CHAPTER – VI

IMPLICATIONS OF WTO ON INDIAN BANKING SECTOR:

MAIN FINDINGS

Indian Banking system grew not only in size but also in complexity, with the increasing level of globalization, liberalization, privatization and new reforms of the Indian Banking Sector, competition will intensity further. Over the last few years Indian Banking, in its attempt to integrate itself with the global banking has been facing lots of hurdles in its way due to its inherent weaknesses, despite its high sounding claims and lofty achievements. In a developing country like ours, banking is seen as an important instrument of development, while with the strenuous NPAs, banks have become helpless burden on the economy. Looking to the changing scenario at the world level, the problem becomes more ironical because Indian banking, cannot afford to remain unresponsive to the global requirements.

Banks in India need to handle these requirements and challenges successfully to keep growing and strengthen then the Indian Banking Sector as well as Indian Economy. The financial strength of individual banks, which are major participants in the financial system, is the first line of defence against financial risks. Banks always maintain good operating standards, risk management system and a sound capital structure, in a better position to absorb the future financial shocks. Efficient delivery of information pertaining to customer needs and preferences will hold the key to success.

Banks are exposed to credit risk, liquidity risk, interest risk, market risk, operational risk and management / ownership risk. It is the credit risk which stands out as the most dreaded one. Though often associated with lending,
credit risk arises whenever a party enters into an obligation to make payment or deliver value to the bank. The nature and extent of credit risk, therefore, depend on the quality of loan assets and soundness of investments. Based on the income, expenditure, net interest income, NPAs and capital adequacy one can comment on the profitability and the long run sustenance of the bank.

The data used in this research work is primary and secondary in nature. The Secondary data have been collected from the published documents of Reserve Bank of India, various Staff Training Colleges, Institute of Development Research in Banking Technology (IDRBT), Monthly Bulletins etc. Reports on Trends and Progress of Banking in India from the Year 2000 to 2010 and data on Indian Economy were also collected for three years. Some other reports published by individual banks and other agencies were also used in this research work.

The collected data were analyzed with the help of some statistical tools like co-relation, regression, average, percentages, compared growth rates etc. The software packages were used are SPSS, DEAP 4.0 etc.

The performance of Indian Banking Sector can be evaluated by various methods. With the advances in computational tools, performance evaluation systems have evolved over a period of time from single-aspect systems to more comprehensive systems covering all aspects of an organization. One of the purpose was Balanced Score Card (BSC) systems; which was coined by Robert Kaplan and David Norton in 1992.

The BSC mechanism addresses the perceived shortcomings in financially oriented performance measurement systems. It supplements traditional financial measures with non-financial measures focused on at least
three other perspectives - customers, internal business processes, and learning and growth. The figure 5 shown below explain the concepts of BSC system.

With this holistic approach on organisation can achieve the followings;

- Consensus about vision and strategy
- Communication of strategy among employees
- Allocation of resources for realization of long-term objectives.
- Learning and modification of objectives

Fig. 5 : Concept of BSC System
• Measurement of past performance against future performance drivers.

This method when implemented for banks, financial indicator in isolation do not yield a very effective performance evaluation since for banks financial performance is the translation of many intangible business processes and performance indicators. Subsequently, banks find it difficult to design a comprehensive strategy for long-term growth. To overcome the limitations, customer behaviour as one of the intangible indicator was included for measuring the bank performance. This was adopted by using Knight’s performance Driver Model, which is shown below in Fig.6 as follows;

![Performance Drive Model](image)

Fig. 6 : Performance Drive Model

Better performance can be realized by the bank’s effort to;

- Understand the customer’s requirements,
- Offer products that satisfy customer’s requirements,
- Help the customer in the choice of alternative solutions, and
Effectively differentiate one’s own services from the competitors. Both the models were used combinedly, but still it had many limitations like skewed focus on any one aspect such as return on equity, volume and growth of credit, deposits etc.

The performance was also evaluated with Annual Compound Growth Rate (ACGR) model which is a regression model used to estimate ACGR. The linear regression model is as follows;

\[ Y_z = a + bz \]

Where \( Y_z \) is the variable in question, the various ratios used in the model (e.g. capital adequacy, business per employees etc); \( a \) is the Intercept, a constant; \( b \) is the slope of the trend line (growth rate); \( z = \text{time} \).

\[ Y_z = Y_0 (1 + g)^z \]

Taking natural log of \( Y_z \) and \( Y_0 \)

\[ Y_z = \ln y_0 + z \ln (1+g) \]

Where \( a = \ln Y_0 \) and \( b=\ln(1+g) \), \( b \) is estimated as follows;

\[ \ln (1+g) = \frac{\sum_{z=1}^{z} (z-z') \ln Y_z}{\sum_{z=1}^{z} X_z^2} \]

Where \( X_z = z-z' \)

Form the equation \( g \) is calculated by taking an antilogarithm of \( \ln(1+g) \) and subtracting 1 from the same.
This model does not satisfy with the original trend and also the regression model for the profit theory \((Y_E) - (K_t - 1) = f(y,h)\) for the period 2000 to 2010 showed deviations. But the alternative way of evaluating performance is measuring the productivity, which can also be measured with the available data and with the ACGR model. For this purpose three variables were considered.

