Financial Liberalization and Banking Sector Efficiency in India:

A Fourier Flexible functional form and Stochastic Frontier Approach

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Abstract: The Indian financial sector has undergone a significant structural transformation since the initiation of financial liberalization during 1990's. It brought significant changes in the financial sector in general and banking in particular. While there have been significant changes in the financial structure, India remains a bank dominated financial system. One of the major objectives of financial liberalization was to make the financial institutions more efficient and competent. Against this backdrop, the present paper intends to analyze the cost efficiency of the Indian banking sector applying the stochastic frontier approach. Using the Fourier Flexible functional form and stochastic cost frontier methodologies, the study finds, the public sector banks are the most efficient banks followed by the domestic private sector and foreign banks. The finding of the study is quite contrary to the international evidence. There could be several potential expiations to this unconventional finding. First, the natural monopoly argument - the public sector banks got the advantage of the first mover and also the economies of scale. Second, the time period of the study is the period of consolidation for the foreign banks and the new private banks. It is because, several banking specific reforms as a part of financial sector reform went on till late 1990's.
Key words: Financial Liberalization; Banking Sector; Cost Efficiency & Stochastic Frontier Approach

INTRODUCTION

The Indian financial sector comprises a large network of commercial banks, financial institutions, stock exchanges and a wide range of financial instruments. It has undergone a significant structural transformation since the initiation of financial liberalization in 1990s. Before financial liberalization, since mid 1960's till the early 1990', the Indian financial system was considered as an instrument of public finance (Agarwal, 2003). The evolution of Indian financial sector in the post independent period can be

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divided in to three distinct periods. During the first period (1947-68), the Reserve Bank of India (RBI) consolidated its role as the agency in charge of supervision and banking control (Sen & Vaidya, 1997). Till 1960's the neo-Keynesian perspective dominated, argued interest rates should be kept low in order to promote capital accumulation (Sen & Vaidya, 1997). During this period Indian financial sector was characterized by nationalization of banks, directed credit and administered interest rates (Lawrence & Longjam, 2003). The second period (1969 - mid 1980's), known as the period of financial repression. The financial repression started with the nationalization of 14 commercial banks[3] in 1969. As a result interest rate controls, directed credit programmes, etc. increased in magnitude during this period (Sen & Vaidya, 1997). The third period, mid 1980's onwards, is characterized by consolidation, diversification and liberalization. However a more comprehensive liberalization programme was initiated by the government of India during early 1990's.The impetus to financial sector reforms came with the submission of three influential reports by the Chakravarty Committee in 1985, the Vaghul in 1987 and the Narasimham Committee in 1991. But the recommendations of the Narasimham Committee provided the blueprint of the reforms, especially with regard to banks and other financial institutions. In 1991, the government of India initiated a comprehensive financial sector liberalization programme. The liberalization programme includes de-controlled interest rates, reduced reserve ratios and slowly reduced government control of banking operations while establishing a market regulatory framework (Lawrence & Longjam, 2003).

The major objectives of the financial liberalization were to improve the overall performance of the Indian financial sector, to make the financial institutions more competent and more efficient. However, Indian financial system continues to be a bank based financial system and the banking sector plays an important role as a resource mobiliser. It remains the principal source of resources for many households, small and medium enterprises and also caters the large industries. And also provides many other financial services. Underlining the importance of the banking sector, several banking sector specific reforms[4] as a part of financial reforms were introduced to improve the performance of the Indian banking sector and to make the Indian banks more competent and efficient. Against this backdrop, the present paper intends to determine the efficiency of the banks operating in India.

INDIAN BANKING SECTOR: AN OVERVIEW

The Indian banking sector has been dominated by the public sector banks in terms of number and asset share. The banking sector comprises of 28 public sector banks with majority government ownership (Table-1), 23 private banks and 27 foreign banks. However, the number of public sector commercial banks the same over last three decades, where as the number of foreign banks has increased over years. The number of domestic private banks has declined with the emergence of some new private banks and exists of many old ones. In terms of asset share, the public sector banks constitute about 70 percent of the total commercial banking asset. However, the asset share of the public sector banks has gone down from about 90 percent in 1980 to about 68 percent in 2007. Even though the number of domestic private banks has declined since 1980s, the asset share of these banks has gone up to about 20 percent in 2007. The total banking sector asset constitutes more than 91.8 percent of the GDP[5] at the end of March 2008 and the commercial banking asset constitutes more than 95 percent of the total banking asset.

Table 1: Private Shareholding in PSBs: 2007

Shareholding (%)	Number of Banks
Up to 10	3
More than 10 & up to 20	1
More than 20 & up to 30	3
More than 30 & up to 40	3
More than 40 & up to 49	11

Source: Reserve Bank of India

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[3] Under the banking companies act 1949.
[4] See annexure - 3
[5] RBI (http://www.rbi.org.in/scripts/PublicationsView.aspx?id=10922)

