Productivity and Cost Efficiency of Commercial Banks in India

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Abstract

This paper examined the productivity and relative cost efficiency of all commercial banks in India from 1993 to 2013 using the data envelopment analysis methodology and Malmquist index. The percentage of banks in the bank groups, such as foreign banks (69 %) , nationalized banks (58%), and old private sectors (77%) that experienced technological change were considerably higher than the new private sector banks and State Bank of India (SBI) associate banks. The total factor productivity changes of the aforementioned three bank groups was due to technological rather than technical efficiency change. Percentage of cost efficient banks in the bank groups such as the new private sector group (75%), SBI and Associate banks (67%), and old private sector banks (56%) was considerably higher than foreign and nationalized banks. The correlation between cost efficiency and technical efficiency ranged from 0.629 to 1 (moderate to strong positive) for different groups of banks. The correlation between cost efficiency and total factor productivity change ranged from -0.067 to -0.993 (weak to strong negative) for different groups of banks.

Keywords : **data envelopment analysis, total factor productivity change, efficiency change, technological change, cost efficiency, and Malmquist index**

JEL Classification: C61, C67, G21, P17

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Measurement of efficiency of banks plays an important role in comparing the extent to which inputs are effectively utilized to generate different levels of output by the banks. Efficiency models are so designed in such a way that it takes different inputs and output variables in different units of measurement to benchmark the best banks with peers so as to study the effect of various policy reforms on banking reforms. A strong financial system not only facilitates financial resources of intermediates, but also ensures efficiency in terms of resource generation and allocation. Efficiency and productivity analysis will help regulators to check and refine policy reforms so as to ensure economic growth. Hence, efficiency and productivity measurement is a continuous activity in the banking sector to ensure that policy measures have a better impact on the economic system.

Productivity can be defined as the ability and willingness of an economic unit to produce maximum possible output with given inputs and technology. In simple terms, efficiency and productivity are often used interchangeably, but they do have some differences. In case of single output and input, efficiency is a ratio of actual output generated to standard output, while productivity is the output produced per unit of input consumed at a given point of time. Accounting measures is one of the productivity estimates, which deals with calculation of

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output per unit change in a single input assuming that all other factors remain constant. Business per employee, profit per employee, ratio of operating costs to average assets, or ratio of operating income to staff expenses are often used as traditional measures of productivity in the banking sector. In case of productivity change, there is a subtle difference between efficiency and productivity. Measures such as total factor productivity (TFP) help to decompose output change into two major components, namely, output change due to change in efficiency and output change due to change in technology. While a change in efficiency measures the increment in output without a rise in input or the amount by which inputs may be reduced without reducing the output, a change in technology represents the change in output that may be attributed to changes in external economic environmental conditions (Oster & Antioch, 1995).

With the above backdrop, this paper makes an attempt to measure the productivity change and cost efficiency of the banking sector over the period from 1991-2013. Data envelopment analysis (DEA) is employed for this purpose. The cost efficiency and productivity change are calculated for banking groups such as nationalized banks (NB), public sector banks (PSB), old private sector banks (OPSSB) , new private sector banks (NPSB), and foreign banks(FB).

Review of Literature

Ahmad and Rahman (2012) examined the relative efficiency of the Islamic commercial banks (ICBs) and conventional commercial banks (CCBs) in Malaysia. The study measured and compared the level of efficiency of both Islamic commercial banks and conventional commercial banks from the year 2003 to 2007. Ten local commercial banks were selected in Malaysia, which comprised of eight conventional commercial banks and two Islamic commercial banks. The data envelopment analysis (DEA) was used to measure the relative efficiency of the selected banks in intermediating inputs into outputs. The study then analyzed the difference in the average efficiency score of the Islamic commercial banks and conventional commercial banks by using the Mann-Whitney U test. This study found that the conventional commercial banks outperformed Islamic commercial banks in all efficiency measures. The findings indicated that the conventional commercial banks may be more efficient than the Islamic commercial banks due to managerial efficiency and technological advancement. The study indicated that the domestic commercial banks' management was well organized, reflecting the effective roles of a bank as the mediator between the savers and entrepreneurs. The technology used in the commercial banks may be up-to-date and fully utilized in the banking operations. However, the study revealed that commercial banks in Malaysia were facing scale inefficiency. This means that the banks were unable to fully utilize their capabilities and capacities in generating outputs from their resources. The findings also indicated that scale inefficiency is the main factor that lead to low technical efficiency in the Islamic commercial banks as their size was relatively smaller than that of the conventional commercial banks. This study identified the most and the least efficient domestic banks, and the findings could be useful to the regulators and the banks to identify the bank's ranking within the industry.

Seong, Nixon, and Stoeberl (2011) made a study for benchmarking using DEA by suggesting a framework based on return on assets (ROA), which is popular and user-friendly to managers. The paper demonstrated the selection of variables using the elements of ROA and applied DEA for measuring and benchmarking the comparative efficiencies of companies in the same industry. Fourteen retail companies in U.S. were included as samples for the study. The three models such as the total asset model, current asset model, and expense model were used in the study to decide on the variables to be used for the data envelopment analysis. In all these models, different types of revenues were used as output variables. In the total asset model, current assets, fixed assets, and other assets were used as input variables. In the current asset model, cash & cash equivalent, accounts receivable, and inventory were used as input variables. In the expense model, cost of goods sold (COGS), selling, general and administrative expenses (SG&A), depreciation and amortization, and "other expenses" were used as input

variables. The input oriented DEA models were used in this study . For computing efficiency, three DEA models were employed. They were slack based model, constant returns to scale model, and variable returns to scale. It was concluded that the approach was applicable to various studies for performance measurement and benchmarking with minor modifications.

Liang, Hua, and Jeanneney (2006) used the data envelopment analysis (DEA) based on the Malmquist index to measure China's total factor productivity change and its two components (i.e., efficiency change and technical progress). It was found that China had recorded an increase in total factor productivity from 1993 to 2001, and that productivity growth was mostly attributed to technical progress, rather than to improvement in efficiency.

Isik and Hassan (2003) utilized a DEA-type Malmquist Total Factor Productivity Change Index to examine productivity growth, efficiency change, and technical progress in Turkish commercial banks during the deregulation of financial markets in Turkey. It was found that all forms of Turkish banks, although in different magnitudes, had recorded significant productivity gains driven mostly by efficiency increases rather than technical progress. Efficiency increases, however, were mostly owing to improved resource management practices rather than improved scales.

Liu (2010) employed the Malmquist productivity index approach, which is calculated from efficiency scores based on DEA linear programming technique, to measure the technical efficiency and productivity change of 25 commercial banks in Taiwan over the post Asian crisis period from 1997 - 2001. It was found that the technical efficiencies of 15 banks had improved, while the same of 10 banks declined over the period. It was also found that the banking industry had a decrease in technical efficiency but owned upward shifts of technology since the year 1998. Based on technical efficiency and the efficiency change of banks, 25 banks in Taiwan were classified into four categories to help realize the competitiveness and technical progress of the banks. Some of the commercial banks need to search for financial innovation activities and carry on production differentiation to be competitive in the market.

Deng, Wong, Wooi, and Xiong (2011) studied bank productivity in Malaysia during 2001-2008, that is, the period of Internet technology waves. Data envelopment analysis (DEA) technique was used to calculate and decompose the Malmquist index of total factor productivity (TFP) growth into technical change and change in scale efficiency. The study found that the average TFP change was 1.4%, which was mainly due to an efficiency change of 3.3%. In addition, foreign banks were found to have a higher efficiency level, followed by the local banks. Finally, the study found that the TFP did not always keep increasing as the technology improved.

