Analysing Bank Productivity Using Malmquist Approach: A Case of Karnataka and Undivided Andhra Pradesh Regional Rural Banks (RRBs)

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ABSTRACT

The paper endeavours to analyse the intertemporal variations in total factor productivity (TFP) in regard to financial efficiency and financial inclusion among the Regional Rural Banks (RRBs) in Karnataka and undivided Andhra Pradesh (AP) across the period of their amalgamation (1999-2011). Considering suitable proxies for financial efficiency (FE) and financial inclusion (Incl) from the annual RRB balance sheet(s) data the TFP of 'RRB's in regard to 'financial efficiency' and 'financial inclusion' across the period of their amalgamation were estimated using the data envelopment analysis (DEA) technique based FEAR programme in R. The findings of the study reveal that the impact on the RRB amalgamation on TFP has been largely indifferent in regard to financial efficiency and financial inclusion among the sample RRBs of Karnataka and Undivided AP. That such indifference could be attributed to the frequent, wavering state policy revisions over the 2000s in the norms pertaining to bank-intermediation in general, and priority sector lending in particular. Such revisions had virtually vitiated the prospects of sustainable branch-level lending for RRBs as evidenced from the negative correlations between technical efficiency (TE) scores in regard to financial efficiency and inclusion for certain years only in the post-amalgamation period as in case of Karnataka RRBs.

Keywords: Financial efficiency, Financial inclusion, Regional rural banks, Karnataka

JEL: C02, C61, G21.

I

INTRODUCTION

The onset of financial sector reforms in response to the economic crisis during the early-1990s led to a spate of changes in policy, regulation and practices in the banking sector as well. These changes cumulatively phrased as the "second phase of economic reforms" or 'banking sector reforms' in the latter half of the nineties, were intended to equip banks on certain regulatory standards of global financial resilience,[1] thereby withstand and operate in an increasingly competitive environment (Toor, 2006, p.1.2). Also given the role of banking as the life-blood of economic activity in general, and given preponderant presence of state-owned banks in the Indian economy (in terms of percentage share in assets to gross domestic product),

efficiency and productivity of banks (as intermediaries of economic activity as also in terms of resource use efficiency) have been the perennial focus of academic research since then.

1.1. *Institutional Reforms in Banking, RRBs, Rural Credit, Supervision and Consolidation*

Historically, the multi-agency approach[2] in rural credit had been highlighted as the policy panacea from the early 1970s to the erstwhile challenges faced by rural areas in regard to financial inclusion. Bank nationalisation in the early seventies while bringing in the social mandate; courtesy the public ownership did not result in the kind of permeation of access to financial services in the rural areas.

The establishment of the regional rural banks (RRBs) in the mid-1970s had been envisioned as the institutional response on part of the extant policy planners to the twin problems of 'lack of network' and the 'lack of appropriate attitude' on part of the commercial bank establishment to enable provision to rural institutional finance for the masses (Reddy, 2012, Srinivasan, 2016).

The economic liberalisation of the nineties instead sounded the death knell for 'social and development banking' in praxis during the earlier decades-in its obsession to comply with "standards of international best practices" in regard to prudential regulation and institutional supervision in the wake of financial liberalisation that had been thrusted upon the economy on an across-the-board basis (Swaminathan and Ramachandran, 2004). Such an obsession on institutional compliance with international standards on regulation had necessitated regulatory convergence among institutions involved in broadly similar activities. Given the large systemic implications of commercial banking in general, many of the regulatory and supervisory norms[3] that were initiated first for commercial banks, had been later indiscriminately extended to their sponsored rural financial institutions (RFIs), viz., regional rural banks (RRBs) as well (Mohan, 2005).

In the context of the RRBs as well, reforms[4] largely followed the pattern as that of commercial banks irrespective of their role in rural institutional finance, indifferent to their special status in regard to the social mandates expected of them and the set of policies hitherto governing them. Under the reforms wrought by liberalisation, regional rural banks have had to forego access to concessionary finances. Commercialisation of the agricultural sector had resulted in increased dependency on bank credit over the nineties, while the deregulation in the interest rates, lack of public investment and liberalisation of agricultural markets during this period had resulted in rampant agrarian distress at large on the one hand, while rendering the health of the public banks (read RRBs) exposed to agriculture increasingly vulnerable on the other. Moreover the high risk perception attributed to agriculture under the Basel framework have additionally necessitated stricter prudential norms under 'capital adequacy and provisioning' which resulted in a significant retreat of rural institutional lending[5] during this period.

