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Productivity and Efficiency of Indian Public Sector Banks - A Suggestive DEA Approach

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Abstract:

Banking sector is the backbone of any economy. It plays a pivotal role in the economic development of a country. Understanding its systemic importance, policy makers are constantly involved in tailoring measures to make the sector more vibrant, competitive and efficient. Against the backdrop of recurrent bank consolidation, increased competition and technological innovation it is important to keep a track on the performance of the sector in order to gauge the success or failures of the varied policy measures. In the present study attempt is been made to study the productivity growth of the Indian banking sector represented by the select 12 public sector banks. The study uses the Malmquist Total Factor Productivity (TFP) Index to assess the productivity growth over the study period. The results of Malmquist Index of TFP growth reflect TFP growth of 3% on an average. This growth is due to growth in both effch (technical efficiency change) as well as techch (technology change) of 1%. Further decomposition of effch into pure technical efficiency and scale efficiency indicate that technical efficiency change is more due to pure technical efficiency than scale efficiency.

Keywords: *Productivity, Total Factor Productivity (TFP), Public Sector Bank (PSU), Technical Efficiency Change (effch), Technology Change (techch).*

Introduction:

Since the launch of the new economic policy in 1991, the Indian financial system has undergone substantial structural changes. Banks being the vital and dominant segment of the financial system are of crucial importance. Indian banking sector has undergone a series of reform measures. All these measures are expected to perk up the productivity and profitability of the banking sector thereby making it more vibrant and competitive. Needless to mention, this is the peculiar nature of the sector which tempts the stakeholders and all others to keep themselves abreast of the performance of the sector. Furthermore, being a systemic institution, any negative performance in banking sector significantly affects an economy unfavourably compared to the failure of any other financial institutions. Stable and efficient banking sector is therefore an essential precondition to increase the level of economic activity.

There are studies made in different countries to assess the efficiency level of banks. Establishing an effective technique for measuring performance of banks has always been stressed upon by researchers and practitioners. It is found that estimates of efficiency are sensitive to the choice of the technique. However, the whole lot of literature available that attempt to measure the performance of banks generally stress upon profitability, productivity, diversification, asset quality etc. as measures of efficiency. Besides, there are studies that examines technical, cost, allocative and profit efficiency of banks. However, a growing and equally important strand of the banking literature focuses on productivity

change. In the present study an attempt is been made to study the productivity growth of the Indian banking sector represented by the select 12 public sector banks. The study uses the Malmquist Total Factor Productivity (TFP) Index to assess the productivity growth over the study period.

Conceptual Background:

Banking Efficiency:

Efficiency is defined as the success with which an organisation uses its resources to produce outputs i.e., the degree to which the observed use of resources to produce outputs of a given quality matches the optimal use of resources to produce outputs of a given quality (Bhagavath, 2006). Thus, efficiency implies comparison of actual Output or Input to optimal Output or Input.

$$Efficiency = \frac{Actual\ Output}{Input} = \frac{Optimal\ Output}{Input}$$

Cost Efficiency:

Cost efficiency is the most conventional concept of efficiency pursued in studies of bank performance. The cost efficiency analysis helps to assess the relative performance of the bank as against the best practice bank in managing the operating costs of producing the same output under the same condition. Empirical measurement of productive efficiency is first made by Farrell (1957). He defines the cost efficiency and decomposes it into its technical and allocative components. Thus, X-efficiency comprises technical and allocative efficiencies of a bank.

Technical Efficiency:

The technical efficiency of a firm refers to its success/failure in transforming its inputs into outputs. A firm is said to exhibit TE if it is able to reduce the variable inputs to produce the same level of output. The bank is then operating on the efficient frontier. A bank's level of technical efficiency is ascertained in relation to an estimated best practice firm. The Overall Technical Efficiency (OTE) of a firm is decomposed into Pure Technical Efficiency (PTE) and Scale Technical Efficiency (STE). Pure Technical inefficiency results from using more inputs than necessary. Such inefficiency arises due to factors such as managerial errors arising from inertia and ignorance, poor quality of inputs etc (Kumbhakar and Sarkar 2004). Scale inefficiency exists if the bank does not operate at constant return to scale.

