Productivity of Indian Nationalised Banks, by Data Envelopment Analysis (DEA): A comparative study of selected Indian Nationalised Banks.

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Abstract

The Analysis investigates the efficiency and productivity of the Public Sector Banks of India. Malmquist data envelopment analysis (DEA) has been used to estimate the different performance measures viz., productivity growth, technological change, technical efficiency and scale efficiency for the period 2001-2011. The "Operation" approach is used on the (panel) data of 12 nationalised banks, where the inputs used are : Interest expenses,Wages as % to total expenses and Operating expenses and the Outputs are : Interest income, Non-interest income. The study showed that the banking sector is directly impacted by the changes in the economy. During the recession of 2007 and 2011, the banking sector faced a negative growth rate.

Keywords: Bank Efficiency, Productivity, Malmquist Productivity Index(MPI), Data Envelopment Analysis(DEA), Indian Banks.

1 Introduction

Banks are the backbone of financial systems, and they play a crucial role in the economic development of countries such as India. The banking system contributes to the economy by mobilising financial resources and channelising them to their most productive uses in the economy.

Banking systems all over the world have seen considerable changes over the years, owing to a variety of causes such as deregulation, globalisation, and technological innovation (Reserve Bank of India, 2008). After the advent of financial sector reform in 1991, the Indian banking industry has seen radial changes and has been subjected to varying degrees of oppressive policies under the transformational regulatory requirements framework. With these initiations laid through the first and second generation reforms, there has been substantial improvement in efficiency and performances of the Indian scheduled commercial banks of our country (Mohan, 2006; Reddy, 2002). This development has resulted in increased competitive pressure among the banks in

India. The competitive forces that have resulted, together with future challenges and a more tighter regulatory environment, have put pressure on Indian banks to perform well. As a result, efficiency has become vital for the survival and expansion of banks(Gupta et al., 2008). It has been empirically found that banks receiving high efficiency scores are much more likely to survive than banks which have relatively low scores (Barr and Siems, 1996).

So with this, the common questions that arise are, "Are the Indian Public Sector banks utilising their resources efficiently?", "Which banks are relatively more efficient in utilising their resources?"," How can banks improve their relative efficiencies?". This is the main motivation behind our study.

2   Literature Review

Over the last two decades, the use of parametric and non-parametric frontier models to quantify the efficiency of financial institutions has gotten a lot of attention. The usage of the DEA technique has been common among the numerous approaches deployed. The literature suggests two main approaches for determining the technical efficiency of banks: parametric techniques, like stochastic frontier analysis (SFA), and non-parametric techniques, like data envelopment analysis (DEA). Stochastic frontier analysis (SFA) was proposed by Aigner et al. (1977) and Meeusen and Van den Broeck (1977) independently which involves an econometric method (Coelli et al. 2005). Data envelopment analysis (DEA) on the other hand was first used in Charnes and Cooper (1984). In this research, Data Envelopment Analysis (DEA) is used.

One of the most frequently used methods to evaluate productivity change is the Malmquist total factor productivity (TFP) index. This index was developed by Malmquist which measures changes in total output relative to inputs. Berg, Forsund and Jansen (1992) (1) introduced the Malmquist index as a measurement of the productivity change in the banking industry. In their research on the Norwegian banking system during the deregulation period 1980-1989, they used this index and a "value added" approach and their results showed that deregulation led to a more competitive environment. The increase of productivity was faster for larger banks, due to the increased antagonism they faced.

Productivity of the Indian Banking system has been an area of research interest for many economists, since Liberalisation in 1991. Significant policy changes have been implemented to boost the banking sector since the deregulation of India's financial sector began in 1992. There is a lot of literature related to Productivity and Efficiency of the Indian Banking system. Noulas and Ketkar's (2) study was one of the first to use a non-parametric production frontier technique (1996). They calculated the technical and scale efficiency of PSBs for 1993 using an intermediation approach with three inputs and two outputs. They discovered an average of 3.75 percent technical inefficiency, two-thirds of which was related to scale inefficiency. As a result, they came to the conclusion that improving scale efficiency could improve bank efficiency in India.

