Testing Catching-Up and Convergence Issue of Efficiency and Productivity Estimates of Indian Banks

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Abstract: This study aims to investigate the presence of catching-up and convergence of efficiency and productivity level of Indian banking sector in the era of technological advancements of banking sector spanning from 2000 to 2010.

This study adopts the concept of β convergence and σ convergence to assess how quickly low efficient and less productive banks are adapting their environment and competition from new entrants and learning from benchmarking institutes so that with the period of time inefficient and unproductive banking units are growing faster to become efficient and productive ones. Presence of convergence and catching-up effects also leads to an increase in the average of efficiency and productivity levels of Indian banks and decline the dispersion between efficient/productive and inefficient/ unproductive ones.

Introduction and Literature Review

Earlier studies suggest a positive influence of deregulation and competition on the efficiency and productivity level of Indian banking system (Sensarma, 2006; Zhao *et al.,* 2010), deregulation accelerate the efficiency gains of Portuguese banks (Canahoto and Dermine, 2003). These findings suggest the convergence and catching-up of efficiency and productivity levels of banking institutions over the study period due to deregulation and increased competition in the market. Concerning the issue of convergence of efficiency level of banking institutions, Kumar and Gulati (2008) reveal the catching-up effect on the inefficient public banks and therefore the banks with the low level of efficiency at the beginning of the period are growing more swiftly than the highly efficient banks. Indian public banks also validate the incidence of convergence in the post reform period. Casu and Giardone (2010) also providesupporting evidence of convergence of efficiency levels towards an average however no evidence of an overall improvement of efficiency levels towards the best practice frontier in European banking sector. Considering the claims of previous studies, this study aims to assess the presence of convergence and catching-up of efficiency and productivity level of Indian banking sector in the era of technological advancements of banking sector (2000-2010).

If the level of efficiency/ productivity of banking units increases over a time period and indicates that the less efficient/ productive banks also tend to perform better and grow to become efficient/ productive, then this phenomenon can be termed as 'convergence of efficiency/ productivity' of Indian banks or the 'catching-up' effect of bank's efficiency and productivity level. Therefore, with the issue of convergence, this study attempts to address the issue of performance of less efficient/ productive banks over the period, role of competition and learning from the benchmarking units.

The phenomenon of convergence can be addressed as the catching-up effect when the less efficient and productive units tend to perform faster to reach the benchmarks and become efficient and productive over the time. Therefore, the catching-up of efficiency and productivity is a scenario when the average efficiency of the units or the number of efficient and productive units is increasing and the convergence of efficiency is a scenario when the dispersion between the efficiency estimates reduces over time (Casu and Giradone, 2010). There are two different concepts of convergence phenomenon in the literature; (i) β Convergence and (ii) σ Convergence (See Barro and Sala-i-Martin, 1991, 1992 and 1995; Quah, 1996; Sala-i-Martin, 1996a, 1996 b; Hendersen and Zeleynuk' 2007).

The 'catching-up' phenomenon is related to the concept of β Convergence and exhibits that the low efficient banks are tending to grow faster to catch-up with the high efficient banks.The existence of β convergence confirms when the improvement in the efficiency level exhibits a negative correlation with the initial level of efficiency (Kumar and Gulati, 2008). Therefore, the negative sign of β values exhibit catching-up effect of efficiency and confirm the presence of β convergence empirically.

The concept of σ convergence considers cross-sectional dispersion, estimates how quickly low efficient banks grow or converge to reach the average value of efficiency level and bridges the gap between efficient and inefficient banks. Therefore, lesser gap between the extremes of the efficiency levels and lower dispersion of efficiency level confirms the presence of σ convergence in a banking sector.