Allocative Efficiency:

A bank enjoys allocative efficiency if it is properly choosing the right mix of inputs given the input price. AE refers to the ability of DMUs to use inputs in optimal proportions, given their respective prices and production technology. It relates to the optimal combination of inputs and outputs at a given price. The objective of producers entails the production of given outputs at minimum cost or utilisation of given inputs to maximise the revenue, or the allocation of inputs and outputs to maximise profit.

Productivity:

Productivity of a firm in simple words can be defined as quantity of output produced per unit of input. If a firm uses single input and produces single output, productivity is the ratio of output and input quantities. Thus, if a firm produces y_0 outputs using x_0 inputs in period 0, its productivity can be indicated as follows

$$\prod_0 = \frac{x_0}{y_0} \quad \text{.....(1a)}$$

Similarly when a firm produces $y_1$output from $x_1$inputs in period 1, its productivity can be indicated as follows

$$\prod_1 = \frac{x_1}{y_1} \quad \text{.....(1b)}$$

In order to ascertain the change in productivity as against the base period 0 the following index is constructed

$$\pi_1 = \frac{\prod_1}{\prod_2} = \frac{y_1/x_1}{y_0/x_0} = \frac{y_1/y_0}{x_1/x_0}$$

However with productive units that uses multiple units and outputs, computation becomes cumbersome. The definition of productivity is complex because it is both a technical and managerial concept. Three different indices are popularly used to evaluate technological changes: the Fischer (1922), Tornqvist (1936), and Malmquist (1953) indices. The present study uses Malmquist indices to measure Total Factor Productivity (TFP) growth.

Input Output of Bank:

As discussed above efficiency of any productive unit is judged on the basis of the relationship between inputs and outputs. But there is lack of consensus amongst researchers as to what constitutes input and output for a bank. Two main approaches are found in literature in this regard.

(i) Production Approach; and
(ii) Intermediation Approach.

Production approach defines the bank activity as production of services and views the banks to be using physical inputs e.g., Labour and Capital to provide deposit and loan account. Berger and Humphery (1992), refer this as the value added approach. Under this approach it is the number of accounts of various types that are taken as measures of output produced by the use of capital and labour.

Input = Labor + Capital

Output = Deposits + Advances

Intermediation Approach

Under the intermediation approach, a bank is treated as a producer of intermediation services as it receives funds from depositors and invests at different risk and maturity profile, by using labour and capital. But banks also produce services for which specific charges are levied. Thus money value of loans and non-interest income are taken as outputs while inputs are taken as labour and capital.

Input = Labor + Capital

Output = Loan + Non Interest Income.

Review of Literature

Berger and Humphrey (1997) established that majority of studies concerning banking efficiency are confined to US banking sector and only a handful of them pertain to developing and transitional economies. In the subsequent period more than 60 empirical

studies on banking efficiency have been published and their scope has expanded to more countries including transition ones (Stavarek, 2005). An attempt is made in this section to review some of these studies on banking sector concerning India and abroad. The overall productivity and profitability of banks are expected to be enhanced owing to deregulation as competition would take its force. With increased competition the banks would strive to alter their input and output mix in a way which would yield maximum returns (Mohan, 2006). Since 1990s there is a flurry of studies on the effect of deregulation on efficiency and productivity of banks. The findings from these studies differ on different counts for using different database, methodology, geographical area and time period of study. Ram Mohan and Ray (2004) make a comparative study of efficiency during the reform period. The study is made on three different categories of banks i.e., Public, Private and Foreign banks. Total Factor Productivity (TFP) is measured through Tornqviist and Malmquist TFP growth model. Comparison is made in four combinations- Two under Tornqvist TFP Growth and two under Malmquist TFP growth. Public Sector Banks are compared with old Private Sector Banks and with Foreign Banks. Out of the total of four combinations, no significant difference is found in three cases. PSBs perform better in one and foreign banks in one. The general perception of superior performance of Private Banks over public banks is contradicted by them. Avkiran (2000) examines the productivity of four major Australian Trading Banks by using Malmquist Productivity Indices. His results indicate a decline in TFP in the initial years of reform and a steady rise later. He further uncovers the fact that increased productivity in Australian retail banking sector are driven more by Technological Progress than Technical Efficiency. Hung (2009) investigate and analyze the efficiency, productivity and technology changes in Vietnamese banks. Both TE and AE are studied in the context of 13 banks for a period of two years (2001-2003) using DEA. To study productivity change and to decompose the same into technical and technology change he makes use of Malmquist index. His study finds that urban banks are cost efficient than their rural counterparts. He also identifies that there is a decline in productivity initially but later it increases. The improvement in TFP is attributable to TE than Technology change. Shammugham and Das (2004) using the stochastic frontier function methodology for panel data for a sample of 94 banks during the reform period 1992-99 found that observed output in banks are less than the potential output due to the prevalence of technical inefficiencies. They claim that the reform measures have not helped banks to raise interest margin but have helped raising non-interest income, investment and credits. Another study by Kumbhakar and Sarkar (2003) finds that the tendency for cost inefficiencies to decline from 1986 to 2000. The cost inefficiency of banks has increased since the initiation of the reforms, though the reduction in inefficiencies over time continues albeit at a slower rate compared to that observed in the pre-deregulation period. Private Banks are generally more cost efficient than public banks.