Table 2: Indian Banking Sector at a Glance

	1980	1985	1990	1995	2000	2005	2006	2007
Asset (Rupees Billion, 1993-94 Prices)								
PSBs	1649.56	2564.02	3619.49	3744.54	5638.22	9452.16	10361.91	12206
Private	90.26	122.27	137.15	326.75	864.24	2279.9	2939.73	3728.88
Foreign	70.82	115.22	222.94	322.83	524.3	818.61	1025.24	1390.77
RRBs	13.35	48.38	84.42	127.02	267.28	414.91	461.08	529.10
Total	1823.98	2849.89	4063.99	4521.13	7294.04	12965.58	14787.97	17854.76
Deposit (Rupees Billion, 1993-94 Prices)								
PSBs	1227.23	1933.5	2577.12	2977.28	4665.95	7654.2	8343.95	9975.96
Private	70.18	95.99	108.68	248.71	719.34	1676.42	2203.42	2761.31
Foreign	38.45	59.86	123.96	239.18	312.14	460.3	584.96	754.34
RRBs	6.95	27.42	55.85	95.06	203.94	331.1	367.01	415.92
Total	1342.81	2116.78	2865.6	3560.23	5901.36	10122.01	11499.34	13907.54
Credit(Rupees Billion, 1993-94 Prices)								
PSBs	779.47	1173.18	1595.78	1516.77	2228.26	4551.44	5689.32	7204.20
Private	38.13	53.24	58.83	135.01	352.75	1179.15	1609.47	2074.81
Foreign	28.28	44.33	77.24	129.94	225.4	401.31	501.73	632.01
RRBs	8.2	29.29	46.97	51.08	78.64	169.39	198.16	236.75
Total	854.08	1300.04	1778.82	1832.81	2885.05	6301.30	7998.68	10147.76
% Share (of Total)								
Asset								
PSBs	90.44	89.97	89.06	82.82	77.30	72.90	70.07	68.36
Private	4.95	4.29	3.37	7.23	11.85	17.58	19.88	20.88
Foreign	3.88	4.04	5.49	7.14	7.19	6.31	6.93	7.79
RRBs	0.73	1.70	2.08	2.81	3.66	3.20	3.12	2.96
Deposit								
PSBs	91.39	91.34	89.93	83.63	79.07	75.62	72.56	71.73
Private	5.23	4.53	3.79	6.99	12.19	16.56	19.16	19.85
Foreign	2.86	2.83	4.33	6.72	5.29	4.55	5.09	5.42
RRBs	0.52	1.30	1.95	2.67	3.46	3.27	3.19	2.99
Credit								
PSBs	91.26	90.24	89.71	82.76	77.23	72.23	71.13	70.99
Private	4.46	4.10	3.31	7.37	12.23	18.71	20.12	20.45
Foreign	3.31	3.41	4.34	7.09	7.81	6.37	6.27	6.23
RRBs	0.96	2.25	2.64	2.79	2.73	2.69	2.48	2.33

Source: Calculated from the Reserve Bank of India

Since 1990's, there has been spectacular growth of the Indian banking sector. Variables like total asset, total deposit, total credit and net profit has been analyzed to study the relative progress of the Indian banking sector. All bank groups have recorded faster asset growth after the financial reforms. Total deposits of the commercial banks have gone up significantly since 1999. The total advances of all commercial banks have gone up significantly over last five years. However, it can be seen that in terms of composition of banking assets, deposits and credit by ownership, the public sector banks still dominates followed by the domestic private banks and foreign banks (Table – 2). There has been a significant decline in the asset share of the public sector banks in favor of the domestic private banks. Recent figure shows, the asset share of the public sector banks have declined to about 68 percent, where as the asset share of the private banks has gone up to 21 percent. In terms of deposits and credit share, the share of public sector banks has deceased to about 70 percent and the share of private banks is on rise.

FINANCIAL LIBERALIZATION AND BANKING SECTOR PERFORMANCE

The credit deposit ratio reflects the management performance of the banks. It can be seen after financial liberalization, most of the banks reported higher C-D ratio. The C-D ratio is the highest in case of the foreign banks and lowest in case of the public sector banks. The overall commercial banking sector witnessed an increase in the credit-deposit ratio. In 1980, the C-D ratio for all commercial banks was 63.32 percent, and increased to 73.46 percent in 2007. The investment deposit ratio has also increased, but marginally.

Table 3: Management Performance and Asset Quality

	1980	1985	1990	1995	2000	2005	2006	2007
Credit-Deposit Ratio (Per cent)								
PSBs	66.63	61.72	65.29	52.56	48.37	58.74	68.27	73.27
Private	54.33	55.46	54.13	54.28	49.04	70.34	73.04	75.14
Foreign	73.55	74.06	62.31	54.33	72.21	87.18	85.77	83.78
All Banks	63.32	60.82	61.64	51.42	49.26	62.63	70.07	73.46
Ratio of Contingent Liability to Asset								
PSBs	0.27	0.25	0.16	0.17	0.14	0.14	0.15	0.14
Private	0.21	0.21	0.09	0.18	0.11	0.19	0.17	0.19
Foreign	0.44	0.47	0.18	0.16	0.31	0.31	0.31	0.34
All Banks	0.25	0.24	0.14	0.15	0.13	0.16	0.16	0.16
Ratio of Investment in Securities to Assets								
PSBs	0.21	0.23	0.22	0.3	0.29	0.34	0.27	0.22
Private	0.2	0.23	0.25	0.21	0.24	0.23	0.23	0.21
Foreign	0.19	0.15	0.14	0.23	0.23	0.22	0.21	0.2
All Banks	0.22	0.22	0.22	0.28	0.28	0.3	0.25	0.22
Ratio of Term Loans to Assets								
PSBs	..	..	..	24.28	35.05	51.64	53.28	54.86
Private	..	..	..	23.47	32.48	65.49	68.4	70.31
Foreign	..	..	..	27.82	46.1	49.16	48.04	49.25
All Banks	..	..	..	24.77	36.09	54.04	55.92	57.74

Source: Reserve Bank of India

The asset quality reflects the structural soundness of the banking sector. The ratio of contingent liability shows, the foreign banks are more exposed to default, which implies the foreign banks provide most sophisticated services. It is because most of the foreign banks are concentrated in urban areas and mostly carter to large clients. The contingent liability to asset ratio of the total commercial banks shows, it has declined from 25 percent in 1980 to 16 percent in 2007 (Table – 3). The foreign banks and the private banks are exposed to more losses in case of default and the public sector banks are less exposed to default. The ratio of investment in securities to assets indicates that banks invest about 20 to 30 percent in government securities in response to SLR (Table – 3). The public sector banks have higher percentage of investment in government securities and the foreign bank's investment is the lowest. The public sector banks prefer to invest more in the government securities because; it is more liquid and the safest investment. Even after financial reforms the PSBs's investment in government securities has gone up.The ratio of term loans to asset shows, over years it has increased to about 58 percent in 2007. The private banks have increased the term loans to about 70 percent and the public sector banks have been almost consistent about 30 percent on average till 2003 and thereafter witnessed a rapid increase in their term loans.