Sathye (2003) (3) used VRS technology and DEA to assess the productive efficiency of 94 Indian banks, including public and private sector banks, as well as overseas banks. For the years 1996–1997, the efficiency was calculated. He used interest and non-interest expense as inputs and interest and non-interest income as outputs in one model. Deposits and staff members were used

as inputs, and loans and non-interest income were used as outputs, in a second DEA analysis. The study discovered that PSBs were on average more efficient than international banks, which were in turn more efficient than private banks, with an average efficiency score of 0.83.

However, this analysis is mainly based on the research of Das (2006)(4), where the performance of the Indian Commercial Banking sector was investigated, during the post-reform period 1992-2002. Data Envelopment Analysis (DEA) was used to evaluate the efficiency estimates of individual banks. Three different approaches were used : Value Added approach, intermediation approach and operating approach to measure efficiency scores vary with changes in inputs and outputs. The study concluded that medium sized public sector banks performed well and are likely to operate at higher levels of technical efficiency.

3 Model and Methodology

For the Efficiency Estimation we have used Malmquist Productivity Index (MPI) for nonparametric Data Envelopment Analysis (DEA). We have used Input-Oriented Operating Approach, (Das et al - 2006) in which we have taken three inputs: Interest expenses, Wages as percentage to total Expenses and Operating expenses, And the two outputs are Interest Income and Non-Interest Income.

Malmquist Productivity Index (MPI) measures the productivity changes along with time variations and can be decomposed into changes in efficiency and technology with Non-Parametric Approach Data Development Analysis. A Malmquist Index is based upon the ratio between two distance functions containing the input and output variables of i-th firm in periods t and t+1. The Malmquist Productivity index is also termed as Total factor productivity change (TFPCH).

$$MPI_I^t = \frac{E_I^t(x^{t+1}, y^{t+1})}{E_I^t(x^t, y^t)} \tag{1}$$

$$MPI_I^{t+1} = \frac{E_I^{t+1}(x^{t+1}, y^{t+1})}{E_I^{t+1}(x^t, y^t)} \tag{2}$$

The geometric mean of two MPI in Equation (1) and Equation (2) gives the Equation (3).

$$MPI_I^G = (MPI_I^t \cdot MPI_I^{t+1})^{\frac{1}{2}} = [(\frac{E_I^t(x^{t+1}, y^{t+1})}{E_I^t(x^t, y^t)}) \cdot (\frac{E_I^{t+1}(x^{t+1}, y^{t+1})}{E_I^{t+1}(x^t, y^t)})]^{\frac{1}{2}} \tag{3}$$

It can further be wriiten as product of two components,

$$EFFCH_I$$

and

$$TECHCH_I^G$$

Where, EFFCH = input oriented efficiency change and TECHCH = input oriented technical change.

$$MPI_I^G = (EFFCH_I \cdot TECHCH_I^G) = \left(\frac{E_I^{t+1}(x^{t+1}, y^{t+1})}{E_I^t(x^t, y^t)}\right) \cdot \left[\left(\frac{E_I^{t+1}(x^t, y^t)}{E_I^{t+1}(x^t, y^t)}\right) \cdot \left(\frac{E_I^t(x^{t+1}, y^{t+1})}{E_I^{t+1}(x^{t+1}, y^{t+1})}\right)\right]^{\frac{1}{2}} \quad (4)$$

The scale efficiency change(SECH) is given by:

$$SECH = \left[\frac{\frac{E_{vrs}^{t+1}(x^{t+1}, y^{t+1})}{E_{crs}^{t+1}(x^{t+1}, y^{t+1})}}{\frac{E_{vrs}^{t+1}(x^t, y^t)}{E_{crs}^{t+1}(x^t, y^t)}} \cdot \frac{\frac{E_{vrs}^t(x^{t+1}, y^{t+1})}{E_{crs}^t(x^{t+1}, y^{t+1})}}{\frac{E_{vrs}^t(x^t, y^t)}{E_{crs}^t(x^t, y^t)}}\right]^{\frac{1}{2}} \quad (5)$$

And the pure efficiency change(PECH) is given by:

$$PECH = \frac{E_{vrs}^{t+1}(x^{t+1}, y^{t+1})}{E_{crs}^t(x^t, y^t)} \quad (6)$$

If TFPCH value greater than 1 that suggests that TFP growth between two periods t and t+1: in the t+1 period, the same quantity of input generates more output. Similarly a TFPCH <1, suggest a decline in growth.