While the reforms had led to a restoration of bank profitability, its attendant costs in terms of an abject neglect of agriculture and the rural credit sector at large had become perceptibly significant (Satish, 2007). Critics of liberalisation have been vocal of the urban bias of state policy on institutional lending in its endeavour to place premium on 'profitability' to utter neglect of 'distributive concerns' across the rural-urban divide (Jayadev, 2013). By 2003-04, as a result of such reform measures large scale effects of rural disintermediation[6] in the form of rampant agrarian distress and stagnation of the rural economy had become discernibly evident. Notwithstanding the above, various committees set up to look into the issue of restructuring of the RRBs inordinately stressed upon the issues of 'ownership and capital adequacy' in the wake of persistent rise in the NPA levels-almost to the exclusion of institutional dimensions of their rural credit activity which eventually led to their amalgamation (Bhatt and Thorat, 2001; Bose, 2005).The amalgamation of the RRBs that ended up being the 'soft policy response' was purportedly aimed at enhancing "institutional viability" at large in the wake of their presumption regarding the possible worsening of the extant underlying trade-offs between financial efficiency and financial inclusion in regard to the RRBs model of financial intermediation in the backdrop of a rapidly liberalising economic environment.

1.2 *Consolidation of the RRBs*

Since their inception, there have been two broad phases in the *amalgamation* of the RRBs in the country. In the first phase (September 2005-March 2010), RRBs of the 'same sponsor' banks 'within the state' were amalgamated bringing down their number to 82 from 196. In the subsequent and ongoing phase, since October 2012, geographically contiguous RRBs 'within a state' under 'different sponsor banks' were to-be amalgamated to have just one RRB in medium-sized states and two/three RRBs in large states.[7]

The estimates on TFP using the DEA models under the bootstrap approach were computed using the Frontier Efficiency Analysis using R (FEAR) package developed by Wilson (2009). To realise aforementioned objective, the present study involves a two-stage-procedure. In the first stage, the study uses data envelopment analysis (DEA), the non-parametric frontier technique, to obtain the estimates of overall technical, pure technical, and scale efficiencies[8] for individual RRBs in regard to financial efficiency and financial inclusion across the amalgamation period. Later, estimation of the total factor productivity (TFP) in regard to financial efficiency and financial inclusion was undertaken using the Bootstrapped Malmquist Productivity Index (MPI) approach for the select sample of RRBs across the period of their amalgamation (1999-2011). This study limits its focus on the TFP findings only for the sample data under consideration. The structure of the paper is as follows: Section II provides a brief review of literature in regard to use of DEA for efficiency and productivity analysis of Indian commercial banks banking area in general; and RRBs

in particular. Section III provides a theoretical exposition on total factor productivity (TFP) in the context of the non-parametric DEA methodology using with the Bootstrapped Malmquist Productivity Index approach. The details in regard to the objectives and sample data considered are given in Section IV. Methodology and analysis of the sample data have been elaborated in Section V, while the final section gives the results and conclusion.

II

LITERATURE REVIEW

Contemporary studies in terms of the extant copious literature in regard to efficiency and productivity analysis of Indian commercial banks have in general, resorted to the use of either the parametric Stochastic Production Frontier (SPF) analysis and/or the non-parametric technique of Data Envelopment Analysis (DEA). Notwithstanding the above, to the author's knowledge, in the context of regional rural banks (RRBs); barring few studies, viz., Reddy (2006), Khankhoje and Sathya (2008) and Kaur *et al*. (2011) that have attempted a performance appraisal of RRBs by using frontier and data envelopment analysis approach respectively; none exists in regard to efficiency and total factor productivity (TFP) analysis of RRBs in particular. Further none of the aforesaid sparse studies pertain to the period of amalgamation of the RRBs. Thus the relevance and significance of our study in a contemporary context is further reinforced in the light of the foregoing scanty literary evidence in regard to the RRBs.

