CHAPTER 5

ECONOMETRIC RESULTS OF COST FUNCTIONS : TIME-SERIES ANALYSIS

On the basis of the methodologies developed in the previous chapter, different cost equations are estimated using the Ordinary Least Square (OLS) method. Time-series and cross-sectional data have been used for the purpose. The best-fit equations for each dependent and output variable for different sample data have been selected on the basis of economic theory and statistical inference. In particular, the inclusion of relevant independent variables, their expected signs, and functional forms are based on economic theory and the statistical significance is indicated by the magnitudes of t-values and $\bar{R}^2$.

Since the regression results are voluminous, and the t-test for significance of coefficients and the F-test for goodness of fit (significance for $\bar{R}^2$) have become by now standard and well known,and hence, no efforts have been made for these significances specifically. Nevertheless, suffice to mention here, a t-value of around two and more with degree of freedom of fifteen and more, the regression results are significant at 5 percent and above significant level. The test for $\bar{R}^2$ is redendent as most of the values in this excercise exceed 0.75, which implies high significance.

Time-series analysis has been done for a period of seventeen years (1970 to 1986). The dependent variable used in the cost function estimation is total current expenses (TCE). The major

cost component, establishment expenses, EC, has also been used as a dependent variable for exploring the source of economies of scale in banking.

To find out the sensitivity of different output measures to the results on economies of scale and to select the best output measure for the banking industry, five alternative output variables have been used for the estimation. These variables are -

a) Volume of Business (VB)
b) Total Assets (TA)
c) Earning Assets (EA)
d) Total Deposits (TD)
e) Total Operating Earnings (TOE)

The other independent variables included in the cost functions are the output-mix variables of respective output variables, total number of branches (TB) and ratio of rural branches to total number of branches (RB)

Four popular alternative forms of the cost functions, viz., cubic, quadratic, linear and double-log have been used for estimation of each cost variable and each output variable for all the bank groups.

The selected cost equations have been used to discuss the types of relationship between dependent and independent variables and their theoretical implications for the banking industry. Then, the elasticities of cost with respect to alternative output measures are calculated to find out the existence of economies (diseconomies) of scale and their policy implications.

The best-fit empirical regression results (the selected cost equations) have been given in Appendix III, Table Numbers 1 through 10. Table Numbers 1 to 5 present the cost-output relationship in the banking industry and in each bank group with each output variable using total current expenses (TCE) as dependent variable. The Table Numbers 6 to 10 display the same information using the establishment expenses (EC) as dependent variable. These estimated cost equations have been discussed for each bank group separately.

5.1 Total Cost Equations : Bank Groupwise Analysis

A All Commercial Bank Group [Banking Industry]

1. Out of the total five alternative output variables used, four (VB,EA,TD,& TOE) fit well with the total current expenses in linear functional form and the remaining one (TA) in cubic functional form.

2. The cost equation with TA as output variable has maximum $\bar{R}^2$ (0.998).

3. All the five cost equations (for five alternative output measures) have listed atleast one significant output-mix variable. The estimated signs of the coefficients of the listed output-mix variables in different cost equations are as follows :

Positive	Negative
EA/VB	DEP./VB
ADV./EA	OA/TA
SD./TD	
INT.EARN/TOE	

4. The total number of branches (TB), which was included as an explanatory (independent) variable in the cost functions, is significantly listed in all the cost equations except the cost equation with TA as an output variable. Further, coefficients of TB variable in all these equations are in accordance with `a prior' positive sign, implying thereby that there are branch diseconomies in the case of All Commercial Banks.

5. The ratio of rural branches to total branches (RB) has turned out to be an important independent variable affecting total current expenses in two cost equations (with TD and TOE as output variables). The coefficients of this variable have negative signs, as hypothesised, in both the equations. This result suggests that the rapid rural branch expansion in the banking industry in India is cost advantageous.

