

Bank Efficiency & Macroeconomic Factors: A Study of Public Sector and Scheduled Commercial Banks of India

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Abstract

This paper investigates the effects of macroeconomic factors on efficiency of banks. The study takes into account primarily PSBs and the SCBs of India. To calculate efficiency part a parametric approach has been employed that is Stochastic Frontier Analysis (SFA) which estimates the stochastic frontier parameters and gives the inefficiency level of the model. The study has taken Profit-inefficiency into consideration and observed that the effect of macroeconomic variables are different for Public Sector Banks and Scheduled Commercial Banks for some of the variables like Per Capita GDP and Broad Money to GDP ratio. Profit-Inefficiency is negatively related to Per Capita GDP for Public Sector Banks but there is a positive relation with Broad Money to GDP ratio. The Scheduled Commercial Banks has an opposite relation that is Per Capita GDP has Positive relation but a negative relation with Broad Money to GDP ratio. This result shows that even if the Technical Efficiency scores are same for different groups of bank, the effect of macroeconomic factors differ between the groups of bank.

Keywords: Bank Efficiency, Non Parametric Methods, Stochastic Frontier Analysis

1. Introduction

Bank Efficiency as a subject in practice is dormant, particularly in case of India. Efficiency, which is often measurable, deals with the mechanism to avoid wastage of resources. Bank Efficiency is essential for developing country as bank services serves as crucial factor for overall economic growth of the country. Matthews (2010) points out that for emerging markets, the issue of bank efficiency has particular importance for the given trend in deregulation and economic reform.

There has been a substantiate increase in the competition among banking industry in India since 1990s. Currently, due to mergers of banks and rationalization of branches Indian banks have started featuring in top 50 banks of the world. Also due to merger there are economies of scale and reduction in cost of doing business. Such reforms are made in view of improving efficiency of the banks.

Most of the studies conducted in studying the efficiency of banks focused on the developed countries such as

United States. But there is a need of doing altogether different study in case of developing countries as the results from the developed countries cannot be applied to the emerging markets due to regulatory limits. In one of the study conducted by Ataulah A., Cockerill T. and Hang Le (2004) a comparative analysis was provided on evolution of technical efficiency of commercial banks in India and Pakistan pre and post implementation of financial liberalization in 1990s.

There are several studies which takes into account the effects of macroeconomics factors on bank efficiency. The study focuses entirely on India, which is one the powerful and emerging economies of Asian Continent. According to Dietsch and Lozano-Vivas (1997) "cross country efficiency comparisons require the proper definition of a common frontier that incorporates country specific macroeconomic conditions. This is the systematic comparison of efficiency measures using a parametric approach and integrating variables into the definition of the common frontier". Some of the macroeconomic

variables affects banking efficiency significantly in PSBs and SCBs of the country.

1.1 Public Sector Banks (PSBs) & Scheduled Commercial Banks (SCBs)

Public Sector Banks are those Scheduled Commercial Banks (SCBs) in which the majority stake is held by the government that is more than 50%. There are around 27 commercial PSBs currently working out of which there are a total of 18 Public Sector Banks alongside 1 state-owned Payments Bank in India. PSBs has the largest number of branches across the country and dominates the Indian Banking System by accounting for 70% of the system assets. It also contributes 75% of total deposits and 70% of total advances of all commercial banks.

The Scheduled Banks in India refer to those banks which have been included in the Second Schedule of Reserve Bank of India Act, 1934. RBI in turn includes only those banks in this Schedule which satisfy the criteria laid down vide section 42(6) (a) of the said Act. They are mentioned as below:

- Nationalized Banks
- State Bank of India and its associates
- Foreign Banks
- Private Sector Banks
- Regional Rural Banks (RRBs)

According to this Act of RBI the banks have to maintain a minimum capital of Rs. 5 lacs and should protect the interest of the depositors. RBI issues instructions from time to time like maintaining stipulated CRR, SLR. The bank can only be a corporation and not a sole-proprietor or partnership firm. Those Banks which are not under this Schedule are called Non-Scheduled Banks. There are certain rights which are being enjoyed by the SCBs and Non-Scheduled Banks do not have rights such as obtaining refinance facility from the apex bank like RBI in case of India. Furthermore they are not given facility for currency chest and also they barred from clearing house and cannot be a member as well.

However, Scheduled banks are allowed to borrow money from the apex bank for banking activities. But on the other hand non-scheduled banks do not have this facility. However, under extreme circumstances, they can ask the apex bank for accommodation. Now, if SCBs wants to become the member of clearing house then they have to turn in the periodic returns to the Central Bank.

After liberalization the banking business environment has been affected in terms of increasing competition and customers are given more importance as the focus is now on customer satisfaction, meeting up the customer expectation also focus was given on decreasing

the intermediates. Pre-liberalization the banks were controlled due to tight regulation policies and variables like size of the branch along with location were kept in focus. When market was thrown into competition the inefficiencies of the Indian Banks came into picture and started eating up the share. This competitive environment introduced public sector banks to new challenge of regaining its share. Even if the PSBs still have the largest contribution for banking indicators but since the liberalization period there is a decline in PSBs share and increase in private sector.

PSBs are still far from reaching the level of private sector and foreign banks when compared on basis of technology. These banks have faced difficulties in improving the technology frontier. Profit maximization and cost reduction programmes were the base for establishing itself in the increased competition. So PSBs started embracing technology to improve customer base by providing better service and started coming up with innovative ideas. In turn, majority of the banks in the public sector domain have significantly improved their profit efficiency. However, there have been fluctuations in profit performance of different bank groups individually.

