risk efficiency from the overall technical efficiency (OTE). The OTE of all the banks working in Indian soil is calculated by the Data Envelopment Analysis Models. The performance indicator variable, non-performing assets, has been used to identify the homogeneous working environment of the banks. The pure technical efficiency is calculated by disentangling the risk factors in different stages. The overall performance of public sector banks is better after removing the risk inefficiency compared to other sector banks.

JEL: C44, C61

Keywords: *Environmental Dea, Risk Factors In Banks, Risk Efficiency Of Banks, Indian Banks Efficiency, Non-Performing Assets.*

Introduction

Due to the implementation of the Narasimham Committee Reforms, there is a huge transition in the Indian banking industry from past 15 years. Due to the globalization, the working environment of the banking sector became more competitive. Due to the digitalization of the functioning of the banks, customers are looking for flexible and profitable services in their day to day life. In India, the banks are working in different environments under different management.

The banks were mainly working under three different ownerships; Government, Private and Foreign. The public sector banks are the mediators between the government and public. These banks are mostly working with government policies to optimize the services to the people who are living in the urban and rural areas and also expand geographically to meet the growing needs of the people.

The other management banks were working under private ownership and their functioning will mainly depend on the deposits and advances made by the customers. Some of the private and foreign banks will provide best services to the customers due to their direct attachment to the customers. The attachment and services are less in public sector banks compare to private banks with the customers. Based on the growing needs of the customers, private banks will provide the best services by adopting the day to day technology. These banks have their own policies to attract the customers and these policies are mostly far away from the people living in rural areas.

Due to the huge competition among these banks, they will offer different varieties of plans and schemes to attract the customers. These banks will provide services in different ways like personal loans, credit cards, loans for start-ups, and for business purposes. The working environment plays a major role in providing these services to the customers and customers will attract based on the working environment of the banks.

Non-Performing Assets (NPA)

The name NPA is used by the financial institutions that refer to the loans. Once the borrower has failed to make the payments like interest, principle etc, for 90 days, the loan is considered to be a non-performing asset. Carrying non-performing assets is also known as the non-performing loans, on the balance sheet places. NPA is an example of a

bad loan. Banks need to be proactive in these loans to minimize the risk, otherwise, all these default loans together form as Non-Performing assets. The central bank of India, RBI, issued guidelines on these NPAs. RBI classified the Non-Performing Assets into different categories based on the period for which the asset has remained as non-performing; these are sub-standard, doubtful and loss assets.

Performance of Banks: Indian Perspective

The performance evaluation of any bank is important to the investors, policy-makers, and customers. If any bank is working in a risk-free environment, then that bank will become as the role model for the other banks working in that environment.

The performance of a bank can be evaluated effectively by considering the risk factors while modeling the banks. The performance of banks can depend on different factors like effective management, internal and external environments of a bank. If the internal system is strong and the management is proactive, that bank will function in an efficient environment by providing good services to the customers. The efficiency evaluation of banks started date back 1985 by Sherman and Gold. [1-2].

In India, the working environment of a bank is not homogeneous. The operating expenses of private and foreign sector banks are more comparing to public sector banks. The public sector banks will focus urban and rural areas equally, but the functioning environment of private and foreign sector banks is almost urban areas. Evaluation of Indian banking efficiency is quite tricky because of the nature of the working environments of the banks. There were a number of studies on banking efficiency using DEA and stochastic frontier analysis models. [3].

Most of the studies in banking efficiency assumed that the banks were working under homogeneous environment and evaluated the efficiency using the basic DEA models [4].

The efficiency of a particular bank is effective if we assess the efficiency in the real working environment. The real working environment of a bank may be determined with the joint effect of the effective input and output variables plus the environmental variables. To capture the exogenous and endogenous effect of environmental variables, there was a number of studies in the literature [5-6]. These studies explain the impact of one exogenously input variable, simultaneous inclusion of exogenous input and outputs variables into the basic DEA models.