PROFITABILITY

Profitability can be measured with two indicators; Return on Asset (ROA) and the Return on Equity (ROE). The return on asset is defined as the ratio of net profit to average asset. It can be seen (Table - 4) that, after financial reforms the banks are more profitable. The foreign banks are more profitable than the domestic private banks and the public sector banks. After financial liberalization, the private and the foreign banks recorded higher rate of return on asset. During the early phase of reforms, the return on asset was negative. But after that it increased from -0.89 percent in 1994 to 1 percent in 2007.

Table 4: Profitability Indicators of the Indian Banking Sector

	1980	1985	1990	1995	2000	2005	2006	2007
Return on Asset								
PSBs	0.09	0.07	0.15	0.34	0.67	0.95	0.88	0.9
Private	..		0.25	1.34	1.02	0.89	1	0.98
Foreign	..	..	1.37	1.96	1.3	1.37	1.74	1.92
All Banks	..	..	0.22	0.47	0.72	0.97	0.96	1
Return on Equity (%)								
PSBs	10.46	5.96	9.26	8.96	13.44	17.61	15.79	16.14
Private	..	..	20.78	28.63	17.18	13.28	13.34	13.71
Foreign	..	..	131.91	23.3	13.55	11.72	14.18	15.98
All Banks	..	..	13.57	8.25	12.56	15.74	14.77	15.51

Source: Reserve Bank of India

Return on equity can be taken as proxy to measure profitability. The private banks are more consistent since 1990's in terms of the return on equity, where as the foreign banks have been the most inconsistent. During early 1990's the return on equity of the foreign banks was about 132 percent and in 2007 it is about 16 percent. The public sector banks are performing better with 16.14 percent return on equity.

CONCENTRATION

The Indian banking sector is dominated by the public sector banks. However, with the initiation of financial liberalization, several private and foreign banks started functioning, which ushered in competition in the Indian banking sector. Even the share of public sector banks in total asset, deposit and credit has declined; still they dominate the Indian banking sector. To measure the degree of concentration, Herfindahl-Hirschman Index (HHI) has been calculated[6]. It can be seen (Table – 5) that over years the concentration in the banking sector has declined significantly in terms of asset, deposits and credit.

Table 5: Herfindahl-Hirschman Index Score

Year	Asset	Deposit	Credit
1980	0.82	0.87	0.84
1985	0.81	0.86	0.82
1990	0.80	0.85	0.81
1991	0.78	0.84	0.80
1992	0.75	0.82	0.78
1993	0.73	0.81	0.76
1994	0.73	0.79	0.73
1995	0.70	0.77	0.70
1996	0.68	0.76	0.66
1997	0.65	0.73	0.62
1998	0.64	0.71	0.63
1999	0.63	0.71	0.63
2000	0.62	0.69	0.62
2001	0.61	0.69	0.61
2002	0.56	0.67	0.56
2003	0.57	0.66	0.56
2004	0.56	0.64	0.55
2005	0.57	0.65	0.56
2006	0.54	0.62	0.55
2007	0.52	0.61	0.55

Source: Calculated

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[6] Formula for the calculation of Herfindahl-Hirschman Index $H = \sum_{i=1}^{N} s_i^2$

THE CONCEPT OF EFFICIENCY

By efficiency, we mean the optimum output that can be produced using any given amount of input. A firm or organization is said to be efficient, when it allocates its resources in such a way as to produce the maximum quantity of output (Tahir & Haron, 2008). The efficiency of the banking sector can be decomposed in to scale efficiency, scope efficiency, pure technical efficiency and allocative efficiency (Chen, 2001). The bank is said to have scale efficiency, when it operates in the range of constant returns to scale and have scope efficiency, when it operates in different diversified locations. Maximizing output from a given level of input is called technical efficiency and when a bank chooses the revenue maximizing mix of output, the allocative efficiency occurs (Chen, 2001). According to Berger, the most important origin of the cost problems in banking is the X-efficiency, which is the differences in the managerial ability to control cost for a given level of production (Chen, 2001). The X-efficiency includes both the technical and allocative efficiency. According to Farrell (1957), the efficiency of a firm consists of two components, the 'technical efficiency'[7] and the 'allocative efficiency'[8]. The combination of these is the measure of total 'economic efficiency'.

ALTERNATE METHODS OF EFFICIENCY MEASUREMENT

Broadly, the approaches to efficiency measurement can be divided into parametric and non-parametric. The basic difference between the two is how much shape is imposed on the frontier and the distributional assumptions imposed on the random error and inefficiency (Berger & Humprey, 1997 as discussed in Tahir & Haron, 2008). There are three parametric approaches for efficiency measurement: the Stochastic Frontier Approach (SFA), the Thick Frontier Approach (TFA) and the Distribution Free Approach (DFA). On the other hand, the Data Envelopment Analysis (DEA) is being widely used as the non-parametric approach to measure efficiency. The parametric method includes production, cost, profit and the revenue function as alternative methods of estimating efficiency, where as the non parametric method uses the linear programming techniques (Ajibefun, 2008). However, there has been no consensus on the superiority of any of the two approaches. But some studies have tried to explain the superiority of SFA method over the DEA method.