1.2 Key Performance Indicators of Banks

The performance indicators are used by the companies to monitor the business. However one of the major issue is to help them in judging the progress against the externally reported strategies of the KPIs which are presented to the board. Measures that matter across the banking industry:

- Capital adequacy
- Customer retention
- Customer penetration
- Assets under management
- Loan loss
- Credit quality
- Asset quality

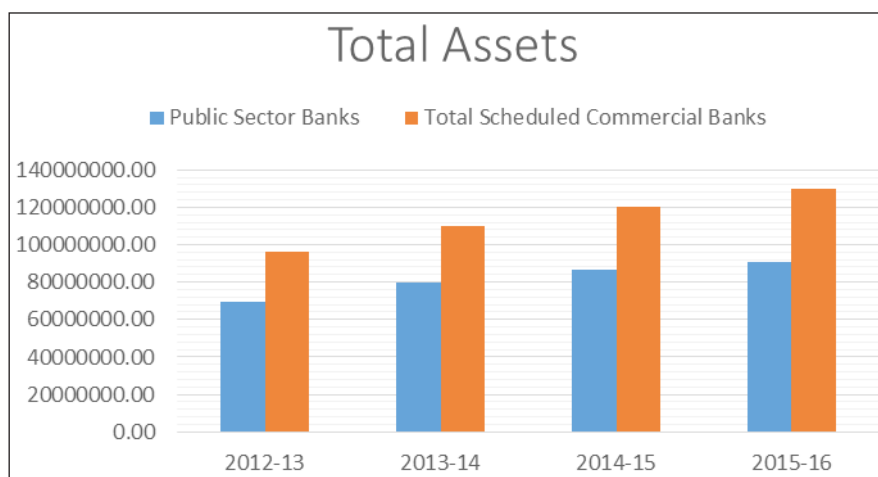
The Key Performance Indicators (KPI) vary with respect to the type of industry. The degree of KPI is conditioned with respect to the industry in which the company operates. So the banks which are performing better has credit quality approximately four times better than those of the average bank whereas net interest risk adjusted margin is about 1.5 times better. The focus is mostly laid on earning profits, focusing on customer base and decreasing NPAs. The performance of different groups of bank has been considered in relation to their goals, mission and objectives. Total Assets, Deposits and

Expenses are some of the key major variables considered to judge the progress of banks. Recent trends (2012-2016) are shown as follows for PSBs and SCBs from the RBI website:

Table 1. Total Assets (Millions)

Bank Groups	2012-13	2013-14	2014-15	2015-16
Public Sector Banks	6,96,22,613	7,96,83,098	8,67,88,327	9,06,17,232
Total Scheduled Commercial Banks	9,58,99,521	10,97,59,286	12,03,69,921	12,95,95,866

Source: www.rbi.org

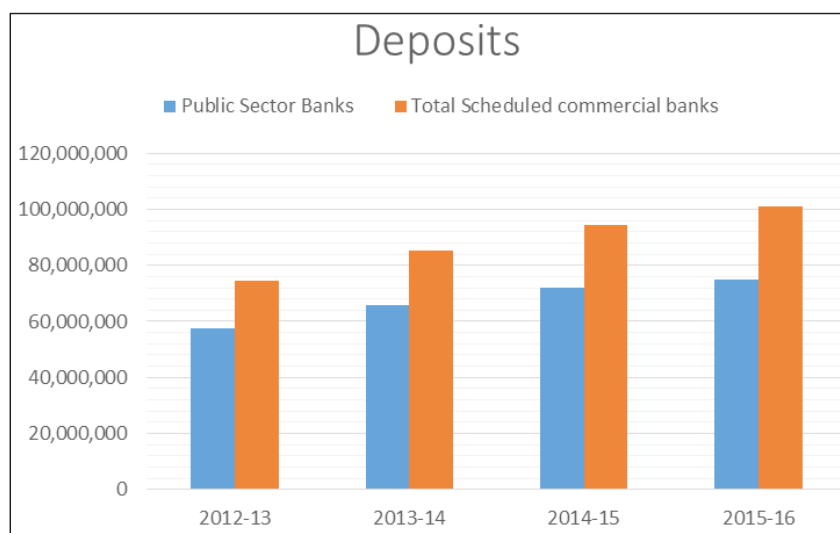


Graph 1. Total Assets (2012-16)

Table 2. Growth in Deposits (Millions)

Bank Groups	2012-13	2013-14	2014-15	2015-16
Public Sector Banks	5,74,56,972	6,58,90,205	7,19,41,924	7,48,61,781
Total Scheduled commercial banks	7,42,96,772	8,53,31,730	9,43,38,380	10,09,26,514