B State Bank of India Group

1. All the five cost functions estimated, using time-series data of SBI group, give cubic cost equations.

2. The cost equation with total operating earning (TOE) as an output variable has the highest $\bar{R}^2$ (0.985) closely followed by TA (0.978).

3. Only the cost equations with TA and TD as output variables list significant output-mix variables. The estimated signs of the coefficients of these output-mix variables are as follows :

Positive	Negative
FD/TD	CASH/TA

4. In the case of SBI group, in all the five estimated cost equations, irrespective of the output variable used, the total number of branches (TB) has emerged as an important explanatory variable influencing the total current expenses (TCE) significantly. But, to our surprise, counter to the expected `a priori' sign, this variable is negatively related with the dependent variable. This result implies the existance of branch economies in the SBI bank group.

5. The ratio of rural branches to total branches (RB) is significantly related with the dependent cost variable in all the five cost equations irrespective of the output variable used. But, against the `a priori' sign, the coefficients of this variable have positive signs implying that the increment in the share of rural branches in the total number of branches is cost disadvantageous for the SBI group.

C Nationalised Bank Group

1. The cost equation with TA as output variable has cubic functional form and other four equations, with output variables VB, EA, TD and TOE, are linear cost equations like the All Commercial Bank group.

2. The $\bar{R}^2$ (0.998) is found to be maximum for cost equation with TOE as output variable. TA followed closely with $\bar{R}^2$ equal to 0.997.

3. All the five cost equations list output-mix variables with following signs of their coefficients:

POSITIVE	NEGATIVE
EA/TA	EA/TA
CASH/TA	DEP./VB
CALL MONEY/EA	INVT./EA
FD/TD	COMM./TOE
SD/TD	

4. The cost equations with EA, TD and TOE output variables listed the total number of branches (TB) as an explanatory variable with `a priori' positive sign implying thereby that there are branch diseconomies in the case of Nationalised Banks.

5. The ratio of rural branches to total branches (RB) has turned out to be an unimportant factor affecting cost as only two cost equations, viz. with VB and TD as output variables, have listed this variable and the signs of the coefficients of this variable in the two equations are positive and negative respectively.

D Indian Private Sector Banks

1. All the cost functions estimated, using time series data of private sector banks, are cubic in output except for TOE which is double-log (Cobb-Douglas).

2. Equation with TOE as output variable has highest $\bar{R}^2$ (0.996), closely followed by TA (0.988).

3. Only one cost equation has significantly listed output-mix variable. This output-mix variable is FA/TA with a positive sign.

4. Like SBI group, Indian Private Sector Bank group also has significant but counter to `a priori' sign, the negative coefficients of total number of branches (TB) in four cost equations except the one with TOE as output variable, which is a double-log equation. This finding indicates the branch economies enjoyed by the Indian Private Sector Bank group.

5. The ratio of rural branches to total branches (RB) has turned out to be totally unimportant variable as none of the cost equations have listed this variable.

E Conclusions [TCE]

The major findings of the time-series analysis for different bank-groups using total current expenses (TCE) as dependent variable can be summarised as follows :

a. With four bank groups and five alternative output variables, there are total twenty best-fit cost-output equations. Out of these twenty equations, eleven are cubic, eight are linear and one is double-log (Cobb-Douglas) in functional form.

b. With respect to a given bank-group, in majority of the cases, the cubic cost equations are found to be having maximum R^2 values.

c. On the basis of the inclusion of explanatory variables, their statistical significance (t-values), the high explanatory power ($\bar{R}^2$) of cost equations, listing of output-mix variables, and the hypothesised preference of a cubic cost equation over all other forms of cost equations, TA becomes the most appropriate output (or size) variable for the banking industry.

d. The total number of branches (TB) has emerged as a very important explanatory variable, as it is listed in 17 out of 20 estimated equations. The All-Commercial Banks and Nationalised Bank groups have the hypothesized signs indicating the presence of diseconomies of branches, whereas, the State Bank of India and Indian Private Sector Bank groups have negative signs, indicating existence of economies of branches.

e. The ratio of rural branches to total branches (RB) shows significant influence over the dependent variable in case of the banking industry and the SBI group only. The

equations with positive sign of TB are found to be having negative sign of RB and vice versa.