From eqn (4) we write

$$TFPCH_I^G = EFFCH_I \cdot \text{TECHCH}_I^G$$

4 Data And Empirical Analysis

4.1 Data

For our Analysis we took the data of 12 Nationalized banks for the time period 2001-2011, from the official website of RBI "Statistical Tables Relating to Banks in India." The Analysis is done using the DEAP software available on the official website of The University of Queensland, Australia

4.2 Empirical Analysis and Result

Now we understand the Malmquist index Summary for all 12 banks for the time period 2002-2012. We will not get the Malmquist index Summary for the year 2001 as we don't have the year 2000, and the Malmquist index also depends upon the previous time period

Consider the table below: The Below table has all 12 Nationalized banks in column 1 and the TFPCH values from year 2002-2011 in column 2 to 12.

Here we can observe that in year 2012, Central bank of India has TFPCH value 1.879, which is highest in all the banks for that particular year. The value 1.879 suggests that there is 87.9% growth in year 2002 with respect to 2001. In the year 2003, Bank of India has highest TFPCH value 1.579. Similarly it can be checked for all the remaining years.

We observe that for the year 2002, all 12 banks have TFPCH value 1, meaning they had positive growth in 2002. For 2003, all the banks except Central Bank of India, had TFPCH value meaning

Banks	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
State Bank of India	1.547	1.358	1.3	1.127	1.159	0.852	0.864	1.02	1.076	0.85
Punjab National Bank	1.709	1.351	1.248	1.349	1	0.845	0.812	1.069	0.948	0.724
Bank of Baroda	1.792	1.56	1.332	1.286	0.934	0.859	0.9	1.042	0.914	0.744
Canara Bank	1.994	1.461	1.277	1.262	0.935	0.867	0.977	1.029	0.944	0.775
Union Bank of India	1.337	1.489	1.446	1.473	0.882	0.632	0.956	0.997	0.988	0.797
Bank of India	1.792	1.579	1.354	1.144	0.944	0.823	0.86	1.007	0.966	0.786
Indian Bank	1.815	1.495	1.3	1.28	0.958	0.915	0.855	1.043	0.95	0.75
Central Bank of India	1.879	0.864	1.394	1.617	1.246	0.615	0.964	0.87	1.021	0.895
Indian Overseas Bank	1.664	1.022	1.306	1.434	1.356	0.439	0.884	1.13	0.991	0.704
UCO Bank	1.476	1.258	1.526	1.327	0.885	0.831	0.865	1.084	1.084	0.918
Bank of Maharashtra	1.305	1.013	1.395	4.288	0.35	0.786	0.849	0.97	1.01	0.815
Punjab and Sind Bank	1.253	1.344	1.244	1.601	0.69	0.78	0.756	0.951	0.914	0.884

Table 1: Malmquist Productivity index for period 2002-2011

all other banks had positive growth but for CBI it was negative. In 2004, we observed that all the banks including the central bank had positive growth. In 2005 we observe that all the banks have positive growth and Bank of Maharashtra has TFPCH Value equal to 4.288, which suggests that the BoM had more that 328% growth during the year 2005. In 2006, the TFPCH value of most banks fell below 1 suggesting a negative growth in the Banking sector and for 2007 and 2008, the TFPCH values for all the banks is <1. Which means that during the period of recession every bank had negative growth during that period of two consecutive years. In year 2009, banks have started to recover and around 8 banks have positive growth, but in 2010 again the banks started to have negative growth and finally in 2011 all the banks again had negative growth, suggesting some event in the market, this event aligns with the recession of 2011, confirming our findings to be correct.