Data Envelopment Analysis (DEA) Models

Data envelopment analysis is a linear programming technique developed to evaluate the efficiency of non-profitable organizations with the help of multiple inputs and outputs. It is a nonparametric method, which will try to maximize the efficiency of an organizational unit under study by comparing with the other units working in the same environment. The organizational unit under study is termed a decision-making unit (DMU).

Each DMU will produce similar outputs with the same inputs under the homogeneous environment. Charnes, Cooper, and Rhodes [7] proposed a dual linear programming problem to evaluate the efficiency of DMUs under the competitive environment where similar inputs are employed to produce similar outputs. Suppose that we have n decision making units (DMU), where each DMU_j,(j=1,2,3,…,n) produces the same s-outputs, y_{rj} , (r=1,2,3,…,m) using the same number of 'm' inputs, say x_{ij}, (i=1,2,…..,m; j=1,2,...,n). An appropriate mathematical programming problem to evaluate the performance of a specific DMU, i.e. DMU0 i

$$\delta^* = \sum_{r=1}^{s} \mu_r u_{r0}$$

$$subject\ to$$

$$\sum_{i=1}^{m} v_i x_{i0} = 1$$

$$\sum_{r=1}^{s} \mu_r u_{rj} - \sum_{i=1}^{m} v_i x_{ij} \ , j = 1,2,\ldots,n$$

$$\mu_r , v_i \geq 0, \quad r = 1,2,\ldots,s, i = 1,2,\ldots,m$$

This CCR model is useful to account for the constant returns to scale (CRTS) efficiencies. In reality, most of the organizational units or organizations may not perform in CRTS environment. It may be an increasing/decreasing RTS. This we called as the returns to scale (RTS) environment.

Due to the nature of the CRTS environment, the above said models failed to account for the real efficiency scores. Banker, Charnes, and Cooper proposed a dual linear programming problem to account for the returns to scale environment by adding one additional constraint into the existing CCR [7] model as:

$$\beta^{*} = Min\ \lambda$$

$$subject\ to$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \lambda x_{io} \quad , \quad i = 1,2,\ldots,m$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{ro} \quad , \quad r = 1,2,\ldots,s$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$\lambda_j \geq 0 \quad , \qquad j = 1,2\cdots,n$$

The above two DEA models are known as the basic Data Envelopment Analysis Models

Environmental DEA Models

In any study, all the input and output variables may not be controllable. In banking environment also some of the available variables are not controllable; these risk factors are termed as non-discretionary variables. The performance of a bank can better be analyzed by identifying and introducing these non-discretionary variables into the models. The effect of exogenous non-discretionary variables can be better explained by identifying a suitable working environment. This will capture the exogenous environmental effect of the DMUs [8].

The effect of an externally fixed input variable can be better captured by identifying a suitable reference set [8].The appropriate reference set can be best identified with the help of some nondiscretionary variables. If 'u' is any nondiscretionary variable under study, the suitable reference set due to Ruggiero [8] is $J = \{j:\ u_j \geq u_0\}$

The DMU_0 is working in superior environment comparing to the other DMUs. Since the proposed model by Ruggiero [8] identified the reference set with the inferior DMUs working in that environment, the DMUs in the reference set may be less. Due to the less number of DMUs, there is a possibility to lose the discriminatory power of the DEA model and number of DMU may become as efficient.

To avoid the difficulty in identifying the suitable reference set from the statistical point of view, a better reference set can be identified by using the quartiles Q1, Q2, and Q3; the number of reference sets becomes as four. This classification is based on the nondiscretionary variable called NPA. The total number of DMUs can be classified into four categories, namely,