5.2 Labour Cost Equations : Bank Groupwise Analysis

To investigate the source of economies/diseconomies of scale, the major cost component, establishment expenses (labour cost), has been used in this section as a dependent variable in the cost-output relationship. A bank group-wise analysis of best-fit labour cost equations follows on lines similar to that of total cost analysis.

A All Commercial Bank Group

1. Out of total five cost equations, three (with TA, TD and TOE as output variables) are quadratic and two (with VB and EA as output variables) are linear cost equations. The quadratic cost equation, with TA as output variable, has the maximum $\bar{R}^2$ (0.998).

2. There are total three cost equations listing output-mix variables. The estimated signs of the coefficients of these output-mix variables are as follows -

Positive	Negative
EA/VB	EA/TA
DEP./VB	OA/TA
	FD/TD
	CD/TD

3. Total number of branches (TB), included as an independent variable, has emerged statistically significant in two cost equations, i.e. for TA and EA output variables. The estimated sign of the coefficient of TB variable is positive in TA cost equation and negative in EA cost equation.

4. The explanatory variable RB has turned out to be not an important variable, as only one labour cost equation, with VB as output variable, has listed this variable with positive sign of its coefficient.

B State Bank of India Group

1. All the five cost equations are quadratic in functional form with maximum $\bar{R}^2$ (0.994) in the case of three cost equations, viz., with output variables VB, TA and TD.

2. There are only two cost equations with output-mix variables. These output-mix variables are EA/VB and CASH/TA with a positive sign to the latter and a negative sign to the former variable.

3. Only one cost equation (with VB as output variable) has a significant TB variable with a positive sign to its coefficient. None of the cost equations in the case of SBI group is having RB as an independent variable affecting labour cost.

C Nationalised Bank Group

1. In the case of Nationalised Banks, there is the presence of Cobb-Douglas type of functional form as four labour cost equations are in double-log. Only one equation, with VB as output variable, is quadratic in output. The double-log labour cost equation with TOE as output variable has the maximum $\bar{R}^2$ (0.997).

2. The signs of coefficients of different output-mix variables listed in the labour cost equations are as follows :

Positive	Negative
log (FA/TA)	log (FD/TD)
log (CM/EA)	log (CD/TD)
log (INT./TOE)	

3. Two cost equations (with output variables TD and TOE) have listed TB variable. Both these equations are in double-log and the values of coefficients of TB variable show the elasticity of labour cost with respect to total number of branches. In these cost equations, the value of elasticity is one (1.00), indicating the presence of neither economies nor diseconomies of branches. If this finding is compared with the total cost findings, it becomes very clear that the source of branch diseconomies in the case of nationalised bank group is non labour cost as the labour cost is showing total optimality.

D Indian Private Sector Bank Group

1. There are two cubic (for VB and TA output variables), one quadratic (for TD output variable) and two double-log (for EA and TOE) cost equations, with maximum $\bar{R}^2$ (0.996) for the equation with TOE as an output variable.

2. The output-mix variables listed in various cost equations are given below with their signs of the coefficients :

Positive	Negative
FA/TA	log (COMM/TOE)
log (CM/EA)	
FD/TD	

3. Out of five labour cost equations, three equations have listed statistically significant TB variable with negative signs of the coefficients. This finding points out that the branch expansion is labour cost effective in the case of Indian Private Sector Bank group.

E Conclusion (EC)

a. Out of the total twenty labour cost equations selected for the analysis, two are cubic, ten are quadratic, two are linear and six are double-log in functional forms.

b. Total assets (TA) and total operating earnings (TOE) are the two output variables giving maximum $\bar{R}^2$ for the respective labour cost equations.

c. Out of the total five output variables used, only the cost equations with TA as an output variable has listed output-mix variables, for all the four bank-groups.

d. TB has emerged only in seven cost equations out of the total twenty cost equations. Like the total current expenses, in the case of the establishment expenses too, the coefficient of TB has negative sign for Private Sector Banks. In the case of SBI, unlike TCE , in the case of EC, TB and RB are not very important factors.