Now we consider the table (2) given below to estimate " MALMQUIST INDEX SUMMARY OF ANNUAL MEANS", which gives us all the information regarding how the banking sector as a whole, performed every year. From this table we observe that for 2002 to 2005 the baking sector had positive growth and when the economic recession hit the growth rate became negative in 2007 and 2008. It started to recover in 2009 but again declined in 2010 and 2011. The mean TFPCH (Geometric) value is 1.071, which suggests that the banking sector as a whole has seen positive growth of around 7% during this time period.

Now we consider table (3) given below to estimate " MALMQUIST INDEX SUMMARY OF FIRM MEANS", which gives us all the information regarding how each bank performed during the given time period. All 12 banks in this period show a positive growth rate, on average it is around 10%.

YEAR	EFFCH	TECHCH	PECH	SECH	TFPCH
2002	1.054	1.53	1.054	1	1.613
2003	0.784	1.651	0.784	1	1.295
2004	0.975	1.375	0.975	1	1.341
2005	0.896	1.655	0.896	1	1.482
2006	1.228	0.735	1.228	1	0.903
2007	0.897	0.844	0.897	1	0.756
2008	1.101	0.796	1.101	1	0.876
2009	1.077	0.943	1.077	1	1.016
2010	1.073	0.915	1.073	1	0.982
2011	0.981	0.816	0.981	1	0.801
MEAN	**0.999**	**1.072**	**0.999**	**1**	**1.071**

Table 2: MALMQUIST INDEX SUMMARY OF ANNUAL MEANS

Bank	Effch	Techch	Pech	Sech	Tfpch
State Bank Of India	1.031	1.061	1.031	1	1.094
Punjab National Bank	0.987	1.084	0.987	1	1.069
Bank Of Baroda	1.004	1.089	1.004	1	1.094
Canara Bank	1.002	1.106	1.002	1	1.108
Union Bank Of India	0.969	1.093	0.969	1	1.059
Bank Of India	0.995	1.089	0.995	1	1.084
Indian Bank	1.009	1.087	1.009	1	1.097
Central Bank Of India	0.992	1.088	0.992	1	1.08
Indian Overseas Bank	0.987	1.042	0.987	1	1.028
Uco Bank	0.987	1.114	0.987	1	1.1
Bank Of Maharashtra	1.031	1.009	1.031	1	1.04
Punjab And Sind Bank	1	1.005	1	1	1.005
Mean	**0.999**	**1.072**	**0.999**	**1**	**1.071**

Table 3: MALMQUIST INDEX SUMMARY OF FIRM MEANS

5   Conclusion

This study has investigated the efficiencies of 12 different Public Sector banks in the period 2001-2011. The study found that the banking sector is directly impacted by the changes in the economy. The recession that hit the economy in 2007 and 2011 affected the banking sector, crucially. It can be inferred from the results that the banking sector faced a negative growth rate. The study also found that the Average TFPCH for all the banks in this time period (2001-2011) is greater than 1, meaning an overall growth of all the banks. The banking sector in the country had an overall growth of around 10%.

Further recommendations: India's banking sector is characterised by large amounts of non-performing assets (NPAs), which came to light after the asset quality review (AQR) in 2016. The AQR divides loans into two categories: performance and non-performing. According to the RBI, the country's central bank, the rate of bad loans increased to as high as 80% in the financial year 2016 due entirely to the AQR. NPAs are clearly an "undesirable" output of a bank. This study can be furthered by taking this into account and checking for the efficiency of banks. In the dataset, there is a column: "Net NPA ratio". This factor can be used and then the efficiency of banks can be evaluated, for a broader picture. Also, this study is limited to nationalised banks only. To get a broader picture of the Complete Indian Banking system's productivity, Data of all the banks, including co-operative banks, private banks and foreign banks can be taken into account and efficiencies and productivity can be evaluated

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