J_1= {DMUs <= Q_1}

J_2= {Q_1< DMUs <= Q_2}

J_3= {Q_2< DMUs <= Q_3}

J_4= {DMUs >= Q_3}

The DEA model to capture the exogenous environmental efficiency with the proposed reference sets is

$$\theta^* = Min\ \lambda$$
$$subject\ to$$

$$\sum_{j=\{J_1,J_2,J_3,J_4\}} \lambda_j \quad x_{ij} \le \lambda x_{io} \quad , \quad i = 1,2,\ldots,m$$

$$\sum_{j=\{J_1,J_2,J_3,J_4\}} \lambda_j \quad y_{rj} \ge y_{ro} \quad , \quad r = 1,2,\ldots,s$$

$$\sum_{j=\{J_1,J_2,J_3,J_4\}} \lambda_j \quad = 1$$

$$\lambda_j \ge 0, \qquad j = 1,2,\ldots,n$$

The above linear programming problem assumes four reference sets to evaluate the endogenous efficiency of DMUs

If a variable 'u' is a non-discretionary factor under study, the effect may be internal or external on the overall bank efficiency. If there is only one input non-discretionary variable, a linear programming problem to capture the effect of that variable is equivalent to [9]

$$\omega^* = Min\ \lambda$$
$$subject\ to$$

$$\sum_{J=\{J_1,J_2,J_3,J_4\}}^{n} \lambda_j \quad x_{ij} \le \lambda x_{io} \quad , \quad i = 1,2,\ldots,m$$

$$\sum_{J=\{J_1,J_2,J_3,J_4\}}^{n} \lambda_j \quad y_{rj} \ge y_{ro} \quad , \quad r = 1,2,\ldots,s$$

$$\sum_{J=\{J_1,J_2,J_3,J_4\}}^{n} \lambda_j \quad u_j \le u_o$$

$$\sum_{J=\{J_1,J_2,J_3,J_4\}}^{n} \lambda_j \quad = 1$$

$$\lambda_J \ge 0 \quad , \qquad J = \{J_1, J_2, J_3, J_4\}$$

Here u_j is a nondiscretionary input factor employed by the j[th] Decision Making Unit (DMU) and u_0 is the nondiscretionary input employed by the DMU whose efficiency is under evaluation. The better method to decompose the overall technical efficiency into different risk factors efficiency is the multiplicative decomposition.

$$Overall\ Technical\ Efficiency \quad (\delta^*) = \underbrace{\left(\frac{\delta^*}{\beta^*}\right)}_{SE} \underbrace{\left(\frac{\beta^*}{\theta^*}\right)}_{Exo.EE} \underbrace{\left(\frac{\theta^*}{\omega^*}\right)}_{Endo.EE} \underbrace{(\omega^*)}_{PTE}$$

The overall technical efficiency (δ^*) is decomposed multiplicatively into scale efficiency (SE), exogenous environmental efficiency (Exo.EE), endogenous environmental efficiency (Endo.EE), and pure technical efficiency (PTE) respectively.

Empirical Analysis

68 banks working in India are considered in this paper. These banks are classified into three categories based on their management. There are 27 public, 21 private and 21 foreign sector banks under this study. The NPA variable considered as an indicator variable to measure the risk efficiency in exogenous and endogenous environments. Unlike the traditional decomposition, the overall technical efficiency is decomposed into scale, risk and pure technical efficiency. The risk efficiency is further decomposed into exogenous environmental and endogenous environmental risk efficiencies.

The non-discretionary variable, NPA, is used to identify the homogeneous environment of a bank. A New statistical method using quartiles developed to identify the best reference set. To capture the endogenous environmental risk efficiency the NPA is included in the DEA model as a non-discretionary variable [9]. The overall DEA model further divided into four stages; first stage scale efficiency; second exogenous environmental efficiency; third endogenous environmental efficiency; and finally the pure technical efficiency is evaluated.

In the risk-free environment (CCR), only 6% of the banks managed without input losses and 94% banks experienced 68% input loss (see Table 1). After disentangling the scale differences, 19% of the banks managed with 100% efficiency and other banks managed with 32% input losses. The banks were experienced more input losses due to the scale inefficiency. The average efficiency change CCR and BCC environments are statistically significant (Mann-Whitney U test; $p < 0.05$).