The existence of σ convergence confirms when there is a decline in the dispersion of technical efficiency levels of Indian banks and therefore a negative sign of σ values confirm the presence of σ convergence empirically.It seems that both σ and β convergence is related however, they are not same. The literature exhibits β convergence as necessary but not a sufficient condition for

σ convergence (Sala-i-Martin, 1996 a). Nevertheless, when both the σ and β convergence occur then it confirms the catching-up and leapfrogging of efficiency level (Koski and Majumdar, 2000). Therefore, first the inefficient banks tend to grow to become efficient and confirm the presence of β convergence and later on they perform ahead to lower the dispersion and identify the presence of σ convergence.

Methodology

This study adopts non parametric Data Envelopment Analysis (DEA) technique to assess the efficiency level and DEA based Malmquist Productivity Inex (MPI) of Indian scheduled commercial banks operating throughout the study period spanning from 2000 to 2010. The balanced panel sample includes 64 scheduled commercial banks including public, private and foreign banks. The study adopts intermediation approach to define inputs-output and therefore inputs include deposits, interest expenses, non-interest expenses and personnel expenses whereas output specified as loans & advances, interest income, and non-interest income. To investigate the issue of convergence of efficiency in the Indian banking sector, this study analyses the distribution, dispersion and trends of efficiency level along with the empirical evidences obtained through the OLS panel data regression.

To estimate 'catching-up' effect empirically, this study follows Casu and Giardone (2010) and adopts following relationship:

$$\Delta e_{i,t} = \alpha + \beta \ln e_{i,t-1} + \rho \Delta e_{i,t-1} + \varepsilon_{i,t} \quad \textbf{(1)}$$

Where i= 1, 2, 3……. 65 banks and t = 1, 2,……,11 years; $e_{i,t}$ is the mean annual technical efficiency of the i[th] bank at time t; $e_{i,t-1}$ is the mean annual technical efficiency of the i[th] bank at time t-1; $\Delta e_{i,t} = \ln e_{i,t} - \ln e_{i,t-1}$; α, β and ρ are the parameters to be estimated and $\varepsilon_{i,t}$ is the error term accounts for random noise in the convergence model.

The study adopts similar formulations of Casu and Giardone (2010) to estimate σ convergence and develops following equation:

$$\Delta\theta_{i,t} = \alpha + \sigma\theta_{i,t-1} + \rho\Delta\theta_{i,t-1} + \varepsilon_{i,t} \quad (2)$$

Where $\theta_{i,t} = \ln e_{i,t} - \ln \overline{e_t}$; $\theta_{i,t-1} = \ln e_{i,t-1} - \ln \overline{e_{t-1}}$; $e_{i,t}$ is the mean annual technical efficiency of the i[th] bank at time t; $e_{i,t-1}$ is the mean annual technical efficiency of the i[th] bank at time t-1; $\overline{e_t}$ is the mean technical efficiency of banks at time t; $\overline{e_{t-1}}$ is the mean technical efficiency of banks at time t-1; $\Delta\theta_{i,t} = \theta_{i,t} - \theta_{i,t-1}$; α, σ, ρ are the parameters to be estimated and $\varepsilon_{i,t}$ is the error term account for random noise in the convergence model.

Results and Discussion:

Catching-up and Convergence of Efficiency Estimates

On the basis of DEA estimation Figure 1 presents the distribution of efficiency of Indian banks in terms of number of most efficient banks (banks which score 1 on efficiency frontier) over the period. This figure indicates an upward trend in the number of efficient banks in Indian banking sector over the study period. Few years evident to be downfall however, in the later years, the Indian banking sector managed it and increased the number of banks on efficiency frontier. It denotes the catching-up effect and convergence of efficiency in the Indian banking sector.

