CHAPTER - 5

A STUDY ON IMPACT OF GLOBAL RECESSION ON THE EFFICIENCY AND PRODUCTIVITY OF INDIAN BANKS BY OWNERSHIP

5.1 Introduction

Examining banking performance has been a common practice among many banking and finance researchers for a number of years. The main reason for continued interest in this area of research is the ever changing banking business environment throughout the world. The effect of recession on bank efficiency has become an important issue. Financial recession was first started in USA and other developed countries. India is no exception and as an emerging market is becoming a competitive and important market not only for financial products but also for other products. Indian banking is a considerable component in Asian financial affairs and has not been subjected to substantial research compared to the countries in the developed world.

The first phase of the crisis started when a moderate correction of house prices in the United States triggered a modest increase in mortgage debt delinquencies and a few failures of financial institutions holding mortgage-backed securities (MBS) or related instruments in 2007. Banks announced large write-downs, directly and indirectly linked to the sub-prime mortgage market, in the United States and elsewhere.

The autumn of 2008 witnessed a quantum shift in the spreading of the financial crisis with a succession of financial institution failures, notably the investment bank Lehman Brothers. These failures typically reflected fundamental
weaknesses, the turbulence led to a consolidation of the financial system as well as the end of the investment bank model in the United States. European markets also experienced crises in the banking system, and a number of large cross-border European banks had to be rescued by governments (e.g. the nationalization of Northern Rock in the United Kingdom). The recession was also affected Indian banking system. Efficient and effective utilization of resources are key objectives of every banker. These topics have always been important in banking, but a number of recent events are helping to bring even greater emphasis to banking efficiency. Increasing competition for financial services, technological innovation, and banking consolidation, for example, are all focusing more attention on controlling costs in banking and providing services and products efficiently. Efficiency was clearly a critical factor in remaining competitive, and most efficient banks have substantial cost and competitive advantages over those with average or below average efficiency.

The performance of the financial institutions was a major concern for both the regulators and the policy makers, since it has a strong linkage with the performance of the economy. The financial sector is reasonably well developed in India. Though small in comparison to USA, but also it has a strong banking system, a set of large and small stock and strong banking system, a set of large and small stock and commodity exchanges, strong equity culture, large number of mutual funds, development institutions like Industrial Development Bank of India, non-banking finance companies, other specialized financial institution, beside a large informal sector.

Efficiency has become critical for banks survival and growth. The productivity was a concerned with real resources use, output from a given set of inputs. This simplistic approach was useful when there was only one technology, one input and
one output. However, for a firm, merely getting the maximum output from a given set of inputs was not adequate since difference technologies, different inputs and different sets of outputs from the same set of inputs are obtained. Thus, more important was the change in productivity over a period of time, from one period to another. Productivity was hence, both, static and dynamic in nature: a measure of both, the change in technology over time and optimal use of resources, for the best available technology, at a given time. Moreover, if the objective of the firm was to maximize profits, the productivity measured as ratio of physical units may not be the best criterion. Hence, in addition to conventional measure of productivity, a “monetized value of productivity” may be a better performance measure.

Productivity of a firm was thus derived from the efficiency of the firm in using optimal technology from a set of available technologies (production function), optimal set of inputs given input prices (cost function), optimal conversion of a given set of inputs for a given technology into an optimal set of outputs (Production function), optimal set of inputs given input prices(cost function), optimal conversion of a given set of inputs for a given technology into an optimal set of outputs (Production function), shifts in the production function (technology changes) and changes in the scale of operations (scale and scope). Concepts of efficiency relate to how well firm employs its resources relative to the existing production possibilities frontier (or, in other words, relative to current ‘best practice’). How an institution simultaneously minimizes costs and maximizes revenue, based on an existing level of production technology. The analysis of a firm’s efficiency, therefore, relies on intra-sector comparison, involves both technological and relative pricing aspects, and has partial indicator value for analyzing productivity performance.
There are two approaches for determining efficiency of a firm: Parametric (econometric) and non-parametric (or, based on mathematical programming). These methods differ in several important ways. The parametric approach was based on the underlying relationship between the parameter under study and various observed independent variables. It therefore requires a specific pre-specified function form of the production or cost function. Non-parametric approach was based on the optimizing behavior of the firms under study. It was based on the concept of efficiency similar to one in the parametric approach but differs from it since this approach does not require any pre-specified function. It takes the data of the actual operations of the firms under study and frontier was formed as the piecewise linear combination of the “most efficient observations.” Thus, efficiency so determined is relative to the “observed best”, rather than an absolute value.

The bank efficiency ratio was a quick and easy measure of a bank's ability to turn resources into revenue. (50% is generally regarded as the maximum optimal ratio). An increase in the efficiency ratio indicates either increasing costs or decreasing revenues. It was important to note that different business models can generate different bank efficiency ratios for banks with similar revenues. For instance, a heavy emphasis on customer service might lower a bank's efficiency ratio but improve its net profit. Banks that focus more on cost control will naturally have a higher efficiency ratio, but they may emphasis on customer service it also have lower profit margins.