These three parameters, which have been taken into consideration, include average earning per employee, business per employee and net profit per employee. An short explanation of the selected variable is outlined below:

1. Average earning per employee = Total expenditure on salary / No. of employees
2. Business per employee = Total business during the Year/No. of employees
3. Net Profit per employee = Total net profit/No. of employees

The result obtained with this model for Public Sector Bank is shown in the Table:5; which is self explanatory – Earning per employee, Business per employee are low where as profit per employee shows a positive sign.
<table>
<thead>
<tr>
<th>Public Sector Banks</th>
<th>Earnings employee (Rs. Millions)</th>
<th>Business per employee</th>
<th>Profit per employee</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Growth %</td>
<td>Mean</td>
</tr>
<tr>
<td>State bank of India</td>
<td>0.31</td>
<td>11.06</td>
<td>22.33</td>
</tr>
<tr>
<td>Bank of Bika &amp; Jaipur</td>
<td>0.29</td>
<td>14.69</td>
<td>18.84</td>
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<td>State Bank of Hyderabad</td>
<td>0.27</td>
<td>12.81</td>
<td>25.50</td>
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<tr>
<td>State Bank of Indore</td>
<td>0.28</td>
<td>8.87</td>
<td>26.90</td>
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<tr>
<td>State Bank of Mysore</td>
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<td>10.88</td>
<td>18.56</td>
</tr>
<tr>
<td>State Bank of Patiala</td>
<td>0.24</td>
<td>6.56</td>
<td>32.00</td>
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<tr>
<td>Allahabad Bank</td>
<td>0.29</td>
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<tr>
<td>Andhra Bank</td>
<td>0.32</td>
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<tr>
<td>Bank of Baroda</td>
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<td>10.51</td>
<td>28.39</td>
</tr>
<tr>
<td>Bank of India</td>
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<td>6.15</td>
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<td>Corporation Bank</td>
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<td>Dena Bank</td>
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<td>Indian Bank</td>
<td>0.31</td>
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<td>Indian Overseas Bank</td>
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<td>7.69</td>
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<td>Oriental Bank of Comm</td>
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<td>Punjab and Sind Bank</td>
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<td>Punjab National Bank</td>
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<td>Syndicate Bank</td>
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<tr>
<td>Mean</td>
<td>0.31</td>
<td>7.86</td>
<td>29.97</td>
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</table>

# shows that growth could not be found out due to negative numbers.

Table 5: Performance of public sector banks (2001-2010)
In this case, total performance was not evaluated. So to evaluate the performance, productivity measurement was completed by using Tornqvist Index of Total Factor Productivity and the Fisher Productivity Index, which can be describe as follows;

Tornqvist Index of Total Factor Productivity: In case of Tornqvist productivity index, the output and input are aggregated by taking a weighed geometric mean of the relative quantities from two periods. Suppose a firm produces multiple outputs of k types. Then output vectors for this firm in periods 0 and 1 are respectively,

\[ y_0 = (y_1^0, y_2^0 - y_k^0) \text{ and } y_0^1 = (y_1^1, y_2^1 - y_k^1). \]

The corresponding price vectors are

\[ P_0^0 = (P_1^0, P_2^0 - P_k^0) \text{ and } P_1^1 = (P_1^1, P_2^1 - P_k^1) \] respectively. From the above information the Tornqvist output quantity index is

\[
A_Q = \begin{bmatrix}
Y_1^0 & V_1 \\
Y_2^0 & V_2 \\
\vdots & \vdots \\
Y_k^0 & \end{bmatrix} \quad \text{with} \quad \sum_{j=1}^k V_j = 1
\]

Where \( v_j = \frac{P_j y_j}{k} \) is the share of output \( j \) in the total value of output set.

As the value share of individual output may be different in different periods, therefore to get the representative share, the arithmetic mean of \( v_j^0 \) and \( v_j^1 \) is taken in empirical literature.

\[
\frac{v_j^0}{\sum_{i=1}^k P_i^0 y_i^0} \quad \text{and} \quad \frac{v_j^1}{\sum_{i=1}^k P_i^1 y_i^1}
\]

Similarly the inputs are aggregated suppose, the input vectors in the two periods is \( x^0 = (x_1, x_2 - x_1^0) \) and \( x^1 = (x_1^1, x_2^1 - x_2^1) \). The corresponding input prices
vectors are $w^0 = (w_1^0, w_2^0 - w_1^0)$ and $w^1 = (w_1^1, w_2^1 - w_1^1)$ then the Tornqvist input quantity index is

$$A\hat{Q}_i = \left( \frac{x_1}{x_1^0} \right) \left( \frac{x_2}{x_2^0} \right) \frac{x_i}{\sum_{j=1}^{l} x_j}$$

Here $x_j = \frac{w_j x_j}{\sum_{j=1}^{l} w_j x_j}$ is the share of input $j$ in total cost of input bundle. For practical purpose like output, the average of two period shares may be used. After taking the aggregation, the aggregated output is taken as ratio of aggregated inputs and the resultant is called Tornqvist Productivity Index.

$$A_{\pi_{TQ}} = \frac{A\hat{Q}_y}{A\hat{Q}_x}$$

When $A\hat{Q}_y > A\hat{Q}_x$, output in period 1 has grown faster than input implies productivity of the firm has increased in period 1 compared to what it was in period 0, and vice-versa.