Table1: Overall Banks Performance

DEA –Environment	δ^*	β^*	θ^*	ω^*
Average Efficiency	0.3193	0.6764	0.7689	0.8099
Number of Efficient Banks	04	13	25	33

Source: Author own Calculations

The exogenous environmental efficiency reveals that 63% percent of the banks were working in an inefficient working environment with 33% of the input losses. To measure the endogenous environmental risk efficiency, NPA is introduced as a nondiscretionary input variable [4]. The efficiency values of these banks under this environment are improved compared to the exogenous environment. In this environment, 51% of the banks are working in the inefficient environment with 19% of the input losses. The average efficiency change from BCC to BCC-Exogenous environment is statistically significant (Mann-Whitney U test; $p < 0.05$).

Sector-Wise Analysis

All 27 public sector banks are inefficient in CCR environment and experienced 78% input losses. (See Table 2). In BCC, BCC-Exogenous, and BCC-Endogenous environments, the input losses are 24%, 11%, and 10% respectively. 52% (14 out of 27) of the banks suffered from risk inefficiency in public sector banks. After disentangling the risk inefficiency from the overall technical efficiency, 52% of the banks became efficient and reduced the average input loss from 78% to 10%. Overall, public sector banks hurt more with scale inefficiency and exogenous factors, like government intervention, fiscal policies adopted by the government, channel the funds for priority sector like agriculture, government policies for the weaker section population etc.

Table2: Public Sector Banks Performance

Dea –Environment	δ^*	β^*	θ^*	ω^*
Average Efficiency	0.2216	0.7605	0.8887	0.8973
Number of Efficient Banks	0	4	12	14

Source: Author own Calculations

All 21 private sector banks are inefficient in CCR environment and experienced 76% input losses (see Table 3). In BCC, BCC-Exogenous, and BCC-Endogenous environments, the input losses are 50%, 42%, and 37% respectively. Overall, 29% (6 out of 21) of the banks suffered from risk inefficiency in Private sector banks. After disentangling the risk inefficiency from the overall technical efficiency, 29% of the banks became efficient

and managed the average input loss from 76% to 37%.

Table3: Private Sector Banks Performance

DEA –Environment	δ^*	β^*	θ^*	ω^*
Average Efficiency	0.2384	0.5030	0.5970	0.6296
Number of Efficient Banks	0	1	5	6

Source: Author own Calculations

Out of 21 foreign sector banks, 17 banks are inefficient in CCR environment and experienced 46% input losses (see Table 4). In BCC, BCC-Exogenous, and BCC-Endogenous environments, the input losses are 25%, 21%, and 12% respectively. 43% (9 out of 21) of the banks suffered from risk inefficiency in foreign sector banks. After disentangling the risk inefficiency from the overall technical efficiency, 43% of the banks became efficient and reduced the average input loss from 46% to 12%.

Table4: Foreign Sector Banks Performance

Dea –Environment	δ^*	β^*	θ^*	ω^*
Average efficiency	0.5361	0.7451	0.7876	0.8811
Number of efficient banks	4	8	8	13

Source: Author own Calculations

The diagram (see Figure 1), reveals that after disentangling the scale differences, exogenous, and endogenous risk factors, the public sector banks are working in better environment with an average efficiency 90% comparing to foreign, 88% and private banks 63%. The public sector banks were benefited more in improving the efficiency (68%), over private sector (39%) and foreign sector banks (34%) respectively.