Farrel's (1957) work on 'the measurement of productive efficiency' laid the basic framework for studying and measuring inefficiency with a frontier. Inefficiency has been defined as 'the deviations of actual from optimum behaviour' (Kaparakis et. al, 1994). The relevant frontier can be constructed and estimated using statistical and mathematical programming techniques. Broadly the techniques can be clubbed in two groups, the deterministic and the stochastic frontiers. The deterministic frontier assumes no statistical noise, where as the stochastic frontier considers the stochastic properties and thus seems statistically more accurate and acceptable. However, this technique is also not error free. Kaparakis et. Al (1994), points out some important problems that exist with the parametric stochastic frontier approach. One of them is, it is required to choose an explicit functional form for the production and the cost function, in many occasions its appropriateness has been questioned. However, the use of flexible functional forms likes the translog attempts to avoid this concern to some extent.

Over years, two principal methods, the data involvement analysis (DEA) and stochastic frontiers have dominated the efficiency measurement literature (Coelli et. Al, 2000). The DEA method is non-parametric, involves mathematical programming and the stochastic frontier is a parametric method, which involves the econometric method. The major advantage of the DEA method is it measures the relative efficiency and major drawback is, it is a deterministic model (Quyyam & Khan, 2007). On the other hand, the major advantage of using SFA method is it allows the measurement error and provides a firm specific efficiency estimate (Staikouras et. al, 2008).

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[7] According to Farrell (1957), the technical efficiency reflects the ability of a firm to obtain maximum output from a given set of inputs (as citied in Coelli et.al, 2000).
[8] Allocative efficiency reflects the ability of a firm to use the inputs in optimal proportions, given prices and technology (as citied in Coelli et.al, 2000). The allocative efficiency has been referred as 'price efficiency' in Farrell's seminal work (Johansson, 2005).

Several studies have indicated that the efficiency results can be sensitive to the method selected for efficiency measurement (Johansson, 2005). Some studies reported to have found different efficiency scores for different methods of efficiency measurement (Chen, 2002 & Johansson, 2005). However, some studies report that there is no significant difference in the level of efficiency scores (Resti, 1999).

However, both the methods have some merits and demerits. According to Ajibefun (2008), the main advantage of the parametric frontier analysis is, being a stochastic frontier production function, it allows the test of hypothesis concerning the goodness of fit of the model. On the other hand, the major disadvantage of the method is, it requires the 'specification of technology' (Ajibefun, 2008). Whereas the non-parametric method, which is otherwise known as the Data Envelopment Analysis (DEA), does not require such kind of specification of a particular functional form certain technology. And the major disadvantage with the non-parametric technique is that it is not possible to estimate parameters for the model and therefore impossible to test hypothesis of the model concerned (Ajibefun, 2008).

STUDIES ON BANKING EFFICIENCY

The estimation of the average productivity was the major area of early banking research. However, in the later stages, the measurement of efficiency emerges as one of the most researched topic in banking sector analysis (Tahir & Haron, 2008). The efficiency estimation in banking gained importance especially in the transitional economies[9]. Several studies have tried to estimate the banking sector efficiency in the light of the financial liberalization and banking sector reforms. Some of them have estimated the technical efficiency (Akmal & Saleem, 2008), some the scale efficiency (Akmal & Saleem, 2008; Quyyam & khan, 2007; Craft & Tirtiroglu, 1998; Karvalo & Kasman, 2005), allocative efficiency, profit and cost efficiency (Karvalo & Kasman, 2005; Craft, 2002; Hasan & Marton, 2003; Staikouras et. al, 2008) and also X-efficiency (Craft & Tirtiroglu, 1998 ; Altunbas et. al, 2001; Fu and Heffernan, 2007; Quyyam & khan, 2007).

A brief survey of literature shows that the cost and X-efficiency measurement is becoming more popular in banking efficiency study. Craft & Tirtiroglu (1998), estimated X-efficiency and the scale efficiency during 1994 and 1995 for both the new and old, state and the private banks in Croatia. Altunbas et. al (2001), estimated the scale economies and the X-efficiency for the European banks between 1989 – 1997. Christopoulos et. al (2002), in their study attempted to estimate the cost efficiency of the Greek banking system during 1993-98. Hasan and Marton (2003), estimated the profit and cost inefficiency of the Hungerian Banking sector during the transition period. Canhoto and Dermine (2003), attempted to investigate the magnitude of efficiency in the Portugal banking sector during the period 1990 – 95. Karvalo and Kasman (2005), measured the cost inefficiency, and scale and scope economies of a panel of 461 banks from 16 Latin American countries during 1995-99. Patti & Hardy (2005), in their study attempted to determine the banking efficiency by ownership. Havrylchyk (2006), examined the efficiency of the Polish banking industry between 1997 and 2001. Fu and Heffernan (2007), examined the cost x-efficiency of the china's banking sector for the period 1985 – 2002. Staikouras et. al (2008), analyzed the cost efficiency in the banking sector of the six South Eastern European countries. Koutsomanoli-Filippaki et. al (2009), analyzed banking sector efficiency and productivity growth in the banking sector of the central and the eastern Europe for the period 1998-2003.

BANKING SECTOR EFFICIENCY IN INDIA: A REVIEW

There have been several studies on the banking sector performance in India in context of financial liberalization. However, few studies have been done on the efficiency of the Indian banking sector. Studies by Bhattacharya et. al(1997),Sathye (2003), Das & Ghosh (2006), Ray & Das (2009) have tried to measure the efficiency of the Indian banking sector. Bhattacharya et. al (1997), in their study examined the productivity efficiency of 70 Indian commercial banks between 1986 to 1991. Using Data Evolvement Analysis (DEA), their study concludes, the public sector banks have been the most efficient followed by the

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[9] However, early literature on banking efficiency shows, the efficiency studies were limited to the US and the European banking sector (Berger & Humphery, 1997 as discusses in Havrylchyk, 2006)

foreign and the private banks. Sathye (2003), using the DEA to estimate efficiency, found the private banks are less efficient than the public and the foreign banks. Das and Ghose (2006) used the non-parametric DEA to estimate the efficiency of the Indian commercial banks in the post reform period, 1992-2002. Using non-parametric DEA to estimate the cost and profit efficiency of the Indian banking sector in the post reform period, Ray and Das (2009) found, the public sector banks are more efficient than the private banks.