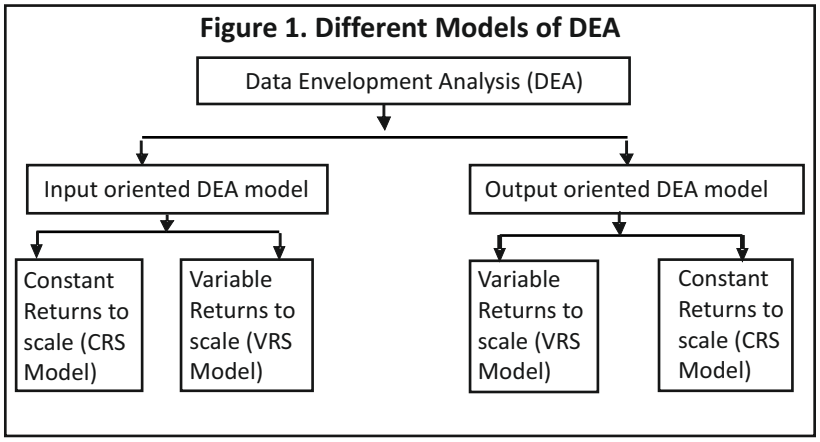
Chandrasekhar and Sonar (2008) examined the effect of information technology investments and related assets on the efficiency and total factor productivity of Indian banks. For this study, panel data of 29 banks (public and private banks) were considered for a period from 2001 to 2006.The results indicated that private sector banks had a slight edge over their counterparts.

Derli (2006) studied the efficiency of the Brazilian banking industry using the data envelopment analysis based on constant returns to scale. IT expenses were used as input variable and deposit as the single output variable. The Malmquist index was used for measuring productivity for the above combination of inputs and outputs. The results revealed that the public institutions were more efficient than the private institutions.

Sharma and Kumar (2013) studied the impact of banking sector reforms on the performance of commercial banks in India. The performance of these banks was measured using profitability indicators. The results revealed that the reforms had a significant impact on total income, especially in the post-reform period for all bank groups.

Sundaram, Geetha, and Kanjana (2008) made an analytical study on efficiency of scheduled commercial banks in India. The authors highlighted the role of the above categories of banks in achieving the economic development by providing effective institutional credit support to various regions/sectors/ sections.

Nagaraju (2014) analyzed the performance of Indian public and private banks by applying the data envelopment analysis (DEA) on a sample of 34 banks by considering the time period from 2006 to 2010. This study revealed that Indian public (nationalized and State Bank group) and private banks underperformed in terms



of marketability and profitability efficiency. However, they performed relatively better in terms of profitability efficiency as compared to the stock market performance (marketability efficiency). Specifically, these inefficiencies were explained by the ownership of the banks, and not by their size.

Objectives of the Study

(1) To study the productivity change of Indian commercial banks in terms of technical efficiency change and technological change using the Malmquist index.

(2) To study the trends in technical efficiency and cost efficiency of Indian commercial banks.

(3) To study the correlation between cost efficiency and technical efficiency.

(4) To study the correlation between cost efficiency and total factor productivity change.

Methodology and Data Sources

The prepared data used for the study were collected from statistical tables relating to banks in India, which are available on the RBI website. The study covers the time period from 1992 (base period) to 2013 in case of foreign banks, nationalized banks, old private sector banks, and SBI and its associates. Furthermore, the study covers the new private sector banks for the period from 1996 (base year) to 2013. The banks which did not have continuous data for the above mentioned period were excluded from the study.

Concepts Related to DEA

(1) Returns to scale measures the relationship between output and inputs. Returns can be constant, increasing or decreasing depending on whether output increases in proportion to, more than or less than inputs, respectively. In the case of multiple inputs and outputs, this means how outputs change when there is an equi-proportionate change in all inputs.

(2) Technical efficiency (constant returns to scale efficiency) is determined by the difference between the observed ratio of combined quantities of an entity's output to input and the ratio achieved by *best practice*. It can be expressed as the potential to increase quantities of outputs from given quantities of inputs, or the potential to reduce the quantities of inputs used in producing given quantities of outputs.

Table 1. Description of Notations

Symbol	Meaning	Symbol	Meaning
TFP	Total Factor Productivity	Pech	Technical Efficiency Change(Relative
S.D.	Standard Deviation		to VRS technology)
Tfpch	Total Factor Productivity Change		
CV (%)	Coefficient of Variation	Sech	Scale Efficiency Change
M	Malmquist Index	TE	Technical Efficiency
Effch	Technical Efficiency Change(Relative to CRS technology)	AE	Allocative Efficiency
Techch	Technological Change	CE	Cost Efficiency
ADCB	Abu Dhabi Commercial Bank Ltd	PNB	Punjab National Bank
BOA	Bank of America	SY	Syndicate Bank
BOBK	Bank of Bahrain & Kuwait	UB	UCO Bank
BONS	Bank of Nova Scotia	UN	Union Bank of India
BB	Barclays Bank plc	UD	United Bank of India
BP	BNP Paribas	VB	Vijaya Bank
CB	CitiBank	AX	Axis Bank limited
CACI	Credit Agricole Corporate and Investment Bank	HD	HDFC Bank Ltd.
DB	Deutsche Bank	IC	ICICI Bank limited
HSBC	Hongkong and Shanghai Banking Corpn. Ltd.	II	Indusind Bank Ltd
MB	Mashreq Bank	CLS	Catholic Syrian Bank Ltd
OIB	Oman international Bank Ltd.	CUB	City union Bank limited
SG	SocieteGenerale	FB	Federal Bank Ltd
SB	Sonali Bank	INV	IngVysya Bank Ltd
SCB	Standard Chartered Bank	JK	Jammu & Kashmir Bank Ltd
BOTMU	The Bank of Tokyo-Mitsubishi UFJ Ltd.	KA	Karnataka Bank Ltd
AL	Allahabad Bank	KV	KarurVysya Bank Ltd
AN	Andhra Bank	LV	Lakshmi Vilas Bank Ltd
BOB	Bank of Baroda	NB	Nainital Bank Ltd
BOI	Bank of India	RB	Ratnakar Bank Ltd
BOM	Bank of Maharashtra	SI	South Indian Bank Ltd
CN	Canara Bank	TM	Tamilnad mercantile Bank Ltd
CBI	Central Bank of India	DL	The Dhanalakshmi Bank Ltd
COB	Corporation Bank	SBJ	State Bank of Bikaner and Jaipur
DE	Dena Bank	SBH	State Bank of Hyderabad
IB	Indian Bank	SBI	State Bank of India
IOB	Indian Overseas Bank	SBM	State Bank of Mysore
OBC	Oriental Bank of Commerce	SBP	State Bank of Patiala
PSB	Punjab and Sind Bank	SBT	State Bank of Travancore

(3) Pure technical efficiency (variable returns to scale efficiency) is the efficiency measure corresponding to VRS assumption that represents pure technical efficiency (PTE) which measures efficiency due to *managerial performance*.

The Figure 1 shows the different models of DEA. Input oriented model is concerned with the amount by which input quantities can be proportionally reduced without changing the output quantities produced. Output oriented model is concerned with the amount by which output quantities can be proportionally expanded without modifying the input quantities used. The Table 1 shows the description of notations used for the study.