Methodology

Establishing an effective technique for measuring bank's performance has always been stressed upon by researchers and practitioners. It is found that estimates of efficiency are sensitive to the choice of the technique. The whole lot of literature available that attempt to measure the performance of banks can be divided into two categories based on the methodologies adopted viz., traditional measures and frontier approaches. The techniques used in the traditional approach are Ratio Analysis, Regression Analysis, Index Number Approach, Taxonomic Method, Multivariate Analysis, Translog Function etc. Traditionally accounting-based cost ratios were used by bank analysts to measure cost efficiency. Although cost ratios are easy to construct and use, they are often difficult to interpret and may prove to be misleading. An alternative to accounting-based efficiency ratios is the Cost Frontier Analysis (CFA). In CFA, the analysts attempt to estimate the maximum amount that

a bank could reduce its costs while still producing the same amount and combination of financial services. Frontier inefficiency, also known as X-inefficiency, imply the scope of potential cost savings. Under frontier approach several parametric and non-parametric techniques are developed to assess such level of efficiency/inefficiency.

- Parametric Approach: (1) Stochastic Frontier Analysis (SFA), (2) Thick Frontier Approach (TFA), and (3) Distribution Free Hull (DFH).
- Non-Parametric Approach: (1) Data Envelopment Analysis (DEA).

Data Envelopment Analysis

Analysis of production possibilities of micro units remained one of the areas of common interest among researchers. This specific area of research gained further popularity after the publication of a seminal paper by Charnes, Cooper and Rhodes (CCR) in 1978 using DEA model. The increasing popular use of the technique to estimate efficiency scores was further extended by Banker, Charnes, & Cooper in 1984. A key inspiration of CCR paper was from Michael James Farrell (1957). Farrell's efficiency analyses were in the nature of parametric frontier functions, being restricted to single output while CCR enabled linking of linear programming to non-parametric specifications of production possibilities.

DEA is a linear programming-based technique to measure the performance efficiency of organizational units like bank known as Decision Making Unit (DMU) relative to other DMUs. The performance of DMUs is assessed in DEA using the concept of efficiency or productivity which is the ratio of weighted outputs (virtual output) to weighted inputs (virtual inputs). The best performing DMU is assigned an efficiency score of unity (or 100 percent) and thus the performance of a DMU vary between 0 and 1.

The operating units of banks have multiple inputs such as staff size, salaries and hours of operation, advertising budget as well as multiple outputs such as profit, market share and growth rate. In this situation it is often difficult for a manager to determine which operating units are inefficient in converting their multiple inputs into multiple outputs. This problem is addressed by DEA. At the same time DEA also assigns a unique set of weights to each DMU. The weights for a DMU are determined using mathematical programming, as that weight which maximizes its efficiency subject to the condition that the efficiencies of other DMUs is restricted to values between 0 and 1.