METHODOLOGY: EFFICIENCY ESTIMATION USING THE STOCHASTIC FRONTIER APPROACH

In recent years, the frontier analysis method has been quite popular. Several studies have been carried out to measure the banking sector performance (efficiency) using the frontier analysis method (Abbasoglu et. al, 2007; Carbo et. al, 2002). The frontier analysis separates the institutions those perform better relative to a particular standard from the institutions those performances are poor. Such separations can be done by using a parametric or non-parametric frontier analysis. The parametric approach includes the stochastic frontier analysis (Sathye, 2003).

The review of literature presented in the paper documents the approaches or methods used in various studies to estimate efficiency or inefficiency. The Stochastic Frontier Method has been extensively used over last decade (Craft & Tirtiroglu, 1998; Karvalo &Kasman ,2005; Hasan & Marton,2003; Craft et. al, 2002; Altunbas et. al, 2001; Staikouras et. al, 2008; Fu and Heffernan, 2007). Several studies have also used the DEA method to estimate the banking efficiency (Quyyam & Khan, 2007; Akmal & Saleem, 2008; Havrylchyk, 2006; Canhoto & Dermine, 2003). As a matter of fact, a brief review of the efficiency studies conducted on the Indian banking sector shows, all studies have used the DEA method to determine the efficiency level of the Indian banks (Bhattacharya et. al, 1997),Sathye (2003), Das & Ghosh (2006), Ray & Das (2009).

Studies on efficiency attempts to measure a firm's position relative to an efficient frontier. The DEA and the SFA are two techniques which help in estimating the position of a firm relative to an efficient frontier (Johansson, 2005). The present study uses the SFA method to estimate the cost efficiency of the Indian banking sector, since using SFA estimation is possible via the production, cost or, the profit function (Johansson, 2005). The Stochastic Frontier Approach (SFA), which is referred as the Econometric Frontier Approach[10] (EFA) was developed by Aigner, Lovell and Schmidt and Van den Broeck in 1977. It specifies a functional form for the cost, profit or the production frontier and allows for random error (Tahir and Haron, 2008).

The cost frontier can be constructed by using the following regression function (Abbasoglu et. al, 2007 & Carbo et. al, 2002).

TC = f Σ (INPUTS) + Σ (OUTPUTS) + e

Where, TC is the total cost.

e is the random error component.

The inputs include, the interest cost[11], labor cost[12] and the capital cost[13].The output includes three variables total loans, investment in securities and other investments. The efficiency indices are calculated by the difference between the cost frontier constructed and the realized total cost (Abbasoglu et. al, 2007).

The basic stochastic frontier model can be written as the followings (Anderation et. al, 2000):

$$\ln TC_i = \ln TC(Q_i, P_i) + U_i + V_i \text{ -----------------------------(1)}$$

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[10] However, the first econometric approach to efficiency measurement was developed by Aigner & Chu in 1968, but did not include a stochastic term to control for random disturbances (Resti, 1997). Subsequently, the SFA was developed with a composite error term, which can be divided in to two parts.
[11] Interest cost = total interest expense / total borrowings
[12] Labor cost = Personal expenses / number of employees
[13] Capital cost = capital expenditure (depreciation) / book value of the total asset

Where, TC stands for the total cost, Q are the vector of outputs and the P for the vector of input prices. Ui is the one sided disturbance term for the cost frontier, which captures the inefficiency (Karvalo & Kasman, 2005; Anderation et. al, 2000). Vi is the random error or, noise term.

And Ui+Vi=Ei.

The stochastic cost frontier can be written as (Anderation et. al, 2000):

$$TC(Q_i, P_i) EXP(V_i)$$ -----------------------------(2)

The cost frontier can be estimated by using the maximum likelihood method and efficiency scores are estimated using the regression errors (Karvalo & Kasman, 2005).

Given the half normal inefficiency stochastic frontier approach, the present study uses the Fourier Flexible (FF) form to examine the cost function specifications, which best fits the cost structure of the Indian banking system (as discussed in Carbo et. al, 2002). Carbo et. al (2002) in their study have used the FF form with the translog functional form. A normal translog cost function with three inputs and three outputs can be of the following form (Anderation et. al, 2000).

$$\ln TC_i(p,Q) = \alpha_0 + \sum_{i=1}^{3} \alpha_i \ln p_i + 1/2 \sum_{i=1}^{3} \sum_{j=1}^{3} \alpha_{ij} \ln p_i \ln p_j + \alpha \ln Q_i + \alpha_{qq} \ln Q_i^2 + \varepsilon_i$$

---------------(3)

However, the reason behind using the FF form with translog functional form is that, the translog features may not fit the data, which are far from the mean in terms of output size or mix (Carbo et. al, 2002). The FF can solve the problem by approximating any continuous function and any of its derivatives[14] (Carbo et. al, 2002). This method was first introduced by Gallant in 1981 and subsequently discussed and used by many including Carbo et. al (2002). The present study uses the methodology developed by Carbo et. al (2002).