In addition, the more a bank generates in fees, the more it may concentrate on activities that carry high fixed costs (and thus create worse efficiency ratios). The degree to which a bank was able to leverage its fixed costs also affects its efficiency ratio; that is, the more scalable a bank is, the more efficient it can become. For these
reasons, comparison of efficiency ratios was generally most meaningful among banks within the same model, and the definition of a "high" or "low" ratio should be made within this context.

Measurement of productivity and efficiency in banks was still in its infancy. The traditional cost income ratio (CIR) was not a suitable ratio to determine productivity. Interest margins as well as labour costs of a country significantly influence the CIR, and therefore this measurement does not appear to be appropriate when analyzing performance in terms of service production and settlement, a procedure based on publicly available data and which enables an approximate evaluation of productivity in banks. The procedure eliminates price components to focus the analysis on the performance. The adjustment of the CIR leads to remarkable changes in the assessment of the productivity in banks. In particular, those banks which currently operate in markets with high interest margins lose top positions in contrast to banks operating in highly competitive markets with low interest margins. High “real” productivity rates of banks serve as an essential starting point for the expected consolidation in the financial market and the harmonization of margins. Banks that are currently benefiting from high interest margins have to direct their attention to making the necessary improvements in their own service capabilities so that they are able to compensate for the decreasing income. Measuring productivity of a bank at the meta-level, i.e. for the bank as a whole, was not precise enough to develop specific recommendations for process improvement. Instead, a modern analysis of productivity should rather focus on banking processes. For this purpose several requirements have to be met. Methods such as Data Envelopment Analysis (DEA) deliver a good insight into banking productivity and efficiency.
A few studies assessed Indian bank performance using the Data Envelopment Analysis (DEA) technique- a nonparametric methodology to evaluate the relative efficiency of production units and can accommodate multiple inputs and outputs. For example, Bhattacharyya, Lovell and Sahay (1997) examined the productive efficiency of Indian commercial banks during 1986-1991 and reported a marginal increase in overall average performance after 1987 and the average efficiency of publicly owned banks was much higher than in the privately owned or foreign owned banks. Sathya (2001) compared productive efficiency of publicly owned, privately owned and foreign owned banks operational in India in the year 1997/1998 and reported that private sector commercial banks as a group was paradoxically lower than that of public sector and Foreign Banks. These studies differ from each other in at least two ways: (i) the time period captured in the analysis and (ii) the input-output variables used in the DEA model. Shanmugam and Das (2004) on the other hand investigated the efficiency of Indian commercial banks during the reform period, 1992-1999 using a parametric methodology. They observed that the state and Foreign Banks are as efficient banking systems contribute in an extensive way for higher economic growth in any country, studies in this nature are very important for policy makers, industry leaders and many others who are reliant on the banking sector.

With this background this chapter analyses the impact of Global Recession Impact of efficiency and productivity on Indian banking sector.

5.2 Methodology

DEA approach

The DEA method was used to estimate the efficiency and productivity of banks operating in India during the sample period of 2001 to 2012. Data
Envelopment Analysis (DEA), pioneered by Fare (1957) and Charnes et al. (1978), is a non-parametric approach for measuring technical efficiency of firms. It involves an application of linear programming (LP) to observed data to form an industry production frontier, against which the efficiency of each firm was measured. The best-practice firms that lie on the production frontier will be given a score of one. All other inefficient firms will be given a score between zero and one. Allocative efficiency can also be estimated if the price information was available.

A simple one-output two-input case is illustrated in Figure 5.1 for DEA technical efficiency measurement. Let the horizontal and vertical axis be labelled as two inputs $X_1$ and $X_2$ respectively. And assume that the output quantity is given at a fixed level $Y^*$. Firms A, B, C, D, E constitute the "Best Practice" production frontier, which is constructed as piece-wise linear convex when DEA is applied to sample data. Firm F is observed to be relatively inefficient in that it produces the same level of output using more of at least one of the inputs. To produce $Y^*$, it uses the two inputs to the amount of $x_1^f$ and $x_2^f$ respectively. To be technically efficient, it could proportionally reduce its usage of $x_1$ to $x_1^c$ and $x_2$ to $x_2^c$, as firm C on the frontier does. The distance CF represents technical inefficiency, which is the amount by which inputs can be decreased to produce the same level of output if the firm is operating efficiently. DEA can gives each firm a score bounded by zero and one to indicate the level of technically inefficiency. The score of technical efficiency (TE) is just the ratio of $OF$ relative to $OC$, as shown in Figure 5.1. This technique can also be extended to multiple outputs and multiple inputs case in DEA.
DEA can incorporate multiple inputs and outputs and be used to calculate technical and scale efficiency as it only requires information on output and input quantities. DEA has the advantage of being a non-parametric technique, and avoids the need to make assumptions regarding the functional form of the best practice frontier. DEA is especially suitable for measuring the efficiency of firms, which lack competitive prices, as the case for Indian banking industry.

