An Empirical Analysis of Cost Efficiencies in the Indian Banking Industry

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ABSTRACT

This study analyzes the cost efficiencies of 35 Indian commercial banks over the period 2007 to 2013. We use translog cost function to evaluate economies of scale in the Indian banking sector. Translog cost function is estimated for total cost, operating cost, non-operating cost, interest expenses, and employee cost. We estimate cost efficiencies with respect to output and output is defined in three different ways--total assets, total deposits, and total loans of Indian banks. Estimates of cost elasticity show that Indian commercial banks are reaping economies of scale with respect to total assets, total deposits, and total loans, because with every rupee increase in assets or deposits or loans, cost is rising less than proportionately. We also find that ownership structure of a bank (public sector or private sector) plays a role in determining cost efficiencies in the Indian banking industry.

JEL Classifications: G21, C23

Keywords: economies of scale; translog cost function; Indian banks

I.   INTRODUCTION

The banking industry in India has come a long way from the nationalization of its banks in 1969 to the liberalization of the financial system since 1991. During the reform process that started in 1991, the banking sector was opened up with the objective of improving the efficiency of the banking system in India through increased competition from private and foreign banks. With this view, the government initiated the process of removing interest rate controls. The government also introduced capital adequacy requirements and other safety norms to ensure a sound banking system. The objective is to strengthen banking supervision and increase competition through licensing of private banks and foreign banks. The ultimate goal is to integrate Indian banks into the global financial system.

Although the amount of assets and deposits managed by the Indian banking industry has increased several folds, empirical research on economies of scale and cost efficiencies in the Indian banking industry is still limited. The issue of economies of scale and cost efficiencies in the banking industry is important for several reasons.

Firstly, the Indian economy is the second fastest growing economy in the world after China. Since these nations represent an engine of growth for the world economy, a large amount of capital is flowing to the stock markets of these nations. Banks, as financial intermediaries, are playing a crucial role by bringing enhanced liquidity and promoting market efficiency by facilitating smooth transfer of funds between borrowers and lenders that will promote capital mobility among nations. A sound and efficient banking system is essential for a smooth integration of Indian financial markets with the rest of the world, because banks play a crucial role in facilitating transfer of funds between borrowers and lenders. Therefore, the size of the banking system is bound to grow further.

Secondly, previous studies show that a country's financial sector influences future economic growth. The banking sector is the most important part of the financial markets. If the Indian banking sector is sound and efficient, it will have a positive impact on India's growth.

Thirdly, we examine the cost efficiencies of Indian commercial banks during the period 2007 to 2013. This time period covers "before-crisis" and "after-crisis" time. Findings from this study will highlight the cost behavior of the Indian banking sector during and after the global financial crisis.

This study will also help the banking industry as well as regulatory agencies such as the Reserve Bank of India (RBI) get a better understanding of the impact of growth of a bank on a bank's expenses and its benefits to bank shareholders in the form of higher returns and increased shareholder wealth.

We distinguish our study from previous studies in two ways. Firstly, this study provides a more comprehensive view of the cost efficiencies in the Indian banking sector. Cost efficiency studies require specifications of input and output variables. This study evaluates cost efficiencies by studying economies of scale not only in total cost, but also in each component of the total cost. Specifically, we evaluate economies of scale in operating cost, non-operating cost, interest expenses, and employee cost. By studying each component of the total cost, we will be able to identify the source of cost efficiencies in total cost. Furthermore, we estimate cost efficiencies with respect to output and output is defined in three different ways--total assets, total deposits, and

total loans. Secondly, this study covers the period of the global financial meltdown and we evaluate the cost efficiencies of the Indian banks during and after this meltdown.

This paper has six sections. Section II provides a discussion of previous research related to this topic. Section III briefly describes our data. Section IV describes our methodology and gives information on banks used in this study. Section V presents our empirical results. Section VI gives our conclusions.

II.   PREVIOUS RESEARCH

Several studies have examined economies of scale in the banking industry. Edirisuriya and O'Brien (2001) studied economies of scale for Australian banks after financial deregulation. They found evidence of economies of scale and scope in four major Australian banks. Toby (2006) reviewed previous studies on economies of scale in the banking industry and concludes that smaller banks are more efficient in comparison to larger banks in most countries. Stimpert and Laux (2011) reported that while costs decline and profitability increases as bank size increases, these relationships do not hold indefinitely and diseconomies of scale are experienced by larger banks. When size is measured by total assets, larger banks begin to encounter lower levels of net income, but the very largest banks are able to enjoy net income that increases at an increasing rate as size increases. When size is measured by total deposits, net income increases at an increasing rate for a wide range of bank sizes and only begins to decrease for the largest banks. McNulty (2000) measured economies of scale for six large Canadian banks. He reported economies of scale in Canadian banking industry due to technological and regulatory changes. Margono and Sharma (2010) estimated cost efficiency, economies of scale, technological progress, and productivity growth among Indonesian banks from 1993 to 2000. They found that average cost efficiency for the banking sector over this period was 70%. They also reported a marked difference in cost efficiency before and after the Asian economic crisis. The banking sector cost efficiency was 80% prior to the crisis and 53% after the crisis. Moreover, results indicated that private-owned banks and joint venture/foreign banks were more efficient than public-owned banks. They attributed cost reductions attributed to technological progress and economies of scale. Kasman (2005) examined the cost efficiency and scale economies of banks operating in Poland and the Czech Republic during the period from 1995 to 2000. They found that Polish banks are, on average, more efficient than Czech banks. The study also suggested that foreign banks operating in the Czech banking sector had significantly higher efficiency levels than those of domestic banks. They also reported evidence of significant economies of scale for small and medium-sized banks, but diseconomies of scale for large-sized banks. Das and Das (2007) used a multi-product Fourier flexible cost function specification to investigate scale economies, cost complementarities and technical progress of Indian banks during the post reform period 1992 to 2003. The empirical results indicate that there exist significant economies of scale for all size classes of banks and there is no evidence of diseconomies of scale, even for larger banks. Ray (2007) evaluated the size efficiency, as distinct from scale efficiency, of Indian banks. He found that often a bank is operating in the region of diminishing returns to scale but is not a candidate for break up.