$$\ln TC = \alpha_0 + \sum_{i=1}^{3} \alpha_i \ln Q_i + \sum_{l=1}^{3} \beta_l \ln P_l + t_1 T +$$

$$1/2[\sum_{i=1}^{3} \sum_{j=1}^{3} \delta_{ij} \ln Q_i \ln Q_j + \sum_{l=1}^{3} \sum_{m=1}^{3} y_{lm} \ln P_m + t_{11} T^2]$$

$$+ \sum_{i=1}^{3} \sum_{m=1}^{3} \rho_{im} \ln Q_i \ln P_m + \sum_{i=1}^{n} \psi_i T \ln Q_i + \sum_{l=1}^{3} \theta_t T \ln P_l +$$

$$\sum_{i=1}^{3} [a_i \cos(Z_i)] + \sum_{i=1}^{3} \sum_{j=1}^{3} a_i \cos(Z_i + Z_j) + b_{ij} \sin(Z_i + Z_j) +$$

$$\sum_{i=1}^{3} \sum_{m=1}^{3} \sum_{k>j,k\neq i}^{3} [a_{ijk} \cos(Z_i + Z_j + Z_k)] + \varepsilon$$

---------------(4)

The inefficiency measures can be calculated by using the above equation (4), which includes a standard translong function, second and third trigonometric terms and two components error terms using a maximum likelihood procedure.

lnTC = log of total cost

lnQi = log of bank outputs (total loans, investment in securities and other investments)

lnPi = log of bank inputs (the interest cost, labor cost and the capital cost)

T = Time Trend

Zi = the adjusted values of the log output *lnQi*

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[14] According to Carbo et. al (2002), "Since the FF is a combination of polynomial and trigonometric expansions, the order of approximation can increase with the size of the sample size".

THE DATA

On banking statistics in India, the Reserve Bank of India (RBI) remains the most reliable source. The data has been taken from the 'Statistical Tables Relating to Banks in India' data base. The present study analyses the efficiency of public sector banks both at pre and the post reform period, and efficiency of the public, private and foreign banks in the post reform period. All the variables used in the study have been deflated with the GDP deflator and converted to constant prices (1993-94 prices). To determine the cost efficiency of the public sector banks both during the pre and post reform period, 27 public sector banks have been taken in to account. Due to data limitation, the pre-reform period has been taken as from 1980 to 1988 and the post reform period has been taken as, 1992 to 2007. To examine the efficiency level of the Indian banks by ownership, 27 PSBs, 17 private banks and 16 foreign banks have been taken in to account. The banks those have been included have been operating continuously since 1996 and banks those discontinued have not been considered.

ANALYSIS OF RESULT

The mean efficiency scores of the Indian public sector banks have been explained in the following table *(Table - 6)*. The result shows, the mean efficiency value of the public sector banks during the post reform period has declined marginally.

Table 6: Descriptive Statistics of Efficiency Scores -Public Sector Banks: Pre (1980-87) and the Post (1992-2007) Reform Period

Period	Observations	Mean	SD	Min	Max
Pre Reform (1980-87)	216	0.974	0.007	0.950	0.988
Post Reform (1992-2007)	416	0.969	0.009	0.928	0.986

The efficiency values of the Indian public sector banks show, there has not been much variation between the two time periods *(Figure – 1 & 2)*. During the study period, the efficiency scores of the public sector banks vary from 0.974 to 0.969. It is important to note that after the initiation of the financial sector reform, the efficiency value of the public sector banks has declined marginally.
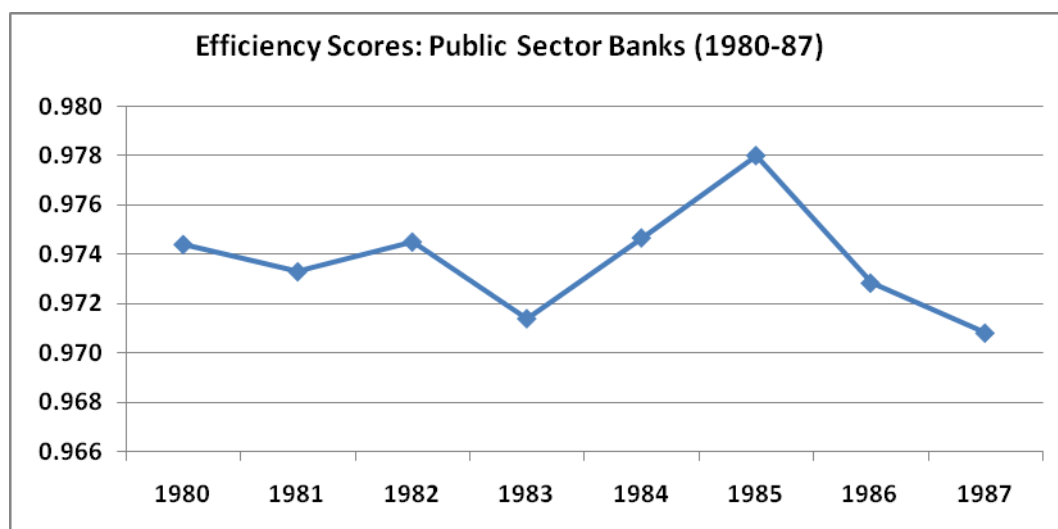
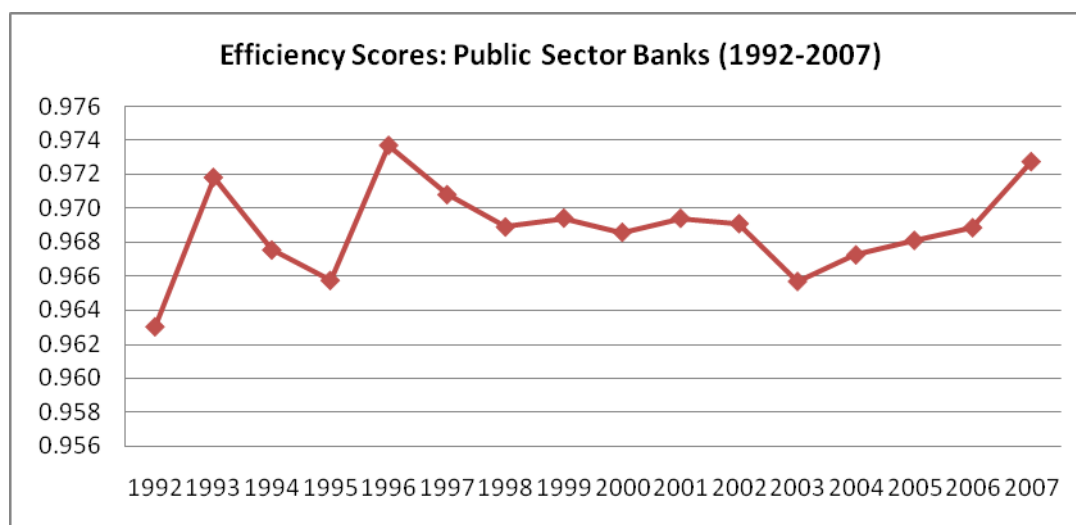**Figure 1: Efficiency scores: public sector banks (1980-87)**