However, DEA has also its own shortcomings. DEA scores only measures efficiency relative to best practice with the sample data. DEA is a deterministic model and therefore the efficiency scores are sensitive to measurement errors. It is important to screen for potential outliers when assembling the data. Despite its limitations, DEA is a useful tool to examine the efficiency of Indian banking industry.

5.3. Malmquist DEA method

One extension with DEA is to apply Malmquist index to panel data to estimate changes in technical efficiency, technological progress and total factor
In order to determine the changes in total factor productivity of banks in India over time, Malmquist approach has been used. DEA approach is to use sample data collected for firms to derive the best-practice production frontier, against which to evaluate the technical efficiency of each firm. By allowing the production frontier to shift over time due to technical change, the Malmquist index can then be derived to measure efficiency change for one year relative to the prior year. Correspondingly, total factor productivity change, which is the product of efficiency change and technical change, can also be estimated.

Following Fare et al. (1990, 1993), use DEA to construct a Malmquist TPF index between period \( t \) (the base period) and period \( s \):

\[
M(y^s,x^s,y^t,x^t) = \left[ \frac{D'_I(y^s,x^s)}{D'_I(y^t,x^t)} \times \frac{D'_I(y^t,x^t)}{D'_I(y^t,x^t)} \right]^{\frac{1}{2}}
\] (1)

where \( M \) is the input-oriented Malmquist TFP index\(^{17} \) \( D'_I(y^s, x^s) \) is the distance function showing a maximal proportional reduction of the observed period \( s \) inputs under the period \( t \) technology. The distance function is defined as follows:

\[
D'_I(y^s, x^s) = \min_{\theta, \lambda} \theta \lambda
\] (2)

where \( \theta \) is a scalar and \( \lambda \) is a vector of constants. Please be noted that \( \theta \) is always between zero and one for intra-period distance function, but can be larger than one for inter-period distance function.

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\(^{16}\) The method is discussed in Fare, Grosskopf, Norris and Zhang (1994)

\(^{17}\) The output and input-oriented approach are equivalent only when constant returns to scale exist (Fare and Lovell 1978). Here we only illustrate the input orientation equation since this orientation is used in the basic model in this study.
Equally being noted, the TFP change is measured under the assumption of constant returns- to-scale production, since demonstrated that a Malmquist TFP index might not correctly measure productivity change when variable returns-to-scale is assumed for the technology.

An equivalent way of writing the Malmquist productivity index is:

\[
M_t(y^t, x^t, y', x') = \left[ \frac{D'_I(y^t, x^t)}{D'_s(y^t, x^t)} \right] \left[ \frac{D'_I(y', x')}{D'_s(y', x')} \right]^{\frac{1}{2}}
\]

That is just the product of technical efficiency change (TEC) and technical change (TC) between period t and s, where

\[
TEC = \frac{D'_I(y^t, x^t)}{D'_s(y^t, x^t)} \quad \text{and} \quad TC = \left[ \frac{D'_I(y', x')}{D'_s(y', x')} \right]^{\frac{1}{2}}
\]

Productivity improvement takes place if \( M_t(\bullet) > 1 \). Analogously, technical efficiency improvement occurs when TEC > 1 and technical progress occurs when TC > 1.

A illustration is given in terms of a simple one-input and one output model where productivity is measured as the ratio of output \( y \) produced to input \( x \) used. The production frontier exhibits constant returns to scale and it can shift over time, and two different frontiers for the current t and for future time period s are labeled accordingly as \( F^t_{crs} \) and \( F^s_{crs} \). Inefficiency is also assumed to exist, and therefore the productivity change of any firm over time will depend on both its position relative to the corresponding constant returns-to-scale frontier (technical efficiency) and position change of the frontier itself (technical change). Take a representative firm A producing at point \( A^t(x^t, y^t) \) in period t and point \( A^s(x^t, y^t) \) in period s for example.
In each period, the firm is operating below the production frontier for that period. Using equations (3), we obtain:

\[ \text{TEC} = \frac{x^e / x^s}{x^b / x^t} \] (4)

\[ TC = \left[ \frac{x^f / x^s \times x^b / x^t}{x^e / x^s \times x^c / x^t} \right]^{\frac{1}{2}} = \left[ \frac{x^f}{x^e} \times \frac{x^b}{x^c} \right]^{\frac{1}{2}} \] (5)

The technical efficiency change under constant returns-to-scale can be further decomposed into two components: pure technical efficiency change under variable returns-to-scale and scale efficiency change. The two concepts are illustrated by adding two variable returns-to-scale frontiers \( F_{VRS}^t \) and \( F_{VRS}^s \), representing for period \( t \) and \( s \) respectively. Pure technical efficiency change of a firm is shown as the change in its position relative to the corresponding variable returns-to-scale frontier between the two periods.