III

MEASURING TFP USING THE BOOTSTRAPPED MPI APPROACH: AN OVERVIEW

The concept of Total Factor Productivity (TFP) refers to the technical relationship between outputs and inputs for given level of production process characterised by extant technological and economic conditions (Primorac and Troskot, 2005). Under a multi-input-output production process, the evolution in ratio of output-input use over time reflects a change in the productivity of the firm or bank in general. The productivity for any given decision-making unit (DMU) or firm is therefore defined as the ratio of the index of the level of output and the index of the level of inputs. Thus, index numbers, viz., the Malmquist Productivity Index (or MPI) which was introduced by Caves *et al*. (1982), are used to measure the changes in productivity between two sets of data across different time periods. Following the work of Färe *et al.* (1994), MPI has since been the standard methodology to evaluate the productivity over time especially under the non-parametric DEA methodology (Primorac and Troskot, 2005).

For the present study, we adopt the output-oriented distance functions to calculate the Malmquist productivity index (MPI) has been selected to analyse the productivity

of RRBs across the period of their amalgamation. MPI approach is usually preferred as it allows the decomposition of productivity into two mutually exclusive components namely, (a) technical efficiency change, and (b) technological change even in the absence of price information and pre-determined optimality criterion such as cost minimisation or profit maximisation. The main disadvantage of the MPI is the lack of a stochastic specification and thus, making it insensitive to any random shocks or data measurement errors (Kumar and Arora, 2011). This limitation is adequately addressed by the adoption of Bootstrapping Malmquist approach using the FEAR package in R (Coelli *et al.* 2005, Simar and Wilson, 1999). In generic sense, MPI is a defined as the product of relative change in efficiency between time *t* and *t+1* (called the catch-up effect) and the technology change occurring between time *t* and *t+1* (called the frontier-shift effect). Further if $M_n > 1$, then productivity has improved over time, and if $M_n < 1$, then we say that productivity has worsened, and if $M_n = 1$ then it indicates absence of change over time in firm's productivity (Alrashidi, 2016).

The TFP change, as measured by MPI, between periods t and $t+1$, can be defined using the period 't' technology as

$$M_n^t (x^{t+1}, y^{t+1}, x^t, y^t) = D_n^t (y^{t+1}, x^{t+1}) / D_n^t (y^t, x^t) \qquad \text{....(1)}$$

Similarly, the MPI using the period 't' technology may be defined as

$$M_n^{t+1} = D_n^{t+1} (y^{t+1}, x^{t+1}) / D_n^{t+1} (y^t, x^t) \qquad \text{....(2)}$$

In order to avoid choosing the MPI of an arbitrary period Färe et al. (1994) specified the Malmquist productivity change index $'M_n'$ as the geometric mean of M_n^t and M_n^{t+1}. Here $D_n^t (y^{t+1}, x^{t+1})$ denotes the input-based distance function of the firm at point (y^{t+1}, x^{t+1}) with reference to the frontier at time $'t'$ and vice-versa under the Shephard distance function approach to efficiency measurement.

Bootstrapping Under the MPI Framework

Bootstrapping is used to correct for the bias in DEA estimators due to the presence of random errors and testing for statistical significance of the estimated Shephard distance functions for computing the 'Malmquist indices' using confidence intervals. Ignoring the statistical noise in the estimation can lead to biased DEA estimates and misleading results because all the deviations from the frontier are considered to be inefficient (Coelli *et al.* 2005, Simar and Wilson, 1999). In this paper, using the output-oriented DEA model, annual bias-corrected technical efficiencies[9] with constant returns to scale, variable returns to scale (after isolating the bias term), and the various bootstrapped Malmquist indices and TFP scores along with their respective confidence intervals were estimated using the package FEAR developed by Wilson (2009).

IV

OBJECTIVE AND SAMPLE DATA OF THE STUDY

The study primarily endeavours to analyse the intertemporal variations in total factor productivity in regard to financial efficiency and financial inclusion among the RRBs across the period of their amalgamation (1999-2011). For the purpose of the present study, the sample data[10] of regional rural banks (RRBs) includes the RRBs of the Undivided State of Andhra Pradesh and Karnataka only. Table 1 shows the details regarding the evolution of the amalgamation of the sample data of RRBs at different stages for the period under study. The impact of amalgamation on TFP has been assessed using the non-parametric frontier technique, viz., Data Envelopment Analysis.