5.3 Final Conclusions On Regression Results

On the basis of the statistical inference, we arrive at the following conclusions :

i) The two independent variables, total current expenses and its major component, establishment expenses, have yielded reasonably good cost functions.

ii) The time series analysis indicates that the total asset (TA) is the best output measure for the banking industry in India.

iii) The cubic form of the cost function has yielded the best results.

5.4 The Economies of Scale Results and Policy Implications

Economies of Scale (SCE) has been defined in terms of output elasticity of cost (el.C,Q).For the cost functions developed in this study, the elasticities of cost have been calculated as follows -

$$el.C,Q = [\partial C/\partial Q] \times [Q/C]$$

where

C = Cost; Total [TC], Labour [EC]
Q = Output

if

e < 1 ; there are economies of scale
e = 1 ; there are neither economies nor diseconomies of scale
e > 1 ; there are diseconomies of scale

With this method, the elasticity can be calculated for each level of output from the estimated cost equations. For our analysis, we have used all the estimated cost equations discussed earlier in this chapter to calculate the output elasticities of cost.

As discussed earlier, the main purpose of using different output variables is to examine the sensitivity of each output measure to elasticity results. But, for policy inference, the surrogative measure of all the elasticities (average of all elasticities of cost with respect to each output variable) has been used. The elasticities have been calculated for all the years of time-series (given in Appendix-IV, Table No. 11 to 18), but for the present discussion, the elasticity at the sample mean has been used, for both, the total cost (el.TC,Q) as well as labour cost (el.EC,Q).

Bank group wise analysis of elasticity results, for both, total cost elasticities (el.TC,Q) and labour (establishment) cost elasticities (el.EC,Q) are discussed below with their policy inferences :

A All Commercial Bank Group

As this bank group includes the scheduled and non-scheduled commercial banks, i.e. the banking industry as a whole, the findings bear greater importance. Other three bank groups used in the analysis (SBI group, Nationalised Bank group and Private Indian Bank group) are sub-groups of All Commercial Bank group.

As pointed out earlier, for policy inferences the surrogative measure of elasticity at sample mean has been used but elasticity of cost with respect to each output variable at the sample mean has also been presented here along with the surrogative elasticity for the comparative analysis.

1 : Elasticity of Total Cost [el.TC,Q]

Table No.1 Output Elasticity of Total Cost [el.TC,Q]

Output Variable	El.at sample mean	Sign of TB coeff.	Sign of RB coeff.	Policy Inference		
				Output	Branches	RB
VB	0.86	+		expand	contract	
TA	0.90			expand		
EA	0.86	+		expand	contract	
TD	0.76	+	-	expand	contract	increase
TOE	0.63	+	-	expand	contract	increase
Surro gative	0.80	+	-	expand	contract	increase

[The blank space in the table shows the non-listing of the said variable in the cost equations]

Findings

1) Irrespective of the output variable used, in the case of All Commercial Banks, the elasticities of total cost (total current expenses) are quite similar and showing the presence of economies of scale. The surrogative measure of elasticity (el.=0.8) is less than one implying there by that there are economies of scale in the banking industry in India. Therefore, the banking industry should be allowed to grow further in business, as still, there is ample scope for it to grow from cost and productivity point of view.

2) The signs of the coefficients of TB variable indicate the existence of branch economies or diseconomies. A positive sign of the coefficients of TB variable indicates the presence of branch diseconomies and a negative sign suggests the presence of branch economies.

In the analysis, we found that the TB variable is positively related with the total current expenses, indicating the presence of branch diseconomies. Hence, the banking industry in India should contract its branch network.

3. The negative sign of coefficient of RB variable explains the fact that rural branches are more cost effective than non-rural branches.