For firm A, it is measured as, \( PTEC = \frac{x^g / x^t}{x^d / x^i} \). And the residual scale efficiency change captures the inter-period change in the firm’s potential to improve its efficiency by moving from operating along variable return frontier to constant return frontier at the given output level, that is,

\[ SEC = \frac{x^e / x^g}{x^b / x^d} \].

Computational difficulties may be confronted since the distance functions may not be always well defined in some inter-period DEA linear programming when variable returns-to-scale technology is assumed.

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18 see Fare et al 1994.
5.4. The Application of DEA Window Analysis Technique

Window analysis was initiated by Charnes et al (1985) for analysing efficiency change over time in a panel data context. Suppose that a set of panel data of size $I \times T$ (I firms and T time periods) on input quantity and output quantity is available. And the panel is long enough to be broken into a series of shorter overlapping panel of equal size $I \times S$ where time period $S \in \{1,2,...,s;s < T\}$ So the pooled sub-panel at time $t$ consists of $I \times S$ firms during the time periods $\{t,t+1,...,t+S-1; t \leq T-S+1\}$. And there are a successive series of such sub-panels(window), starting at where $t=1$ and ending at where $t=T-S+1$. DEA can then be applied to each pooled sub-panel sequentially. The resultant efficiency score of a firm in a sub-panel is compared with its score in another sub-panel, as well as comparison among firms in the same window. The width of the windows, $S$, is arbitrarily chosen in most of cases.

The sub-panel sets are not nested, so the best-practice production frontier may shift outward or inward across sub-panels. Efficiency scores within a sub-panel are calculated relative to their own best-practice frontier for the given time period and therefore careful interpretation is needed when compared with efficiency scores from other sub-panels. Nevertheless, window analysis technique allows us to examine the trend of a firm's efficiency performance over time in addition to comparison among a group of firms at a particular point in time. As noted by Charnes et al. (1985), window analysis could be used to examine some properties of the efficiency measures across as well as within window, such as stability of efficiency scores or outlier diagnosis. The technique can also be used in conjunction with other frontier approaches, by applying these approaches to a series of adjacent subsets of a panel.
data sequentially. Window analysis technique can also be used to relieve degrees-of-freedom problem when the number of outputs and inputs is large relative to the number of firms at a certain point of time. It provides a trade-off between the two extreme cases: running separate DEA on each set of cross-sectional data at a single time period and running one DEA on the complete panel dataset. The former has the advantage of allowing the reference technology to change over time, but may lead to degrees-of-freedom problem if \( I \) is relatively small. The latter has no such problem, but explicitly assumes that technology is constant over time, which may be unrealistic if \( T \) is relatively long.

**5.5. The Data and Model**

**Data**

The study used secondary source of data and DEA model to examine the efficiency and productivity performance of commercial banks operating in India during and after global recession. Ideally, the more banking groups included in the sample the better explanatory power of the DEA model. However, some tradeoff has to be made between increasing sample size and maintaining homogeneity of sampled firms. When there are too many organisations with diversified range of business included in the sample, it may no longer be appropriate to compare them directly because of the heterogeneity in the nature of business.

In order to fully capture the banking industry in India, the study select the bank population under study on the following criteria. Firstly, the sample only includes banks that are incorporated in India with full banking licenses. Other types of financial institutions without banking authorities, such as building societies, credit unions, merchant banks and finance companies, are excluded from this study. Public
sector Bank are composed of State Bank of India and Nationalised banks. Other scheduled commercial banks were come under the category of Private Sector Banks. Foreign bank branches operating in India are also included in this study. Secondly, commercial banks which were operating from 2001 to 2012 were considered for the study. Commercial banks which were not operating more than a year during the study period were also excluded from the study. Thirdly, availability of data dictated the selection of banks in the sample to certain degree.

The number of firms examined varies slightly from year to year during the sample period due to merger and acquisition, or entry and exit of the market. This leads to an unbalanced panel data.

5.6. Input and Output Variables

In the banking literature, there has been some disagreement on the definition of bank inputs and outputs and how they could be measured. Two main approaches, production approach and intermediate approach, have dominated the literature to measure the input and output variables in financial institutions. The production approach emphasizes the commercial activities taking place at the banks, that was, producing deposit and loan accounts. Output was defined as number of deposit and loan accounts or transactions processed on the accounts. Inputs are considered as labour and total assets used to perform such transactions and provide other financial services. The intermediation approach views banks' primary role as financial intermediary that flows financial assets between savers and investors. Variables are measured in monetary units. The value of earning assets, such as loan and investment, consists of the principal outputs. Labour, total assets and loanable funds are generally treated as inputs.
As often argued, the production approach neglects banks' role as financial intermediaries to transfer funds by defining inputs as labour and loanable funds only. It does not incorporate interest costs into the model where interest costs represents a large share of total operating cost in any bank. In this regard, the intermediation approach was advantageous since it includes total costs of banking. However, the choice over the approaches often depends on the availability of data. Given the limitation of availability of data for Indian financial institutions, the inputs and outputs employed in this study follow the intermediation approach to modelling banks, which are viewed as financial intermediaries that transfer financial assets between savers and investors.