Table 1
Descriptive statistics for the variables used in this study

Overall Sample	2007	2008	2009	2010	2011	2012	2013
Number of Banks	35	35	35	35	35	34	34
Total Expenses	5,840.5	7,634.5	9,695.5	10,494.8	12,284.4	16,647.2	19,336.0
	8,065.0	10,045.0	12,364.6	13,466.3	15,451.4	19310.4	21,664.6
Operating Expenses	1,751.5	2,024.2	2,465.7	3,049.7	3,767.2	3,856.3	3,852.2
	2,569.1	2,935.2	3,491.9	4,441.2	5,375.9	4,577.9	5,207.3
Non-Operating Expenses	4,089.0	5,610.4	7,393.7	7,445.2	8,517.1	12,790.9	15,483.8
	5,520.9	7,156.3	9,043.3	9,148.3	10,154.5	14,809.5	16,616.5
Interest Cost	3,477.9	5,002.3	6,584.9	6,755.8	7,488.2	11,075.1	13,214.1
	4,608.9	6,375.4	7,968.6	8,349.9	8,684.7	11,541.5	13,540.9
Employee Cost	830.5	904.0	1,134.2	1,316.1	1,742.5	1,942.5	2,200.2
	1,359.9	1,346.2	1,690.1	2,139.3	2,478.0	2,894.6	3,152.2
Assets	81,455	101,877	124,683	144,224	173,948	208,723	240,795
	107,470	133,386	169,673	185,819	218,184	242,417	281,651
Deposits	64,710	79,690	99,499	116,486	140,450	165,835	191,036
	81,307	97,294	128,919	141,389	166,452	188,559	216,668
Loans	47,419	59,220	75,353	86,400	106,107	130,449	149,220
	63,445	77,115	97,698	110,858	134,369	155,309	186,965
Public Sector Banks							
Number of Banks	20	20	20	20	20	20	20
Total Expenses	7,558.1	9,658.7	12,443.9	14,014.4	1,6533.3	21,764.4	24,884.8
	8719.7	10,584.1	13,790.6	15,741.1	1,8264.7	10,728.1	24,904.1
Operating Expenses	2,195.8	2,408.2	2,880.6	3,762.1	4,942.7	4,856.4	4,567.7
	2771.8	3,056.9	3,790.0	5,208.3	6,514.8	2,845.2	6,106.6
Non-Operating Expenses	5,362.3	7,250.5	9,563.3	10,252.3	11,590.6	16,908.0	20,317.1
	5,977.6	7,560.8	6,354.5	10,611.1	11,823.5	7,962.2	18,879.7
Interest Cost	4,535.0	6,472.9	8,501.2	9,350.9	10,303.3	14,681.5	17,233.2
	4,807.2	6,515.1	5,810.4	9,655.9	10,019.2	6,548.7	15,362.7
Employee Cost	1,209.0	1,250.3	1,524.3	1,849.8	2,420.2	2,578.6	2,907.1
	1,683.9	1,649.0	679.4	2,673.5	3,043.1	1,142.3	3,852.0
Assets	107,027	133,315	167,592	195,799	235,360	271,804	312,978
	116686	147,937	198,895	218,387	256,139	144,762	325,709
Deposits	87,095	107,416	137,978	163,490	196,360	224,683	257,869
	90,354	110,232	152,512	165,605	194,193	88,420	250,667
Loans	63,212	78,847	100,309	120,185	146,388	174,460	200,905
	69,641	85,730	57,234	130,943	158,759	78,301	222,213
Private Sector Banks							
Number of Banks	15	15	15	15	15	14	14
Total Expenses	3,550.3	4,935.6	6,030.8	5,802.1	6,619.1	9,337.1	11,409.3
	6,704.0	8,922.0	9,381.2	7,926.8	8,178.7	10,728.1	13,036.3
Operating Expenses	1,159.0	1,512.1	1,912.4	2,099.8	2,199.9	2,427.6	2,830.2
	2,223.5	2,783.7	3,089.5	3,065.2	2,825.0	2,845.2	3,524.1
Non-Operating Expenses	2,391.3	3,423.5	4,118.5	3,702.3	4,419.1	6,909.4	8,579.1
	4,486.3	6,150.3	6,354.5	4,917.0	5,404.7	7,962.2	9,625.5
Interest Cost	2,068.4	3,041.5	3,690.4	3,295.7	3,734.6	5,923.0	7,472.5
	4,062.1	5,822.1	5,810.4	4,510.1	4,530.0	6,548.7	7,755.4
Employee Cost	325.8	442.3	552.9	604.5	838.9	1,033.8	1,190.3
	406.7	557.9	679.4	682.1	902.0	1,142.3	1,292.1
Assets	47,358	59,960	67,471	75,457	92,064	118,607	137,677
	85,971	101,056	100,454	101,307	118,322	144,762	163,867
Deposits	34,862	42,722	48,194	53,814	65,904	81,765	95,561
	57,488	62,737	62,135	62,967	75,419	88,420	103,176
Loans	26,362	33,051	37,881	41,354	52,399	67,575	79,078
	48,602	56,420	57,234	52,646	65,063	78,301	92,044

For each variable, first line represents the mean value and second line shows the standard deviation.

III.   DATA

Data covers the fiscal year ending March 31st 2007 to March 31st 2013. The data sample consists of 20 state owned banks and 15 private sector banks for each year in the sample except for 2012 and 2013. In 2012 and 2013, we have 14 private sector banks. Table 1 provides a summary statistics of the variables used in this study.[1]

During the period 2007 to 2013, on an average:

- Total expenses have gone up by more than 230 percent for the banks as a whole (229 percent for public sector banks and 221 percent for private sector banks);
- Operating expenses have increased by 120 percent (108 percent for public sector banks and 144 percent for private sector banks);
- Non-operating expenses have increased by 279 percent (279 percent for public sector banks and 259 percent for private sector banks);
- Interest cost that represents of cost of funds for banks has gone up by 280 percent (280 percent for public sector banks and 261 percent for private sector banks);
- Employee cost has gone up by 165 percent (140 for public sector banks and 265 percent for private sector banks);
- Total assets have increased by 196 percent (192 percent for public sector banks and 191 percent for private sector banks);
- Total deposits have gone up by 195 percent (196 percent for public sector banks and 174 percent for private sector banks), and
- Loans have gone up by 215 percent (218 percent for public sector banks and 200 percent for private sector banks).

Thus, there is more than proportionate increase in total expenses relative to assets, deposits, and loans. Most of the increase in total expenses is due to increase in non-operating expenses that have gone up by 279 percent during the period 2007 to 2013. Operating expenses, on an average, show a lower percentage increase relative to increase in assets, deposits, and loans.

As shown in Table 1, during the period 2007-2013, percentage increase in total expenses, non-operating expenses, and interest cost is higher for public sector banks, but operating expenses have gone up more at private sector banks relative to public sector banks. Public sector banks also show a relatively higher increase in total assets, total deposits, and loans in comparison to private sector banks. Employee cost has gone up significantly more for private sector banks in comparison to public sector banks during the seven-year period of 2007 to 2013.

IV.   METHODOLOGY

Our methodology involves estimation of the coefficients of a translog cost function to determine which factors contribute to economies of scale and their degree of contribution. We then estimate cost elasticity with respect to the amount of assets using the first derivative of the translog cost function. Cost elasticity is estimated for the total sample for each year and for subsets of the annual samples. The subsets are created according to ownership of the bank.

In order to investigate economies of scale in banks, we use a two-part methodology. The first part is an estimation of coefficients for a translog cost function to determine which factors contribute to economies of scale and the extent to which they contribute for each of the even years in the period 2007 to 2013. We estimate economies of scale for total expenses of a bank and also with respect to each component of the total expenses, namely operating expenses, non-operating expenses, interest expense (cost of funds), and employee cost.

The second part is an estimation of coefficients for a translog cost function using the panel data approach. The panel data approach allows for pooling of observations on a cross-section of banks over seven years. When observations possess the double dimension (cross section and time series), the crucial aspect of the problem is to have a clear understanding of how differences in behavior across individuals and/or through time could and should be modeled. A panel data set offers several econometric benefits over traditional pure cross section or pure time series data sets. The most obvious advantage is that the number of observations is typically much larger in panel data, which will produce more reliable parameter estimates and, thus, enable us to test the robustness of our linear regression results. Panel data also alleviates the problem of multicollinearity, because when the explanatory variables vary in two dimensions (cross-section and time series), they are less likely to be highly correlated. Panel data sets make it possible to identify and measure effects that cannot be detected in pure cross section or time series data. For instance, sometimes it is argued that cross section data reflect short-run behavior, while time series data emphasize long-run effects. By combining the cross-section and time series features of a data set, a more general and comprehensive dynamic structure can be formulated and estimated. The use of panel data suggests that individuals, firms, states, or countries are heterogeneous (Balestra 1995). Time series and cross-section studies not controlling for this heterogeneity run the risk of obtaining biased results (Baltagi 2000). Panel data controls for individual heterogeneity.

