IS PAKISTAN'S BANKING SECTOR PRODUCTION FUNCTION COBB-DOUGLAS? ESTIMATES OF THE ELASTICITY OF SUBSTITUTION

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ABSTRACT: *This study is an endeavor to look into the magnitude of elasticity of substitution (EOS) among factors of production to analyze the impact on the Pakistani banking sector. It draws upon a comprehensive time series dataset covering the period 1980-2013. To achieve this purpose the current analysis employ Constant Elasticity of Substitution (CES) production function in order to follow up a quantitative evaluation of Elasticity of Substitution in the Pakistan's banking sector. This paper also investigates returns to scale during the time period under consideration. A time series analysis recourse to econometric tests including unit root tests and test of cointegration and Fully Modified OLS, are employed to check the stationary and identify possible long-run equilibrium relations and coefficients of production function. The empirical results emerged out demonstrate that the estimate of the EOS between capital and labor is significantly more than unity. It implies that substitution possibilities appear to be efficient tool to instigate positive outcomes without inevitably resulting in a decline in output. It comes into view quite evidently from the signs and magnitudes of coefficients that there exists an increasing returns to scale which indicates that as the banking sector doubles its inputs the output will be more than doubled. The results give policy guidance for possible substitution between inputs.*

Key Words: Production Function, Elasticity of Substitution, Unit Root tests, Cointegration, Fully Modified Ordinary Least Square (FMOLS), Kmenta's Approximation.

1. INTRODUCTION

Pakistan's Banking sector has been obsequious to various forms of deregulation, liberalization, globalization as well as dramatic amelioration in information and communication technology (ICT). Many of these changes have deep entailment for productivity of the financial sector [8,9;3;15,16]. In repercussion, Pakistani banking sector is becoming progressively more competitive. The growth in performance of this sector has a noticeable effect on overall economy. In empirical literature, much attention is being paid to establishing its production relationships which are based on certain restrictive assumptions. The most famous of these production functions is in [6] and is also known as 'Work Horse' production function. It comes with the assumption of EOS = 1. However, EOS $\gtreqless$ 1 is a more realistic assumption which is permitted in constant elasticity of substitution (CES) production function, formulated in [2]. This paper uses the same to find the elasticity of substitution (EOS) between inputs in banking sector of Pakistan to evaluate the possibility of substitution between them without compromising their performance.

1.1 Objectives

Following are the objectives of the paper:

1. To estimate the elasticity of substitution between labour and capital in banking sector of Pakistan.
2. To find the type of returns to scale that is applicable in banking sector of Pakistan.

2. LITERATURE REVIEW

There have been a number of studies on the σ since introduction of the concept by Hicks in 1932. Literature on elasticity of substitution regarding Pakistan's sectors is scarce and on financial sector scarcer. Therefore, limited number of studies are reviewed.

In [5], authors analysed the capital labor substitution for selected manufacturing industries in Pakistan for both large and small scale firms and found that CRS existed for majority of industries. By using efficient method of evaluation of the substitution elasticities, for firm level data found that almost all industries included in the sample have elasticities greater than zero. For small scale firms the elasticities are less than one though for large scale firms the elasticities are not different from one. He concluded that stringent conditions on which substitution is analysed from aggregate data, analysis of data has to be identified at more disaggregated levels.

[4] investigated technical and substitution relationship among inputs, and inputs-outputs of Saudi banking sector. Using pooled time-series and cross-sectional data with 170 observations covering the period 1980-1996, he found CES and its Kamenta's approximation properly explain the behaviour production function of the banking industry in Saudi Arabia. A major finding of this paper is that the sector tends to have increasing return to scale shifting from constant return to scale in the eighties. The return to scale in the industry now is 1.024. This means that an increase in the inputs by certain percentage will lead to an increase in the outputs by more percentage. Among the findings of this paper is that the industry enjoys an acceptable level of efficiency.

Others [7], estimated the CD and CES for the manufacturing industry in Nigeria for the period 1980-1997. He has taken into account the process of unused capacity that was characterized by the industry in recent times. He found that among the two production functions the CD production function estimations give better results while taking into considering all the pertinent econometric criteria. He concluded that the CDPF gives better explanation of aggregate PF in Nigerian manufacturing industry for the period studied.