The Fisher Productivity Index: The Fisher Productivity Index is the geometric mean of Laspeyres and Paasche quantity indexes. Keeping all the input and output sets for period 0 and 1 as assumed in above for Tornqvist Index, the Laspeyres quantity index is ratio of the two output vectors at base period prices and computed as

$$L_y = \frac{\sum_{j=1}^{k} y_j^1}{\sum_{j=1}^{k} y_j^0}$$
In terms of share of individual outputs in the total value of output, it may be written as

\[ L_y = \sum_{j=1}^{k} \lambda_j^0 \left( \frac{y_j^1}{y_j^0} \right) \text{ where } \lambda_j^0 = \frac{p_j^0 y_j^0}{\sum_{i=1}^{k} p_i^0 y_i^0} \]

For Passche output quantity index, the value of ratio of the two vectors at current prices is taken as:

\[ P_y = \frac{\sum_{j=1}^{k} p_j^2 y_j^2}{\sum_{j=1}^{k} p_j^2 y_j^0} \]

In terms of share it may be written as

\[ P_y = \sum_{j=1}^{k} \mu_j^0 \left( \frac{y_j^1}{y_j^0} \right) \text{ where } \mu_j^0 = \frac{p_j^1 y_j^0}{\sum_{i=1}^{k} p_i^0 y_i^0} \]

The Fisher output quantity index is geometric mean of Laspeyres and Paashce output quantity indexes as

\[ F_y = \sqrt{L_y \times P_y} \]

In an analogous manner, the Laspeyres, Paasche and Fisher quantity indexes are computed as:

\[ L_x = \frac{\sum_{j=1}^{l} x_j^1 y_j}{\sum_{j=1}^{l} x_j^0 y_j} \quad P_x = \frac{\sum_{j=1}^{l} x_j^0 y_j}{\sum_{j=1}^{l} x_j^1 y_j} \quad F_x = \sqrt{L_x \times L_y} \]

Thus Fisher Productivity index is

\[ \pi_F = \frac{F_y}{F_x} \]
But with this method, the result shows some deviations as it was difficult to aggregate the inputs and outputs, even the index numbers were considered as the best method of aggregating;

An alternate model, which was introduced by RBI in 1992 can be used; known as CAMEL, i.e., Capital adequacy, Assets quality, management, Earning quality and Liquidity. As the name indicates, CAMEL is a more comprehensive system of organizational analysis as compared to purely financial analysis. This is because; CAMEL includes both financial performance indicators as well as managerial aspects of organizational performance. The analysis of the CAMEL model applied to Indian banks shows that banks still emphasize financial aspect more in order to measure and evaluate their performance. As these banks start complying with the Basel II Accord from March 2007, they need to rethink on the lines of capital requirements, market discipline and supervisory review for operational risk.

**Basel Accord**

As per the FSA of WTO, Basel Committee recommended a series of banking and financial regulations. The Basel Accords are Basel – I, Basel – II and Basel – III.

**Basel - I**

It emphasized the importance of adequate capital by categorizing it into two Tiers: Tier – I, or core capital (the sum of shareholders equity, retained earnings, capital surplus and capital reserves), Tier 2 or supplementary Capital (consisted of loan loss allowances, preferred stock with maturity greater than 20 years, subordinated debt, unclosed capital reserves and hybrid capital instruments).
The two principal purpose of the Basel – I were to ensure an adequate level of capital in the international banking system and to create a “more level playing system competitive terms so that banks could not longer build business volume without adequate capital backing. The Accord were widely recognized and during the 1990s the Accord became an accepted world standard, with well over 100 countries applying the Basel framework to their banking system.

Limitations of Basel – I

- Limited differentiation of credit risk.
- State nature of default risk
- No recognition of term structure of credit risk
- Simplified calculation of potential future counter party risk.
- Lack of recognition of portfolio diversification effects.

Basel – II

Basel – II is the revised capital accord of Basel I, defined as the minimum regulatory capital which is to be allocated by each bank based on its risk profile of assets The Based – II framework is based on three pillar architecture which are mutually reinforcing. The pillars can be described as;

- **Pillar – I**
  Minimum capital requirement This imposes minimum capital requirements pm credit, market and operational risks to reduce impact of losses on exposure.

- **Pillar – II**
  Supervisory review process : This imposes specific bank supervision to promote better risk management.
• **Pillar – III:**
  Market discipline – It promotes market discipline through greater public disclosure.