The most intuitive way to account for individual and/or time differences in the context of panel data regression is to use the fixed effects model. The fixed effect model assumes that difference across banks can be captured in differences in the constant term. The regression coefficients (the slope parameters) across groups in this model are unknown, but fixed parameters. It is also known as the least square dummy variable (LSDV) model and we use the LSDV fixed-effect model to estimate cost efficiencies in the Indian banking industry.

A.   Translog Cost Function[2]

In financial economics, the translog model is the most pervasive approach for investigating economies of scale.[3] The translog cost model implicitly assumes a U-shaped average cost function. It is used here because it allows economies of scale to vary with level of bank assets.

The estimation of scale economies with a translog cost function requires cost and output measures. For the banking industry, the output in this paper has been defined in three different ways:
*   Total assets
*   Total deposits

- Loans

Total cost of each bank is defined as the total expenses of a bank. A bank's total expense is modeled as a function of total assets and control variables that affect level of expenses.

We use translog cost function to estimate economies of scale in the Indian banking industry. Ordinary least squares (OLS) regression is used to find coefficients of the independent variables. Equations 1a to 1c show the translog cost functions to estimate economies of scale for the Indian banks (See Latzko, 1999).

$$\text{Ln COST} = \beta_0 + \beta_1 \text{ Ln ASSETS} + \tfrac{1}{2} \beta_2 (\text{Ln ASSETS})^2 + \Sigma_j \beta_j X_j + e \qquad (1a)$$

$$\text{Ln COST} = \beta_0 + \beta_1 \text{ Ln DEPOSITS} + \tfrac{1}{2} \beta_2 (\text{Ln DEPOSITS})^2 + \Sigma_j \beta_j X_j + e \qquad (1b)$$

$$\text{Ln COST} = \beta_0 + \beta_1 \text{ Ln LOANS} + \tfrac{1}{2} \beta_2 (\text{Ln LOANS})^2 + \Sigma_j \beta_j X_j + e \qquad (1c)$$

In the translog function, definition of COST depends on the input variable with respect to which we are computing economies of scale. Therefore, cost can be the dollar amount of a bank's total expenses, operating expenses, non-operating expenses, total interest expenses, and employee cost. In Equation 1a, ASSETS represent the total assets under management at a bank. Equation 1b shows the translog cost function to estimate economies of scale with reference to total deposits of a bank. Equation 1c shows the translog cost function to estimate economies of scale with reference to loans made by banks. X_j includes control factors that affect the costs of management and administration of a bank. In equation 1a, we do not use any control variables. In Equations 1b and 1c, we use size of the bank as measured by total assets as control variables.

B.   Cost Elasticity

The most common measure of operating efficiency in economies of scale studies is the elasticity of cost with respect to the output. When the rate of increase in output exceeds the rate of increase in cost in an industry, economies of scale characterize that industry. For the banking industry, cost elasticity with respect to assets can be used to evaluate the existence and extent of economies of scale. It is measured by percentage change in cost associated with a percentage change in bank assets. We calculate this elasticity by taking the first derivative of the translog cost function (Equation 1) with respect to assets. The result is Equation 2.

$$\frac{\partial(\text{Ln COST})}{\partial(\text{Ln ASSETS})} = \beta_1 + \beta_2(\text{Ln ASSETS}) \qquad (2a)$$

$$\frac{\partial(\text{Ln COST})}{\partial(\text{Ln DEPOSITS})} = \beta_1 + \beta_2(\text{Ln DEPOSITS}) \qquad (2b)$$

$$\frac{\partial(\text{Ln COST})}{\partial(\text{Ln LOANS})} = \beta_1 + \beta_2(\text{Ln LOANS}) \qquad (2c)$$

where COST can represent total expenses, total operating expenses, total non-operating expenses, interest expenses, or employee cost of a bank in Equations 2a to 2c. ASSETS represent total assets of a bank in Equation 2a, DEPOSITS are total deposits of a bank in Equation 2b, and LOANS are total loans made by a bank in Equation 2c.

If cost elasticity is less than one, bank's expenses increase less than proportionately with changes in bank assets. This implies that economies of scale exist. If the elasticity is greater than one, we can infer that diseconomies of scale exist.

To investigate the existence of economies of scale, we estimate the scale economy measure for each observation and then average across observations to derive the group scale economy measure. The cost elasticity is found for each observation (bank). Then an average across observations is computed to obtain the group average elasticity.

We estimate cost elasticities for the total group of banks in each annual sample. We also estimate elasticities for groups within each annual sample where the groupings are according to ownership—private sector or public sector banks.

V.   EMPIRICAL RESULTS

A.   Cost Function

Regression results for total annual samples of banks are shown in Table 2. Some of the results are as expected, while others are not.

Model 1 in Table 2 shows that our model in equation 1 explains 98% to 99% of the total expenses of a bank. Table 2 shows that size of the bank as measured by assets is positively related to total expenses. As bank size grows, total expenses also increase and the coefficient on natural logarithm of assets is statistically significant in explaining the total expenses. Ownership structure does not play a statistically significant role in explaining total expenses of a bank. Cost elasticity ranges between 0.92 in 2010 and 1.05 in 2007 and it is statistically significant for each year in our sample. Cost elasticity in 2007 is 1.05, which means that for every rupee increase in assets, total expenses increased by 1.05 rupees, which points to diseconomies of scale. In six out of seven years, Indian banks have statistically significant cost elasticity below 1, which points to economies of scale for Indian banks. Panel data also shows that there are cost efficiencies in terms of lower expenses for Indian banks, because cost elasticity for the entire sample is below 1 and it is statistically significant.

The panel data model in Table 2 also shows that operating expenses are impacted by ownership structure in a statistically significant manner. Public sector banks have lower operating expenses in comparison to private sector banks. There are economies of scale with respect to operating expenses in 2011 and 2013 only. However, panel data shows that there is cost efficiency associated with total assets of a bank, because the cost elasticity is 0.96 for the panel data and it is statistically significant. On an average, for every rupee increase in total assets, total cost increased less than proportionately for Indian banks during the period 2007 to 2013.

Table 2

Regression results for the translog cost function for total expenses of a bank to measure economies of scale with respect to size of the bank as measured by total assets