TABLE 1. EVOLUTION OF SAMPLE RRBS (ACROSS THEIR AMALGAMATION)

Evolution of Undivided AP RRBs as on March					
2003		2006		2007	
S.No.	Name of the RRB	S.No.	Name of the RRB	S.No.	Name of the RRB
(1)	(2)	(3)	(4)	(5)	(6)
(1)	Nagarjuna GB[#]	(1)	APGVB	(1)	APGVB
(2)	Sri Visakha GB				
(3)	Sangameshwra GB				
(4)	Manjira GB				
(5)	Kakathiya GB				
(6)	Chaitanya GB	(2)	CGGB	(2)	CGGB
(7)	Godavari GB				
(8)	Sri Saraswathi GB	(3)	TGB	(3)	TGB
(9)	Sathavahana GB				
(10)	Golconda GB				
(11)	Srirama GB				
(12)	Kanakadugra GB	(4)	Kanakadurga GB	(4)	SAPTAGIRI
(13)	Shri Venketeshwara GB	(5)	Shri Venketeshwara GB		
(14)	Pinakini GB	(6)	Pinakini GB	(5)	APGB
(15)	Rayalseema GB	(7)	Rayalaseema GB		
(16)	Sree Anantha GB	(8)	Sree Anantha GB		
Evolution of Karnataka RRBs as on March					
2003		2006		2007	
S.No.	Name of the RRB	S.No.	Name of the RRB	S.No.	Name of the RRB
(1)	(2)	(3)	(4)	(5)	(6)
(1)	Tungabhadra GB	(1)	Pragathi GB	(1)	Pragathi GB
(2)	Chitradurga GB				
(3)	Sahyadri GB				
(4)	Kolar GB				
(5)	Krishna GB	(2)	Krishna GB	(2)	Krishna GB
(6)	Cauvery GB	(3)	Cauvery GB	(3)	Cauvery- Kalpatharu GB
(7)	Kalpatharu GB	(4)	Kalpatharu GB		
(8)	Malaprabha GB	(5)	Chickmangalur-Kodagu GB	(4)	Chickmangalur-Kodagu GB
(9)	Bijapur GB	(6)	Karnataka Vikas GB	(5)	Karnataka Vikas GB
(10)	Vardha GB				
(11)	Netravati GB				
(12)	Chickmangalur-Kodagu GB				
(13)	Visweswaraya GB	(7)	Visweswaraya GB	(6)	Visweswaraya GB

Source: NABARD documents, # GB stands for Grameena Bank

Data and Specification of Variables

The study considered two different models for estimation of technical efficiency (TE) and TFP for the sample RRBs across the amalgamation period. One, TE and TFP estimation for financial efficiency (or FE), having total income per branch (as the proxy variable for financial efficiency) as the lone output variable under Model 1, and two, TE and TFP estimation for financial Inclusion (or Incl), having total business per branch (as equivalent to sum of 'total deposits per branch' and total advances per branch) as the proxy variable for financial inclusion as the lone output variable under Model 2.

In general financial efficiency is considered usually in terms of commercial viability or in other words 'maximisation of profit' for a given level of factor(s) investment. In the present study context 'financial efficiency' of the RRBs is perceived as a latent variable, proxied holistically[11] by the 'total income' variable which is the sum total of interest income and non-interest income as considered under accounting terminology. Similarly for 'financial inclusion', the study considered 'total business per branch' as the appropriate proxy variable, defined as the aggregate sum of savings and advances (considered in 'per branch' terms) as being the wholesome indicator variable of bank performance under the framework of financial inclusion.

As regards input variables**,** under Model 1 for financial efficiency (with total income per branch as the lone proxy 'output' variable), four metric[12] input variables were considered for implementing the FEAR package routine (Wilson, 2009) for estimation of TE and TFP respectively. These input variables were 'fixed assets per branch' (FA) as the fixed factor input variable, followed by 'gross advances per branch (GAdv), 'gross investment per branch' (GInv) and 'staff per branch' (Staff) as the three other variable inputs. Under Model 2, for financial inclusion (with total business per branch as the lone proxy 'output' variable), the study considered only three metric [13]input variables viz. 'fixed assets per branch' (FA), 'gross investment per branch' (GInv) and 'staff per branch' (Staff) for implementing the FEAR package routine (Wilson, 2009b) for estimation of TE and TFP respectively.