Malmquist Index

The tool used for measuring productivity change over time is the Malmquist index. This index is calculated for panel data. The index is decomposed into technical efficiency change and technological change. So, it is the product of technical efficiency change and technological change. The efficiency change (EC) term relates to the degree to a decision making unit (DMU), which may be an organization or any other entity. Here, it refers to whether banks improve or degrade their efficiency. This is also known as the catch-up effect. Technical change (TC) reflects the change in the efficient frontiers (due to change in technology) between the two time periods. This is also known as frontier shift (or innovation).The formula for Malmquist total factor productivity index is given in equation(2).The index is calculated using a distance function from time period denoted as *"t"* to the subsequent period $t+1$.

$$M(I^t, O^t, I^{t+1}, O^{t+1}) = \sqrt{\frac{D^t(I^{t+1}, O^{t+1})}{D^t(I^t, O^t)} \times \frac{D^{t+1}(I^{t+1}, O^{t+1})}{D^{t+1}(I^t, O^t)}} \quad \text{----------} (1)$$

where,
M = Malmquist index,
I = Input variables of decision making units,
O = Output variables of decision making units,
D = Distance function,
t = Starting time period,
$t+1$ = Time period subsequent to *'t'*.

$$M(I^t, O^t, I^{t+1}, O^{t+1}) = \underbrace{\left[\frac{D^{t+1}(I^{t+1}, O^{t+1})}{D^t(I^t, O^t)}\right]}_{Efficiency\ Change} \times \underbrace{\left[\sqrt{\frac{D^t(I^{t+1}, O^{t+1})}{D^{t+1}(I^{t+1}, O^{t+1})} \times \frac{D^t(I^t, O^t)}{D^{t+1}(I^t, O^t)}}\right]}_{\textbf{Technical Change}} \quad \text{.....} (2)$$

$$\text{Efficiency Change } (EC) = \frac{D^{t+1}(I^{t+1}, O^{t+1})}{D^t(I^t, O^t)} \quad \text{.....} (3)$$

$$\text{Technical Change } (TC) = \left[\sqrt{\frac{D^t(I^{t+1}, O^{t+1})}{D^{t+1}(I^{t+1}, O^{t+1})} \times \frac{D^t(I^t, O^t)}{D^{t+1}(I^t, O^t)}}\right] \quad \text{.....} (4)$$

Equation (2) = Equation(3) x Equation(4).

The first ratio in equation (1) indicates Malmquist index at time *'t'*. This ratio measures the productivity change from time *'t'* to time '$t+1$' with technology at time *'t'* as reference, whereas the second ratio in the same equation estimates the change in productivity from time *'t'* to time *'t*+1' with technology at time '$t+1$'. Equation (1) is decomposed into efficiency change and technical change and shown in equation (2) as efficiency change (EC) and technical change (TC).The values of TC, EC, and Malmquist index (M) lies between 0 and 1.When the value of :

(1) M is equal to 0, there is no change in productivity.
(2) M is greater than 1, there is an improvement in productivity.
(3) M is lesser than 1, there is a deficiency in productivity.

In this study, an output oriented model is used to calculate the Malmquist index. The input variables used are based on the intermediary approach .The input variables used are deposits and borrowings. The output variables used are advances, investments, and net interest income.

Cost Efficiency

Farell (1957) stated that efficiency of a firm consists of two major components, namely technical efficiency and allocative efficiency. Technical efficiency indicates the ability of a firm to obtain maximum output from a given set of inputs. Price/Allocative efficiency indicates the ability of a firm to use the inputs in optimal proportions given their respective prices. These two measures are combined to provide a measure of overall economic efficiency/cost efficiency.

Suppose price information of inputs is available in addition to input and output variables and also an objective of either a cost minimization or revenue maximization is considered, technical and allocative efficiencies can be estimated. For a variable returns to scale (VRS) cost minimization, input oriented DEA model (shown below) can be run to find out the technical efficiency .

Minimize $\boldsymbol{S_n}$ subject to

$$\sum_{j=1}^{N} W_j Y_{ij} - Y_{in} \geq 0, \qquad i = 1,2,\ldots\ldots,I$$

$$\sum_{j=1}^{N} W_j X_{kj} - S_n X_{kn} \leq 0, \quad k = 1,2,\ldots\ldots,K$$

$$\sum_{j=1}^{N} W_j = 1$$

$$W_j \geq 0 \quad j = 1,2,\ldots\ldots N$$

N = number of decision making units/service units being compared in the DEA analysis,
S_n, = Efficiency rating of the decision making unit/service unit being evaluated by DEA under respective models of DEA,
Y_{ij} = amount of output i used by decision making unit/service unit j,
X_{kj} = amount of input k used by decision making unit/service unit j,
i = number of inputs used by the decision making unit/service unit,
k = number of outputs generated by the decision making unit/service unit,
I = number of output variables,
K = number of input variables,
W_j are weights applied across N organizations.

After calculating technical efficiency, cost minimization DEA model is run to calculate cost efficiency/economic efficiency.

Minimize $W_i x_i$
Subject to
$\Lambda Y - y_i \geq 0,$
$-\Lambda X + x_i \geq 0,$
$\sum_{j=1}^{N} \Lambda_j = 1,$
$\Lambda_j \geq 0 \quad j = 1,2 \ldots\ldots N$

W_i = Vector of input prices for i-th DMU,
x_i = Cost minimizing vector of input quantities for i-th DMU,
y_i = output levels.

The total cost efficiency (CE) or economic efficiency of i - th DMU can be calculated as :

$$CE = \frac{\text{Minimum cost of } i - \text{th DMU}}{\text{Observed cost of } i - \text{th DMU}}$$

In this study, the input oriented model is used to calculate cost efficiency. The input variables used are based on the intermediary approach .The input variables used are deposits and borrowings. The variables used for price of inputs are interest on deposits and interest on borrowings. The output variables used are advances, investments, and net interest income.

Selection of Input and Output Variables

There are three major methods in selecting input and output variables used for measuring banking efficiency. They are the production approach (PA), the intermediation approach (IA), and the asset approach (AA). The Figure 2 shows the various methods/approaches used in selection of input and output variables to be used for the study. The approaches are described below :

(1) Production Approach : The production approach considers banks as producers of deposit accounts and loan services. The number of accounts serviced or transactions processed are measures of outputs. Inputs include