Figure 2: Efficiency scores: public sector banks (1992-2007)

Table 7: Descriptive Statistics of Efficiency Scores by Bank Ownership (1996-2007)

Ownership	Observations	Mean	SD	Min	Max
PSBs	323	0.911	0.038	0.760	0.982
Private	204	0.907	0.043	0.751	0.977
Foreign	179	0.866	0.093	0.570	0.991
All	706	0.898	0.061	0.570	0.991

The mean efficiency score of the Indian banking sector as a whole is about 0.9 (Table-7). The public sector banks and the private banks have the mean efficiency which is higher than the all banks mean efficiency. The foreign banks are found to be least efficient among the bank groups. The public sector banks are the most efficient, followed by the domestic private banks. The average efficiency score of the public, private and the foreign banks (Figure – 3) shows, even the public sector banks are the most efficient, in recent years since 2004, the private banks are becoming more efficient and the foreign banks are becoming almost equally less efficient.
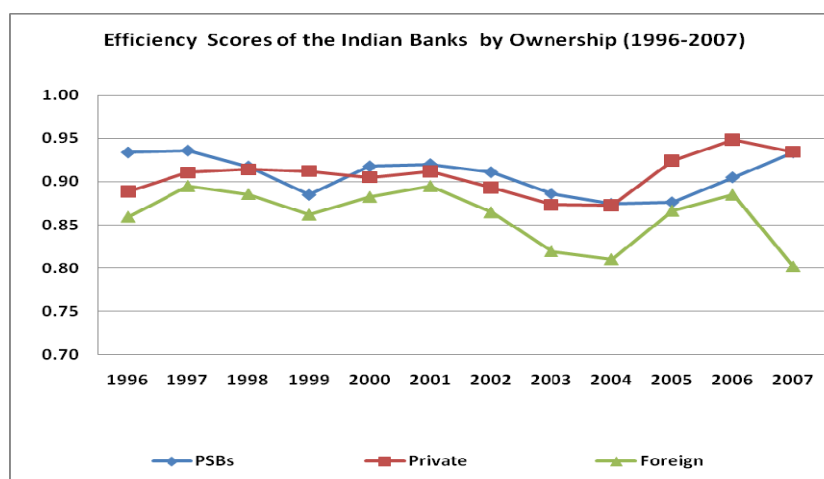

Figure 3: Efficiency scores of the India banks by ownership (1996-2007)

The efficiency scores of the individual banks show[15], out of 27 public sector banks, only 2 banks are found to score less than the mean efficiency during the post reform period (1996-2007). The Bank of Maharashtra seems to be the most efficient public sector bank in the post reform period *(Table – 1.1A, annexure – 1).* Out of 17 private banks, 4 banks found to score less than the mean efficiency *(Table – 1.2A, annexure – 1).* The efficiency score of the Tamiland Mercantile Bank is the highest among the private sector banks. Out of 16 foreign banks, only 3 banks are found to have obtained a higher efficiency score which is higher than the mean efficiency score. The Citi Bank found to be the most efficient foreign bank operating in India (Table – 1.3A, annexure – 1).

The results are quite similar to earlier studies on banking sector efficiency in India. Bhattacharya et. al (1997), found the Public sector banks are most productive efficient, followed by the foreign and the domestic private banks. Sathye (2003), found that the private banks are less efficient than the foreign and public banks. Ray and Das (2009), also reported to have found the public sector banks to be more efficient than the private banks. While all three studies concluded the public sector banks to be more efficient, the first two studies found the foreign banks are more efficient than the domestic private banks. However, the present study found that the domestic private banks are more efficient than the foreign banks and the public sector banks are the most efficient ones.

SUMMARY

The paper attempts to explore the efficiency levels and the performance of the Indian banking sector in the context of financial liberalization. Being a bank based financial system; the banking performance has an obvious impact on the economy. The study finds, there have been significant changes in the performance of the banking sector in India. The relative importance of the public sector banks has been declining with the emergence of the domestic private banks and more foreign banks. The asset, deposit and the credit share shows the share of public sector has been declining and the share of the private banks is increasing, which implies declining concentration and increasing competition. The foreign banks are found to be the more profitable in comparison to the domestic private and the public sector banks. However, the efficiency results of the study are quite contrary to the international evidence. The public sector banks are found to be the most efficient banks followed by the domestic private sector and foreign banks. There could be several potential expiations to this unconventional finding, even though the findings are with the line of previous studies conducted on Indian banking sector for different time periods. First, the natural monopoly argument - the public sector banks got the advantage of the first mover and also the economies of scale. Second, the time period of the study is the period of consolidation for the foreign banks and the new private banks. It is because, several banking specific reforms as a part of financial sector reform went on till late 1990's. It is evident from the efficiency scores of the domestic private banks. Since early 2000's, the domestic private banks are becoming relatively more efficient.