In [1] authors examined productivity in the banking sector of Nigeria by using two major production functions CD and CES known in the economic literature. The estimation results of the ordinary least square (OLS) showed the substitution parameters α and β have positive values of less than one. The addition of these values of α and β is greater than one, which shows that as the banking sector inputs becomes double, the output in terms of deposit will be greater than double. The result has supported the theory as substitution parameters in the CES production function were positive. The speed of adjustment was also found to be good for the long run. It is evident from review of literature that dearth of empirical evidence on EOS of inputs in banking sector. There is space for research on Pakistani Banking sector for finding its elasticity of substitution. This paper attempts to do so.

3. DATA AND METHODOLOGICAL ISSUES

3.1 Function

In this study we used FA and SW as are independent variable which are regressed against TD.

3.1.1 Unit root model

$TD_t = \alpha TD_{t-1} + \mu_{1t}$

If we subtract TD_{t-1} from both sides of equation (4), we have

$\Delta TD_t = (\alpha - 1)TD_{t-1} + \mu_{1t}$

In the same way:

$FA_t = bFA_{t-1} + \mu_{2t}$

$\Delta FA_t = (b-1)FA_{t-1} + \mu_{2t}$

$SW_t = cSW_{t-1} + \mu_{3t}$

$\Delta SW_t = (c-1)SW_{t-1} + \mu_{3t}$

3.1.2 Johansen-Juselius Procedure

Johansen cointegration test is applied on the variables and can be shown mathematically:

$\Delta TD_t = \alpha_1 + \sum_i \alpha_{11}(i)\Delta TD_{t-i} + \sum_i \alpha_{12}(i)\Delta FA_{t-i} + \beta_1 Z_{t-1} + e_{1t}$

$\Delta TD_t = \alpha_1 + \sum_i \alpha_{11}(i)\Delta TD_{t-i} + \sum_i \alpha_{12}(i)\Delta SW_{t-i} + \beta_1 Z_{t-1} + e_{1t}$

Here $\Delta TD_t, \Delta FA_{t-i}$ and ΔSW_{t-i} are the differences in lagged form of the short term disturbances; e_{1t} and e_{1t} arethe serially un-correlated and Z_{t-1} is the error correction (EC) term, get from the cointegration relation discovered and measures the degree of past disequilibrium.

3.1.3 Fully Modified Ordinary Least Squares (FMOLS)

Cointegrating equations can be estimated on the basis of VAR model results. FMOLS is useful for estimation if series are cointegrated of first difference I (1). FMOLS was developed by [17] that gives best possible estimates of cointegrating regressions. ([17]).

$X_t = \hat{\Gamma}_{21}' D_{1t} + \hat{\Gamma}_{21}' D_{1t} + \hat{\epsilon}_t$

or directly from the difference regressions

$\Delta X_t = \hat{\Gamma}_{21}' \Delta D_{1t} + \hat{\Gamma}_{21}' \Delta D_{1t} + \hat{\upsilon}_t$

Allow $\hat{\Omega}$ and $\hat{\Lambda}$ exist the long-run covariance matrices calculated using the residuals $\hat{\upsilon}_t = (\hat{\upsilon}_{1t}, \hat{\upsilon}_{2t}')'$. Then the modified data may be described as

$y_t^{+} = y_t - \hat{\omega}_{12}\hat{\Omega}_{22}^{-1}\hat{\upsilon}_2$

estimated bias correction term can be described as

$\hat{\lambda}_{12}^{+} = \hat{\lambda}_{12} - \hat{\omega}_{12}\hat{\Omega}_{22}^{-1}\hat{\Lambda}_{22}$

The estimator of FMOLS is specified by

$\hat{\theta} = \begin{bmatrix}\hat{\beta}\\ \hat{\gamma}_1\end{bmatrix} = \left(\sum_{t=1}^{T} Z_t Z_t'\right)^{-1}\left(\sum_{t=1}^{T} Z_t y_t^{+} - T\begin{bmatrix}\hat{\lambda}_{12}^{+\prime}\\ 0\end{bmatrix}\right)$

Where $Z_t = (X_t', D_t')'$. The most important part of FMOLS estimation is the building of long-run covariance matrix estimators $\hat{\Omega}$ and $\hat{\Lambda}$.