In this study, the outputs used in the measurement of efficiency are advances, investment and number of branches. The inputs chosen are labour, total assets, and loanable funds. Net loans are the amount of loans, advances and bills discounted net of provisions. Investment comprises investment in India and outside investments. Number of branches was the number of full-service branches in a bank, excluding those agencies. Labour was defined as the number of full-time equivalent staff employed in the bank. Total assets represents the fixed assets and other assets. Loanable funds are measured as the value of total liabilities.

An important advantage of Malmquist index is that, it allows us to distinguish between shifts in the frontier (technology change, TC) and improvement in efficiency relative to the frontier (efficiency change, TEC), which are two mutually exclusive and exhaustive sources of total factor productivity change (TFPC). It is also possible to decompose efficiency change into its distinct components with Malmquist index; changes in management practices (pure efficiency change, PTEC) and changes in production scales (scale efficiency change, SEC). This treatment ideally improves
analystical efforts while tracing the underlying sources of productivity developments.

5.7 Empirical Findings

The study empirically investigated Efficiency and Productivity for three major Indian Banking Groups over the period of 2002 to 2012. The period up to 2008 was considered as pre-recession period while the subsequent period 2009 to 2012 was regarded as post-recession period. Since the basic components of Malmquist index was related to measure technical efficiency, Technical efficiency change and technological progress are the two sources of total factor productivity growth.

As mentioned earlier, the present study applies DEA-Malmquist Productivity Indices approach to measure TFP change and its scores. The study has used computer software DEAP (Coelli, 1996) to compute these indices. Average estimates (geometric mean) of Malmquist indices of total factor productivity change (TFPC), decomposed into technical efficiency change (TEC) and technological change (TC). TEC was further decomposed into pure technical efficiency change (PTEC) and scale efficiency change (SEC). The value of TFPC greater than one reveals productivity growth, value equal to one indicates no change and lower than unity indicates regress in productivity growth. To estimate percentage change in productivity, one is subtracted from the TFPC index and then value is multiplied by 100, [(TFPC-1) x 100]. The rules applies to the other indices presented in the table.
Table 5.1 Technical Efficiency Score by Bank Type

<table>
<thead>
<tr>
<th>Bank Types</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Sector Banks</td>
<td>1.127</td>
<td>1.047</td>
<td>0.995</td>
<td>1.008</td>
<td>0.981</td>
<td>1.004</td>
<td>1.026</td>
<td>1.006</td>
<td>0.965</td>
<td>1.013</td>
<td>0.985</td>
<td>1.014</td>
</tr>
<tr>
<td>Private Sector Banks</td>
<td>0.974</td>
<td>1.014</td>
<td>0.997</td>
<td>1.035</td>
<td>0.971</td>
<td>0.960</td>
<td>1.025</td>
<td>0.993</td>
<td>1.020</td>
<td>0.997</td>
<td>0.990</td>
<td>0.997</td>
</tr>
<tr>
<td>Foreign Banks</td>
<td>1.021</td>
<td>0.985</td>
<td>1.110</td>
<td>0.907</td>
<td>1.042</td>
<td>0.989</td>
<td>1.001</td>
<td>0.948</td>
<td>1.060</td>
<td>0.923</td>
<td>0.772</td>
<td>0.978</td>
</tr>
</tbody>
</table>

Figure 5.2 Technical Efficiency Score by Bank Type

Technical efficiency score by bank type for three banking group presented in Table no 5.1. The results reveals that Public Sector Banks were more Technically efficient fallowed by Foreign Banks and Private Banks over a period of study.

Technical efficiency was fluctuated during study period none of the banks were not showing study increase. Out of 11 years Public Sector Banks technical efficiency was increased in 7 years, remaining 4 years it was decreased. Private Sector Banks Technical efficiency was increased for 4years and for 7 years it was decreased. In case of Foreign Banks it was increased for 5years and remaining 6years it was regressed. During the study period Technical efficiency of Foreign Banks were more
fluctuated and Public Sector Banks was less. Empirical findings shows that in the post crisis period out of 4 years Public Sector Banks were efficient in 2 years (2009,2011), at the same time Private Sector Banks and Foreign Banks efficiency was increased in only one year (2010) and remaining three years it was regressed.

Overall results reveals that technical efficiency of Public Sector Banks was increased in most of years and in 2004, 2006, 2010 and 2012 was decreased a little there was no greater difference. The above shows increase in the maximum output that can be produced from a given level of inputs.