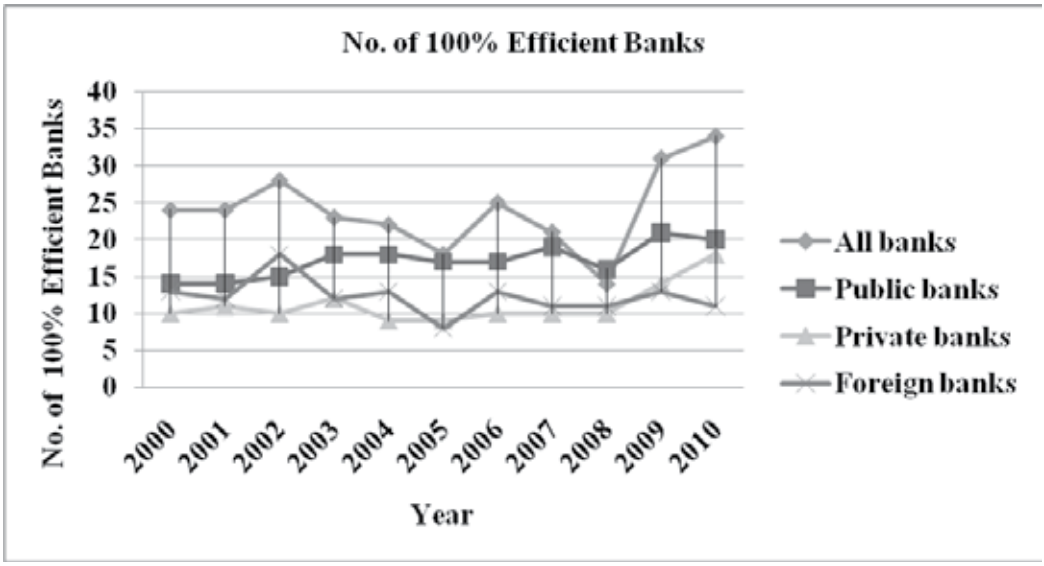

Figure 1: No. of 100% Efficient Banks across the Different Ownership Groups

Number of efficient banks obtained through DEA analysis is increasing over the period which indicates the less efficient banks in the beginning of the study period are growing faster and catching-up with the efficient banks in the later years of the study period and becoming efficient in their operations.This advises that the low performers are learning, keeping pace and catching-up with the high performers in the Indian banking sector. It exhibits that the less efficient banks in the beginning of the study period are growing faster and catching-up with the efficient banks in the later years of the study period.

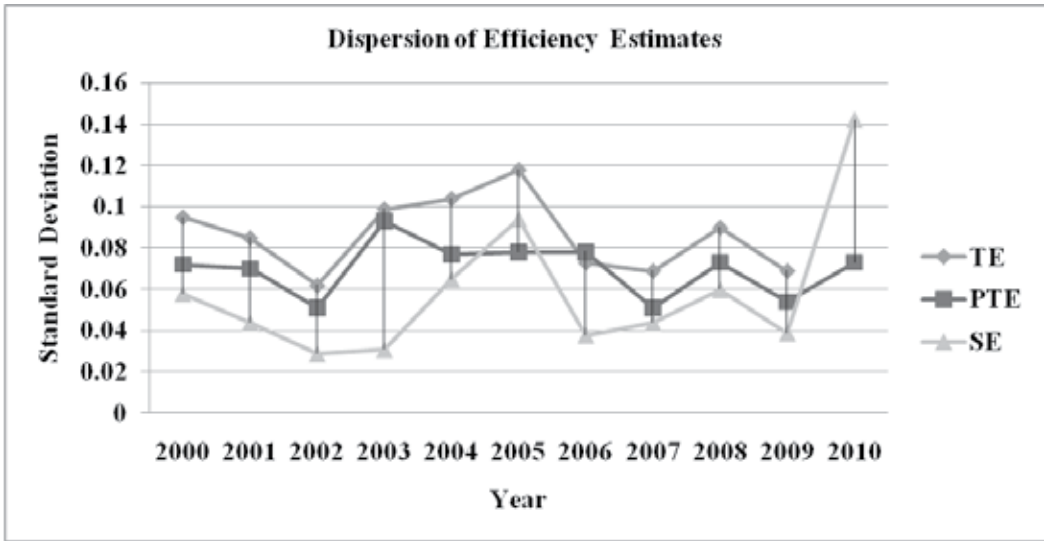

Figure 2: Dispersion of Efficiency Scores (All Banks)