The DEA approach forms the efficiency frontier out of piecewise linear stretches thereby forming a convex production possibility set. The firms on the frontier are considered 100 per cent efficient. The efficiency frontier envelops the available data. In DEA frontier, efficient observations are those for which no other DMUs have as much or more of every output or as little of every input. Those DMUs forming the efficiency reference set are known as the peer group for the inefficient units. When the inefficient units are projected onto the envelopment surface, the efficient units closest to the projection and whose linear combination comprises this virtual unit form the peer group for that particular DMU.

Another useful metric within the DEA framework is the Malmquist Total Factor Productivity (TFP) index.

Malmquist Total Factor Productivity Index (MTFPI):

In the last two decades, the literature on productivity growth measurement has been extended from the standard calculations of TFP employing production function framework towards more refined decomposition methods. To overcome the shortcomings of growth accounting approach and to identify the components of productivity change, techniques have been developed that are based on the decomposition of TFP index. A method of measuring productivity with growing popularity is the use of Malmquist Index. Three different indices are frequently used to evaluate technological changes: the Fischer Model, Tornqvist Model and Malmquist Index (1953). The Malmquist index has several features,

which makes it an attractive approach. First, it is a TFP index. Second, it can be constructed using distance functions which are primal measures based only on input and output quantities rather than on price. Third, the index can be decomposed into technical efficiency change and technological change. Efficiency change can further be decomposed into pure efficiency change and scale components. As efficiency and technical changes are analogous to the notions of technological innovation and adoption respectively, the dynamics of the recent growth observed in the manufacturing sector of the Indian economy can be appreciated better. Finally, assumptions do not need to be made with regard to objectives of firms or regions in terms of, say, cost minimisation or profit maximisation objectives, which could be inappropriate in certain situations.

Measuring technical efficiency is an attempt to quantify how well the inputs are converted into outputs by the production process. However, used in isolation, technical efficiency can be a misleading measure of productivity for an organisation or industry where major environmental changes are under way, e.g., deregulation or technological change. Another source of productivity improvement that should be studied is technological progress. Technological progress represents shift of the efficient frontier due to technological innovation, and it should be distinguished from gains in technical efficiency represented by units moving toward the frontier. Hence a study in the nature of total factor productivity is essential to discover the efficacy of a concern to convert inputs into outputs as well as technological improvement.

The present study also makes use of Malmquist (1953) Total Factor Productivity Index (MTFPI) to measure the productivity changes. The MTFPI measures changes in total output relative to inputs. It is one of the most frequently used methods to evaluate productivity change. The MTFPI measures the TFP change between two data points by calculating the ratio of the distances of each data point relative to a common technology. The Malmquist input oriented TFP change index between the base period t and the following period t+1 is defined as

$$M_0(Y_s, X_s, Y_t X_t) = \sqrt{\left[\frac{d_0^s(Y_t, X_t) * d_0^t(Y_t, X_t)}{d_1^s(Y_s, X_s) * d_1^t(Y_s, X_s)}\right]} \quad \text{.....(1)}$$

Thus Malmquist Productivity Index is a product of two: (i) Change in Technical Efficiency (TE) or how close a bank is to the efficient frontier (Catching -Up Index) and (ii) Technological Change i.e., the change in best practice index or how much the benchmark production function shifts at each bank's observed input mix (Innovations and Shocks). This is also termed as the 'frontier shift' effect. Thus equation (3) can be decomposed into:

$$Efficiency\ Change = \frac{d_1^t(Y_t, X_t)}{d_0^s(Y_s, X_s)} \quad \text{.....(2)}$$

$$\text{and } Techno\log ical\ Change = \sqrt{\left[\frac{d_0^s(Y_t, X_t) * d_1^s(Y_s, X_s)}{d_0^s(Y_t, X_t) * d_1^t(Y_s, X_s)}\right]} \quad \text{.....(3)}$$

If Malmquist productivity index is greater than one it indicates progress in TFP and if it is less than one it indicates decline in TFP. Productivity changes reflect changes in technological progress as well as technical efficiency: $M = (E)X(T)$ where E and T stand for technical efficiency change and technology change respectively.

Data and Source:

The present study measures the TFP growth of 12 Public Sector Banks (PSBs) by using Malmquist TFP index. The relevant information is collected from Reserve Bank's Publication viz, Report on Trends & Progress of Banking in India, Statistical Tables Relating to Banks in India, respective websites of the bank, financial express etc. The study period is five years from 2004-2005 to 2008-2009.