Source: www.rbi.org

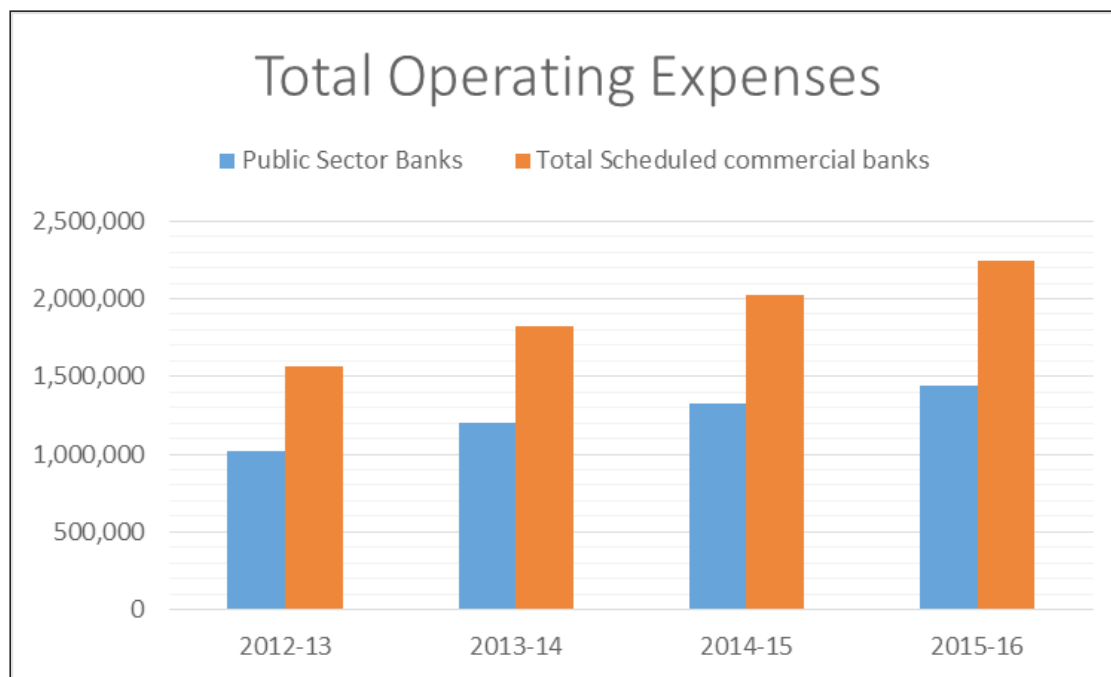


Graph 2. Deposits (2012-16)

Table 3. Operating Expenses (Millions)

Bank Groups	2012-13	2013-14	2014-15	2015-16
Public Sector Banks	10,18,667	12,05,662	13,23,656	14,44,002
Total Scheduled commercial banks	15,66,636	18,24,156	20,28,026	22,43,516

Source: www.rbi.org



Graph 3. Operation Expenses

1.3 Macroeconomic conditions of India

The growth of a country is judged by considering macroeconomic conditions such as Real Per Capita GDP, Inflation Rate and Interest Rate. These variables, although important but cannot tell anything about a country's status of freedom in any field. Introduction of liberalization has exposed the Indian banks to more competition, so any industry looks for ease of doing business.

Table 4. Index (1995-2019)

Index year	Country's Score	Government Spending	Business Freedom	Monetary Freedom	Trade Freedom	Investment Freedom	Financial Freedom
2019	55.2	77.3	57.1	72.4	72.4	40	40
2018	54.5	77.7	56.4	75.9	72.4	40	40
2017	52.6	77.4	52.8	75	72.6	40	40
2016	56.2	78.1	47.6	72.8	71	35	40
2015	54.6	78.3	43.3	65.3	64.6	35	40
2014	55.7	77.8	37.7	65.5	65.6	35	40
2013	55.2	77.9	37.3	65.3	63.6	35	40
2012	54.6	74.8	35.5	62.9	64.1	35	40

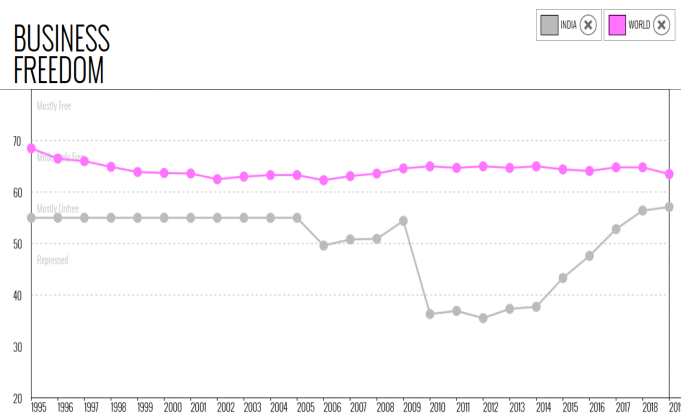
2011	54.6	77.8	36.9	65.1	64.2	35	40
2010	53.8	76.1	36.3	67.5	67.9	35	40
2009	54.4	77.8	54.4	69.3	51	30	40
2008	54.1	73.5	50.9	70.3	51	40	30
2007	53.9	71.4	50.8	77.2	51.2	40	30
2006	52.2	74.6	49.6	77.6	24	50	30
2005	54.2	76.3	55	77.4	38	50	30
2004	51.5	77.1	55	77	23.6	50	30
2003	51.2	71.9	55	77.6	23	50	30
2002	51.2	78.1	55	70.8	21.8	50	30
2001	49	76.5	55	68.2	25.6	30	30
2000	47.4	73	55	63.7	19.6	30	30
1999	50.2	90.6	55	67.2	24	30	30
1998	49.7	89.7	55	65.6	13.2	50	30
1997	49.7	88.7	55	65.1	13.2	50	30
1996	47.4	88.7	55	65.6	14	50	30
1995	45.1	92.4	55	71.7	0	50	30

Source: www.heritage.org/index/

After liberalization the Indian economy started to develop into an open market from the shackles of closed market which was the case before liberalization. During the early 1990s measures were taken to liberalise the economy by deregulating industries, turning state owned into private enterprises. A burdensome regulatory environment discourages the entrepreneurship that could provide broader private-sector growth which can be seen since 1995 there is not much change in the score of business freedom that is 55 to 57.1 in 2019. The state maintains an extensive presence in many areas through public-sector enterprises. Also the monetary freedom index is not flexible but it has increased after a significant downfall from 2010-2018. Improvement in monetary freedom contributes to competitive environment in financial markets which helps the efficiency score to increase not only in banking system and financial markets.