The devastating impact of the financial crisis and the ensuing global recession prompted the authorities to reconsider the international framework regulating the banking system, known as Basel – II. These accords, developed by the Basel Committee on Banking Supervision, deal with the whole spectrum of regulatory and supervisory issues, including liquidity standards, credit, operational and market risk management and accounting standards. However, the main feature of these regulations is that banks have to comply with a minimum Tier 1 capital requirement ratio to their risks weighted assets of 4.0% (Tier 1 capital is core capital, consisting of equity, retained earnings and other instruments); the risk weighting is calculated by using a standardized or internal – ratings based approach. The goal of these capital requirements is for the bank to be able to absorb unexpected losses, such as those that occurred during the latest financial crisis.

**Limitations of Basel - II**

- The capital requirement ratio of 4% was inadequate to withstand the huge losses that were incurred.
- Responsibility for the assessment of counterparty risk is assigned to the ratings agencies, which proved to be vulnerable to potential conflicts of interest.
- The capital requirement is ‘pro-cyclical’ if the global economy expands and assets prices rise, the country and counterparty risks associated with a borrower tend to decrease and thus the capital requirement is lower, however, in the event of a recession,
the reverse is also true, thus raising the capital requirement for banks and further restraining lending.

- Basel II incentivizes the process of ‘securitization’, as financial institutions that repackage their loans into asset-backed securities are then able to move them off their balance sheets and thus reduce the assets’ risk-weighting. As a result, this process enabled many banks to reduce their capital requirement, take on ongoing risks and increase their leverage.

**Basel – III**

The Basel Committee propose the Basel – III guidelines, having various objectives as follows

1. The document Basel – III: International framework for liquidity, risk measurement, standards and monitoring, strengthen global capital and liquidity rules with the goal of developing more stable banking sector. The objective of the reforms is to improve the banking sector’s ability to absorb shocks arising from financial and economic stress.

2. To improve risk management and governance as well as strengthen banks transparency and disclosures of systemically significant cross border banks.

3. To maintain a strong and resilient banking system for sustainable economic growth.

4. To improve confidence in the solvency and liquidity of many banking institutions.

5. To improve a number of fundamental reforms to the international regulatory framework. The reforms strengthen bank level, or micro prudential, regulation, which will help raise
the strength of individual banking institutions to periods of stress.

The key components of the proposed Basel III guidelines are:
1. Constituents of capital
2. Capital Conservation Buffer
3. Counter Cyclical Buffer
4. Leverage Ratio
5. Liquidity
6. Risk Coverage

Basel – III is an opportunity as well a challenge for banks. It can provide a solid foundation for the next developments in the banking sector, and it can ensure that past pitfalls are avoided. The primary objectives of the Basel reforms are to ensure the reduction of incidence, severity, and costs of financial crises and the associated output loss. Basel – III is likely to have less of an impact on the global economy. To the extent that banks try to comply more quickly with Basel III’s capital and leverage requirements, this may lead to an increase in loan spreads, the tightening of loan terms or a cut-back in lending volumes. As the Banks in Indian and across the world move to Basel – III compliance, the demand for out of the box banking solutions for regulatory reporting and aligning their operations to meet the stringent Basel III norms will grow manifold.

Data Envelopment Analysis

Later on, Data Envelopment Analysis (DEA) has been use to assess the performance and efficiency of the Indian banking units.

DEA is commonly used to evaluate the efficiency of a number of producers. A typical statistical approach is characterized as a central tendency approach and it evaluates producers relative to an average producer. In contrast, DEA is an extreme point method and compares each producers with
only the “best” producers. By the way, in the DEA literature, a producer is usually referred to as a decision making unit or DMU. Extreme point methods are not always the right tool for a problem but are appropriate in certain cases.

A fundamental assumption behind an extreme point method is that if a given producer, A, is capable of producing Y(A) units of output with X(A) inputs, then other producers should also be able to do the same if they were to operate efficiently. Similarly, if producer B is capable of producing Y (B) units of output with X(B) inputs, then other producers should also be capable of the same production schedule. Producers A, B and others can then be combined to form a composite producer with composite inputs and composite outputs. Since this composite producer does not necessarily exist, it is sometimes called a virtual producer.

The heart of the analysis lies in finding the “best” virtual producers for each real producer. If the virtual producer is better than the original producers by either making more output with the same input or making the same output with less input then the original producer is inefficient. Some of the subtleties of DEA are introduced in the various ways that producers. A and B can be scaled up or down and combined.

The procedure of finding the best virtual producer can be formulated as a linear program.

**Advantages of DEA :**

- No need to explicitly specify a mathematical form for the production function
- Proven to be useful in uncovering relationships that remain hidden for other methodologies.
- Capable of handling multiple inputs and outputs
- Capable of being used with any input-output measurement
The sources of inefficiency can be analysed and quantified for every evaluated unit.

Limitations of DEA

The same characteristics that make DEA a powerful tool can cause some limitations.