Variable Selection:

Input		Output
Interest Expenses	Operating Expenses	Business (Advances & Deposits)

Empirical Results:

Efficiency Analysis:

The TE scores from 2005 to 2009 for the sample banks are exhibited in Table 1. The mean TE scores of individual banks as well as all the banks taken together is displayed in the Table 1. Table 1 reflects that on an average Vijaya Bank exhibit the most superior performance followed by UCO bank. The mean TE score of Vijaya Bank is estimated at 97% is highest amongst all. However it still leaves the scope of further cost savings of 3%. In other words Vijaya Bank can still produce the same output with 3% lesser output. Central Bank of India is considered least efficient with TE score of 90%. If we study the mean TE score of all the banks over the study period one can discover a fluctuating trend.

Table 1
Technical Efficiency (TE) Scores of Banks (2005-2009)

Bk. Code	*Bank*	*TE(2005)*	*TE(2006)*	*TE(2007)*	*TE(2008)*	*TE(2009)*	*Average*
1	Allahabad Bank	0.924	0.924	1	0.962	0.947	0.9514
2	Andhara Bank	0.845	0.923	0.908	0.933	0.947	0.9112
3	Bank of India	0.884	0.912	0.896	0.893	0.934	0.9038
4	Bank of Baroda	0.928	1	0.912	0.914	0.922	0.9352
5	Bank of Maharashtra	0.855	0.92	0.986	1	0.956	0.9434
6	Canara Bank	0.937	0.941	0.936	0.872	0.889	0.915
7	SBI	1	1	0.924	0.772	0.883	0.9158
8	UBI	0.862	0.949	0.968	1	1	0.9558
9	Vijaya Bank	0.915	1	1	0.959	0.995	0.9738
10	UCO Bank	0.94	1	0.999	0.944	0.942	0.965
11	Union Bank of India	0.805	0.932	0.889	0.935	0.995	0.9112
12	CBI	0.884	0.912	0.896	0.893	0.934	0.9038
	Mean	0.898	0.951	0.943	0.923	0.945	0.932

Based on the average TE scores the banks are classified into five efficiency group. Table 2 presents this. From the table it is clear that there is least concentration of banks in 0.75-0.80 efficiency range in all the years of study. Whereas on an average maximum concentration of banks are found in 0.90-0.95 efficiency range.

Table 2
Classification of Banks in Efficiency Range

Efficiency Range (Based on TE Scores)	2004-2005		2005-2006		2006-2007		2007-2008		2008-2009	
	Bank Code	TE	Bank Code	TE	Bank Code	TE	Bank Code	TE	Bank Code	TE
0.75-0.80	Nil	Nil	Nil	Nil	Nil	Nil	7	0.772	Nil	Nil
	2	0.85	Nil	Nil	11	0.889	Nil	Nil	Nil	Nil
0.80-0.85	11	0.81								
	3	0.884	Nil	Nil	3	0.896	3	0.893	6	0.889
	5	0.86					6	0.872	7	0.883
0.85-0.90	8	0.862					12	0.89		
	12	0.884								
0.90-0.95	1	0.92	1	0.924	2	0.91	2	0.933	1	0.947
	4	0.93	2	0.923	4	0.91	4	0.914	2	0.947
	9	0.92	3	0.912	6	0.94	9	0.959	3	0.934
	10	0.94	5	0.92	7	0.92	10	0.944	4	0.922
			6	0.94			11	0.935	10	0.94
			8	0.95					12	0.934
			11	0.932						
			12	0.912						
0.95-1.00	7	1.00			1	1	1	0.962	5	0.956
					5	0.99	5	1	8	1
					8	0.97	8	1	9	0.995
					9	1.00			11	0.995
					10	1.00				
					12	0.90				

Productivity Growth

The main concern of the present study is to analyse the productivity growth of the sample banks. Table 3 shows the Malmquist Index of TFP growth and further decomposition into technical efficiency and technological change. Analysis of table reflects TFP growth of 3% on an average. This growth is due to growth in both effch *(technical efficiency change)* as well as techch *(technology change)* of 1% in both the cases. Further decomposition of effch into pure technical efficiency and scale efficiency indicate that technical efficiency change is more due to pure technical efficiency than scale efficiency where a growth of 1.1% and 0.2% is identified for pure technical efficiency and scale efficiency respectively. Year-wise analysis of tfpch *(total factor productivity change)* scores reveals a decline in the initial two years by 0.8% and 1.9% in 2006 and 2007 respectively thereafter it exhibited productivity growth of 9.6% and 4.2% respectively.