2 : Elasticity of Labour Cost [el.EC,Q]

Table No. 2 Output Elasticity of Labour Cost

Output Variable	el.TC,Q	el.EC,Q	Policy Inference
VB	0.86	1.03	el.TC,Q<el.EC,Q<1
TA	0.90	0.79	expand output,both
EA	0.86	1.05	labour and non-
TD	0.76	0.84	labour costs are
TOE	0.63	0.87	economical
Surro gative	0.80	0.92	

Finding

1. The surrogative measure of elasticity, which has been used for policy inference, points out the presence of marginal economies of scale as both, total cost elasticity and labour cost elasticity are less than one. It can therefore be concluded that the banking industry has scope to expand output and in the process increase the labour productivity.

B State Bank of India Group

Our initial findings on the elasticities suggest that the banking industry is enjoying economies of scale but suffering from branch diseconomies. But, it is quite possible that some groups of banks within the industry are having altogether different picture. To investigate this aspect, the elasticities of costs have been calculated for three different bank groups. Out of these three bank groups, SBI group is the oldest.

1 : Elasticity of Total Cost [e1.TC,Q]

Table No. 3 Output Elasticity of Total Cost [e1.TC,Q]

Output Variable	El.at sample mean	Sign of TB coeff.	Sign of RB Coeff.	Policy Inference		
				Output	Branches	RB
VB	1.65	-	+	contract	expand	contract
TA	1.74	-	+	contract	expand	contract
EA	1.26	-	+	contract	expand	contract
TD	2.45	-	+	contract	expand	contract
TOR	1.45	-	+	contract	expand	contract
Surrogative	1.71	-	+	contract	expand	contract

Findings

1) Like the All Commercial Banks (ACB), in the case of SBI group too, the output elasticity of total cost is not very sensitive to the output measures used. The elasticity of cost with respect to various output variables and surrogative measure strongly notify the presence of diseconomies of scale in SBI bank group. Therefore, the SBI group should be discouraged from grow further in business.

2) The signs of the coefficients of TB variable are negative. Hence, this bank group should be allowed to expand its branches for taking advantage of the existing branch economies.

3) There are branch economies prevailing in the case of this group and hence, the branch network should be increased. However, the sign of RB suggests opening of new branches in the non-rural areas only.

2 : Elasticty of Labour Cost [el.EC,Q]

Table No. 4 Output Elasticity of Labour Cost [el.EC,Q]

Output Variable	el. TC,Q	el. EC,Q	Policy Inference
VB	1.65	0.73	1 < el.TC,Q > el.EC,Q
TA	1.74	0.86	
EA	1.26	0.89	source of diseconomies
TD	2.45	0.92	of scale is non-labour
TOE	1.45	0.74	cost.
Surro gative	1.71	0.82	

Findings

1) The output elasticities of labour cost are less than one in all the cases. Hence, the labour cost is showing economies of scale. When this finding is compared with the total cost elasticities, it becomes very apparent that the cause of diseconomies of scale in SBI group is not the labour cost but the non-labour cost.

C Nationalised Bank Group

The Nationalised Bank group is the biggest bank group in the banking industry in India and the findings on this group has major influence on the whole banking industry.

1 : Elastcity of Total Cost [el.TC,Q]

Table No. 5 Output Elasticity of Total Cost [el.TC,Q]

Output Variable	El.at sample mean	Sign of TB coeff.	Sign of RB coeff.	Policy Inference		
				Output	Branches	RB
VB	0.86		+	expand		expand
TA	1.19			contract		
EA	0.90	+		expand	contract	
TD	0.71	+	-	expand	contract	contract
TOE	0.85	+		expand	contract	
Surro gative	0.90	+		expand	contract	

Findings

1. Irrespective of the output variable used (except in the case of TA), elasticity results are not very sensitive to the output measures used. The surrogative measure of elasticity indicates the occupancy of marginal economies of scale in Nationalised Bank group. On account of this, it is exhorted that this bank group should be allowed to grow further.