Figure 2. Approaches for Selecting Input and Output Variables

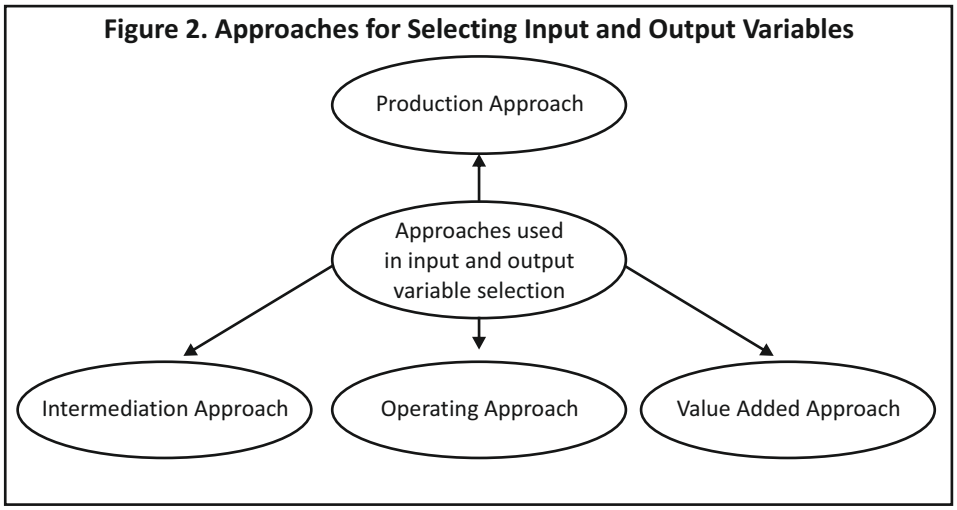


Table 2. Production Approach

Authors	Input	Output
Benston (1965)	Number of employees and physical capital	The number of accounts or its related transactions
Sherman and Gold (1985)	Labor, capital (rent paid to each branch),cost of supplies	Number of transactions
Ferrier and Lovell (1990)	Labor, expenditure on materials, occupancy costs, and expenditure on furniture and equipments	Number of deposit, accounts (demand, time), number of loans (real, estate, comm., inst.)

Table 3. Intermediation Approach

Authors	Input	Output
Bhattacharyya et al. (1997)	Interest expense, operating expense	Advances, investments, deposits
Shanmugam and Das (2004)	Deposits, borrowings, labor, fixed assets	Net interest margin, non-interest margin, credit, investment

capital and labor, but do not include interest costs. The production approach is more suitable for branch efficiency studies, as at most times, bank branches basically process customer documents and bank funding, while investment decisions are mostly not under the control of branches (Berger & Humphrey, 1997). The Table 2 exhibits the combinations of inputs and outputs used in the production approach.

(2) Intermediation Approach : In this approach, banks are considered as intermediaries who are involved in transformation and transfer of financial resources from units in surplus to units in deficit. This approach is suitable for banks where more activities are concerned with turning large deposits and funds purchased from other financial institutions into loans and financial investments. In this approach, total loans and securities are the best measures of outputs, whereas deposits along with labor and physical capital are defined as inputs (Sealey Jr. & Lindley, 1977). The Table 3 exhibits the combinations of inputs and outputs used in the intermediary approach.

(3) Value-Added Approach : In this approach, the inputs or outputs are identified based on the share of value added. Items of the balance sheet with a substantial share of value added are considered as important outputs. Bhattacharyya, Lovell, and Sahay (1999) used labor, physical capital as inputs, and fixed deposit, savings deposit, current deposit, investment loans and advances, and number of branches as outputs.

(4) Operating Approach : According to Leightner and Lovell (1998), banks are considered as business units with an objective of generating revenue from the total cost incurred for running the business. The total revenue (interest and non-interest income) is defined as output and total expenses are defined as inputs.

Analysis, Results, and Discussion

The Table 4 shows year wise productivity changes of foreign banks. It is found that there is an improvement in total factor productivity (more than 1) in the years 1993, 1994, 1997-2004, and 2010 to the extent of 24%, 15%, 20%, 37%, 27%, 5%, 24%, 1%, 3%, 28%, and 24%, respectively. It is evident from the Table that the improvement in productivity in the years 1994, 1999, and 2004 is due to improvement in technical efficiency change ; whereas, the productivity change is due to technological innovation or change for the years 1993, 1997, 1998, 2000-2003, and 2010. The C.V% of technical efficiency change is 32%, which is higher than 18.42% (C.V. % of total factor

Table 4. Malmquist Index of Annual Means (Foreign Banks)

Year	Effch	Techch	Pech	Sech	Tfpch
1993	0.661	1.87	1	0.661	1.236
1994	1.7	0.675	1	1.7	1.147
1995	0.935	0.865	1	0.935	0.809
1996	1.178	0.756	1	1.178	0.89
1997	1.02	1.18	1	1.02	1.204
1998	0.848	1.613	1	0.848	1.368
1999	1.215	1.043	1	1.215	1.268
2000	0.767	1.371	1	0.767	1.052
2001	0.724	1.71	1	0.724	1.239
2002	0.912	1.111	1	0.912	1.013
2003	0.843	1.223	1	0.843	1.031
2004	1.326	0.967	1	1.326	1.283
2005	0.812	1.193	1	0.812	0.969
2006	1.545	0.472	1	1.545	0.73
2007	0.917	0.815	1	0.917	0.747
2008	0.653	1.372	1	0.653	0.896
2009	1.832	0.546	1	1.832	1
2010	1.019	1.217	1	1.019	1.24
2011	0.866	1.007	1	0.866	0.872
2012	1.413	0.651	1	1.413	0.920
2013	0.915	0.956	1	0.915	0.875
Mean	**1.052**	**1.077**	**1**	**1.052**	**1.038**
S.D.	**0.337**	**0.374**	**0**	**0.337**	**0.191**
C.V.%	**32.011**	**34.729**	**0**	**32.011**	**18.424**

Table 5. Malmquist Indexof Firm Means (Foreign Banks)

Banks	effch	Techch	Pech	Sech	Tfpch
ADCB	0.972	1.019	1	0.972	0.99
BOA	0.98	1.009	1	0.98	0.989
BOBK	0.987	1.008	1	0.987	0.995
BONS	1.014	1.037	1	1.014	1.051
BB	1.053	1.119	1	1.053	1.178
BP	1.013	1.019	1	1.013	1.032
CB	0.994	1.003	1	0.994	0.997
CACI	1.014	0.992	1	1.014	1.005
DB	1.004	1.02	1	1.004	1.024
HSBC	1.033	0.989	1	1.033	1.021
MB	1.009	0.987	1	1.009	0.996
OIB	1.068	0.986	1	1.068	1.053
SG	0.997	1.015	1	0.997	1.013
SB	1	1.02	1	1	1.02
SCB	0.973	0.991	1	0.973	0.965
BOTMU	1.006	1.008	1	1.006	1.014
Mean	**1.007**	**1.014**	**1.000**	**1.007**	**1.021**
S.D.	**0.026**	**0.032**	**0.000**	**0.026**	**0.048**
C.V.%	**2.625**	**3.124**	**0.000**	**2.625**	**4.666**

productivity change). This implies that total factor productivity change is more consistent when compared to change in technical efficiency. The pure technical efficiency is 100 % (=1) for all the banks . This implies that improvement in scale efficiency is stable.

The Table 5 shows bank wise productivity changes of foreign banks calculated by using the Malmquist index. The banks denoted as BONS, BB, BP, CACI, DB, HSBC, OIB, SG, SB, and BOTMU show an improvement in total factor productivity (values more than 1) to the extent of 5%, 18%, 3%, 0.05%, 2%, 2%, 5%, 1%, 2%, and 1%, respectively. The productivity improvement of banks denoted as BONS, BB, BP, SG, SB, and BOTMU is due to technological change (innovation or process change) rather than technical efficiency change. For the banks such as CACI, DB, OIB, and SB, the change is due to technical efficiency change. There is an improvement in technical efficiency (more than 1) for the banks BONS, BB, BP, CACI, DB, and OIB. In case of banks, the C.V. % of technical efficiency change (2.62) is less than that of total factor productivity change (4.66) .This means that technical efficiency change is more consistent when compared to TFP change. The average TFP change and technical change are almost equal to 1, which means that the overall improvement is stable.