Variables	2007	2008	2009	2010	2011	2012	2013	Panel Data Model
# of Banks	35	35	35	35	35	34	34	243
Dependent Variable: Natural Logarithm of Total Expenses in Indian Rupees								
Adjusted R^2	0.99	0.99	0.99	0.99	0.98	0.99	0.98	0.99
Ln of Assets	0.73 (3.26*)	0.79 (3.02*)	0.76 (2.57**)	0.70 (2.80*)	0.85 (2.18**)	0.75 (3.62*)	0.97 (2.73*)	0.89 (9.23*)
½ (Ln of Assets^2)	0.03 (1.22)	0.02 (0.79)	0.02 (0.68)	0.02 (1.01)	0.01 (0.20)	0.02 (0.97)	-0.002 (-0.05)	0.01 (0.74)
Public Sector	-0.01 (-0.26)	-0.05 (-1.03)	-0.07 (-1.33)	0.01 (0.19)	0.06 (0.91)	0.03 (1.02)	0.01 (0.16)	-0.01 (-0.37
Cost Elasticity	1.05 (8.79*)	1.01 (2.30**)	0.96 (-11.13*)	0.92 (-18.91*)	0.93 (-51.30*)	0.96 (-11.13*)	0.95 (-165.87*	0.97 (-9.05*)
Dependent Variable: Natural Logarithm of Operating Expenses in Indian Rupees								
Adjusted R^2	0.95	0.94	0.94	0.93	0.94	0.94	0.99	0.94
Ln of Assets	0.29 (0.55)	0.41 (0.67)	0.60 (0.96)	-0.01 (-0.01)	0.29 (0.41)	0.23 (0.38)	1.40 (5.37*)	0.52 (2.47*)
½ (Ln of Assets^2)	0.07 (1.34)	0.06 (1.03)	0.04 (0.71)	0.09 (1.49)	0.06 (0.95)	0.06 (1.13)	-0.04 (-1.90**)	0.04 (2.25**)
Public Sector	-0.13 (-1.27)	-0.25 (-2.25**)	-0.39 (-3.33*)	-0.28 (-2.32**)	-0.04 (-0.34)	-0.06 (-0.64)	0.04 (1.15)	-0.22 (-5.41*)
Cost Elasticity	1.04 (3.03*)	1.07 (5.73*)	1.05 (5.69*)	1.01 (0.54)	0.98 (-1.76**)	1.05 (5.69*)	0.94 (-3.59*)	0.96 (-79.34*)
Dependent Variable: Natural Logarithm of Non-Operating Expenses in Indian Rupees								
Adjusted R^2	0.98	0.98	0.99	0.99	0.98	0.99	0.95	0.98
Ln of Assets	0.88 (2.78*)	0.87 (2.75*)	0.75 (2.57**)	1.06 (4.03*)	1.13 (2.81*)	0.94 (4.35*)	-0.13 (-0.23)	1.03 (9.74*)
½ (Ln of Assets^2)	0.01 (0.38)	0.01 (0.35)	0.02 (0.65)	-0.01 (-0.50)	-0.02 (-0.54)	0.001 (0.08)	0.09 (1.97**)	-0.01 (-0.76)
Public Sector	0.04 (0.68)	0.03 (0.45)	0.05 (0.86)	0.14 (2.92*)	0.11 (1.63)	0.07 (1.93***)	-0.34 (-3.84*)	0.07 (3.53**)
Cost Elasticity	0.998 (-0.82)	0.98 (-10.59*)	0.94 (-18.06*)	0.95 (-27.01*)	0.90 (-25.77*)	0.94 (-18.06*)	0.91 (-15.36*)	0.95 (-92.49*)
Dependent Variable: Natural Logarithm of Interest Expenses in Indian Rupees								
Adjusted R^2	0.99	0.98	0.99	0.99	0.98	0.99	0.98	0.99
Ln of Assets	0.88 (2.83*)	0.82 (2.27**)	0.95 (3.56*)	0.83 (2.83*)	1.01 (2.56**)	0.95 (3.56*)	1.27 (3.42*)	1.13 (10.61*)
½ (Ln of Assets^2)	0.01 (0.35)	0.01 (0.41)	-0.001 (-0.03)	0.01 (0.28)	-0.01 (-0.32)	-0.001 (-0.03)	-0.03 (-0.89)	-0.02 (-1.86**)
Public Sector	0.05 (0.84)	0.08 (1.22)	0.04 (0.85)	0.19 (3.60*)	0.18 (2.81*)	0.04 (0.85)	0.10 (1.67***)	0.10 (4.66*)
Cost Elasticity	0.99 (-6.32*)	0.93 (-36.37*)	0.94 (-463.29*)	0.91 (-59.32*)	0.90 (-54.17*)	0.94 (-463.29*)	0.92 (-10.03*)	0.93 (-50.76*)

Dependent Variable: Natural Logarithm of Employee Cost in Indian Rupees							
Adjusted R^2	0.91	0.90	0.92	0.92	0.90	0.92	0.93	0.93
Ln of Assets	0.06	0.45	0.29	0.07	0.10	0.29	0.11	0.34
	(0.08)	(0.57)	(0.40)	(0.09)	(0.11)	(0.40)	(0.15)	(1.33)
½ (Ln of Assets^2)	0.08	0.04	0.06	0.07	0.07	0.06	0.07	0.05
	(1.12)	(0.61)	(0.89)	(1.16)	(0.89)	(0.89)	(1.14)	(2.31**)
Public Sector	0.21	0.06	0.01	0.07	0.12	0.01	-0.03	0.06
	(1.44)	(0.44)	(0.10)	(0.53)	(0.86)	(0.10)	(-0.23)	(1.19)
Cost Elasticity	0.92	0.93	0.92	0.86	0.90	0.92	0.94	0.93
	(-5.06*)	(-8.01*)	(-6.71*)	(-10.16*)	(-7.05*)	(-6.71*)	(-4.44*)	(-18.10*)

This table reports the regression results of the translog cost function for the years 2007-2013. To estimate cost elasticity for each year, we estimate scale economy for individual bank and then average across observations to find the scale economy measure for the entire sample. A two tailed t-test tests for whether the average cost elasticity is significantly different from 1.0. t-statistics have been reported in parentheses. * Statistically significant at the 1% significance level, **Statistically significant at the 5% significance level, and ***Statistically significant at the 10% significance level

As the size of the bank as measured by total assets increases, non-operating expenses are rising less than proportionately as is evidenced by below 1 cost elasticity throughout the sample period. Panel data also confirms that there is cost efficiency associated with non-operating expenses, interest rates, and employee costs, because the cost elasticity is below 1 and is statistically significant throughout the sample period. Panel data regression results in Table 2 show that public sector banks have a statistically significantly lower operating cost in comparison to private sector banks. On the other hand, public sector banks have a higher non-operating cost and interest expenses relative to private sector banks. Ownership structure does not impact employee cost in a statistically significant manner.

Table 3 shows the regression results for the translog cost function for cost efficiencies for Indian banks with respect to total deposits of a bank with size of the bank as measured by total assets as a control variable.

On an average, our model explains 97% to 99% of the total expenses of a bank with respect to total deposits of a bank. Natural logarithm of deposits is positively related to the total expenses of a bank for each year in the sample and the relationship is statistically significant in all years except for the year 2009. Ownership structure plays a role in determining the total expenses of a bank, with a negative coefficient on the public sector banks reporting lower total expenses relative to private sector banks.

Cost elasticity is less than one for every year from 2007 to 2013 except for the year 2009, which points to economies of scale in total expenses for Indian commercial banks with respect to deposits of the banks. Highest economies of scale are experienced in 2007 with a cost elasticity of 0.79, which means for every rupee increase in deposits, total expenses, on an average, increased by 0.79 rupees only. In 2009, the cost elasticity is 1.01 and it points to diseconomies of scale for that year with respect to deposits. However, the panel data results show overall there are economies of scale in total expenses with respect to deposits for the pooled sample of 2007 to 2013 with a highly statistically significant cost elasticity of 0.95.