Period of the Study: The sample panel data of input-output variables comprised those of 29 RRBs (13 RRBs of Karnataka and 16 RRBs of Undivided AP) for the pre-merger period (viz., 1999-2003) of 5 years and 11 RRBs (6 RRBs of Karnataka and 5 RRBs of Undivided AP for the post-merger period (viz., 2007-2011) of 5 years each respectively.

V

METHODOLOGY AND ANALYSIS OF THE SAMPLE DATA

The methodology adopted regarding the present study objective of assessing the 'inter temporal' variations in 'total factor productivity' (TFP) of the sample RRBs in

regard to financial efficiency and financial inclusion across the period of amalgamation comprised a two-stage procedure as elucidated below:

Computing RRB-wise TFP in regard to Financial Efficiency and Inclusion

In the first stage, the study uses data envelopment analysis (DEA), a non-parametric frontier technique, to obtain the estimates of overall technical, pure technical, and scale efficiencies for individual RRBs in regard to financial efficiency and financial inclusion across the amalgamation period.

Later, estimation of the 'total factor productivity' (TFP) in regard to financial efficiency and financial inclusion was undertaken using the Bootstrapped Malmquist Productivity Index (MPI) approach for the select sample of RRBs across the period of their amalgamation (1999-2011).

Analysis of the Sample Data

Initially, the study inquires into the question of significance differences in technical efficiency (TE) in regard to financial efficiency and inclusion among the sample RRBs of Karnataka and Undivided AP across the period of their amalgamation. For the above purpose, four statistical tests, viz. ANOVA, Mann-Whitney-U test, Kruskal-Wallis test, and Kolmogorov-Smirnov test were applied on the mean and median pure technical efficiency (PTE) scores of RRBs of both the sub-periods across the amalgamation. Given that the input-output variables for the study were based on branch-level data of the RRBs; the study inquired into the statistical significance in regard to the differences in managerial efficiency only (as reflected by bias-corrected PTE scores) across amalgamation for the sample RRBs as against 'overall technical efficiency' (OTE) and 'scale efficiency' scores for both states respectively. All the tests under the study, favoured the acceptance of null hypothesis. In fact, all of the tests illustrated a secular outcome in terms of 'no significant difference' for both sub-periods in the bias-corrected pure technical efficiency scores for the sample RRBs of Karnataka and Undivided AP across the period of their amalgamation (Table 2). This result effectively corroborates our erstwhile assertion in regard to the insignificance of amalgamation on technical efficiency (TE) in regard to financial efficiency and inclusion for the sample RRBs of Karnataka and Undivided AP.

On the Efficiency-Inclusion Trade-off Contention

That the amalgamation of RRBs had augmented the fragility of the extant framework of institutional lending of RRBs at the branch level---is corroborated by the fluctuating and inconsistent evidence of trade-offs between financial efficiency and inclusion in terms of negative correlation scores between TE (efficiency) and TE

TABLE 2. TEST OF DIFFERENCES IN PURE TECH EFFICIENCY (PTE) SCORES FOR SAMPLE RRBS
ACROSS AMALGAMATION

State	Karnataka RRBs				
Mean	Type of sample scores	FE	Decision	Incl	Decision
(1)	(2)	(3)	(4)	(5)	(6)
S.No	Test Applied (Statistics)				
	ANOVA (F-statistics)	0.177 (0.685)	Insig	1.362 (0.277)	Insig
	Mann Whitney' U (Z-statistics)	8.00 (0.421)	Insig	4.00 (0.095)	Insig
	Kruskal-wallis (χ2-statistics)	0.889 (0.685)	Insig	3.153 (0.076)	Insig
	Kolmogorov-Smirnov (D-Stats)	0.177 (0.685)	Insig	1.265 (0.082)	Insig
Median		FE	Decision	Incl	Decision
S.No	Test Applied (Statistics)				
	ANOVA (F-statistics)	0.136 (0.722)	Insig	1.633(0.237)	Insig
	Mann Whitney' U (Z-statistics)	9.00 (0.548)	Insig	4.000 (0.095)	Insig
	Kruskal-wallis (χ2-statistics)	0.538 (0.463)	Insig	3.172 (0.075)	Insig
	Kolmogorov-Smirnov (D-Stats)	0.632 (0.819)	Insig	1.265 (0.082)	Insig
State	Andhra Pradesh RRBs				
	Type of Sample Scores				
Mean		FE	Decision	Incl	Decision
S.No	Test Applied (Statistics)				
1	ANOVA (F-statistics)	0.875 (0.377)	Insig	0.680 (0.433)	Insig
2	Mann Whitney' U (Z-statistics)	5.00 (0.151)	Insig	12.000 (1.000)	Insig
3	Kruskal-wallis (χ2-statistics)	2.47 (0.116)	Insig	0.011 (0.917)	Insig
4	Kolmogorov-Smirnov (D-Stats)	0.949 (0.329)	Insig	0.316 (1.000)	Insig
Median		FE	Decision	Incl	Decision
S.No	Test Applied (Statistics)				
1	ANOVA (F-statistics)	0.764 (0.408)	Insig	0.707 (0.425)	Insig
2	Mann Whitney' U (Z-statistics)	4.00 (0.095)	Insig	10.5 (0.69)	Insig
3	Kruskal-wallis (χ2-statistics)	3.172 (0.075)	Insig	0.176 (0.675)	Insig
4	Kolmogorov-Smirnov (D-Stats)	1.265 (0.082)	Insig	0.316 (1.000)	Insig