To understand the concept of convergence of efficiency in Indian banking sector figure 2 presents the dispersion of technical, pure technical and scale efficiency estimates in the Indian banking sector. The dispersion is very high on the scale efficiency of the Indian banking sector primarily in the year 2010. However, the dispersion values are coming closer in case of pure technical and technical efficiency and therefore, the distribution of technical and pure technical efficiency gets tighter over the time, confirming the pace of convergence of efficiency in the Indian banking sector. This convergence may be an effect of high competition and learning from the previous experiences, failures and peers. To draw inclusive conclusions on the issue of convergence, the study analyses the results of equation 1 of β convergence and equation 2 of σ convergence. These equations are estimated by using pooled OLS Panel data regression model.The results of the OLS model for the presence of β and σ convergence are presented in the table 1 and 2 respectively.

Table 1: β Convergence (Dependent variable $\Delta e_{i,t}$, Change in the Annual Technical Efficiency Estimates of Individual Banks over Time)

Variable	Coefficient	Standard Error	t-statistics	p-value
α	-0.052	0.0067	-7.776	0.000
β	-0.568	0.049	-11.457	0.000
ρ	-0.078	0.045	-1.7394	0.082
Goodness-of-Fit:				
R^2		**0.200**		
Adjusted R^2		**0.198**		
F-statistic		72.053		
Prob (F-statistic)		0.000		
Durbin-Watson Statistics		1.801		

[**Source:** Author's own calculations derived from the OLS (ordinary Least Square Panel regression using E-views 7 statistical package]
[**Note:** The significance level is 5% and therefore $p < 0.05$ describes the significant coefficient values of results.]

Table 1 presents the results of OLS regression on the panel data of technical efficiency estimates of individual banks over the study period to assess the presence of β convergence in the Indian banking sector. The regression results describe negative and statistically significant sign (-0.568) at the 1% level for the β coefficient. This negative sign exhibits a statically significant relationship between the initial level of efficiency estimates and the change in the efficiency estimates. This implies a negative relationship between the improvements in the efficiency level and previous year's efficiency estimates. This relationship confirms the presence of β convergence and therefore, the Indian banking sector converging towards best practicing units and inefficient banks are catching-up with the efficient banks and tend to grow faster than the efficient banks.

Negligible difference between the R-squared and Adjusted R-squared values with the statistically significant F-values depicts the goodness-of-fit of the derived relationship model. Durbin-Watson statistics is 1.80 which is nearly equal to 2 and rejects the possibilities of autocorrelation in the dependent and independent variables.

Table 2: σ Convergence (Dependent variable $\Delta\theta_{i,t}$)

Variable	Coefficient	Standard Error	t-statistics	p-value
α	-0.0170	0.0058	-2.894	0.0039
σ	-0.673	0.0485	-13.870	0.000
ρ	-0.276	0.0477	-5.792	0.000
Goodness-of-Fit:				
R^2	0.7977			
Adjusted R^2	0.7970			
F-statistic	1129.875			
Prob (F-statistic)	0.000			
Durbin-Watson statistics	1.67			

[**Source:** Author's own calculations derived from the OLS Panel regression using E-views 7 statistical package]

[**Note:** The significance level is 5% and therefore $p < 0.05$ describes the significant coefficient values of results]

Table 2 presents the results of σ convergence model and reveal that the coefficient of σ convergence exhibits negative and statistically significant relationship at the 1% level of significance. This advocates that dispersion in distribution of efficiency estimates of Indian banking sector has decreased over time and the gap between the efficient and inefficient banks' have declined over the period of study. These results confirm the presence of σ convergence in Indian banking industry and denote how quickly individual banks are converging to average level of efficiency. The results confirm the goodness-of-fit of a model with the high R-square and adjusted R-square values with statistically significant F-values.