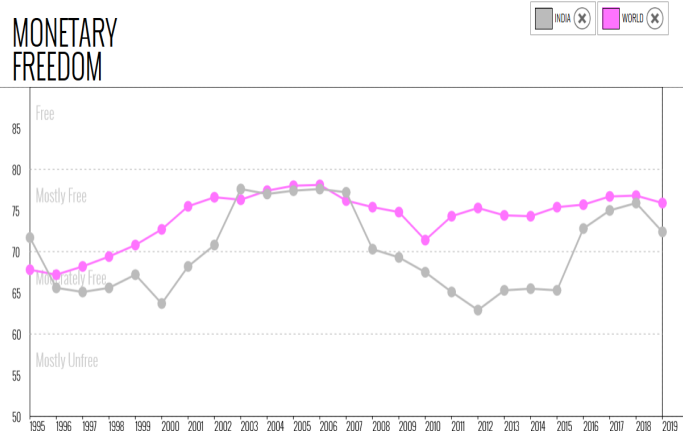
Open Market indicators, trade freedom, investment freedom and financial freedom have not outperformed in two decades. Trade freedom which was 0 in 1995 has come a long way to reach a value of 72.4 due to rigorous policies favouring trade openness. Now, the financial freedom Index of India has not come a very

far way. The financial freedom indicator tells the degree of independence of financial sector from government control. This type of freedom showcases the competition in banking sector and drives it to work efficiently.



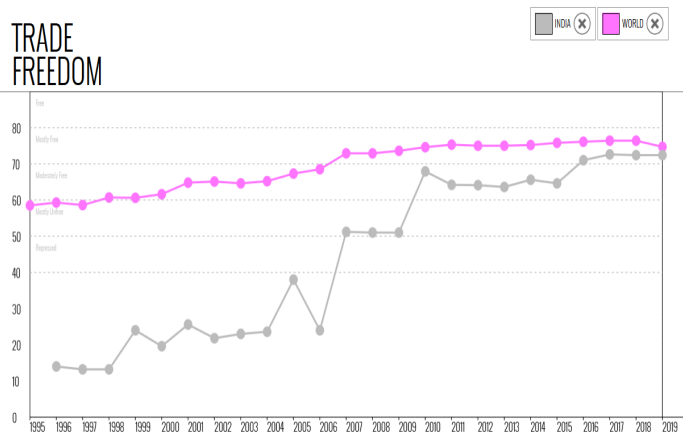
Graph 4. Business Freedom (Comparison India with World Post-Liberalization)

Source: www.heritage.org/index/



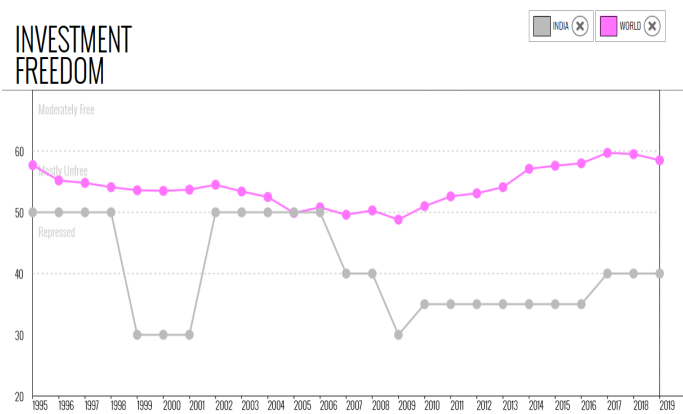
Graph 5. Monetary Freedom (Comparison of India with World Post-Liberalization)

Source: www.heritage.org/index/



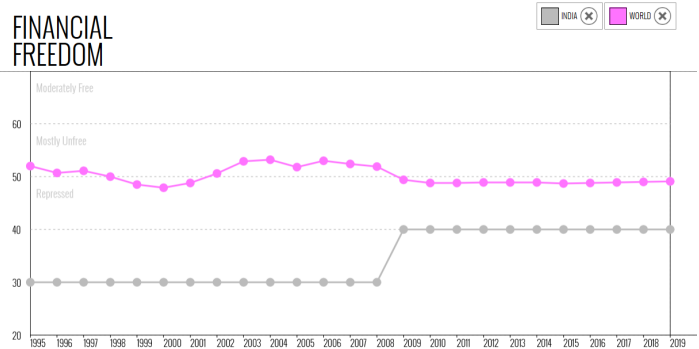
Graph 6. Trade Freedom (Comparison of India with World Post-Liberalization)

Source: www.heritage.org/index/



Graph 7. Investment Freedom (Comparison of India with World Post-Liberalization)

Source: www.heritage.org/index/



Graph 8. Financial Freedom (Comparison of India with World Post-Liberalization)

Source: www.heritage.org/index/

2. Literature Review

There exists many published literature on effect attributing to banking efficiency and macroeconomic variable. However, the very recent study is done in an oil dependent country, Azerbaijan by Hasanov, Bayramli and Al-Musehel (2018). This authors focused on studying recent economic trends of the country by examining the recent economic cycle on bank profitability and the results showed that the profitability of the banking system in a country like Azerbaijan gets affected by both bank specific and macroeconomic variables.

If we take the case of under developing nations like of West Africa then there is a study by Combey and Togbenou (2017) who investigated the short run and long run relationship between the banking sector profitability and macroeconomic variables in Togo. They suggested in their article that for having stable banking profitability, the banking sector will be affected by real GDP growth rate, effective real exchange rate and the volatility in inflation. Agade (2009) based his study in Kenya and examined the macroeconomic effect on efficiency of banking sector. Agade came to conclusion in his study that the macroeconomic factors like GDP growth rate and exchange rate effected operational efficiency of bank positively.

Chan, Karim and Zaidi (2010) did the study across different regions for developing nations of Asia and Middle, East and North Africa. The authors analysed the effect of macroeconomic variables for cost and profit efficiency of commercial banks. The study helped in concluding that the macroeconomic factors effect bank efficiency across region. This approach concluded that the developed nations have positive relation with Per Capita GDP and profit efficiency but for developing nations it is negative.