<table>
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<tr>
<th>Bank Types</th>
<th>2002</th>
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<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Sector Banks</td>
<td>0.918</td>
<td>1.041</td>
<td>1.034</td>
<td>0.939</td>
<td>0.874</td>
<td>0.900</td>
<td>0.954</td>
<td>1.010</td>
<td>1.041</td>
<td>0.929</td>
<td>1.011</td>
<td>0.968</td>
</tr>
<tr>
<td>Private Sector Banks</td>
<td>1.126</td>
<td>0.011</td>
<td>1.005</td>
<td>1.068</td>
<td>1.098</td>
<td>1.085</td>
<td>1.015</td>
<td>1.022</td>
<td>0.982</td>
<td>1.049</td>
<td>1.042</td>
<td>0.954</td>
</tr>
<tr>
<td>Foreign Banks</td>
<td>1.086</td>
<td>0.996</td>
<td>1.068</td>
<td>1.104</td>
<td>1.009</td>
<td>1.041</td>
<td>1.072</td>
<td>1.210</td>
<td>0.872</td>
<td>1.188</td>
<td>0.978</td>
<td>1.056</td>
</tr>
</tbody>
</table>

**Figure No 5.3 Technical Change Score by Bank Type**

![Graph showing technical change score by bank type from 2002 to 2012.](image-url)
Table No 5.2 provides an overview of Technical change score of three bank groups, namely Public Sector Banks, Private Sector Banks and Foreign Banks. Empirical results spell out that Foreign Banks has achieved greater technical change than other two groups. The Foreign Banks have recorded Technical change score growth by their high technological knowledge. Public Sector Banks and Private Banks have to compete with the Foreign Banks and with their high technological knowledge. Foreign Banks technical change score was increased in eight years, but Public Sector Banks technical change was achieved growth only in five years remaining six it was declined, it shows that Public Sector Banks was not utilized existing technology optimally.

Empirical findings shows that after Global recession period Public sector and Private banks has achieved three years growth in technical change remaining one year only it was declined. In case of Foreign Banks only two years 2009 and 2011 was technical change is showing increment remaining two years it was decreased. It indicates that Public Sector Banks were shown study growth after recession but Foreign Banks were affected than other groups. Foreign Banks with their high technological knowledge also affected greatly by global recession than Public Sector Banks. Private Sector Banks have achieved highest technical change score after recession period it was because of RBI Appropriate monetary policy dynamic financial regulations.
Table No 5.3 Pure Technical Efficiency Score by Bank Type

<table>
<thead>
<tr>
<th>Bank Types</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
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<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Sector</td>
<td>1.061</td>
<td>1.041</td>
<td>1.000</td>
<td>1.008</td>
<td>1.001</td>
<td>1.028</td>
<td>1.008</td>
<td>0.991</td>
<td>0.972</td>
<td>1.040</td>
<td>0.973</td>
<td>1.011</td>
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<tr>
<td>Banks</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Private Sector</td>
<td>0.971</td>
<td>1.024</td>
<td>0.977</td>
<td>1.026</td>
<td>0.988</td>
<td>0.970</td>
<td>1.021</td>
<td>0.986</td>
<td>1.011</td>
<td>1.005</td>
<td>0.991</td>
<td>0.997</td>
</tr>
<tr>
<td>Banks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foreign Banks</td>
<td>1.029</td>
<td>0.949</td>
<td>1.060</td>
<td>0.953</td>
<td>1.050</td>
<td>0.970</td>
<td>1.036</td>
<td>0.936</td>
<td>1.067</td>
<td>1.006</td>
<td>0.700</td>
<td>0.977</td>
</tr>
</tbody>
</table>

Pure Technical Efficiency Score by bank type was provided in Table no –5.3. Empirical findings indicate that efficiency was not biased by input change or increment. Empirical finding reveals that during the study period Public Sector Banks were scored more in Pure technical efficiency than Private Sector Banks and Foreign Banks were achieved least score on that.

By observing overall period of time Public Sector Banks were achieved greater technical efficiency. It was showing 8 years increment remaining three years only it was regressed. On the other hand Private Sector Banks were achieved only 5
years pure technical efficiency remaining 6 years in was decreased. When we come to Foreign Bank it was a little bit more than private banks it was increased in 6 years and remaining 5 years there is no pure technical efficiency was recorded.

After global recession out of four years all the three banking sector were not achieved pure technical efficiency Public and Private Sector Banks pure technical efficiency was not having much difference and Foreign Banks was more regressed than other groups.