Table 3
Regression results for the translog cost function for economies of scale with respect to deposits

Variables	2007	2008	2009	2010	2011	2012	2013	Panel Data with Fixed Effects Model
# of Banks	35	35	35	35	35	34	34	243

Dependent Variable: Natural Logarithm of Total Expenses in Indian Rupees

Economies of Scale with respect to Deposits

Variables	2007	2008	2009	2010	2011	2012	2013	Panel
Adjusted R^2	0.98	0.98	0.97	0.98	0.99	0.98	0.97	0.99
Ln of Deposits	2.27	1.64	0.79	1.13	1.52	1.24	1.59	1.06
	(3.03^*)	(2.07^{**})	(0.88)	(1.85^{**})	(2.59^*)	(2.02^{**})	(1.84^{**})	(6.57^*)
½ (Ln of Deposits^2)	-0.14	-0.07	0.02	-0.02	-0.06	-0.03	-0.06	-0.01
	(-1.77^{**})	(-0.83)	(0.19)	(-0.30)	(-0.98)	(-0.48)	(-0.73)	(-0.67)
Public Sector	-0.02	-0.11	-0.18	-0.14	-0.12	-0.10	-0.12	-0.08
	(-0.31)	(-1.46)	(-1.94^{**})	(-2.28^{**})	(-2.05^{**})	(-1.69^{***})	(-1.56)	(-3.86^*)
Assets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(2.34^{**})	(1.32)	(0.25)	(1.10)	(1.67)	(1.10)	(0.93)	(1.31)
Cost Elasticity	90.79	0.89	1.01	0.93	0.90	0.89	0.90	0.95
	(-7.55^*)	(-8.64^*)	(2.18^{**})	(-19.27^*)	(-9.76^*)	(-18.71^*)	(-9.42^*)	(-62.57^*)

Dependent Variable: Natural Logarithm of Operating Expenses in Indian Rupees

Variables	2007	2008	2009	2010	2011	2012	2013	Panel
Adjusted R^2	0.95	0.94	0.91	0.92	0.94	0.93	0.94	0.94
Ln of Deposits	0.91	0.59	0.08	-0.36	0.67	0.11	0.61	0.78
	(0.84)	(0.45)	(0.05)	(-0.26)	(0.53)	(0.09)	(0.50)	(2.27^{**})
½ (Ln of Deposits^2)	0.002	0.04	0.09	0.13	0.02	0.07	0.03	0.02
	(0.01)	(0.31)	(0.63)	(0.95)	(0.20)	(0.64)	(0.24)	(0.46)
Public Sector	-0.17	-0.34	-0.50	-0.47	-0.22	-0.21	-0.48	-0.29
	(-1.51)	(-2.62^*)	(-3.37^*)	(-3.28^*)	(-1.81^{***})	(-1.82^{***})	-4.32^*	(-6.84^*)
Assets	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00
	(0.81)	(0.36)	(-0.12)	(-0.04)	(0.62)	(0.03)	(0.84)	(0.90)
Cost Elasticity	0.93	1.02	1.06	1.08	0.89	0.92	0.95	0.996
	(-176.9^*)	(2.57^*)	(3.60^*)	(3.37^*)	(-27.25^*)	(-6.38^*)	(-8.94^*)	(-2.71^*)

Dependent Variable: Natural Logarithm of Non-Operating Expenses in Indian Rupees

Variables	2007	2008	2009	2010	2011	2012	2013	Panel
Adjusted R^2	0.97	0.97	0.97	0.99	0.99	0.99	0.97	0.99
Ln of Deposits	2.66	1.87	0.94	1.97	1.95	1.68	1.95	1.21
	(3.01^*)	(2.18^{**})	(1.15)	(3.72^*)	(3.45^*)	(2.79^*)	(2.22^{**})	(7.07^*)
½ (Ln of Deposits^2)	-0.18	-0.09	0.000	-0.10	-0.10	-0.07	-0.09	-0.03
	(-1.92^{**})	(-1.04)	(0.01)	(-1.91^{**})	(-1.75^{***})	(-1.19)	(-1.11)	(-1.51)
Public Sector	0.03	-0.03	-0.06	0.001	-0.06	-0.06	-0.03	0.004
	(0.35)	(-0.41)	(-0.67)	(0.02)	(-1.15)	(-1.02)	(-0.38)	(0.19)
Assets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(2.20^{**})	(1.35)	(0.38)	(2.16^{**})	(1.91^{***})	(1.56)	(0.96)	(1.33)
Cost Elasticity	0.76	0.90	0.95	0.86	0.82	0.87	0.90	0.89
	(-6.78^*)	(-5.65^*)	(-555.6^*)	(-7.31^*)	(-9.52^*)	(-9.59^*)	(-5.92^*)	(-48.49^*)

Dependent Variable: Natural Logarithm of Interest Expenses in Indian Rupees

Variables	2007	2008	2009	2010	2011	2012	2013	Panel
Adjusted R^2	0.97	0.97	0.97	0.99	0.99	0.98	0.99	0.99
Ln of Deposits	2.88	1.97	1.41	1.72	1.85	1.51	2.22	1.30
	(3.13^*)	(2.11^{**})	(1.73^{**})	(2.95^*)	(3.11^*)	(2.35^{**})	(4.01^*)	(7.34^*)

½ (Ln of Deposits^2)-	-0.20	-0.10	-0.05	-0.08	-0.09	-0.06	-0.12	-0.04
	(-2.10^{**})	(-1.07)	(-0.56)	(-1.36)	(-1.55)	(-0.90)	(-2.29^{**})	(-2.03^{**})
Public Sector	0.05	0.02	-0.05	0.05	0.02	-0.01	-0.08	0.03
	(0.52)	(0.27)	(-0.61)	(0.86)	(0.32)	(-0.10)	(-1.49)	(1.41)
Assets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(2.35^{**})	(1.39)	(0.76)	(1.87^{**})	(1.81^{***})	(0.96)	(1.81^{***})	(1.30)
Cost Elasticity	0.77	0.90	0.86	0.83	0.83	0.82	0.82	0.86
	(-5.86^{*})	(-5.48^{*})	(-13.90^{*})	(-10.92^{*})	(-9.82^{*})	(-16.05^{*})	(-8.00^{*})	(-42.09^{*})

Dependent Variable: Natural Logarithm of Employee Cost in Indian Rupees

Adjusted R^2	0.92	0.91	0.90	0.93	0.91	0.92	0.92	0.93
Ln of Deposits	-0.09	0.18	-0.35	0.45	0.57	0.14	1.06	1.06
	(-0.06)	(0.12)	(-0.23)	(0.39)	(0.38)	(0.10)	(0.75)	(2.58^{*})
½ (Ln of Deposits^2)	0.10	0.07	0.12	0.04	0.03	0.07	-0.02	-0.02
	(0.66)	(0.47)	(0.82)	(0.30)	(0.18)	(0.50)	(-0.13)	(-0.54)
Public Sector	0.16	-0.02	-0.09	-0.08	-0.05	-0.13	-0.15	0.01
	(1.09)	(-0.12)	(-0.59)	(-0.60)	(-0.35)	(-0.99)	(-1.18)	(0.14)
Assets	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	0.00
	(0.14)	(0.12)	(-0.09)	(0.70)	(0.62)	(0.68)	(0.93)	(2.25^{**})
Cost Elasticity	0.96	0.93	0.96	0.89	0.80	0.95	0.94	0.82
	(-1.84^{**})	(-5.15^{*})	(-1.64^{***})	(-13.63^{*})	(-53.51^{*})	(-4.10^{*})	(-30.28^{*})	(-103.19^{*})

t-statistics have been reported in parentheses. * Statistically significant at the 1% significance level, **statistically significant at the 5% significance level, and ***Statistically significant at the 10% significance level

Table 3 also shows that public sector banks have statistically significant lower operating cost relative to private sector banks. Furthermore, there are cost efficiencies in operating expenses, non-operating expenses, interest expenses, and employee costs with respect to total deposits of a bank. Panel data shows that the cost elasticity is below 1 and it is statistically significant for operating expenses, non-operating expenses, interest expenses, and employee costs.

Table 4 evaluates cost efficiencies for Indian commercial banks with respect to loans with total assets of the bank as a control variable. Our model explains, on an average, 98 percent to 99 of total expenses of a bank with respect to loans of a bank. Total expenses are positively related to total loans for each year in the sample from 2007 to 2013. Panel data also shows that the relation between total expenses and total loans is positive and is statistically significant. The coefficient on natural logarithm of loans is below 1 for the year 2007 to 2010, which means that for every rupee increase in loans, total expenses increase by less than one, but in 2011, 2012, and 2013 the coefficient on natural logarithm of loans is more than one, which implies that for every one rupee increase in loans, total expenses increase by more than a rupee. Ownership structure plays a role in influencing total expenses of a bank. Public sector banks have lower total expenses relative to private sector banks.