Earlier than relating the options existing for calculating $\hat{\Omega}$and $\hat{\Lambda}$, it will be helpful to identify the scalar estimator

$\hat{\omega}_{1.2} = \hat{\omega}_{11} - \hat{\omega}_{12}\hat{\Omega}_{22}^{-1}\hat{\omega}_{21}$

Which can may be described as the estimated long-run variance of υ_{1t} conditional on υ_{2t}. If preferred, degree-of-freedom improvement to $\hat{\omega}_{12}$ can be useful.

3.2 The Data

Data is collected for the period, 1980 to 2013 and is obtained from different publications of Money and Banking Statistics provided by the State Bank of Pakistan. To estimate a production function, time series data is needed on output (measured by total deposits). Fixed assets are used as proxy of capital inputs and these are the values of buildings, land, machinery, tools and office equipment, etc. As labor input Wages and Salaries are used as proxy for labor instead of number of employees due to lack of data which include all remunerations, compensation for work done during the year.

3.3 Estimable Model

The estimable model is deduced from [2] version of CES production function:

$\text{TD} = A\,\{\delta.(FA)^{-\rho} + (1-\delta).(SW)^{-\rho}\}^{-\frac{\nu}{\rho}}$

A = technology parameter.

δ = distribution parameter for FA.

(1 – δ) = distribution parameter for SW.

υ = degree of homogeneity and return to scale parameter.

ρ = substitution parameter.

Here it is assumed that A=1, therefore:

$\text{TD} = \{\delta.(FA)^{-\rho} + (1-\delta).(SW)^{-\rho}\}^{-\frac{\nu}{\rho}}$

CES production function can yield any value of EOS (i.e. $0 \le \text{EOS} \le \infty$). It is non-linear in parameters and cannot be linearized to estimate using customary linear estimation techniques. Therefore, applying [10] approximation to the CES is used to estimate it and is written as follows:

$$ln|TD_t| = ln|A| + \beta_1.ln|FA_t| + \beta_2.ln|SW_t| + \beta_3.\left(ln\left|\frac{FA_t}{SW_t}\right|\right)^2 + \varepsilon_t$$

Where $\delta = \frac{\beta_1}{\beta_1+\beta_2}$, $\upsilon = \beta_1 + \beta_2$ & $\rho = \frac{-2\beta_3(\beta_1+\beta_2)}{\beta_1\beta_2}$

The elasticity of substitution EOS is denoted by σ and is a function of ρ:

$\boldsymbol{\sigma = \frac{1}{1+\rho}}$

3.3.1 Unit root test

To solve the problem of stationarity a unit root test has been employed. The test of ADF and PP are used to check H_0 of a unit root or non-stationary of the series alongside the alternative hypothesis of stationary. These tests have been executed at level as well as 1st difference. The PP and ADF statistics indicate that all variables are integrated of order one, I(1).

Table 1: Results of the Unit Root Test

	ADF		PP	
Variables	**t-statistic**			
	At level	**1st difference**	**At level**	**1st difference**
ln |TD|	0.202	-5.373***	0.1970	-5.373***
ln |FA|	0.211	-8.261***	0.0900	-8.517***
ln |SW|	0.719	-3.437**	0.4876	-3.437**
$\left(\ln\left\|\frac{FA}{S\&W}\right\|\right)^2$	-1.170	-2.199**	-1.260	-15.418***

Source: Authors estimations

3.3.2 Co-integration Analysis

The AIC and SIC suggests 4 lag length of VAR model. The reported trace test statistic for the null hypothesis of no cointegration (H_0: r = 0) is 89.7026 which is higher than the critical value of 47.8561 at the 5% significance level. This shows the presence of 1 cointegrating vector among the TD, FA, SW. The maximum Eigenvalue statistic testing the null hypothesis of no cointegration (H_0: r = 0) is rejected at the 5% significance level. This confirms the presence of 1 cointegrating vector.