Dietsch and Lozano-Vivas (2000) concluded that the differences in the efficiency especially cost efficiency

between Banks of France and Spain is due to difference in banking system such as the accessibility and structure of the banks in the two countries along with macroeconomic condition. The authors also found in the study that per-capita income increase cost inefficiency of the banking industry in France and Spain. Effendi et al. based their study on Indonesian Banking sector which also had similar conclusion which were given by Chan, Karim and Zaidi (2010) that macroeconomic factors differ across bank groups.

3. Methodology and Data

3.1 Methodology

3.1.1 Efficiency

The theory of efficiency is based on consumers and producers successfully optimizing their output. The producer focuses on maximizing its production, minimizing cost and maximizing profits. The Econometric techniques are formed to estimate the functional parameters like production, cost or profit functions of producers. The conventional regression technique observes the deviations from actual and optimal choices which are stochastic term. The origin of stochastic term is due to the presence of technological deficiency and is caused when there is non-optimal allocation of resources in production.

The efficient frontier analysis has two kinds of methods which are shown as follows:

- Non Parametric Methods – Linear programming and operational research are used to efficiently determine the frontier. Methods like Data Envelopment Analysis (DEA) or Free Disposal Hull (FDH) are Non-Parametric.
- Parametric Methods – Like Stochastic Frontier Analysis (SFA), Thick Frontier Approach (TFA) and Distribution Free Approach (DFA). Econometric Theory is used to estimate the two parts of regression equation i.e. pre-specified functional form and an additional stochastic term models the inefficiency.

For calculation of the efficiency, parametric approach is adopted i.e. SFA, a technique which models the behavior of a producer. The efficiency estimates or scores are produced by SFA for different units. In this way, SFA distinguishes mediation and redress measures. Since effectiveness scores change crosswise over units, they can be identified with unit's qualities like size, possession, area, and so on. Along these lines one can recognize wellspring of wastefulness.

3.1.2 Stochastic Frontier Model

The SFA approach was dealt with production function model which was firstly given by Aigner, Lovell and

Schmidt (1977) in Formulation and Estimation of Stochastic Frontier Production Function Models. The Stochastic Frontier Model then started considering panel data which was originally given for cross section data and assumed firm effects that are random variable and is distributed as truncated normal. Battese and Coelli (1992) considered time varying efficiencies. The error structure of production function model by Aigner et al. is given as:

$$\epsilon_i = v_i + u_i \quad i = 1, 2, \dots, N \quad (1)$$

The error component represents the symmetric disturbance and is assumed to be independently and identically distributed with $N(0, \sigma^2)$. The error component is assumed to be distributed independently of v_i , and to satisfy $u_i \leq 0$. The concern will be with the case in which u_i is derived from $N(0, \sigma^2)$ distribution truncated above at zero. However, other one-sided distributions are tenable, and also consider the case in which u_i has an exponential distribution.

Technical efficiency is the ratio of actual output against potential output. It has two sorts of inefficiencies, input arranged and yield situated specialized productivity. Input arranged specialized proficiency is utilized to set up that it is so conceivable to change input levels, for example, input vector holding the output steady. So it is to quantify the extent to which the input is reduced by using labour and capital without changing the level of output. The technical efficiency based on output gives a set of inputs. If assumed that the producers are fully efficient and also assume the distribution to be truncated normal. It is a distribution in which both sides of normal distribution have been truncated.

There are various techniques to measure technical efficiency. Now, to estimate the profit efficiency of PSBs and SCBs of India the study adopts the transcendental logarithmic stochastic frontier profit function which was followed by Battese and Coelli (1995). This model is specified as follows which is the general form of profit frontier model

$$Y_t = \text{Exp}(\beta X_t + V_t - U_t) \quad t = 1, 2, \dots, T \quad (2)$$

Here Y_t denotes the bank's output for time period t ; X_t is the vector of Input variables for the time period t ; β is vector of unknown parameters to be estimated; V_t is a stochastic term which are assumed to be i.i.d. that is independent and identically distributed and follows normal distribution with mean 0 and variance σ^2 ; U_t is associated to technical inefficiency and are unobserved, positive random variables of production, also U_t is independent of V_t and it also follows F distribution.

Now, is given as

$$U_t = \{Exp[-\tau(t-T)]\}U \quad t = 1, 2, \dots, T \quad (3)$$

Here, is an unknown scalar parameter to be estimated, which determines the time variant nature of the inefficiencies. If,, then technical inefficiencies of banks decline over time. If, then the technical inefficiencies of banks increase over time. If,, then technical inefficiency of bank remains constant. is independent and identically distributed which has both unknown mean μ and unknown variance . The profit efficiency is given as

$$TE_t = Exp(-U_t) \quad t = 1, 2, \dots, T \quad (4)$$

The value lies in between zero and one,

Now, to analyse the macroeconomic factors effecting bank efficiency is being studied. So, bank efficiency is already modelled, so we will therefore analyse the effect of major macroeconomic variable on bank efficiency which is given as

$$U_t = Z_t\delta + W_t \quad t = 1, 2, \dots, T \quad (5)$$

Here, is a vector of macroeconomic variables that might effect bank efficiency

δ is vector of unknown parameters to be estimated

$$W_t \sim \text{iid } N(0, \sigma^2 W)$$

$$U_t \sim \text{iid } N(m_t, \sigma^2 U) \quad \text{where, } m_t = Z_t\gamma$$

The usefulness of the above model, in equation 5, is that it can give inefficiency effects for profit and cost as a function of macroeconomic variables so that it is believed to have bank efficiency.

$$u_t = \alpha_t + \beta_1 PGDP_t + \beta_2 INF_t + \beta_3 IR_t + \beta_4 NTR_t + \beta_5 BM_t + \epsilon_t \quad t = 1, 2, \dots, T \quad (6)$$

Here, is the efficiency score of a bank group at time period t ; is the Per Capita GDP at constant prices at time period t ; is the inflation rate of the country at time period t ; is the interest rate of the country at time period t ; is the Net Trade as percentage of GDP at time period t ; is the M_3 to GDP ratio at time period t ; is the error term.