In 2007, cost elasticity equals one, but is not statistically significant and in 2008, cost elasticity of total expenses to total loans is 1.03 and is statistically significant. In all other years in the sample, cost elasticity is below one and statistically significant. Panel data results show that during the sample period of 2007 to 2013, the cost elasticity is below one at 0.92 and there are cost efficiencies in total expenses with respect total loans for Indian commercial banks.

Table 4
Regression results for the translog cost function for economies of scale regarding loans

Variables	2007	2008	2009	2010	2011	2012	2013	Panel Data with Fixed Effects
# of Banks	35	35	35	35	35	34	34	243
Dependent Variable: Natural Logarithm of Total Expenses in Indian Rupees								
Economies of Scale with respect to Deposits								
Adj. R^2	0.99	0.99	0.98	0.99	0.98	0.99	0.98	0.98
Ln of	0.80	0.82	0.81	0.82	2.05	1.08	1.04	1.36
Loans	(1.78**)	(1.73***)	(1.54)	(1.74***)	(3.12*)	(2.36**)	(1.54)	(5.92*)
½ (Ln of	0.2	0.02	0.01	0.01	-0.12	-0.01	-0.01	-0.04
Loans^2)	(0.36)	(0.32)	(0.26)	(0.21)	(-1.77**)	(-0.31)	(-0.12)	(-1.70***)
Public	-0.06	-0.11	-0.14	-0.09	-0.002	-0.04	-0.08	-0.13
Sector	(-1.14)	(-2.11**)	(-2.34**)	(-1.78***)	(-0.03)	(-0.99)	(-1.34)	(-4.69*)
Assets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.15)	(0.12)	(0.15)	(0.56)	(2.20**)	(0.61)	(0.04)	(2.65*)
Cost	1.00	1.03	0.96	0.93	0.84	0.92	0.99	0.92
Elasticity	(0.95)	(7.08*)	(-16.17*)	(-36.3*)	(-7.39*)	(-29.18*)	(-7.31*)	(-27.84*)
Dependent Variable: Natural Logarithm of Operating Expenses in Indian Rupees								
Adj. R^2	0.94	0.93	0.94	0.93	0.93	0.95	0.96	0.94
Ln of	0.67	0.82	0.68	-0.28	1.49	-0.04	0.002	0.76
Loans	(0.62)	(0.69)	(0.62)	(-0.23)	(1.23)	(-0.03)	(0.01)	(1.89**)
½ (Ln of	0.03	0.01	0.03	0.12	-0.06	0.09	0.09	0.02
Loans^2)	(0.21)	(0.11)	(0.28)	(1.00)	(-0.51)	(0.84)	(0.86)	(0.51)
Public	-0.16	-0.29	-0.46	-0.40	-0.10	-0.16	-0.43	-0.35
Sector	(-1.31)	(-2.27**)	(-3.73*)	(-3.23*)	(-0.83)	(-1.59)	(-4.84*)	(-7.45*)
Assets	0.00	0.00	0.00	-0.00	0.00	-0.00	0.00	0.00
	(0.40)	(0.43)	(0.12)	(-0.22)	(1.18)	(-0.41)	(0.04)	(1.16)
Cost	0.98	0.92	0.997	1.01	0.83	0.97	1.03	0.98
Elasticity	(-4.02*)	(-38.63*)	(-0.39)	(0.55)	(-14.44*)	(-1.58)	(1.60)	(-11.82*)
Dependent Variable: Natural Logarithm of Non-Operating Expenses in Indian Rupees								
Adj. R^2	0.99	0.99	0.99	0.99	0.98	0.99	0.98	0.98
Ln of	0.85	0.80	0.77	1.52	2.37	1.53	1.41	1.62
Loans	(1.56)	(1.62)	(1.51)	(2.95*)	(3.51*)	(2.92*)	(1.97**)	(6.98*)
½ (Ln of	0.02	0.02	0.01	-0.06	-0.15	-0.06	-0.04	-0.06
Loans^2)	(0.26)	(0.34)	(0.29)	(-1.16)	(-2.18**)	(-1.09)	(-0.60)	(-2.79*)
Public	-0.01	-0.04	-0.01	0.06	0.05	0.001	0.02	-0.04
Sector	(-0.20)	(-0.71)	(-0.23)	(1.05)	(0.74)	(0.02)	(0.25)	(-1.61)
Assets	-0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(-0.14)	(-0.13)	(0.10)	(1.33)	(2.21**)	(1.12)	(0.16)	(3.00*)
Cost	1.05	1.01	0.61	0.87	0.72	0.85	0.95	0.91
Elasticity	(13.37*)	(2.01**)	(-128.30*)	(-10.60*)	(9.50*)	(-12.75*)	(-6.00*)	(-18.21*)
Dependent Variable: Natural Logarithm of Interest Expenses in Indian Rupees								
Adj. R^2	0.99	0.98	0.99	0.98	0.98	0.99	0.99	0.98
Ln of	0.70	0.69	1.10	1.26	2.14	1.33	1.94	1.75
Deposits	(1.29)	(1.23)	(2.30**)	(2.08**)	(3.07*)	(2.34**)	(3.24*)	(7.43*)
½ (Ln of	0.03	0.03	-0.02	-0.03	-0.13	-0.04	-0.10	-0.08
Deposits^2)	(0.54)	(0.47)	(-0.34)	(-0.61)	(-1.83***)	(-0.70)	(-1.68***)	(-3.32*)
Public	-0.01	0.01	-0.01	0.11	0.13	0.05	-0.02	-0.01

Sector	(-0.09)	(0.23)	(-0.28)	(1.75***)	(1.84***)	(1.05)	(-0.37)	(-0.55)
Assets	-0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(-0.42)	(-0.24)	(0.44)	(1.04)	(1.97***)	(0.42)	(1.06)	(3.03*)
Cost	1.01	1.00	0.94	0.61	0.71	0.88	0.80	0.90
Elasticity	(0.95)	(0.31)	(-20.95*)	(-32.38*)	(-11.36*)	(-15.82*)	(-10.46*)	(-17.40*)

Dependent Variable: Natural Logarithm of Employee Cost in Indian Rupees

Adj. R^2	0.90	0.89	0.91	0.93	0.89	0.93	0.93	0.93
Ln of	0.72	1.43	0.91	0.88	1.60	0.32	0.58	0.74
Deposits	(0.48)	(0.97)	(0.71)	(0.70)	(1.06)	(0.23)	(0.43)	(1.67***)
½ (Ln of	0.01	-0.06	-0.01	-0.01	-0.08	0.05	0.03	0.01
Deposits^2)	(0.05)	(-0.40)	(-0.05)	(-0.06)	(-0.55)	(0.36)	(0.22)	(0.31)
Public	0.21	0.05	-0.03	-0.01	0.08	-0.07	-0.11	-0.06
Sector	(1.26)	(0.32)	(-0.20)	(-0.08)	(0.53)	(-0.56)	(-0.92)	(-1.14)
Assets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.54)	(0.85)	(0.68)	(0.91)	(1.26)	(0.56)	(0.40)	(1.71***)
Cost	0.80	0.81	0.83	0.80	0.72	0.88	0.92	0.89
Elasticity	(-123.27*)	(-16.39*)	(-114.43*)	(-137.09*)	(-17.85*)	(-12.35*)	(-13.66*)	(-105.92*)

t-statistics have been reported in parentheses. * Statistically significant at the 1% significance level, **statistically significant at the 5% significance level, and ***Statistically significant at the 10% significance level

Table 4 also shows that public sector banks have lower operating expenses relative to private sector banks. Ownership structure does not play a statistically significant role in influencing the non-operating expenses, interest expenses, and employee cost with respect to total loans of a bank.