The Table 6 shows year wise productivity changes of nationalized banks. It is found that there is an improvement in total factor productivity (more than 1) in the years 1993, 1994, 1996, 1997, 2002, 2008, 2010, and

Table 6. Malmquist Index of Annual Means (Nationalized Banks)

Year	Effch	Techch	pech	sech	Tfpch
1993	0.921	1.59	1	0.921	1.464
1994	0.887	1.369	1	0.887	1.213
1995	1.007	0.876	1	1.007	0.882
1996	0.947	1.075	1	0.947	1.018
1997	0.919	1.167	1	0.919	1.073
1998	1.12	0.887	1	1.12	0.994
1999	0.885	1.089	1	0.885	0.964
2000	1.084	0.894	1	1.084	0.969
2001	1.004	0.9	1	1.004	0.903
2002	1.051	0.973	1	1.051	1.022
2003	1.131	0.855	1	1.131	0.968
2004	0.97	0.986	1	0.97	0.956
2005	1.023	0.886	1	1.023	0.906
2006	1.018	0.845	1	1.018	0.86
2007	1.073	0.885	1	1.073	0.95
2008	0.852	1.22	1	0.852	1.04
2009	1.15	0.817	1	1.15	0.94
2010	0.932	1.08	1	0.932	1.007
2011	1.049	0.808	1	1.049	0.847
2012	0.994	0.972	1	0.994	0.967
2013	0.99	1.027	1	0.99	1.017
Mean	**1.000**	**1.010**	**1.000**	**1.000**	**0.998**
S.D.	**0.084**	**0.196**	**0.000**	**0.084**	**0.133**
C.V.%	**8.409**	**19.461**	**0.000**	**8.409**	**13.372**

Table 7. Malmquist Index of Firm Means (Nationalized Banks)

Bank	Effch	Techch	Pech	Sech	Tfpch
AL	0.995	1.02	1	0.995	1.015
AN	0.989	1.003	1	0.989	0.992
BOB	1.01	1	1	1.01	1.011
BOI	1.003	1.007	1	1.003	1.01
BOM	0.991	0.999	1	0.991	0.99
CN	1.012	1.007	1	1.012	1.019
CBI	0.999	1.002	1	0.999	1
COB	1	1.005	1	1	1.005
DE	1.001	0.993	1	1.001	0.994
IB	0.996	0.968	1	0.996	0.964
IOB	0.987	1.001	1	0.987	0.988
OBC	0.999	1.01	1	0.999	1.01
PSB	1	0.975	1	1	0.975
PNB	0.99	0.997	1	0.99	0.987
SY	0.984	1.012	1	0.984	0.996
UB	1.001	1.021	1	1.001	1.022
UN	0.987	1.001	1	0.987	0.987
UD	1	0.941	1	1	0.941
VB	1	0.927	1	1	0.927
Mean	**0.997**	**0.994**	**1.000**	**0.997**	**0.991**
S.D.	**0.008**	**0.025**	**0.000**	**0.008**	**0.025**
C.V.%	**0.758**	**2.497**	**0.000**	**0.758**	**2.536**

2013 to the extent of 46%, 21%, 2%, 7%, 2%, 4%, 1%, and 2%, respectively. It is evident from the Table that the improvement in productivity in all these years except 2002 is due to improvement in technological innovation or change. The productivity change in the year 2002 is attributed to technical efficiency change. The C.V% of technical efficiency change is 8.4%, which is less than 13.372% (C.V. % of total factor productivity change). This implies that technical efficiency change is more consistent when compared to change in total factor productivity.

The Table 7 shows bank wise productivity changes of nationalized banks calculated by using the Malmquist index. The banks denoted as AL, BOB, BOI, CN, COB, BC, and UB show an improvement in total factor productivity (values more than 1) to the extent of more than 1%, only for these banks. The productivity improvement of banks denoted as AL, BOI, COB, OBC, and UB is due to technological change (innovation or process change) rather than technical efficiency change. For the banks such as BOB and CN, the change is due to technical efficiency change. There is an improvement in technical efficiency (more than 1) for the banks BOB, BOI, CN, and UB. In case of banks, the C.V. % of technical efficiency change (0.758) is lesser than that of total factor productivity change (2.536). This means that technical efficiency change is more consistent when compared to TFP change. The average TFP change and technical change is less than 1, which means that there is a reduction in overall productivity improvement.

The Table 8 shows year wise productivity changes of new private sector banks. It is found that there is an improvement in total factor productivity (more than 1) in the years 1998 and 2006. It is evident from the Table that the improvement in productivity in these years is due to improvement in technological innovation or change. The C.V% of technical efficiency change is 6.59%, which is less than 13.48% (C.V. % of total factor productivity change). This implies that technical efficiency change is more consistent when compared to change in total factor productivity for these banks.

The Table 9 shows bank wise productivity changes of new private sector banks calculated by using the Malmquist index. All the banks in this category have value of TFP change less than 1. The banks denoted as AX and II show an improvement in technical efficiency (values more than 1). This implies that these banks have the opportunity to improve the usage of technology or process innovation so as to improve the total factor productivity over time. By comparing the C.V. %, technical efficiency change is consistent when compared to total factor productivity change.

The Table 10 shows year wise productivity changes of old private sector banks. It is found that there is an improvement in total factor productivity (more than 1) in the years 1993, 1994, 1997, 1998, 1999, 2002, 2008, 2009, 2010, and 2013 to the extent of 22.10%, 3.60%, 14.20%, 13.80%, 18.20%, 9.90%, 7.60%, 4.20%, 1.80%, and 0.40%, respectively. It is evident from the Table that the improvement in productivity in all these years is due to improvement in technological innovation or change of value more than 1. The C.V% of technical efficiency change is 6.98%, which is less than 11.77% (C.V. % of total factor productivity change). This implies that technical efficiency change is more consistent when compared to change in total factor productivity.

The Table 11 shows bank wise productivity changes of old private sector banks calculated by using the Malmquist index. The banks FB, INV, JK, and KA have value of TFP change more than 1. This improvement is attributed to technological change. The banks denoted as AX and II show an improvement in technical efficiency (values more than 1). All the banks have technical efficiency of either less than or equal to 1. This implies that these banks have the opportunity to improve the technical efficiency and that in turn helps to improve the total factor productivity over time.

The Table 12 shows the year wise productivity changes of SBI and its associate banks . It is found that there is an improvement in total factor productivity (more than 1) in the years 1993, 1994, 1997, 1998, 1999, 2003, and 2008. It is evident from the Table that the improvement in total factor productivity in the years 1993, 1994, 1998, 1999, and 2003 is due to improvement in technological innovation or change of value more than 1. The improvement in total factor productivity in the years 1997 and 2008 is due to improvement in technical efficiency change of value more than 1. For years other than the above mentioned, there is no improvement in total factor productivity because TFP change values are less than 1.

The Table 13 shows bank wise productivity changes of SBI and its associate banks calculated by using the Malmquist index. It can be inferred from the Table that no banks have total factor productivity of value more than 1. This implies that this category of banks has not improved its total factor productivity over time. This is because both the technical efficiency change and technological change did not contribute towards the improvement in total factor productivity.

The Table 14 shows the cost efficiency of new private sector banks. The bank denoted as AX is cost inefficient to the extent of 72.4% in producing deposits and borrowings given the cost of deposits and borrowings in the form of interest on deposits and borrowings, respectively. The other banks denoted as HD, IC, and II are 100% cost efficient.