3.2 Data

This study is based on PSBs and SCBs of India and the data taken is for the period after liberalization, 1992-2016. The profit efficiency score estimated for the banks selected to study followed cross section data approach. The span of 25 years is considered for reaching an accurate and consistent measure of efficiency for banking industry.

Study requires both banking industry data and macro level data. Most of the data is being collected from EPWRF

India Time Series for Bank Groups that is PSBs and SCBs. Some of the variables are also collected from RBI website for the industry specific data. The macroeconomic variables were obtained from three database, Fred Economic Data, St. Louis Fed, Ministry of Statistics and Programme Implementation (MOSPI) and Organisation for Economic Co-operation and Development (OECD).

3.2.1 Measurement of Variables

The output oriented measurement approach is being adopted in which the output is measured by the transactions taken place and inputs are labour and capital in physical units. We will calculate the profit efficiency score by applying the output oriented approach. Profit efficiency is also referred as total efficiency which focuses on achieving both technical efficiency and allocative efficiency at a proper level. A bank might not be operating on the profit frontier due to scale inefficiency.

In this study, Total Assets (TA) are used to represent the dependent variable, which include financing, asset management, dealing with securities, investment of securities, and placements with other banks. The input variables or the independent variables taken are time, total deposits (TD) and total expenses (TE). The study is conducted for 25 years after liberalization from 1992-2016. So, to find the productive efficiency of banks over time, we have chosen time as an input variable. Total deposits comprises of cash deposited by customers or other banks and total expenses here as an input variable is basically overhead expenses which includes both operating and personal expenses.

From equation 2,

$$\ln(TA_t) = \beta_0 + \beta_1 \ln(TD_t) + \beta_2 \ln(TE_t) + \beta_3 t + (V_t - U_t) \quad t = 1, 2, \dots, T \quad (7)$$

The variables as explained above are the natural logarithm of Total Assets in dependent variable and total deposits and total expenses in the independent variable; t is time in years.

For estimating equation 7, STATA provides an application of stochastic frontier analysis for cross section as well as panel data. This study deals with cross section data and distribution is truncated normal. STATA gives the technical inefficiency term in the *sfcross* command. Command is *sfcross logtass logtdep logtexp year, distribution(tnormal) emean(logprofits) nolog*

Now to compute the level of Technical Efficiency of Banks during 1992 to 2016, STATA uses another command *predict te, jlms*

The above command generates the efficiency score for each year for both groups of bank i.e. PSBs and SCBs. The score 0 means technically inefficient and 1 means technically efficient.

The technical inefficiency scores are generated for both bank groups, now, we will see how inefficiency correlates with the macroeconomic factors. Per Capita GDP is taken as the parameter to see the economic growth of the country which is positively related to the technical efficiency for both PSBs and SCBs but close to zero, so it is expected that country is now on the path of more mature banking system that is competitive. Broad money to GDP ratio is also positively related with the technical efficiency. Broad money to GDP ratio is one of the proxy for financial development of the country, other proxies were not observed due data unavailability. A positive relation with the Financial Development parameter creates an expectation that it will make banks to operate in an efficient way and there will be more intense competition in the banking market. The other parameters such as Interest Rate, Inflation Rate and Net Trade is expected to have negative relation with the technical efficiency. In case of Interest Rate negative relation would mean there as the interest rate increases the banks will be unable to borrow money for investment purposes and pay back the amount efficiently.

4. Results and Discussion

4.1 Public Sector Banks

Table-5 shows the results of SFA for the PSBs which is done to get the profit efficiency. The distribution is assumed to be truncated normal from which the efficiency coefficients and its t-value is obtained. SFA use Maximum-Likelihood estimator to estimate.

Table 5. Results of Frontier Analysis for PSBs

Independen ^{Nt} Variable (PSBs)	Parameters	Coefficients	t-value
Constant	β_0	24.26684	0.64
Total Deposits	β_1	1.101337*	-0.46
Total Expenses	β_2	-0.0358955	-0.63
Time	β_3	-0.0125075	6.34
Inefficiency Term (Profits)	U_t	-1.699893	-0.43

*Significant at 1%

From the Frontier regression model we have obtained total deposits, total expenses and time. Total deposits has positive coefficient and is significant at 1 % and total expenses has negative coefficient but is insignificant. Time which is trend variable, here is taken as a proxy for technological progress which is insignificant. During the period of study there has been a negative technological progress in case of PSBs. So there is an inward shift in production possibility frontier. This negative relation

with trend shows the slump or sluggish working nature of Public Sector banks of India. This can also be due to the changes brought through innovations and any technological change is not significant for PSBs.

Now, the next is Mu Model which is Technical inefficiency model and this technical inefficiency is also dependent variable. The coefficient of this variable is -1.699893 i.e. negative so it means it is actually a positive effect on technical efficiency because it has negative effect on technical inefficiency. The negative here means that Profits/Losses have negative effect on technical inefficiency and a positive relationship between Profits/Losses and Technical Efficiency. If we are getting more and more of Profits then we are reaching a situation where technical inefficiency is being reduced. So PSB's in India have become much more efficient owing to profits but it is also insignificant.

If , from equation (7) is statistically not different from zero, then the equation will collapse to cobb douglas specification, also our stochastic frontier model will reduce to a cobb douglas production function with no errors. So it is necessary to run diagnostic checks as follows.