Panel data results shows cost efficiencies for Indian banks in operating expenses, non-operating expenses, interest expenses, and employee cost, because the cost elasticity is below one and is statistically significant.

B.   Economies of Scale by Ownership

Table 5 shows cost elasticity of total expenses, operating expenses, non-operating costs, interest expenses, and employee cost with respect to total assets, total deposits, and total loans when we analyze economies of scale by bank ownership.

On an average, cost elasticity of total expenses with respect to total assets is less than one for public and private sector banks and is statistically significant for each year in the sample since 2009. Total expenses of public and private sector banks do not increase in the same proportion as the increase in assets, which points to economies of scale throughout the sample period. Panel data shows that both public and private sector banks have same cost elasticity of total expenses with respect to total assets at 0.96.

For each year in the sample, private sector banks report higher cost efficiencies over public sector banks. Panel data results show that cost elasticity of operating expenses with respect to total assets for public sector banks is 0.99 and for private sector banks is 0.94. Private sector banks show more cost efficiencies relative to public sector banks for every rupee increase in total assets.

Table 5
Economies of scale by bank ownership for Indian banks for the period 2007 to 2013

	2007	2008	2009	2010	2011	2012	2013	Panel Data
Cost elasticity with respect to Total Assets								
Cost Elasticity of Total Expenses with respect to Total Assets of a Bank								
Public Sector Banks	1.07 (13.13*)	1.02 (5.6*)	0.97 (-9.26*)	0.94 (-17.32*)	0.93 (-49.61*)	0.99 (-1.71)	0.951 (-178.5*)	0.96 (-76.35*)
Private Sector Banks	1.03 (3.08*)	0.99 (-.87)	0.95 (-9.49*)	0.91 (-14.68*)	0.92 (-36.01*)	0.97 (-4.61*)	0.952 (-98.2*)	0.96 (-56.56*)
Cost Elasticity of Operating Expenses with respect to Total Assets of a Bank								
Public Sector Banks	1.08 (6.50*)	1.10 (9.54*)	1.07 (9.44*)	1.06 (3.57*)	1.01 (0.94)	0.96 (-3.59*)	0.98 (-1.24)	0.99 (-2.33**)
Private Sector Banks	0.99 (-0.59)	1.02 (1.29)	1.02 (1.25)	0.94 (-2.06**)	0.94 (-3.52*)	0.89 (-5.68*)	0.88 (-4.27*)	0.94 (-11.71*)
Cost Elasticity of Non-Operating Costs with respect to Total Assets of a Bank								
Public Sector Banks	1.003 (2.06**)	0.98 (-8.78*)	0.95 (-16.96*)	0.94 (-32.01*)	0.89 (-29.03*)	0.957 (-172.6*)	0.90 (-18.9*)	0.95 (-104.60*)
Private Sector Banks	0.99 (-3.06*)	0.97 (-8.97*)	0.93 (-13.91*)	0.95 (-15.12*)	0.91 (-14.56*)	0.956 (-102.8*)	0.93 (-7.19*)	0.95 (-53.08*)
Cost Elasticity of Interest Expenses with respect to Total Assets of a Bank								
Public Sector Banks	0.993 (-4.27*)	0.93 (-37.7*)	0.943 (-517.89*)	0.92 (-63.62*)	0.89 (-58.01*)	0.905 (-48.12*)	0.91 (-13.2*)	0.92 (-60.65*)
Private Sector Banks	0.98 (-6.58*)	0.92 (-25.18*)	0.944 (-293.18*)	0.91 (-42.66*)	0.90 (-33.19*)	0.918 (-24.07*)	0.95 (-3.97*)	0.94 (-26.45*)
Cost Elasticity of Employee Cost with respect to Total Assets of a Bank								
Public Sector Banks	0.96 (-2.82*)	0.96 (-5.89*)	0.96 (-4.38*)	0.90 (-7.92*)	0.94 (-4.45*)	1.02 (1.10)	0.97 (-2.13**)	0.96 (-11.86*)
Private Sector Banks	0.86 (-5.78*)	0.90 (-7.35*)	0.88 (-6.66*)	0.81 (-9.00*)	0.86 (-6.98*)	0.89 (-2.98*)	0.90 (-4.79*)	0.89 (-17.48*)
Cost elasticity with respect to Total Deposits								
Cost Elasticity of Total Expenses with respect to Total Deposits of a Bank								
Public Sector Banks	0.72 (-11.75*)	0.85 (-12.9*)	1.02 (5.88*)	0.920 (-25.1*)	0.87 (-13.92*)	0.88 (-23.20*)	0.87 (-13.2*)	0.89 (-37.67*)
Private Sector Banks	0.90 (-2.24**)	0.94 (-2.9**)	0.99 (-1.19)	0.95 (-10.3*)	0.94 (-3.94*)	0.92 (-9.53*)	0.94 (-3.55*)	0.95 (-11.84*)
Cost Elasticity of Operating Expenses with respect to Total Deposits of a Bank								
Public Sector Banks	0.932 (-199.44*)	1.04 (6.24*)	1.12 (7.48*)	1.16 (7.22*)	0.91 (-26.43*)	0.95 (-3.97**)	0.96 (-6.79*)	0.99 (-4.73*)
Private Sector Banks	0.93 (-118.39*)	0.99 (-0.86)	0.99 (-0.26)	0.98 (-0.48)	0.88 (-21.37*)	0.87 (-6.58**)	0.93 (-8.16*)	0.97 (-14.56*)

Cost Elasticity of Non-operating expenses with respect to Total Deposits of a Bank

Public Sector Banks	0.67	0.85	0.946	0.80	0.76	0.84	0.86	0.88
	(-10.86*)	(-9.73*)	(-627.6*)	(-11.6*)	(-13.66*)	(-13.32*)	(-9.37*)	(-27.38*)
Private Sector Banks	0.90	0.97	0.945	0.94	0.89	0.92	0.97	0.96
	(-1.73)	(-1.14)	(-371*)	(-2.20**)	(-3.77*)	(-3.67*)	(-1.31)	(-5.43*)

Cost Elasticity of Interest Expenses with respect to Total Deposits of a Bank

Public Sector Banks	0.67	0.84	0.83	0.78	0.78	0.79	0.76	0.86
	(-9.81*)	(-9.53*)	(-19.2*)	(-15.7*)	(-13.98*)	(-20.32*)	(-11.63*)	(-26.51*)
Private Sector Banks	0.92	0.97	0.90	0.89	0.90	0.86	0.91	0.96
	(-1.13)	(-1.03)	(-6.57*)	(-4.66*)	(-3.97*)	(-7.82*)	(-2.64**)	(-5.43*)

Cost Elasticity of Employee Cost with respect to Total Deposits of a Bank

Public Sector Banks	1.02	0.97	1.03	0.92	0.81	0.98	0.94	0.90
	(1.00)	(-2.53**)	(1.54)	(-11.9*)	(-55.06*)	(-1.50)	(-35.9*)	(-105.33*)
Private Sector Banks	0.89	0.88	0.87	0.86	0.78	0.90	0.95	0.96
	(-3.90*)	(-5.88*)	(-3.73*)	(-12.04*)	(-39.33*)	(-5.12*)	(-16.85*)	(-4.89*)