- Since DEA is an extreme point technique, noise (even symmetrical noise with zero mean) such as measurement error can cause significant problems.
- DEA is good at estimating “relative” efficiency of a DMU but it converges very slowly to ‘absolute” efficiency. In other words, it can tell you how well you are doing compared to your peers but not compared to a “theoretical maximum”.
- Since DEA is a non parametric technique, statistical hypothesis tests are difficult and are the focus of ongoing research.
- Since a standard formulation of DEA creates a separate linear program for each DMU, large problems can be computationally intensive.

Inefficiency measuring with DEA

Data Envelopment Analysis (DEA) has been recognized as a valuable analytical research instrument and a practical decision support tool. DEA has been credited for not requiring a complete specification for the functional form of the production frontier nor the distribution of inefficient deviations from the frontier. Rather, DEA requires general production and distribution assumptions only. However, if those assumptions are too weak, inefficiency levels may be systematically underestimated in small samples. In addition, erroneous assumptions may cause inconsistency with a bias over the frontier. Therefore, the ability to alter, test and select production assumptions is essential in
Conducting DEA-based research. However, the DEA models currently available offer a limited variety of alternative production assumptions only.

**Performance Ranking in DEA**

Traditional DEA models do not allow for ranking DMUs, specifically the efficient ones. Also, it is possible in DEA that some of the inefficient DMUs are in fact better overall performances that certain efficient ones. This is because of the unrestricted weight flexibility problem in DEA. Cross efficiencies in DEA is one method that could be utilized to identify good overall performers and effectively rank DMUs.

**Weight Restrictions in DEA**

Weight restrictions allow for the integration of managerial preferences in terms of relative importance levels of various inputs and outputs. Methods for incorporating weight restrictions have been suggested by several researchers. Although weight restrictions effectively discriminate between efficient and inefficient units, ranking DMUs can still be an issue, Dyson et.al.(1990).

**Efficiency Changes Over Time**

In order to capture the variations of efficiency over time, Charnes et al. (1985) proposed a technique called ‘Window Analysis’ in DEA the window analysis assesses the performance of a DMU over time by treating it as a different entity in each time period. This method allows for tracking the performances of a unit or a process.

As DEA is a linear programming technique outlined by Farrell (1957) and operationalised by Charnes, Cooper and Rhodes (1978) to evaluate the efficiency of public sector non-profit organizations. It is a non-parametric, deterministic technique for determining the relative efficient production frontier,
based on the empirical data on chosen inputs and outputs of a number of entities called decision making units (DMUs). From the set of data, DEA identifies reference points that define the efficient frontier and evaluate the inefficiency of other; interior points i.e. relatively inefficient DMUs that are below that frontier. DEA is also called extreme point method and compares each producer with only the best producers. The advantage of DEA over regression based stochastic frontier methods has been its multi-inputs and multi-outputs environment and robustness with respect to the functional relationships between inputs and outputs. Decision Making Units (DMU’s) having multiple inputs and multiple outputs. In this research work DMUs are the Indian banking units, preferably, nationalized banks.

**CCR Model**

Several different mathematical programming DEA models have been proposed in the literature. Essentially, these models seek to establish which of n DMUs determine the envelopment surface or best practice frontier or efficient frontier. The geometry of this surface is prescribed by the specific DEA model employed. In the present study, the CCR (named after its developers Charnes, Cooper and Rhodes, 1978) model is used to obtain efficiency measures corresponding to the assumptions of constant returns-to-scale (CRS) and variable returns-to-scale (VRS), respectively.

It extended Farrel’s approach and constructed a model that generalizes the single-input, single output measure of efficiency of a decision making unit (MU) to a multiple input and multiple output setting. DEA is based on fractional programming formulation, where a measure of efficiency for each DMU is obtained as a maximum of a ratio of weighed outputs to weighted inputs. For illustration of CCR model, assume that there are n DMUs to be evaluated. Each
consumes different amounts of \(i_{th}\) inputs and produces \(r_{th}\) different outputs i.e. DMU\(_j\) consumes \(x_j\) amounts of input to produce \(y_{ij}\) amounts of output.

Let \(x \in \mathbb{R}^1\) and \(y \in \mathbb{R}_{m^+}\). Assuming constant-return to scale and strong disposability of inputs and outputs and convexity of the production possibility set, the technical efficiency of the \(s_{th}\) DMUs can be obtained as:

\[
\text{Max. } h_s = \frac{\sum_{r=1}^{m} u_r y_{rs}}{\sum_{i=1}^{l} \sum_{r=1}^{m} v_i x_{ij}}
\]

Subject to \(u_r, v_i \geq 0\)