The Table 15 shows the cost efficiency of foreign banks. The banks denoted as ADCB, BOBK, BONS, BB, BP, CACI, DB, HSBC, MB, OIB, SG, and BOTMU are cost inefficient to the extent of 70.80%,61.10%,88.70%,66.80%,71.30%,43.00%,75.30%,59.20%,53.90%,75.50%, 58.90%, and 41.10%, respectively in producing deposits and borrowings given the cost of deposits and borrowings in the form of interest on deposits and borrowings, respectively. The other banks denoted as ADCB, BOA, CB, SB, SCB, and RBS are 100% cost efficient.

Table 8. Malmquist Index of Annual Means (New Private Sector Banks)

Year	Effch	Techch	Pech	sech	Tfpch
1996	1.226	0.432	1	1.226	0.53
1997	1.072	0.868	1	1.072	0.93
1998	0.961	1.09	1	0.961	1.048
1999	1.04	0.817	1	1.04	0.85
2000	1	0.84	1	1	0.84
2001	1	0.955	1	1	0.955
2002	1	0.998	1	1	0.998
2003	1	0.728	1	1	0.728
2004	1	0.8	1	1	0.8
2005	0.917	0.918	1	0.917	0.842
2006	0.981	1.028	1	0.981	1.008
2007	1.024	0.899	1	1.024	0.921
2008	1.035	0.923	1	1.035	0.956
2009	1.012	0.853	1	1.012	0.864
2010	0.912	0.992	1	0.912	0.904
2011	1.001	0.906	1	1.001	0.907
2012	1.054	0.938	1	1.054	0.988
2013	1.021	0.905	1	1.021	0.924
Mean	**1.014**	**0.883**	**1**	**1.014**	**0.889**
S.D.	**0.067**	**0.142**	**0**	**0.067**	**0.120**
C.V.%	**6.594**	**16.08**	**0**	**6.594**	**13.48**

Table 9. Malmquist Index of Firm Means (New Private Sector Banks)

Bank	effch	Techch	Pech	Sech	Tfpch
AX	1.039	0.927	1	1.039	0.963
HD	0.988	0.857	1	0.988	0.847
IC	1	0.85	1	1	0.85
II	1.022	0.844	1	1.022	0.862
Mean	**1.012**	**0.870**	**1.000**	**1.012**	**0.881**
S.D.	**0.023**	**0.039**	**0.000**	**0.023**	**0.055**
C.V.%	**2.245**	**4.451**	**0.000**	**2.245**	**6.290**

Table 10. Malmquist Index of Annual Means (Old Private Sector Banks)

Year	Effch	Techch	Pech	Sech	Tfpch
1993	0.942	1.297	1	0.942	1.221
1994	0.87	1.192	1	0.87	1.036
1995	1.068	0.899	1	1.068	0.96
1996	1.025	0.87	1	1.025	0.891
1997	1.018	1.122	1	1.018	1.142
1998	0.993	1.145	1	0.993	1.138
1999	1.035	1.142	1	1.035	1.182
2000	1.011	0.948	1	1.011	0.958
2001	0.942	0.97	1	0.942	0.913
2002	0.963	1.142	1	0.963	1.099
2003	0.94	1.056	1	0.94	0.992
2004	1.066	0.872	1	1.066	0.929
2005	1.056	0.734	1	1.056	0.775
2006	0.957	0.898	1	0.957	0.86
2007	1.098	0.824	1	1.098	0.905
2008	1.019	1.056	1	1.019	1.076
2009	0.928	1.122	1	0.928	1.042
2010	0.971	1.049	1	0.971	1.018
2011	0.961	0.872	1	0.961	0.838
2012	1.023	0.931	1	1.023	0.952
2013	0.81	1.24	1	0.81	1.004
Mean	**0.986**	**1.018**	**1**	**0.986**	**0.997**
S.D.	**0.069**	**0.151**	**0**	**0.069**	**0.117**
C.V.%	**6.980**	**14.82**	**0**	**6.980**	**11.77**

Table 11. Malmquist Index of Firm Means (Old Private Sector Banks)

Bank	Effch	techch	pech	Sech	tfpch
CLS	0.98	1.018	1	0.98	0.997
CUB	0.967	1.031	1	0.967	0.997
FB	0.972	1.038	1	0.972	1.008
INV	0.982	1.033	1	0.982	1.015
JK	1.012	1.026	1	1.012	1.038
KA	0.985	1.021	1	0.985	1.006
KV	0.972	1.026	1	0.972	0.997
LV	0.975	1.025	1	0.975	0.999
NB	1	0.942	1	1	0.942
RB	1	0.932	1	1	0.932
SI	0.964	1.029	1	0.964	0.991
TM	0.973	1.005	1	0.973	0.977
DL	1	0.978	1	1	0.978
Mean	**0.984**	**1.007**	**1.000**	**0.984**	**0.990**
S.D.	**0.015**	**0.035**	**0.000**	**0.015**	**0.028**
C.V.%	**1.538**	**3.480**	**0.000**	**1.538**	**2.874**

Table 12. Malmquist Index of Annual Means (SBI and its Associates)

Year	Effch	Techch	Pech	sech	Tfpch
1993	1.032	1.12	1	1.032	1.156
1994	0.972	1.275	1	0.972	1.239
1995	0.996	0.896	1	0.996	0.892
1996	1.014	0.85	1	1.014	0.862
1997	1.023	1.019	1	1.023	1.042
1998	0.965	1.071	1	0.965	1.034
1999	0.973	1.164	1	0.973	1.133
2000	1.023	0.973	1	1.023	0.995
2001	1.012	0.922	1	1.012	0.933
2002	0.993	0.989	1	0.993	0.982
2003	1.001	1.003	1	1.001	1.005
2004	0.993	0.949	1	0.993	0.942
2005	1.035	0.776	1	1.035	0.804
2006	0.983	0.809	1	0.983	0.795
2007	1.007	0.836	1	1.007	0.842
2008	1.029	0.985	1	1.029	1.013
2009	0.975	0.98	1	0.975	0.955
2010	1.026	0.865	1	1.026	0.887
2011	0.946	0.875	1	0.946	0.828
2012	0.981	0.96	1	0.981	0.942
2013	0.986	0.972	1	0.986	0.959
Mean	**0.998**	**0.966**	**1**	**0.998**	**0.964**
S.D.	**0.025**	**0.121**	**0**	**0.025**	**0.116**
C.V.%	**2.494**	**12.496**	**0**	**2.494**	**12.022**

Table 13. Malmquist Index of Firm Means (SBI and its Associates)

Firm	Effch	Techch	Pech	sech	tfpch
SBJ	0.998	0.968	1	0.998	0.965
SBH	0.999	0.988	1	0.999	0.987
SBI	1.001	0.985	1	1.001	0.986
SBM	1	0.941	1	1	0.941
SBP	0.991	0.954	1	0.991	0.946
SBT	1	0.922	1	1	0.922
Mean	**0.998**	**0.958**	**1**	**0.998**	**0.956**
S.D.	**0.004**	**0.026**	**0**	**0.004**	**0.026**
C.V.%	**0.366**	**2.687**	**0**	**0.366**	**2.728**

Table 14. Cost Efficiency of New Private Sector Banks

Bank	TE	AE	CE
AX	0.467	0.591	0.276
HD	1	1	1
IC	1	1	1
II	1	1	1
Mean	**0.867**	**0.898**	**0.819**
S.D	**0.267**	**0.205**	**0.362**
C.V.%	**30.747**	**22.779**	**44.200**