Therefore, these results conclude that Indian banking sector has witnessed catching-up of efficiencies over the time and inefficient banks are learning from their previous experiences and growing to catch-up the best practicing banks. The simultaneous presence of σ convergence and convergence exhibit the catching-up and leapfrogging effect in the Indian banking sector. These results also confirm the positive effect of competitive pressures on performance of the Indian banking sector that came into force due to deregulation, new technological practices and entry of new private and foreign players.

Catching-Up and Convergence of TFP Estimates of Indian Banks

Following the similar model specification and formulations as of convergence testing of efficiency estimates, this study assesses the convergence of TFP in Indian banking sector over the study period.

To estimate β convergence this study adopts following specifications:

$$\Delta y_{i,t} = \alpha + \beta \ln y_{i,t-1} + \rho \Delta y_{i,t-1} + \varepsilon_{i,t} \quad \textbf{(3)}$$

Where i= 1,2,3…….65 banks and t=1,2,……..,11 years; $y_{i,t}$ is the mean annual TFP of the i[th] bank at time t; $y_{i,t-1}$ is the mean annual TFP of the i[th] bank at time t-1; $\Delta y_{i,t} = \ln y_{i,t} - \ln y_{i,t-1}$; α, β and ρ are the parameters to be estimated and $\varepsilon_{i,t}$ is the error term accounts for random noise in the convergence model. To estimate σ convergence, this study develops following equation:

$$\Delta \omega_{i,t} = \alpha + \sigma \omega_{i,t-1} + \rho \Delta \omega_{i,t-1} + \varepsilon_{i,t} \quad \textbf{(4)}$$

Where, $\omega_{i,t} = \ln y_{i,t} - \ln \overline{y_t}$; $\omega_{i,t-1} = \ln y_{i,t-1} - \ln \overline{y_{t-1}}$; $\overline{y_t}$ is the mean TFP of all banks at time t; $\overline{\quad}$ is the mean TFP of all banks at time t-1; $\Delta \omega_{i,t} = \omega_{i,t} - \omega_{i,t-1}$;α, σ, ρ are the parameters to be estimated and $\varepsilon_{i,t}$ is the error term account for random noise in the convergence model.

This study adopts pooled OLS panel data regression model to analyses the relationships exhibited in equation 3 and 4 and explores the presence of convergence in TFP changes of Indian banks over the study period. The results of the OLS model for the presence of β and σ convergence are presented in the table 3 and 4 respectively.

Table 3: β Convergence (Dependent variable $\Delta y_{i,t}$, Change in the Annual TFP Estimates of Individual Banks over Time)

Variable	Coefficient	Standard Error	t-statistics	p-value
α	0.0159	0.0184	0.867	0.386
β	-0.982	0.0532	-18.450	0.000
ρ	0.134	0.0462	2.909	0.004
Goodness-of-Fit:				
R^2	**0.417**			
Adjusted R^2	**0.414**			
F-statistic	181.87			
Prob (F-statistic)	0.000			
Durbin-Watson Statistics	1.915			

[**Source:** Author's own calculations derived from the OLS (ordinary Least Square Panel regression using E-views 7 statistical package]
[**Note:** The significance level is 5% and therefore $p < 0.05$ describes the significant coefficient values of results.]

Table 3 presents the results of OLS regression on the panel data of TFP estimates of individual banks over the study period to assess the presence of β convergence in the Indian banking sector. The regression results describe negative and statistically significant sign (-0.982) at the 1% level for the β coefficient. This implies a negative relationship between the improvements in the TFP level and previous year's TFP. This relationship confirms the presence of β convergence and therefore, the productivity of Indian banking sector converging towards best practicing units and less productive banks are catching-up with the productive banks and tend to grow faster than the productive banks.Negligible difference between the R-squared and Adjusted R-squared values with the statistically significant F-values depicts the goodness-of-fit of the derived relationship model. Durbin-Watson statistics is 1.915 which is nearly equal to 2 and rejects the possibilities of autocorrelation in the dependent and independent variables.