Where \(y_{rs}\) = the amount of the \(r_{th}\) type output produced by the \(s_{th}\) DMU; \(x_{ij}\) = the input of \(i_{th}\) type used by \(j_{th}\) DMU, \(u_r\) and \(v_i\) are the weights assigned to output and input respectively. The efficiency score of different decision making units is computed by determining the values of weights \((u_r, v_i)\). However, this problem has an infinite number of solutions since if \((u^*, v^*)\) is optimal than \((hu^*, hv^*)\) is also optimal for each positive scalar. To avoid this problem, the above model may be transformed into another linear programming model by restricting the denominator of the objective function \(h_s\) to unity and adding this as a constraint to the problem which can be written as

\[
\text{Max. } h_s = \sum_{r=1}^{m} u_r y_{rs}
\]

Subject to \(\sum_{i=1}^{l} v_i x_{ij} = 1\).
For the above linear programming problem, the dual can be written as.

\[
\min z_s = \theta_y
\]

Subject to

\[
\sum_{j=1}^{n} \lambda_j y_{jr} \geq y_{ir}
\]

\[
\Theta_s x_{ir} - \sum_{j=1}^{n} \lambda_j x_{ij} \geq 0
\]

\[
u_i^3 0; \text{for } j = 1, 2, \ldots, n; \text{ } r = 1, 2, \ldots, m; \text{ } i = 1, 2, \ldots, l;
\]

Both the above problems yield an optimal solution \( \theta_s^\phi \) which is efficiency score for particular DMUs and efficiency scores for all \( \theta_y \) Of them are obtained by repeating them for each DMU, \( j = 1, 2, \ldots, n \), The value of \( \ldots \) is always less than or equal to unity DMUs for which \( \theta_s^\phi > 1 \) are relatively inefficient and those for which \( \theta_s^\phi = 1 \) are relatively efficient.

It is rally difficult to select the inputs and outputs and their appropriateness for modeling the bank as a firm. Normally, the “Bank Performance Model” considers the input (Resources) as salary expense, premises and fixed assets, other non-interest expenses, purchase funds etc. and Output (desired outcome) as earning assets, interest income, non-interest income. The efficiency can be derived as the ratio of weighted sums of the inputs and outputs (>0)
Most of the existing research studies, made the selection on the basis of circumstances and availability of the information given in banking system. Keeping in view the practical aspects and data availability of Indian banking system, in the present study, three major approaches are adopted to make the selection of inputs and outputs for measuring the efficiency of banks:

a. Intermediation approach,
b. Value added approach and
c. Income approach.

As non interest income is one of the major component of the output of a bank, so included it as one of the output in asset approach and named it as intermediate approach. The first two approaches are related to economic growth and safety objectives, while last approach reflects the profit goal. The inputs and outputs selected under these approaches for investigating the performance of Indian banks shown in the Table-6. Where capital expenditure is derived by subtracting the expenses related to wages and salaries from the operating expenses, available funds are derived by taking the sum of deposits and borrowings, other income includes all the non-interest income.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Approach</th>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Intermediation</td>
<td>Capital expenditure wages and salaries available funds.</td>
<td>Advances investments other income</td>
</tr>
<tr>
<td>2.</td>
<td>Value Addition</td>
<td>Capital expenditure wages and salaries interest expenses.</td>
<td>Advances investments other income deposits</td>
</tr>
<tr>
<td>3.</td>
<td>Income Approach</td>
<td>Capital expenditure wages and salaries interest expenses.</td>
<td>Interest income other income</td>
</tr>
</tbody>
</table>

Table 6 : Input and output of a bank
In this research work data were analysed by the DEAP Ver.4.0 software. The efficiency of Indian banks has been derived from input oriented DEA technique by using annual frontiers with the assumption that each year is independent of each other. The DEA works as follows:

- The DEA computes a separate set of weights for each bank.
- The weight optimized to make that bank’s score the best possible.
- There exist a constraint; no bank’s efficiency exceeds 1 when using the same weight.

The figure shown below Fig. 7 shows the efficiency.

![Efficiency Measure](image-url)

**Fig. 7**: Efficiency Measures
The efficiency scores are estimated by using input oriented DEA CCR model which is based on the assumption of constant return to scale. It is observed that Indian commercial banks attained the average efficiency levels of 0.907, 0.898 and 0.890 under intermediate, value addition and income approaches respectively with corresponding average proportion of banks that experienced their position on frontier were 23.65%, 28.78% and 20.63% of all the commercial banks under all the three approaches respectively for the period 2000-10 (Table-6.). The estimated efficiency scores and the proportion of banks on the frontier derived from intermediation approach and value addition approach are in general higher than the efficiency scores based on income approach. It implies the dominance of financial soundness of the commercial banks in India over the profitability orientation of the banks.

To examine the impact of WTO on banks the efficiency score of post financial liberalization period (2005-10) when Basel II norms was implemented is compared with the previous period (2000-2005) with Basel I norms and it is found that efficiency of the nationalized banks based on intermediation approach has reduced in the former period. The Indian commercial banks on the average are not able to minimize the cost of inputs significant improvement in the efficiency. It may be the result of aggressive opening of the branches by the some of the banks, as RBI has relaxed the rules for opening the branches in the recent years and it may have consumed additional cost for the bank and also it may take time to fully operationalized them.