Cost elasticity with respect to Total Loans

Cost Elasticity of Total Expenses with respect to Total Loans of a Bank

Public Sector Banks	1.01	1.04	0.96	0.93	0.78	0.92	0.98	0.95
	(4.20*)	(11.24*)	(-14.8*)	(-36.7*)	(-10.63*)	(-33.33*)	(-10.57*)	(-73.46*)
Private Sector Banks	0.99	1.01	0.94	0.92	0.92	0.93	0.99	0.96
	(-2.02**)	(2.10**)	(-13.1*)	(-26.9*)	(-2.43**)	(-16.15*)	(-2.27**)	(-34.54*)

Cost Elasticity of Operating Expenses with respect to Total Loans of a Bank

Public Sector Banks	0.99	0.93	1.02	1.08	0.80	1.02	1.07	1.01
	(-1.55)	(-40.4*)	(2.80**)	(3.85*)	(-17.98*)	(1.05*)	(4.47*)	(4.63*)
Private Sector Banks	0.95	0.92	0.97	0.92	0.87	0.91	0.96	0.98
	(-5.24*)	(-24.2*)	(-2.77*)	(-2.25*)	(-7.15*)	(-3.34*)	(-1.29)	(-8.06*)

Cost Elasticity of Non-operating expenses with respect to Total Loans of a Bank

Public Sector Banks	1.06	1.02	0.60	0.84	0.64	0.83	0.93	0.87
	(18.58*)	(5.50*)	(-146.6*)	(-14.9*)	(-12.83*)	(-16.09*)	(-9.17*)	(-58.62*)
Private Sector Banks	1.04	0.99	0.62	0.92	0.83	0.90	0.98	0.91
	(6.04*)	(-1.16)	(-81.17*)	(-4.46*)	(-3.84*)	(-5.74*)	(-1.45)	(-25.35*)

Cost Elasticity of Interest Expenses with respect to Total Loans of a Bank

Public Sector Banks	1.02	1.02	0.93	0.58	0.64	0.86	0.75	0.85
	(4.20*)	(3.58*)	(-26.64*)	(-38.9*)	(-14.77*)	(-19.32*)	(-13.94*)	(-51.87*)
Private Sector Banks	0.98	0.98	0.95	0.66	0.81	0.91	0.87	0.90
	(-2.02**)	(-2.24**)	(-11.14*)	(-19.0*)	(-5.08*)	(-7.69*)	(-4.23*)	(-21.17*)

Cost Elasticity of Employee Cost with respect to Total Loans of a Bank

Public Sector Banks	0.81	0.78	0.83	0.80	0.68	0.91	0.94	0.81
	(-139.55*	(-21.8*)	(-131.1*)	(-154*)	(-21.53*)	(-10.25*)	(-11.87*)	(-116.29*)
Private Sector Banks	0.80	0.85	0.84	0.81	0.78	0.85	0.90	0.84
	(-82.61*)	(-8.06*)	(-72.12*)	(-88.9*)	(-9.43*)	(-10.16*)	(-10.80*)	(-61.03)

As per panel data, interest expenses of public sector banks do not increase at the same rate as the interest expenses of private sector banks. The cost elasticity for public sector banks is 0.92 and the cost elasticity for interest expenses is 0.94 for private sector banks. Therefore, for every one rupee increase in total assets, public sector banks' cost of funds, on an average, is 2 basis points lower than private sector banks. With regard to employee cost, private sector banks enjoy higher cost efficiency than public sector banks, which points to higher employee productivity for private sector banks over public sector workers.

Both public and private sector banks enjoy cost efficiencies with regard to total deposits with cost elasticity at less than one. With increase in deposits, total expenses, operating expenses, non-operating expenses, interest expenses, and employee cost rise less than proportionately. With regard to deposits, panel data results show that public sector banks enjoy higher cost efficiencies in total expenses, non-operating expenses, interest expenses, and employee cost relative to private sector banks. Private sector banks show higher cost efficiencies in operating expenses with regard to total deposits over public sector banks.

The panel data results in Table 5 show that private sector banks attain cost efficiencies in total expenses, operating expenses, non-operating expenses, interest expenses, and employee cost with respect to total loans for each year in sample. Panel data model shows that cost efficiencies in total expenses, non-operating expenses, interest expenses, and employee cost with respect to loans are higher for public sector banks over private sector banks. In operating expenses, the panel data model shows that private sector banks are more efficient for every rupee increase in loans. In fact, for public sector banks, every rupee increase in loans is accompanied by a 1.01 increase in operating expenses.

VI.   SUMMARY AND CONCLUSIONS

India started the process of economic reforms and opened up its banking sector in 1991. The goal was to improve the efficiency of the Indian banking sector with an aim to integrate into the global financial sector. This study analyzed the cost efficiencies of Indian commercial banks over the period 2007 to 2013. We used the translog cost function to evaluate economies of scale in the Indian banking sector. The translog cost function was estimated for total cost as well as for each component of total cost, namely operating cost, non-operating cost, interest expenses, and employee cost. We estimated cost efficiencies with respect to output and output was defined in three different manners--total assets, total deposits, and total loans. Estimates of cost elasticity showed that Indian commercial banks are reaping economies of scale when output is measured in terms of total assets of a bank. This study showed that total cost increases less than proportionately to increase in assets, which points to economies of scale with reference to assets. This study also found evidence of cost efficiencies in operating expenses, non-operating expenses, interest expenses, and employee cost when the size of the bank as measured by total assets rises.

When output is measured in terms of total deposits and total loans, Indian banks continue to enjoy cost efficiencies with less than proportionate increases in total expenses, operating expenses, non-operating expenses, interest expense, and employee cost with every rupee increase in total deposits.

Results also show that ownership structure of a bank plays a role in determining cost efficiencies in the Indian banking industry. The study found that private sector banks spend less on employee cost for every rupee increase in assets, which points to higher efficiency or productivity for private sector employees.

When output is measured in terms of deposits, public sector banks enjoy higher cost efficiencies in total expenses, non-operating costs, interest expenses, and employee costs. For every rupee increase in deposits, public sector banks spend less in comparison to private sector banks. Public sector banks have branches all over India including rural India and it is easier for them get deposits in comparison to private sector banks. When output is measured in terms of loans, public sector banks continue to enjoy slightly higher cost efficiencies than their private sector counterparts except in operating expenses.

ENDNOTES

1. Bank of Rajasthan, a private-sector bank, merged with ICICI bank. Therefore, we have only 14 private sector banks in 2012 and 2013.
2. A translog cost function is a Taylor series expansion for estimating the dual of a Cobb-Douglas production function. In the area of models of producer behavior, the paper by Arrow, Chenery, Minhas, and Solow (1961) calls into question the inherent restriction of the Cobb-Douglas model that all elasticities of factor substitution are equal to 1. Researchers have since developed numerous flexible functions that allow substitution to be unrestricted. The transcendental logarithmic, or translog, function is the most frequently used flexible function in empirical work. The function was developed by Kmenta (1967) as a means of approximating the production function. According to Guilkey, Lovell, and Sickles (1983), a translog function is the most reliable of the several available alternatives. Typically, translog cost function includes input prices.
3. Many studies have used translog cost functions to study economies of scale in the financial services industry. These include studies by Bers, Springer, and Thomas (1990) (real estate investment trusts), Goldberg, Hanweck, Keenan, and Young (1991) (securities industry), Drake (1992) (U.K. Building societies), Noulas, Miller, and Ray (1993) (large sized U.S. banks), Zumpano and Elder (1994) (real estate brokerage services), Clark and Speaker (1994) (banking industry), McNulty, Verbrugge, and Blackwell (1995) (thrifts), Altunbas and Molyneuz (1996)(French, German, Italian, and Spanish banking markets), Lang and Welzel (1996) (German cooperative banks), and Latzko (1999).

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