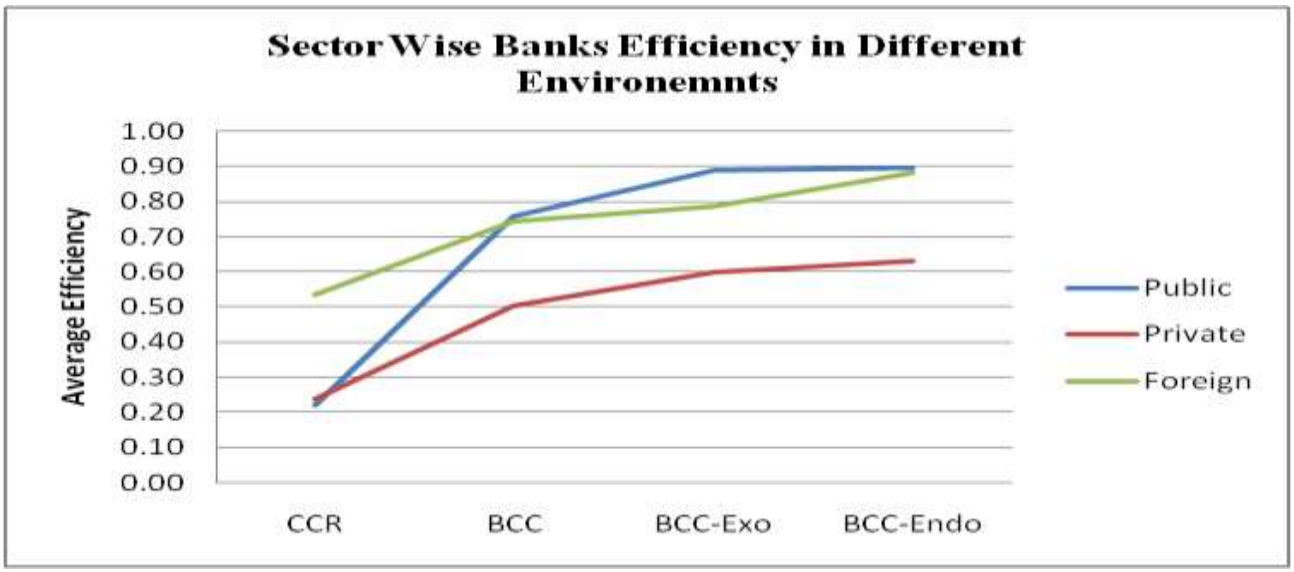

Fig1: Efficiency of Banks – Sector Wise

Source: Author own Interpretation

Overall, the banks experienced more input losses due to scale inefficiency (see Table 5). Due to scale inefficiency, banks experienced 49% input losses. The environmental DEA models captured the impact of exogenous and endogenous environmental risk factors. Due to Exogenous and endogenous environmental risk inefficiency the banks experienced on an average 12% and 5% input losses respectively.

Table5: Average Scale, Exogenous, Endogenous Risk Efficiencies

Dea –environment	Se	Eere	Eore
All banks	0.5085	0.8827	0.9519
Public sector	0.3091	0.8571	0.9863
Private sector	0.5651	0.8552	0.9622
Foreign sector	0.7182	0.9461	0.8947

Source: Author own Calculations

Due to the assumption of the constant returns to scale the public sector banks experienced more input losses comparing to private and foreign banks (69%). The foreign sector banks experience fewer input losses (28%), comparing to the private banks (43%) and public sector banks (49%).In the exogenous risk efficient environment, foreign sector banks working in a better environment with 5% input losses comparing to other banks. The public sector banks are working better after disentangling the exogenous and endogenous risk inefficiency with 1% input loss. Overall, the performance of public sect banks is better after removing the scale and risk inefficiencies.

Conclusion

A new environmental DEA model is proposed to measure the performance of banks functioning in Indian soil. NPA is used as an indicator variable to identify the working environment of the banks using quartiles. The traditional multiplicative decomposition method has been used to disentangle the exogenous and endogenous risk factors efficiency from the overall technical efficiency.

The overall performance of the banks in risk-free environment is looking poor with 94% inefficient banks experiencing with 68% of input losses. The banks hurt more due to the scale inefficiency as 32%. The NPAs were used to perform the risk efficiency. After removing the exogenous inefficiency 36% of the banks attained 100% efficiency.

The public sector banks experience more input losses due to scale inefficiency comparing to private and foreign sector banks. The performance of the foreign sector banks is better in scale efficient environment with 28% input losses. The public and private sector banks performed equally in exogenous efficiency environment with 14% input losses. The performance of the public sector banks is better after removing the impact of the risk factors.

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SE: Scale Efficiency; EERE: Exogenous Environmental Risk Efficiency; EORE: Endogenous Environmental Risk Efficiency.