Table 2: Tests for Cointegration

		Trace Test			
Hypothesis		**Eigen value**	**Trace Stat**	**5% Critical Value**	**p-value**
H_0	**H_1**				
r =0	**r =1**	0.908	89.703	47.856	0.000
r ≤1	**r =2**	0.447	20.623	29.797	0.382
r ≤2	**r =3**	0.092	3.468	15.495	0.942
r ≤3	**r =4**	0.023	0.678	3.841	0.041
H_0	**H_1**	**Maximum Eigenvalue Test**			
r =0	**r =1**	0.908	69.079	27.584	0.000
r ≤1	**r =2**	0.447	17.155	21.132	0.165
r ≤2	**r =3**	0.092	2.790	14.265	0.960
r ≤3	**r =4**	0.023	0.678	3.841	0.410

Note: r stands for the number of cointegrating vectors

Source: Authors' estimates

3.3.3 Parameters of Kmenta's Approximation and CES

The prerequisite for Fully modified ordinary least square in favor of approximation of parameters in the long run parameters is so as there exists a cointegrating relation between a set of I(1) variables is contented in support of our data. So we can pertain this method to estimate the vector of cointegration.

Table 3: Parameter Estimation of CES Production Function

Parameter Estimates			
Kmenta Approximation (FMOLS)		**CES**	
β_0	-13.697	**δ**	0.415
β_1	0.684	**ν**	1.648
β_2	0.964	**ρ**	-0.114
β_3	0.023	**σ_{CES}**	1.129
Adj. R^2	0.893	**(1-δ)**	0.585

Source: Authors' estimations

Substituting the estimated parameters in Kmenta's Approximation equation and therefore CES production function, we get:

$$ln|TD_t| = -13.6972 + 0.6839\,(ln|FA_t|) + 0.9642\,(ln|SW_t|) + 0.0229\left(ln\left|\frac{FA_t}{SW_t}\right|\right)^2$$

$$\text{TD} = \{0.4150\,(FA)^{-0.1143} + 0.5850\,(SW)^{-0.1143}\}^{-14.4242}$$

For CD production function, the EOS is equivalent to 1. σ_{ces} = 1.1290 implies that production function for Pakistani banking industry is quite close to case of Cobb Douglas but CES is a more suitable functional form. Value of **δ** shows the functional distribution of total deposits via fixed assets and **(1-δ)** shows the functional distribution of output via salaries and wages. Comparison of the two distribution parameters show relative share of salaries and wages (58.503%) as compared to that of fixed assets (41.497%). **ν** shows the elasticity of scale. Originally, the CES function developed by [2] could only model constant returns to scale, but later [10] added the parameter **ν**, which allows for increasing or decreasing returns to scale if $\nu \gtrless 1$, respectively. Degree of homogeneity of can be observed from **ν**(= 1.648>1). It implies that IRS prevails in the Pakistani banking industry.

ρ = -0.114, represents the substitution parameter that determines the EOS (σ_{ces}). (σ_{ces}) is 1.129. It is greater than 1, implying high substitution-ability between the inputs i.e. fixed assets (proxy for capital) and salaries and wages (proxy for labor). This shows that labor and capital are relatively easily substitutable in long term. As in developing country like Pakistan, capital accumulation is often the main source of economic growth. The high elasticity of substitution implies that changes in wages have significant effect on employment demonstrating a sturdy effect of wages and salaries on labour productivity through substitution of capital for labour and also technology in banking industry is flexible. The high elasticity of substitution between factors of production implies that there exists flexibility to adjust the factors of production in response to changes in factor prices and/or growth in demand for products of the banking industry emanating from any external or internal reasons. It also implies that production costs can be down by substituting high input price factor with relatively lower input price factor. The R^2 shows that 89% of the variations in the dependent variable are explained by the independent variables.

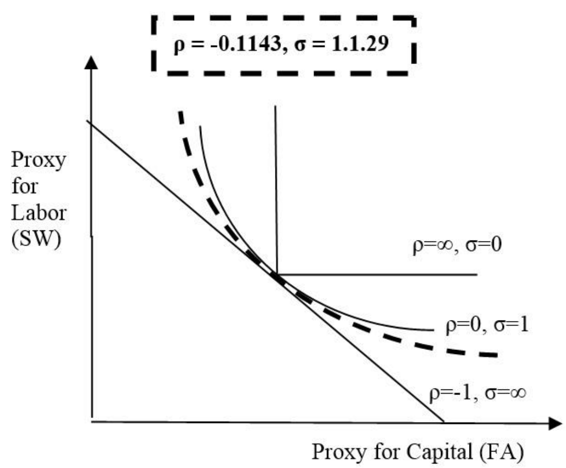

Figure: 1

Source: Authors' Drawing

4. CLOSING REMARKS

This study estimated the elasticity of substitution for banking sector of Pakistan by way of estimating CES production function. The results showed presence of increasing returns to scale (IRS) this sector.