Variance of error term can be categorized into 2 parts:

- Variance coming from the inefficiency component
- Variance coming from random component

$$\sigma^2 = \sigma_u^2 + \sigma_v^2 \quad (8)$$

The ratio between the variance of technical inefficiency component to the total variance of the error term will give a statistical value that accounts for the proportion or variation in the output accounted by the technical inefficiency. This statistical value will range between 0 & 1. If ratio is close to 1 means much variation is accounted by technical inefficiency and stochastic frontier model will be most appropriate. If ratio is close to 0 means very little variation is being accounted by technical inefficiency so not reasonable to estimate stochastic frontier for this purpose. Then the variation comes from random component of the variance of error term.

Table 6. Diagnostic Test (PSBs)

Variable	Standard Deviation	Variance
sigma_u	0.4896494	0.23975653492036
sigma_v	0.0291392	0.00084909297664
sum(u+v)	0.5187886	0.2406056
Ratio(u/u+v)	0.943832228	0.996471018
Ratio(v/u+v)	0.056167772	0.003528982

From above we can conclude that technical inefficiency accounts for 99.647% variation in output. It is very close to 1 which justifies the stochastic frontier model for PSBs. There was another postestimation test which was given by Kumbhakar, Wang and Horncastle (2015) and they suggested the likelihood ratio test statistic in A Practioner's Guide to Stochastic Frontier Analysis Using Stata.

$$-2[L(H_{Res}) - L(H_{unres})] \quad (9)$$

Here and represent the computed values from log likelihood of restricted ordinary least square model and unrestricted from stochastic frontier model respectively. So, the null hypothesis is given as, $H_0 =$ No Technical Inefficiency/ Stochastic Frontier model is not appropriate and alternative hypothesis is given as $H_a =$ Technical Inefficiency

Table 7. Likelihood Ratio Test (PSBs)

Unrestricted	50.5459
Restricted	66.13133791
$-2[L(H_{Res}) - L(H_{unres})]$	-31.17087

Now the Critical value of the mixed Chi-Square distribution, which is given by Kodde and Palm (1986), with one degree of freedom which is equal to the number of restrictions involved and 5% level of significance is 2.705 which is more than -31.1708, so we reject the null hypothesis which says that stochastic frontier analysis is not appropriate so in other words we rejecting the null hypothesis of No Technical inefficiencies. This test is based on the one sided hypothesis tests. This justifies the Stochastic Frontier Analysis Model.

4.2 Scheduled Commercial Banks

The results of SCBs are shown in Table 8 which are given by running SFA in STATA. Here also we are concerned with the technical efficiency values.

Table 8. Results of Frontier Analysis of SCBs

Independent Variable (SCBs)	Parameters	Coefficients	t-value
Constant	β_0	-17.86463	-0.8
Total Deposits	β_1	0.9414248*	14.95
Total Expenses	β_2	0.0051958	0.09
Time	β_3	0.0094322	0.81
Inefficiency Term (Profits)	U_t	-1.659166	-0.47

*Significant at 1%

The Frontier regression model gives the positive Total deposits and is significant at 1 % and total expenses also has positive coefficient but is insignificant. Time as a trend variable shows a positive technological progress in case of SCBs during the same period in which PSBs has shown a negative technological progress. So there is an outward shift in production possibility frontier. This positive relation with trend shows that even though PSBs still are in bad position even after liberalization but overall the Scheduled Commercial Banks, which includes almost all banks of India. The innovations or technological changes have changed the face of SCBs in a positive way.

The coefficient of variable in Technical Inefficiency Model is -1.659166 i.e. negative so it means it is actually a positive effect on technical efficiency because it has negative effect on technical inefficiency. The negative here means that Profits/Losses have negative effect on technical inefficiency and a positive relationship between Profits/Losses and Technical Efficiency. If we are getting more and more of Profits then we are reaching a situation where technical inefficiency is being reduced. So SCBs in India have become much more efficient owing to profits but it is also insignificant.

Table 9. Diagnostic Test (PSBs)

Variable	Standard Deviation	Variance
sigma_u	0.5030769	0.253086367
sigma_v	0.0325332	0.001058409
sum(u+v)	0.5356101	0.254144776
Ratio(u/u+v)	0.939259547	0.995835409
Ratio(v/u+v)	0.060740453	0.004164591

From above we can conclude that technical inefficiency accounts for 99.583% variation in output. It is very close to 1 which justifies the stochastic frontier model for SCBs. Now, run the alternative postestimation test by Kumbhakar, Wang and Horncastle (2015), the null hypothesis is given as, $H_0 =$ No Technical Inefficiency/ Stochastic Frontier model is not appropriate and the alternative hypothesis i.e. $H_a =$ Technical Inefficiency. This postestimation criteria is considered to be more reliable.

Table 10. Likelihood Ratio Test (PSBs)

Unrestricted	52.8385
Restricted	68.12229101
$-2[L(H_{Res}) - L(H_{unres})]$	-30.5675

According to by Kodde and Palm (1986), the Critical value of the mixed Chi-Square distribution with one degree of freedom is equal to the number of restrictions involved and 5% level of significance is 2.705 which is more than -30.5675, so we reject the null hypothesis which says that stochastic frontier analysis is not appropriate so in other words we rejecting the null hypothesis of No Technical inefficiencies. This test is based on the one sided hypothesis tests. This justifies the Stochastic Frontier Analysis Model.

Table 11. Efficiency Scores (1992-2016)

Bank Group	Technical Efficiency (Mean)	Standard Deviation	Variance	Min	Max
Public Sector Bank	0.8289802	0.0176679	0.000312	0	0.99033
Scheduled Commercial Bank	0.9064183	0.2728167	0.07442	0	0.98921

The efficiency scores for PSBs and SCBs are given in Table-11, which basically gives the profit efficiency values. The mean value of efficiency for period 1992-2016 for PSBs is 82.89% and for SCBs is 90.64%. So SCBs are more efficient than the PSBs which is quite acceptable because SCBs include almost all the banks existing in India.