2. The Nationalised Bank group should contract its branch network as it is suffering from branch diseconomies.

3. The results on RB are inconclusive as in only two out of five cost equations this variable has appeared, one is with a negative sign and the other with a positive sign of the coefficients respectively.

2 : Elasticity of Labour Cost [el.EC,Q]

Table No. 6 Output Elasticity of Labour Cost [el.EC,Q]

Output Variable	el. TC,Q	el. EC,Q	Policy Inference
VB	0.86	1.57	1>el.TC,Q<el.EC,Q>1
TA	1.19	1.01	
EA	0.90	0.93	labour productivity
TD	0.71	0.87	has not kept pace
TOE	0.85	1.17	with the wage bill
Surro gative	0.90	1.11	

Findings

1) The output elasticity of labour cost is more than one, indicating the presence of diseconomies of scale. This could mean that the labour productivity has not kept pace with wage bill and the source of overall economies of scale in Nationalised Bank group is expenses on non-labour factors of production.

D Indian Private Sector Banks

1 : Elasticity of Total Cost [el.TC,Q]

Table No. 7 Output Elasticity of Total Cost [el.TC,Q]

Output variable	El.at sample mean	Sign of TB Coeff.	Policy Inference	
			Output	Branches
VB	1.01	-	no change	expand
TA	1.00	-	no-change	expand
EA	1.04	-	no-change	expand
TD	0.98	-	no-change	expand
TOE	0.86	+	increase	contract
Surro gative	0.98	-	no change	expand

Findings

1) The output elasticity of total cost is equal to one for all the output measures (except TOE) as well as for the surrogative measure. It suggests that there are neither economies nor diseconomies of scale in the case of Indian Private Sector Banks, that is,this group is operating at it's optimum.

2) The negative signs of TB coefficients suggest that the private sector banks should expand their branches and transfer some business from heavily loaded branches to the newly opened ones.

2 : Elasticity of Labour Cost [el.EC,Q]

Table No. 8 Output Elasticity of Labour Cost [el.EC,Q]

Output Variable	el. TC,Q	el. EC,Q	Policy Inference
VB	1.01	1.20	el.TC,Q = el.EC,Q = 1
TA	1.00	1.02	
EA	1.04	1.13	optimum use of factors
TD	0.98	1.04	of production;
TOE	0.86	0.88	optimality reached
Surro gative	0.98	1.05	

Finding

1. For both total cost and labour cost, the elasticity is equal to one. That means, there are neither economies nor diseconomies of scale.

5.5 Overall Findings

1. The empirical analysis of this work is based on regression results of twenty best-fit cost equations using time-series data of Indian commercial banking industry and its three major groups for the period 1970-86. Majority of these equations have cubic functional forms.

2. Out of the five alternative output measures tried in our exercise, viz. VB, TA, EA, TD, and TOE, TA has turned out to be the most appropriate one.

3. The findings of the cost elasticity of output show that there is no significant difference in the value of elasticities by changing the output measure. This implies that elasticities are not sensitive to output measures.

4. The results of the cost elasticities of output for banking industry clearly indicate the scope for further expansion of output and overall contraction of bank branches but increase in the share of rural branches in it.

5. In case of SBI,our results indicate policy implications of reducing the overall output but expansion of branch network. In contrast to the implications for the banking industry, for this bank group, the analysis is suggestive of reduction in the ratio of rural branches to total branches.

6. The policy implications of NB with reference to output and branches are similar to those recommended for the banking industry as a whole, as discussed in para 3 above.

7. The findings for Indian Private Sector Banks Group suggest that this group has reached optimality in terms of output, but still has further scope for branch expansion.

8. For future policy, it will be cost efficient to transfer some branches of Nationalised Banks to SBI group, particularly, those with lower (than average) output per branch as SBI group branches are too loaded with output.

9. There is a scope for increase in the proportion of rural branches to total branches, considering the industry as a whole. On the other hand, for SBI group, the results suggest the reduction in this ratio. Hence, the policy implication is to increase this ratio in case of Nationalised Banks.