From a policy perspective, the level of capital intensity in the banking sector is not proportionate in relation to the factor endowments and, consequently, at hand is a requirement to convey the banking sector towards larger use of capital-intensive technology. In the long run, though, actions designed at the steady replacement of capital with labor in production techniques may come to fruition. Future research can focus on more advanced form of elasticity of substitution production functions and include newer factors of production like ICT capital.

REFERENCES

1. Abiola, A. Capital-labour substitution and banking sector performance in Nigeria (1960-2008). *Central Bank of Nigeria Economic and Financial Review*, ***48***: 109-115 (2010).
2. Arrow, K. J., Chenery, H.B., Minhas, B.S., & Solow. R. M. Capital labour substitution and economic efficiency. *Review of Economics and Statistics*, ***43***: 155-73 (1961).
3. Ashfaq, K., Younas, Z. I., & Mehmood, B. Impact of ownership structure on default risk: A case of banking sector of Pakistan. *Corporate Ownership and Control.* ***11***(2): 144-152 (2014).
4. Ayoub, M-E. Estimating constant elasticity of substitution for Saudi banking sector. *Journal of King Abdul Aziz University: Economics and Administration.* ***12***(2): 3-12 (1999).
5. Battese, G. E., & Malik, S. J. Estimation of elasticities of substitution for CES production functions using data on selected manufacturing industries in Pakistan. *The Pakistan Development Review*, ***26***(2): 161-177 (1987).
6. Cobb, C. W., & Douglas, P. H. A theory of production. *The American Economic Review*, ***18***(1): 139-165 (1928).
7. Ekanem, O.T. & Oyefusi, S.A. Estimating aggregate production function for the manufacturing industry in Nigeria 1980-1997. Unpublished Work (2000).
8. Hassan, N. U., Zohaib, M., Yaqub, M. S. & Mehmood, B. Do Pakistani banks create value? *Journal of Applied Environmental and Biological Sciences*, ***4***(9S): 407-415 (2014).
9. Imran, M., Mehmood, B., Hussain, H., & Sair, S. A. Do macroeconomic and bank specific factors affect capital buffer: Case of Pakistani banks. *Science International*, ***27***(2): 1481-1486 (2015).
10. Kmenta, J. On the estimation of the CES production function. *International Economic Review*, ***8***: 180-189 (1967).
11. Malik, S., Mushtaq. M., & Nazli, H. An analysis of production relations in the large scale textile manufacturing sector of Pakistan. *Pakistan Development Review*, ***28***: 27-42 (1989).
12. Mehmood, B., Feliceo, A. & Shahid, A. What causes what? Aviation demand and economic growth in Romania: Cointegration estimation and causality analysis. *Romanian Economic Business Review*, ***9***(1): 21-33 (2014).
13. Mehmood, B., Shahid, A., & Younas, Z. I. Interdependencies between aviation demand and economic growth in India: Cointegration equation estimation, *Economic Affairs*, ***58***(4): 335-345 (2013).
14. Mehmood, B., & Shahid, A. Aviation demand and economic growth in Czech Republic: Cointegration estimation and causality analysis. *Statistika*, ***94***(1): 54-63 (2014).
15. Mehmood, B., Younas, Z. I., & Ahmed, N. Macroeconomic and bank specific covariates of non-performing loans (NPLs) in Pakistani commercial banks: Panel data evidence. *Journal of Emerging Economies and Islamic Research*, ***1***(3): 1-15 (2013).
16. Mustafa, S. & Mehmood, B. Efficiency change in Pakistan commercial banking sector: A pre and post digital-restructuring analysis, *Journal of Emerging Economies and Islamic Research*, ***3***(1): 1-12 (2015).
17. Phillips, P. C., & Hansen, B. E. Statistical inference in instrumental variables regression with I(1) processes. *The Review of Economic Studies*, ***57***(1), 99-125 (1990).