**Table No 5.4 Scale Efficiency Score by Bank Type**

<table>
<thead>
<tr>
<th>Bank Types</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Sector Banks</td>
<td>1.062</td>
<td>1.005</td>
<td>0.995</td>
<td>1.000</td>
<td>0.981</td>
<td>0.976</td>
<td>1.018</td>
<td>1.015</td>
<td>0.993</td>
<td>0.974</td>
<td>1.013</td>
<td>1.003</td>
</tr>
<tr>
<td>Private Sector Banks</td>
<td>1.003</td>
<td>0.990</td>
<td>1.020</td>
<td>1.008</td>
<td>0.983</td>
<td>0.990</td>
<td>1.004</td>
<td>1.007</td>
<td>1.010</td>
<td>0.992</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Foreign Banks</td>
<td>0.992</td>
<td>1.037</td>
<td>1.047</td>
<td>0.951</td>
<td>0.992</td>
<td>1.019</td>
<td>0.966</td>
<td>1.013</td>
<td>0.994</td>
<td>0.917</td>
<td>1.102</td>
<td>1.002</td>
</tr>
</tbody>
</table>

Table no –5.4 reports the scale efficiency score by bank type, since scale efficiency change which was the change in the degree to which a firm optimises the scale of its operation. Over a period of time empirical finding shows that Public Sector Banks (1.003) were optimizing the scale of its operation followed by Foreign Banks(1.002) and Private Sector Banks (1.000).
Analyzing over all period of time Foreign Banks were more fluctuated than other groups it was recorded only 5 years increment out of 11 years. Private Sector Banks were optimally utilized scale of its operation in 7 years and Public Sector Banks achievement was marginally differed it was achieved growth of scale efficiency in 6 years.

After Global recession period out of four years all the three groups were achieved marginal difference in scale efficiency Public sector bank has shows 0.998 decrease in scale efficiency. Where Private Sector Banks shows 1.002 and Foreign Banks was 1.006 of increment in scale efficiency.

**Table No 5. 5 Total Factor Productivity Change Score by Bank Type**

<table>
<thead>
<tr>
<th>Bank Types</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Sector</td>
<td>1.035</td>
<td>1.090</td>
<td>1.028</td>
<td>0.946</td>
<td>0.858</td>
<td>0.903</td>
<td>0.978</td>
<td>1.016</td>
<td>1.005</td>
<td>0.940</td>
<td>0.996</td>
<td>0.981</td>
</tr>
<tr>
<td>Banks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Sector</td>
<td>1.096</td>
<td>0.011</td>
<td>0.907</td>
<td>1.105</td>
<td>1.067</td>
<td>1.042</td>
<td>1.041</td>
<td>1.015</td>
<td>1.002</td>
<td>1.046</td>
<td>1.032</td>
<td>0.942</td>
</tr>
<tr>
<td>Banks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foreign Banks</td>
<td>1.109</td>
<td>0.981</td>
<td>1.185</td>
<td>1.001</td>
<td>1.051</td>
<td>1.030</td>
<td>1.073</td>
<td>1.147</td>
<td>0.924</td>
<td>1.097</td>
<td>0.754</td>
<td>1.032</td>
</tr>
</tbody>
</table>
Table no 5.5 shows Total Factor Productivity change score by bank type. The results reveals that Foreign Banks were showing progress of 1.032 both Private and Public Sector Banks total factor productivity was regressed. Technical change may be the main driver of Foreign Banks total factor productivity. But TFP growth was regressed for both Public Sector Banks and Private Sector Banks.

Private Sector Banks shows less fluctuation that was only two years TFP was decreased remaining nine years it was increased, like that Foreign Banks also achieved eight years increment, but Public Sector Banks TFP was increased in five years and remaining six years it was regressed. Technical change factor may be the most regressing factor of Public sector bank.

After Global Recession period Private Sector Banks was achieved all the four years TFP growth. Since technical change was the major driving factor of TFP of Private Sector Banks. Public sector bank TFP was increased in 2009 and 2010 remaining two years it was decreased. Same thing has happened for Foreign Banks.
also and they achieved only two years increment of TFP that is 2009 and 2011 and in the year 2010 and 2012 it was regressed achieved,

Empirical results spell out that the Private sector and Foreign Banks have recorded TFP growth by their high technological knowledge. Public Sector Banks have to compete with the Private and Foreign Banks and with their high technological knowledge. The foreign bank has a strong competitive effect on the banking sector.

**Table No 5.6 Mean Technical Efficiency Score by Bank Type**

<table>
<thead>
<tr>
<th>Bank type</th>
<th>Effch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Sector Bank</td>
<td>1.013</td>
</tr>
<tr>
<td>Private Sector Bank</td>
<td>0.998</td>
</tr>
<tr>
<td>Foreign Bank</td>
<td>0.974</td>
</tr>
</tbody>
</table>

**Figure No 5.7 Mean Technical Efficiency Score by Bank Type**

![Bar chart showing mean technical efficiency scores by bank type]
The mean technical efficiency scores of Public, Private and Foreign Banks are shown in the figure 5.7. The results reveals that only Public banks have shown an improvement in technical efficiency score by an amount of 1.3%. Both private and Foreign Banks have experienced regress in technical efficiency score in the study period with a value of 0.998 and 0.974 respectively.