Table 3
Malmquist Index Summary of Annual Means

Year	effch	techch	pech	sech	tfpch
2006	1.06	0.936	1.032	1.027	0.992
2007	0.998	0.984	1.001	0.997	0.981
2008	0.97	1.129	1.008	0.962	1.096
2009	1.026	1.016	1.004	1.022	1.042
Mean	1.013	1.014	1.011	1.002	1.027

Note: effch = technical efficiency change; techch = technology change; pech = pure technical efficiency change; sech = scale efficiency change; and tfpch = total factor productivity change.

It is clear from Table 3 that over the years growth in pure technical efficiency is more accountable for growth in technical efficiency change index than scale efficiency. This reflects the managerial efficiency in controlling costs.

Table 4 exhibits Malmquist Index Summary of firm means. It can be seen that of all the sample banks 10 banks exhibit productivity growth whereas two banks viz Bank of Baroda and State Bank of India display productivity decline of 0.2% and 14.2% respectively. Productivity regress in case of Bank of Baroda is mainly due to regress in technical efficiency change index whereas in case SBI it is due to regress in technological change index.

Table 4

Malmquist Index Summary of Firm Means

Banks	*effch*	*techch*	*pech*	*sech*	*tfpch*
Allahabad Bank	1.006	1.026	1.003	1.004	1.032
Andhara Bank	1.029	1.031	1.011	1.018	1.061
Bank of India	1.014	1.026	1.011	1.003	1.04
Bank of Baroda	0.998	1	1.018	0.981	0.998
Bank of Maharashtra	1.028	1.045	1.027	1.001	1.075
Canara Bank	0.987	1.016	1	0.987	1.003
SBI	0.969	0.885	1	0.969	0.858
UBI	1.038	1.044	1	1.038	1.084
Vijaya Bank	1.021	1.036	1.016	1.005	1.058
UCO Bank	1.001	1.034	0.993	1.008	1.034
Union Bank of India	1.054	1.003	1.046	1.008	1.057
CBI	1.014	1.028	1.011	1.003	1.042
Mean	1.013	1.014	1.011	1.002	1.027

Summary and Conclusion:

The present study is an attempt to analyse the productivity growth of 12 select public sector banks. Based on the data collected for five years from 2005 to 2009, it is identified that almost all the banks exhibit TE scores of more than 90%. The banks under study still reflect the scope of further cost reduction ranging from 3 to 10%. Amongst the banks, Vijaya bank reflects the most superior performance and which in most of the years set the benchmark performance for other bank. Classification of banks in five efficiency range reveals the least concentration of banks in 0.75-0.80 efficiency and a maximum concentration in 0.90-0.95 efficiency range in all the years of study. The results of Malmquist Index of TFP growth. reflects TFP growth of 3% on an average. This growth is due to growth in both effch *(technical efficiency change)* as well as techch *(technology change)* of 1% in both the cases. Further decomposition of effch into pure technical efficiency and scale efficiency indicate that technical efficiency change is more due to pure technical efficiency than scale efficiency where a growth of 1.1% and 0.2% is identified for pure technical efficiency and scale efficiency respectively. Year-wise analysis of tfpch *(total factor productivity change)* scores reveals a decline in the initial two years by 0.8% and 1.9% in 2006 and 2007 respectively thereafter it exhibited productivity growth of 9.6% and 4.2% respectively. It is also seen that of all the sample banks 10 banks exhibit productivity growth. Decomposition of technical efficiency change index into pure technical efficiency and scale efficiency, results indicate dominance of pure technical efficiency. This reveals managerial efficiency in controlling costs. . Thus we can conclude that the Indian Public sector banks are technically quite efficient in converting their inputs into outputs backed by improved productivity. However there still exists ample scope for the sample banks to reduce their cost.

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