Table 15. Cost Efficiency of Foreign Banks

Bank	TE	AE	CE
ADCB	0.49	0.596	0.292
BOA	1	1	1
BOBK	0.39	0.999	0.389
BONS	0.402	0.282	0.113
BB	0.341	0.974	0.332
BP	0.288	0.998	0.287
CB	1	1	1
CACI	0.579	0.985	0.57
DB	0.248	0.997	0.247
HSBC	0.506	0.807	0.408
MB	0.461	1	0.461
OIB	0.253	0.969	0.245
SG	0.412	0.999	0.411
SB	1	1	1
SCB	1	1	1
BOTMU	0.736	0.8	0.589
RBS	1	1	1
Mean	**0.594**	**0.906**	**0.550**
S.D	**0.294**	**0.195**	**0.321**
C.V.%	**49.511**	**21.518**	**58.368**

Table 16. Cost Efficiency of Nationalized Banks

Bank	TE	AE	CE
AL	0.966	0.882	0.852
AN	0.916	0.946	0.867
BOB	0.705	0.824	0.581
BOI	0.863	0.573	0.494
BOM	0.997	0.999	0.996
CN	0.773	1	0.772
CBI	1	0.851	0.851
COB	1	1	1
DE	0.981	1	0.98
IB	0.906	0.626	0.567
IOB	1	0.632	0.632
OBC	0.895	0.999	0.894
PSB	1	1	1
PNB	1	1	1
SY	0.842	1	0.842
UB	0.904	0.602	0.544
UN	0.993	0.999	0.993
UD	1	1	1
VB	1	1	1
Mean	**0.934**	**0.891**	**0.835**
S.D	**0.087**	**0.160**	**0.182**
C.V.%	**9.329**	**17.961**	**21.785**

Table 17. Cost Efficiency of Old Private Sector Banks

Bank	TE	AE	CE
CLS	0.917	0.928	0.851
CUB	0.810	0.873	0.707
FB	1	1	1
INV	1	1	1
JK	1	1	1
KA	0.937	0.962	0.901
KV	1	1	1
LV	1	1	1
NB	1	1	1
RB	1	1	1
SI	1	1	1
TM	0.838	0.998	0.836
DL	1	1	1
Mean	**0.962**	**0.982**	**0.946**
S.D	**0.067**	**0.039**	**0.094**
C.V.%	**6.983**	**3.986**	**9.962**

Table 18. Cost Efficiency of SBI and Associates

Bank	TE	AE	CE
SBJ	0.957	0.995	0.953
SBH	0.993	0.945	0.938
SBI	1	1	1
SBM	1	1	1
SBP	1	1	1
SBT	1	1	1
Mean	**0.992**	**0.990**	**0.982**
S.D	**0.017**	**0.022**	**0.029**
C.V.%	**1.736**	**2.236**	**2.907**

The Table 16 shows the cost efficiency of nationalized banks. The banks denoted as ALAN, BOB, BOI, BOM, CN, CBI, DE, IB, IOB, OBC, SY, UB, and UN are cost inefficient to the extent of 14.80%, 13.30%, 41.90%, 50.60%, 0.40%, 22.80%, 14.90%, 2.00%, 43.30%, 36.80%, 10.60%, 15.80%, 45.60%, and 0.70%, respectively in producing deposits and borrowings given the cost of deposits and borrowings in the form of interest on deposits and borrowings, respectively. In the above category of banks, the bank denoted as CN is most cost efficient and UB is the least cost efficient. The other banks denoted as COB, PSB, PNB, UD, and VB are 100% cost efficient.

The Table 17 shows the cost efficiency of old private sector banks. The banks denoted as CLS, CUB, KA, and TM are cost inefficient to the extent 14.90%, 29.30%, 9.90%, and 16.40%, respectively in producing deposits and borrowings given the cost of deposits and borrowings in the form of interest on deposits and borrowings, respectively. In the above category of banks, the bank denoted as KA is most cost efficient and CUB is the least cost efficient. The other banks denoted as FB, INV, JK, KV, LV, NB, RB, SI, and DL are 100% cost efficient.

The Table 18 shows the cost efficiency of SBI and associate banks. The banks denoted as SBJ and SBH are cost inefficient to the extent 5% and 6%, respectively producing deposits and borrowings given the cost of deposits and borrowings in the form of interest on deposits and borrowings, respectively. The other banks denoted as SBI, SBM, BP, and SBT are 100% cost efficient.

The Table 19 shows the correlation between cost efficiency and technical efficiency of different banking groups. It can be found that there is a positive correlation between cost efficiency (CE) and technical efficiency (TE). There is a strong positive correlation (close to 1) between TE and CE in case of foreign banks, new private sector banks, and old private sector banks ; whereas, in case of nationalized banks, SBI and associates, the correlation is moderately positive. This indicates that if banks are efficient in utilizing deposits and borrowings (inputs) to produce advances and net interest income (outputs), then banks are economically efficient in using the inputs at the given cost of deposits and borrowings.

The Table 20 and Figure 3 show the percentage of bank groups with technological efficiency change, efficiency change, and total factor productivity change. In case of foreign bank groups, 53% of the banks have total factor productivity improvement, 69% of the banks have technological change (improvement), and 56% of the banks have improvement in technical efficiency. In case of the nationalized bank group, 33% of the banks have total factor productivity improvement, 58% of the banks have technological change (improvement), and 26% of the banks have improvement in technical efficiency. In case of old private sector banks, 31% of the banks have total

Table 19. Correlation Between Cost Efficiency and Technical Efficiency

Foreign banks	0.964
Nationalized banks	0.617
New private sector banks	1
Old private sector banks	0.972
SBI and Associates	0.629

Table 20. Percentage of Bank Groups with Improved Technological Efficiency Change, Efficiency Change, and Total Factor Productivity Change

Bank group	Total Factor Productivity Change	Technological Efficiency change	Efficiency Change
Foreign Banks	53%	69%	56%
Nationalized Banks	33%	58%	26%
Old Private Sector Banks	31%	77%	8%