Table No 5.7 Mean Scale Efficiency Score by Bank Type

<table>
<thead>
<tr>
<th>Bank type</th>
<th>Sech</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Sector Bank</td>
<td>1.003</td>
</tr>
<tr>
<td>Private Sector Bank</td>
<td>1.001</td>
</tr>
<tr>
<td>Foreign Bank</td>
<td>1.002</td>
</tr>
</tbody>
</table>

Figure No 5.8 Mean Scale Efficiency Score by Bank Type

Bank wise picture of the scale efficiency score by the bank type can be seen by the figure no 5.8. The results shows that Public Sector Banks have shown improvement in scale efficiency score followed by foreign bank and private bank an
amount of 0.3%, 0.2% and 0.1% respectively. Hence all types of banks have shown improvement in mean scale efficiency during study period.

Table No 5.8 Mean Pure Efficiency Score by Bank Type

<table>
<thead>
<tr>
<th>Bank type</th>
<th>Pech</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Sector Bank</td>
<td>1.011</td>
</tr>
<tr>
<td>Private Sector Bank</td>
<td>0.997</td>
</tr>
<tr>
<td>Foreign Bank</td>
<td>0.972</td>
</tr>
</tbody>
</table>

Figure No 5.9 Mean Pure Efficiency Score by Bank Type

In the above table no:5.8 and figure:5.9 we find the mean pure efficiency score of public sector bank, private sector bank and foreign bank. The result reveals that only Public Sector Banks have shown an improvement in pure efficiency score by an amount 1.1%. Both private and Foreign Banks have experienced regress in pure efficiency during the study period with a value of 0.997 and 0.972 respectively.
Table No 5.9 Mean Technical Change Score by Bank Type

<table>
<thead>
<tr>
<th>Bank type</th>
<th>Techch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Sector Bank</td>
<td>0.966</td>
</tr>
<tr>
<td>Private Sector Bank</td>
<td>0.864</td>
</tr>
<tr>
<td>Foreign Bank</td>
<td>1.053</td>
</tr>
</tbody>
</table>

Table No 5.10 Mean Technical Change Score by Bank Type

We can found the mean technical change score of Public Sector Banks, Private Sector Banks and Foreign Banks in table no:5.9 and figure no:5.10. The results reveals that only Foreign Banks have shown an improvement in technical change score by an amount 5.3%. Both public sector bank and Private Sector Banks have experienced regress in technical change score in the study period with a value of 0.966 and 0.864 respectively. Naturally it reveals that Foreign Banks come with high technical knowledge and achieved high growth with a value of 1.053. Domestic banks public and private banks have been failed in competition of technical knowledge of Foreign Banks.
Table No 5.10 Mean Total Factor Productivity Change Score by Bank Type

<table>
<thead>
<tr>
<th>Bank type</th>
<th>Tfph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Sector Bank</td>
<td>0.979</td>
</tr>
<tr>
<td>Private Sector Bank</td>
<td>0.862</td>
</tr>
<tr>
<td>Foreign Bank</td>
<td>1.025</td>
</tr>
</tbody>
</table>

Figure No 5.11 Mean Total Factor Productivity Change Score by Bank Type

The mean total factor productivity change score of public, private and Foreign Banks are shown in the table no:5.10 and figure no:5.11. The results reveals that only Foreign Banks have shown an improvement in total factor productivity change score an amount of 2.5%. Both public and private banks have regressed in total factor productivity change score in the study period with a value of 0.979 and 0.862 respectively. It revels that the main driver of total factor productivity change score of Foreign Banks was technical change score and Foreign Banks come with high
technological knowledge and domestic banks have to improve their technology to give competition to Foreign Banks or to face their competition.

The empirical results reveals that the efficiency and productivity of Indian Banking Sector has declined during the financial crisis period compared to pre-crisis period. And also the different indicators of efficiency and productivity measured through the DEA Malmquist analysis have proved that the performance of public, private and Foreign Banks are not same during the study period. Hence the hypothesis of efficiency and productivity have been decreased during recession period was accepted.

**5.8 Sum Up**

The study examined several efficiency measures and productivity changes in the Indian banking sector by classifying as Public Sector Banks, Private Sector Banks and Foreign Banks for pre-recession period (2002-2007) and after recession period (2008-2012). The analysis results indicate that the technical efficiency, technical change, pure technical efficiency, total factor productivity of public and private banks was not decreased but the Foreign Banks were regressed.

In the scale efficiency score of public, private banks was lower than the Foreign Banks. Significant allocative inefficiency showed that the Indian commercial banks were unable to use the inputs mix properly. Total factor productivity mean of Foreign Banks was 1.025 only because of Foreign Banks come with high technical knowledge domestic banks were lack of that. In the pure efficiency score our domestic banks shown better performer than Foreign Banks.

The findings indicate that domestic banks should upgrade their technical knowledge with their counterpart Foreign Banks. The true source of the crisis we have
experienced are not only widespread but also more hidden. Our banking sector should resist the temptation to round up the most proximate suspects and pin the blame only on them. Greedy bankers can be regulated; lax government officials can be replaced. This is a convenient focus, because the villains are easily identified and measures can be taken against malfeasance and neglect.