4.3 Effect of Macroeconomic Factors on Bank Efficiency

Table 12 consolidates the technical efficiency scores with the macroeconomic variables for both the bank groups i.e. PSBs and SCBs. The Macroeconomic variables taken to study from 1992-2016 are Per Capita GDP, Rate of Interest, Inflation rate, Net Trade and Broad Money to GDP Ratio.

Table 12. Macroeconomic Variables Effect on PSBs and SCBs

Macroeconomic Variables	Technical Efficiency Score of PSBs	Technical Efficiency Score of SCBs
Intercept	2.96179***	1.11541*
	(-0.95357)	(-0.7086)
GDP Per Capita (At Constant Price)	-0.00332**	0.00024
	(-0.00189)	(-0.0014)
Interest Rate (in %)	-0.06003*	-0.01538
	(-0.03837)	(-0.02851)
Inflation Rate (in %)	-0.03537	-0.0508***
	(-0.0314)	(-0.02334)

Net Trade (% of GDP)	-0.09811*	-0.09133**
	(-0.0629)	(-0.04674)
Broad Money to GDP Ratio	68.19779*	-8.04938
	(-43.49346)	(-32.3202)

Note: ***Significant at 5%, **Significant at 10%, *Significant at 15%, Parentheses contains corresponding Standard Errors

The GDP Per Capita is negatively affecting the efficiency for PSBs and positively affecting the efficiency for SCBs but it is significant for PSBs at 10% level and insignificant for SCBs. An increase in Per capita GDP by single unit increases efficiency for SCBs by 0.00024 and decreases efficiency by -0.00332. The Rate of Interest has negative effect on efficiency for both the groups but is significant at 15% for PSBs and is insignificant for SCBs. Now, if we see for Inflation Rate and Net Trade then both show a negative effect on the efficiencies for banks but inflation rate is insignificant for PSBs and significant for SCBs at 5% level of significance but net trade is significant for both PSBs as well as for SCBs at 15% and 10% respectively. The last indicator i.e. Broad Money i.e. M_3 to GDP ratio has a very high positive effect on efficiency which is 68.19779 and is significant as well at 15 % level of significance for PSBs but the same macroeconomic indicator shows a negative but an insignificant effect on efficiency for SCBs. The results are in line with findings of Effendi et al. and Chan, Zaini and Karim (2010) for the research work which implied that changes in technical efficiency is explained by macroeconomic variables. So the effect of macroeconomic factors can be different across the different bank groups.

5. Conclusion

The banking efficiency scores is obtained for both PSBs and SCBs by following SFA, which is a parametric approach and was based on Batters and Coelli (1995) model. The macroeconomic variables i.e. Per capita GDP, Rate of Interest, Rate of Inflation, Net Trade and Broad money M_3 to GDP ratio are analysed to find out the impact on technical efficiency of Indian banks after liberalization period (1992 to 2016).

The results show that the technical efficiency are effected by most of the macroeconomic variables. Most of the variables are significant for PSBs except for Rate of Inflation but for SCBs Net Trade and Rate of Inflation are the only macroeconomic variables which are significantly effecting the efficiency scores of Banks under SCBs. The PSBs are mostly affected by almost all the variables such as Per Capita GDP, rate of Interest, Net Trade and financial development indicator i.e. broad money to GDP ratio.

References

1. Agade R. (2014) The Effect of Macroeconomic Variables on Operational Efficiency of Banking Sector in Kenya, University of Nairobi.
2. Aigner, D., Lovell, C. and Schmidt, P. (1977) Formulation and estimation of stochastic frontier production function models, *Journal of Econometrics*, 6, pp. 21-37.
3. Ataullah, A., Cockerill, T. and Hang Le (2004) Financial liberalization and bank efficiency: A comparative analysis of India and Pakistan, *Applied Economics*, 2004, 36, pp. 1915–1924.
4. Battese, G. E. and Coelli, T. J. (1995) A model for technical inefficiency effects in a stochastic frontier production function for panel data, *Empirical Economics*, 20, pp. 325-332.
5. Berger, A. N. and Humphrey, D. B. (1992) Measurement and efficiency issues in commercial banking, in: Z. Griliches (Ed.) *Output Measurement in the Service Sectors*, National Bureau of Economic Research, *Studies in Income and Wealth*, vol. 56, pp. 24-79.
6. Chan, S-G, MZA Karim (2010) Bank Efficiency and Macroeconomic Factors: The Case of
7. Developing Countries, *Global Economic Review*, 39, pp. 269-289.
8. Combey, A. and Togbenou, A. (2017) The Bank Sector Performance and Macroeconomic Environment: Empirical Evidence in Togo, *International Journal of Economics and Finance*; Vol. 9, No. 2.
9. Dietsch, M. and Lozano-Vivas, A. (2000) How the environment determines banking efficiency: a comparison between French and Spanish industries, *Journal of Banking and Finance*, 24, pp. 985-1004.
10. Hasanov, F. Bayramli, N. and Al-Musehel, N. (2018) Bank-Specific and Macroeconomic Determinants of Bank Profitability: Evidence from an Oil-Dependent Economy, *International Journal of Financial Studies* 2018, 6, 78.
11. Kodde, D. and Palm, F. (1986) Wald Criteria for Jointly Testing Equality and Inequality Restrictions, *Econometrica*, Vol. 54, No. 5 (September, 1986), 1243-1248.
12. Kumbhakar, S. C. and Sarkar, S. (2003) Deregulation, ownership, and efficiency change in Indian banking: an application of stochastic frontier analysis, *Journal of Money, Credit and Banking*, 35, pp. 403_424.
13. Matthews, K. (2010) *Banking Efficiency in Emerging Market Economies*, Cardiff Business School, Cardiff University.