In case of income based approach, the efficiency of nationalized banks has improved significantly after the post liberalization period. It shown the market oriented environment Indian banks have the more advantages to create the income from their resources.
The efficiency scores of commercial banks based on variable return to scale (VRS) which is also known as pure technical efficiency and independent of the size of the bank. This measure of technical efficiency free from scale factor and purely reflects the managerial performance to organize the inputs in the production process. Thus, pure technical efficiency measure has generally been used as an index to capture managerial performance. It is evident from the results that VRS efficiency score is highest for the intermediation approaches. The average pure technical efficiency experienced by Indian banks produced the figures 0.958, 0.949 and 0.948 under intermediate, value addition and income approaches respectively for the period (2000-10). The average proportion of efficient banks for pure technical efficiency crossed more than 55% under value addition approaches (Table-7). The number of efficient banks also turned double under VRS technical efficiency in relation to CRS efficiency.

<table>
<thead>
<tr>
<th>Approach</th>
<th>Efficiency</th>
<th>2000-10</th>
<th>2000-05</th>
<th>2005-10</th>
<th>Coefficient (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermediation</td>
<td>CRS</td>
<td>0.908</td>
<td>0.916</td>
<td>0.893</td>
<td>-2.784(0.014)</td>
</tr>
<tr>
<td></td>
<td>VRS</td>
<td>0.958</td>
<td>0.954</td>
<td>0.950</td>
<td>-0.588(0.566)</td>
</tr>
<tr>
<td></td>
<td>Scale</td>
<td>0.952</td>
<td>0.960</td>
<td>0.940</td>
<td>-2.678(0.017)</td>
</tr>
<tr>
<td>Value Addition</td>
<td>CRS</td>
<td>0.898</td>
<td>0.898</td>
<td>0.910</td>
<td>1.211(0.245)</td>
</tr>
<tr>
<td></td>
<td>VRS</td>
<td>0.949</td>
<td>0.950</td>
<td>0.946</td>
<td>-0.618(0.546)</td>
</tr>
<tr>
<td></td>
<td>Scale</td>
<td>0.949</td>
<td>0.944</td>
<td>0.962</td>
<td>2.312(0.035)</td>
</tr>
<tr>
<td>Income</td>
<td>CRS</td>
<td>0.890</td>
<td>0.859</td>
<td>0.897</td>
<td>3.827(0.002)</td>
</tr>
<tr>
<td></td>
<td>VRS</td>
<td>0.948</td>
<td>0.934</td>
<td>0.946</td>
<td>1.767(0.098)</td>
</tr>
<tr>
<td></td>
<td>Scale</td>
<td>0.941</td>
<td>0.920</td>
<td>0.949</td>
<td>2.754(0.015)</td>
</tr>
</tbody>
</table>

Regression coefficient for structural change in the average efficiency from the period 2000-05 and 2005-10.

Table 7: Impact of changing financial environment on banking efficiency

To verify the impact of WTO on VRS efficiency score, the period (2005-10) is compared with previous period (2000-05) and it is found that efficiency of nationalized banks shows fail to improve their performance based on
intermediation approach and value addition approach. The statistical significant difference in the income based efficiency score for the second half period (2005-10) imply that the nationalized banks, management practices has improve the financial soundness in the profitability of the banks.

<table>
<thead>
<tr>
<th>Approach</th>
<th>Efficiency</th>
<th>2000-10</th>
<th>2000-05</th>
<th>2005-10</th>
<th>*Coefficient (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermediation</td>
<td>CRS</td>
<td>23.86</td>
<td>27.17</td>
<td>19.50</td>
<td>-3.701 (0.002)</td>
</tr>
<tr>
<td></td>
<td>VRS</td>
<td>49.76</td>
<td>48.99</td>
<td>50.33</td>
<td>0.353 (0.730)</td>
</tr>
<tr>
<td></td>
<td>Scale</td>
<td>27.00</td>
<td>30.26</td>
<td>21.50</td>
<td>-3.056 (0.008)</td>
</tr>
<tr>
<td>Value Addition</td>
<td>CRS</td>
<td>28.78</td>
<td>29.31</td>
<td>28.17</td>
<td>1.211 (0.245)</td>
</tr>
<tr>
<td></td>
<td>VRS</td>
<td>56.01</td>
<td>55.29</td>
<td>58.00</td>
<td>0.950 (0.356)</td>
</tr>
<tr>
<td></td>
<td>Scale</td>
<td>29.34</td>
<td>29.81</td>
<td>29.83</td>
<td>-0.006 (0.996)</td>
</tr>
<tr>
<td>Income</td>
<td>CRS</td>
<td>20.36</td>
<td>18.81</td>
<td>19.17</td>
<td>0.168 (0.870)</td>
</tr>
<tr>
<td></td>
<td>VRS</td>
<td>46.83</td>
<td>39.66</td>
<td>48.50</td>
<td>4.698 (0.000)</td>
</tr>
<tr>
<td></td>
<td>Scale</td>
<td>21.78</td>
<td>20.05</td>
<td>21.00</td>
<td>0.369 (0.799)</td>
</tr>
</tbody>
</table>

* Regression coefficient for structural change in the average efficiency from the period 2000-05 and 2005-10.