Table 4: σ Convergence (Dependent variable $\Delta\omega_{i,t}$)

Variable	Coefficient	Standard Error	t-statistics	p-value
α	-0.706	0.0183	-0.385	1.000
σ	-1.066	0.0677	-15.74	0.000
ρ	0.155	0.0501	3.102	0.002
Goodness-of-Fit:				
R^2		**0.418**		
Adjusted R^2		**0.415**		
F-statistic		182.79		
Prob (F-statistic)		0.000		
Durbin-Watson statistics		1.928		

[**Source:** Author's own calculations derived from the OLS Panel regression using E-views 7 statistical package]
[**Note:** The significance level is 5% and therefore $p < 0.05$ describes the significant coefficient values of results]

Table 4 presents the results of σ convergence model and reveal that the coefficient of σ convergence exhibits negative and statistically significant relationship at the 1% level of significance. This advocates that dispersion in distribution of TFP estimates of Indian banking sector has decreased over time and the gap between the productive and unproductive banks' have declined over the period of study. These results confirm the presence of σ convergence in Indian banking industry and denote how quickly individual banks are converging to average level of productivity. The results confirm the goodness-of-fit of a model with the high R-square and adjusted R-square values with statistically significant F-values.

The simultaneous presence of σ convergence and convergence exhibit the catching-up and leapfrogging effect in the Indian banking sector. These results also confirm the positive effect of competitive pressures on performance of the Indian banking sector that came into force due to deregulation, new technological practices and entry of new private and foreign players.

Conclusion

These results conclude that Indian banking sector has witnessed catching-up of efficiencies and productivity level over the time and inefficient& unproductive banks are learning from their previous experiences and growing to catch-up the best practicing banks. The simultaneous presence of both concepts of convergence (sigma and beta) exhibit the catching-up and leapfrogging effect in the Indian banking sector. These results also confirm the positive effect of competitive pressure on performance of the Indian banking sector that came into force due to deregulation, new technological practices and entry of new private and foreign players.

References

Barro, R., Sala-i-Martin X (1991). "Convergence across states and regions," *Brookings Papers on Economic Activity,* 1 : 107–182

Barro, R., Sala-i-Martin X (1992). "Convergence,"*Journal of Political Economics,* 100 : 223–251.

Barro, R., Sala-i-Martin X (1995). "Economic growth," Boston: *McGraw Hill*.

Canhoto, A. and Dermine, J. (2003). "A note on banking efficiency in Portugal, new vs. old banks,"*Journal of Banking & Finance,* 27 : 2087-2098.

Casu, B. and Girardone, C. (2010) "Integration and efficiency convergence in EU banking markets,"*Omega*, 38 : 260–267.

Henderson,D.J. andZeleynuk, V. (2007). "Testing for (efficiency) catching-up,"*Southern Economic Journal*, 73(4): 1003–1019.

Koski, H.A. and Majumdar, S.K. (2000). "Convergence in telecommunications infrastructure development in OECD countries" *Information Economics and Policy*, 12, (2) : 111–131.

Kumar, S., and Gulati, R. (2008). "Did efficiency of Indian public sector banks converge with banking reforms?" *International Review of Economics,* 56 : 47-84.

Quah, D. (1996). "Twin peaks: growth and convergence in models of distribution dynamics"*Economic Journal*, 106 : 1045–1055.

Sala-i-Martin X (1996a). "Regional cohesion: evidence and theories of regional growth and convergence," *European Economic Review*, 40 : 1325–1352.

Sala-i-Martin X (1996b). "The classical approach to convergence analysis,"*Economic Journal*, 106 : 1019–1036.

Sensarma, R (2006). “Are foreign banks always the best? Comparison of state-owned, private and foreign banks in India,” *Economic Modelling*, 23 : 717-735.

Zhao, T., Casu, B. and Ferrari, A. (2010). “The impact of regulatory reforms on cost structure, ownership and competition in Indian banking,” *Journal of Banking & Finance*, 34 : 246–254.