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[15] See annexure - 1

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ANNEXURE

Annexure 1:

Table 1.1A: Mean Efficiency Scores of the Indian Public Sector Banks, 1996-2007

Name of the Bank	Efficiency Score	Name of the Bank	Efficiency Score
State Bank of India	0.907	Central Bank Of India	0.902
State Bank of Bikaner & Jaipur	0.920	Corporation Bank	0.921
State Bank of Hyderabad	0.915	Dena Bank	0.905
State Bank of Indore	0.907	Indian Bank	0.911
State Bank of Mysore	0.907	Indian Overseas Bank	0.917
State Bank of Patiala	0.903	Oriental Bank of Commerce	0.911
State Bank of Saurashtra	**0.898**	Punjab & Sind Bank	0.911
State Bank of Travancore	0.914	Punjab National Bank	0.919
Allahabad Bank	0.916	Syndicate Bank	0.922
Andhra Bank	0.907	Uco Bank	0.905
Bank of Baroda	0.912	Union Bank of India	0.915
Bank of India	0.922	**United Bank of India**	**0.889**
Bank of Maharashtra	0.925	Vijaya Bank	0.909
Canara Bank	0.909		

Table 1.2A: Mean Efficiency Scores of the Indian Private Banks, 1996-2007

Name of the Bank	Efficiency Score	Name of the Bank	Efficiency Score
Bank of Rajasthan	**0.897**	Karnataka Bank	0.918
Catholic Syrian Bank	0.913	Karur Vysya Bank	0.917
City Union Bank	0.902	Lakshmi Vilas Bank	0.982
Dhanalakshmi Bank	**0.894**	Lord Krishna Bank	0.908
Federal Bank	0.918	Nainital Bank	0.902
Hdfc Bank	0.909	**Sangli Bank**	**0.891**
Icici Bank	0.908	South Indian Bank	0.907
Indusind Bank	**0.895**	<u>Tamilnad Mercantile Bank</u>	<u>0.924</u>
Jammu & Kashmir Bank	0.916		

Table 1.3A: Mean Efficiency Scores of the Foreign Banks Operating in India, 1996-2007

Name of the Bank	Efficiency Score	Name of the Bank	Efficiency Score
Abn Amro Bank	0.864	Deutsche Bank	0.867
Abu Dhabi Commercial Bank	0.824	**Hsbc**	**0.913**
American Express Bank	**0.907**	Mashreq Bank	0.870
Bank of America	0.864	Oman International Bank	0.824
Bank of Bahrain & Kuwait	0.896	Societe Generale	0.808
Bank of Nova Scotia	0.864	Sonali Bank	0.843
Barclays Bank	0.850	Standard Chartered Bank	0.875
<u>**Citibank**</u>	<u>**0.918**</u>		

Annexure 2:

List of Public Sector Banks

SL No.	Bank name	SL No.	Bank name
1	State Bank of India	15	Central bank of India
2	State Bank of Bikaner & Jaipur	16	Corporation Bank
3	State Bank of Hyderabad	17	Dena Bank
4	State Bank of Indore	18	Indian Bank
5	State Bank of Mysore	19	Indian Overseas Bank
6	State Bank of Patiala	20	Oriental Bank of Commerce
7	State Bank of Saurashtra	21	Punjab & Sind Bank
8	State Bank of Travancore	22	Punjab National Bank
9	Allahabad Bank	23	Syndicate Bank
10	Andhra Bank	24	Uco Bank
11	Bank of Baroda	25	Union Bank of India
12	Bank of India	26	United bank of India
13	Bank of Maharashtra	27	Vijay bank
14	Canara Bank		

List of Private Banks

SL No.	Bank name	SL No.	Bank name
1	Bank of Rajasthan	10	Karnataka Bank
2	Catholic Syrian Bank	11	Karur Vysya Bank
3	City Union Bank	12	Lakshmi Vilas Bank
4	Dhanalakshmi Bank	13	Lord Krishna Bank
5	Federal Bank	14	Nainital Bank
6	HDFC Bank	15	Sangli Bank
7	ICICI Bank	16	South Indian Bank
8	Indusind Bank	17	Tamilnad Mercantile Bank
9	Jammu & Kashmir Bank		

List of Foreign Banks

SL No.	Bank name	SL No.	Bank name
1	ABN AMRO Bank	9	Deutsche Bank
2	Abu Dhabi Commercial Bank	10	Hong Kong & Shanghai Banking Corporation
3	American Express Bank	11	Mashreq Bank
4	Bank of America	12	Oman International Bank
5	Bank of Bahrain & Kuwait	13	Societe Generale
6	Bank of Nova Scotia	14	Sonali Bank
7	Barclays Bank	15	Standard Chartered Bank
8	Citibank	16	State Bank of Mauritius

Annexure 3:

The Financial Sector Reforms: Sequence

The first half of 19980s: Interest rate deregulation

1991: Comprehensive reform

From a stronger regulation towards prudential regulation and supervision

Reduction of Cash Reserve Ratio (CRR) and Statutory Liquidity Ratio (SLR)

Interest rate and entry deregulation

Adoption of prudential norms

(3)   1992: (a) RBI guidelines for income recognition and asset clarification

　　　　　(b) Adopted Basel accord capital adequacy standard

(4)   1993: Entry to the private sector banks

(5)   1994: interest rate deregulation phased manner

(6)   1997: Banks were allowed to set their own interest rates on all term deposits of maturity more than 30days and all advances exceeding Rs 200000.