Table 8 : Impact of changing financial environment on banking efficiency.

The Scale Efficiency

The banks recorded higher scale efficiency under intermediate in comparison to other two approaches for the period (2000-10).

During the period (2005-10) on the average scale efficiency had improved under the income approach. The average scale efficiency based on proportion of banks on frontier decrease considerably based on intermediation and value added approach. It means this period has provided less space to the banks to extend their business to take the benefits of size.
The Efficiency on Bank Size

For categorization of the efficiency of banks on the basis of size, a total asset of the bank is taken as a parameter of size. The banks are classified into four categories by computing the quartile of total assets of the banks. Instead of restricting to fixed for classification of the size, the quartile figures for each year’s total assets are used, which shows the relative size of banks in each year. The variables considered were EVN, Size, Equity, Operating expenditure, Return on Asset etc. were considered.

The results exhibit that in general the banks falling in above quartile Q2 in their assets size are more efficient than lower size banks under all approaches as shown in the Table-9.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Intermediate Approach</th>
<th>Value addition Approach</th>
<th>Income Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.079</td>
<td>0.029</td>
<td>0.007</td>
</tr>
<tr>
<td>1. EVN</td>
<td>0.058</td>
<td>0.007</td>
<td>0.000</td>
</tr>
<tr>
<td>2. SIZE</td>
<td>-0.001</td>
<td>0.010</td>
<td>0.933</td>
</tr>
<tr>
<td>3. EQUITY</td>
<td>0.000</td>
<td>0.000</td>
<td>0.392</td>
</tr>
<tr>
<td>4. OPEXP</td>
<td>0.036</td>
<td>0.003</td>
<td>0.000</td>
</tr>
<tr>
<td>5. ROA</td>
<td>-0.009</td>
<td>0.003</td>
<td>0.002</td>
</tr>
<tr>
<td>6. WAGES</td>
<td>0.000</td>
<td>0.000</td>
<td>0.704</td>
</tr>
<tr>
<td>7. R. Suuarred</td>
<td>0.118425</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8. Log Likelihood</td>
<td>496.2589</td>
<td>-</td>
<td>186.262</td>
</tr>
<tr>
<td>9. Total Obs</td>
<td>1109</td>
<td>1109</td>
<td>1109</td>
</tr>
</tbody>
</table>

Table 9: Total analysis of DEA CRS based inefficiency of banks.

The Table-9 represents the estimated regression model based on CCR model taking the technical inefficiency as a dependent variable. All the models satisfy the goodness of fit as reflected by the log likelihood statistics. The key observations of the estimated results described as follows;
1. ENV variable which is proxy for financial liberalization has shown positive impact on the CRS based value addition and income approach: it reflects that financial liberalization put pressure on the banks to improve their income based activities.

2. The ownership coefficient has positive effect on the technical efficiency based on all three approaches. It shows the public sector banks are on average less efficient in relation to non-public sector banks. It means public sector banks are not able to fully utilize the technological factors and experienced problems in utilizing their resources more efficiency to take the benefit of existing environment.

3. The explanatory variable size has statistically positive influence on the technical efficiency; this indicates that the larger size of a bank provides better conversion of inputs into outputs.

4. Equity capital as a ratio of total assets has positive effect on the technical inefficiency in all the three models.

5. The operating expenses ratio proxied by the operating cost as a proportion of total assets. It impacts the banking efficiency negatively under all three approaches. Banks of all groups have incurred heavy costs for computerizing and networking of their branches. On the other hand, after liberalization of Indian economy, the competitiveness in the financial sector has increased many folds, this situation of competitiveness has forced the banks to pay higher salaries for attracting and retaining the competent persons. This situation has inflated the intermediation cost of the banks which is also reflected in the form of its association with inefficiency score.

6. The return on assets (ROA) which is the measure of profitability of the bank has significant positive effect on the technical efficiency based in
intermediation and value addition approaches. It has also emerged as one of the best performance because of its direct association with the efficiency of a bank.

7. The wages derived from wages and salaries as a proportion of total expenses, reported negative effect the efficiency.

The result based on the three approaches highlight that efficiency based on income approach has improved significantly from the year 2005 to 2010 with the inclusion of Basel II norms. It shows, in the market oriented environment, Indian banks have more advantages to create the income from their resources. The efficiency of public sector banks are not encouraging out of which only six PSBs shows a positive sign, but other PSB should strive their best to be competitive as Basel III norms is on the way. The DEA used is not only useful in bench marking in Indian Banking Sector, but also can provide information. The large scale efficiency analysis can give insight into Banking Industry dynamics and structural changes. Many factors have positive influence in the efficiency include size of the banks, equity capital, return on assets and financial environment; on the other hand the factors like operating expenses, share of wages etc. has negative influence on the efficiency.