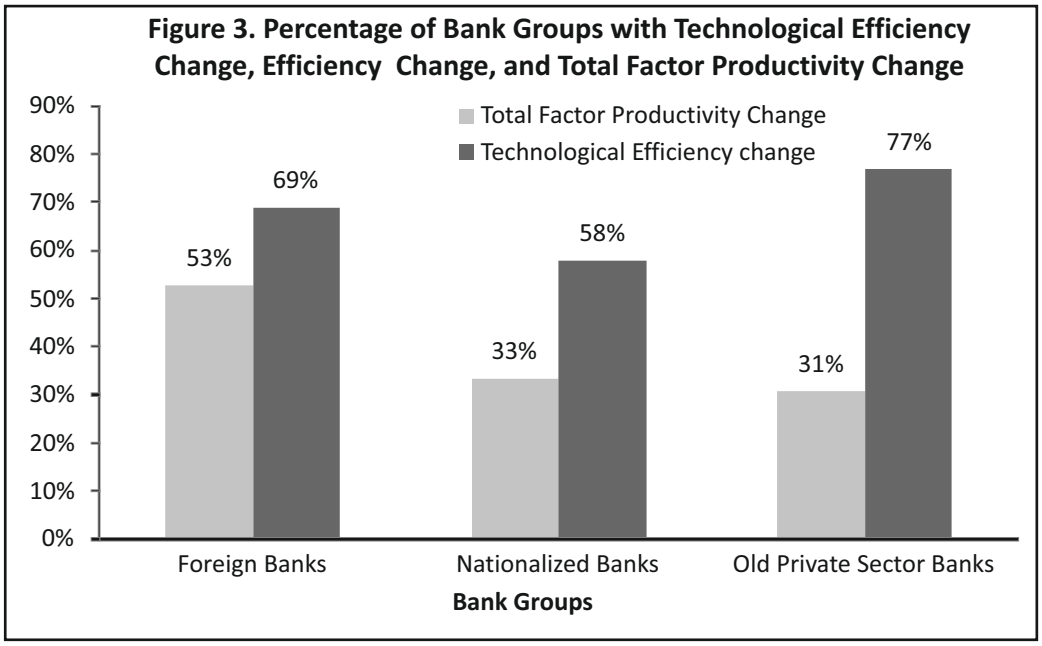


Table 21. Percentage of Bank Groups with Technical Efficiency, Allocative Efficiency, and Cost Efficiency

Bank	Technical Efficiency	Allocative Efficiency	Cost Efficiency
New Private Sector Banks	75%	75%	75%
Foreign Banks	29%	35%	29%
Nationalized Banks	37%	42%	26%
Old Private Sector banks	56%	56%	56%
SBI and Associates	67%	67%	67%

factor productivity improvement, 77% of the banks have technological change (improvement), and 8% of the banks have improvement in technical efficiency. Overall, total factor productivity is driven by technological (change) for all categories of banks because percentage of banks is maximum in technological change.

The Table 21 and Figure 4 show percentage of bank groups with 100% technical efficiency, allocative efficiency, and cost efficiency. In this study, cost efficiency refers to the ability of banks to minimize use the inputs such as deposits and borrowings in an optimal manner given the interest costs for both and maximizes output. Percentage of banks (75%) which are cost efficient in the new private sector group is maximum, followed by SBI and associate banks (67%), old private sector banks (56%), foreign banks (37%), and nationalized banks (29%). The same trend is repeated for allocative efficiency and technical efficiency in case of SBI and associate banks, old private sector banks, followed by nationalized banks and then foreign banks (least efficient).

The Table 22 shows the correlation between cost efficiency and total factor productivity change. It can be inferred from this Table that there is a negative relationship between total factor productivity and cost efficiency for all the bank groups. Banks (here, new private sector banks and SBI associates) having the highest (to moderate) negative correlation have no change in total factor productivity, but witness increase in cost efficiency to the extent of 100%. Also, banks having better total factor productivity change have lesser cost efficiency. This is evident from Tables 21 and 22.

Chandrasekhar and Sonar (2008) revealed that the private sector had experienced better productivity change than public sector banks because of technology usage. Derli (2006) found using single input (IT expenses) and

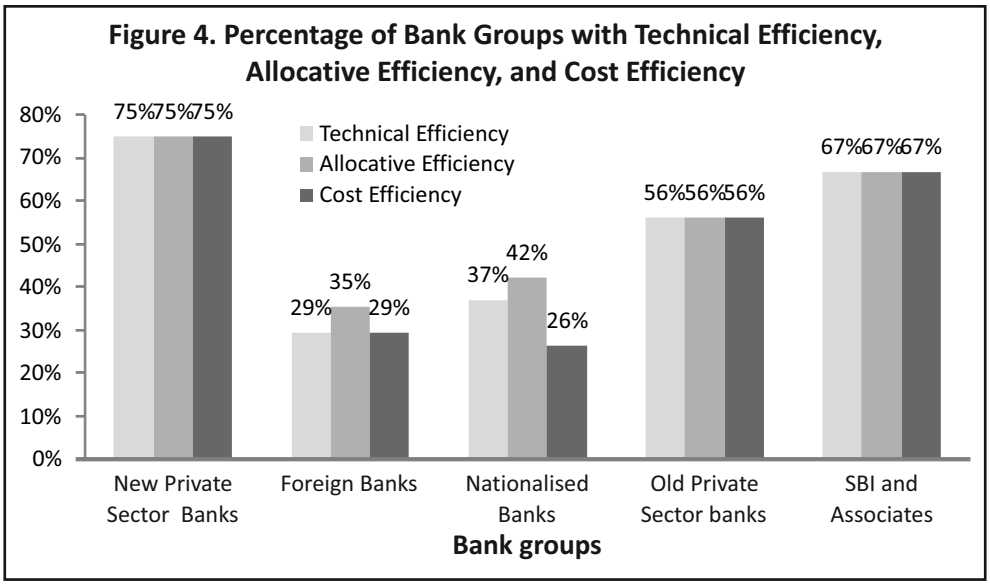


Table 22. Correlation Between Cost Efficiency and Total Factor Productivity Change

Bank Group	Correlation
New Private Sector Banks	-0.993
Foreign Banks	-0.438
Nationalized Banks	-0.400
Old Private Sector Banks	-0.067
SBI and its Associates	-0.576

output measures that public sector institutions are efficient in using technology. Deng et al. (2011) revealed that foreign banks have higher TFP change (improvement) than local banks. Liu (2010) found that TFP change of most of the banks was due to technology rather than technical efficiency. In this study, we also observed similar results that total factor productivity change was due to technology rather than technical efficiency change for the bank groups such as foreign banks, nationalized, and old private sector banks (maximum percentage of banks). Furthermore, the study period and the nature of inputs considered are different compared to previous studies.

Implications

The study used data envelopment analysis methodology to measure productivity change and cost efficiency using the Malmquist index. This methodology helps banks to benchmark productivity change over time with best performing units (banks) and accordingly increase or decrease inputs to achieve overall (cost) economic efficiency. The study revealed that total factor productivity is contributed by technological changes rather technical changes. Measurement of components of productivity change help banks to vary either the technology part or amount of input used to achieve the improvement in overall productivity.

Summary and Conclusion

The objective was to study the productivity change and cost efficiency (overall efficiency) of commercial bank groups in India. The bank groups that witnessed total factor productivity improvement are foreign groups,

nationalized groups, and old private sector groups to the extent of 53%, 33%, and 31% (percentages of banks), respectively. In these categories of banks, technological change varies to the extent of 69%, 58%, and 77% (percentages of banks), respectively. In terms of technical efficiency, the above bank groups witnessed improvement to the extent of 56%, 26%, and 8% (percentages of banks). Overall, the total factor productivity is driven by technological (change) for all categories of banks because percentage of banks is maximum in technological change. Percentage of banks having total factor productivity change is the highest in case of foreign banks followed by nationalized and old private sector banks. Percentage of cost efficient banks (75%) in the new private sector group is maximum, followed by SBI and associate banks (67%), old private sector banks (56%), foreign banks (37%), and nationalized banks (29%).

Limitations of the Study and Scope for Further Research

The study used secondary data obtained from the financial statements of banks for a period from 1993-2013. Future studies can carry out comparisons of productivity and cost efficiency among different branches of banks. Also, the cost efficiency of the banks can be compared with non-performing assets (NPA indicators) to check the nature of the relationship between them. Apart from the intermediary approach, there are other methods such as production approach and value added approach that are used for selecting input and output variables. These methods can also be used to compare productivity and cost efficiency and can be tested for difference in results among them.

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