Source: Author's calculation. Figures in brackets indicate the p-value at 5 per cent level of significance.

(Incl.) for certain years only (in particular for Karnataka RRBs) in the post-merger period. As regards Undivided AP RRBs, the correlation scores between TE (efficiency) and TE (Incl.) for all the other years (barring 2007) across the period of amalgamation remained positive validating the long-standing assertion in regard to the absence of the alleged efficiency-inclusion trade-offs that had been cited as the ground for the amalgamation of the RRBs on a nation-wide basis (Table 3).

On Total Factor Productivity (in Regard to Financial Efficiency) of RRBs

For the sample RRBs of Karnataka, one finds that the trend graph of the MPI in regard to financial efficiency witnessed sharp fluctuations, exhibiting negative TFP rates of growth in both pre-and post-merger period. Contrastingly, for the RRBs of Undivided AP, barring the year 2003, the trend graph of MPI in regard to efficiency across the amalgamation remained though largely stable and non-negative but, exhibited low to marginal rates of growth in regard to TFP (Figure 1). For RRB-wise details on MPI and TFP values in regard to financial efficiency for the sample RRBs of Karnataka and Undivided AP see Table 4.

TABLE 3. CORRELATION SCORES BETWEEN TE (FE) and TE (INCL)

State	Karnataka		Andhra Pradesh	
Year	CRS[#]	VRS[#]	CRS[#]	VRS[#]
(1)	(2)	(3)	(4)	(5)
Pre-Merger				
1999	0.72	0.80	0.46	0.17
2000	0.97	0.96	0.81	0.92
2001	0.65	0.56	0.34	0.29
2002	0.61	0.61	0.16	0.23
2003	0.41	0.63	0.19	0.52
Post-Merger				
2007	- 0.47	- 0.49	0.1	- 0.36
2008	0.37	0.79	0.54	0.24
2009	- 0.78	- 0.68	0.42	0.23
2010	0.41	0.81	0.90	0.51
2011	- 0.20	- 0.55	0.81	0.65

Source: Author's calculation, #Figures under the column are bias-corrected values at 5 per cent level of significance.
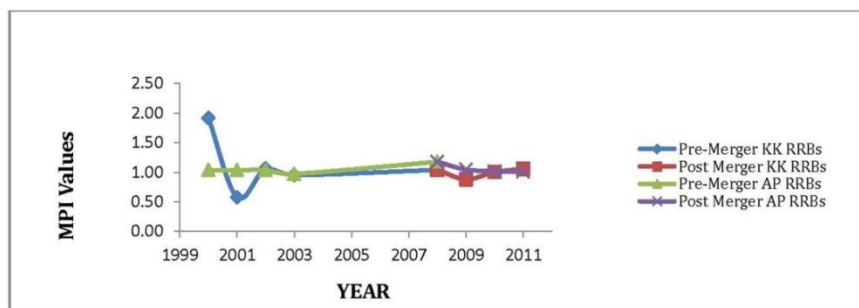
Source: Author's calculation.
Figure 1. Trends in MPI-FE for Sample RRBs.

TABLE 4. RRB-WISE MPI-(FE). ESTIMATES ACROSS THE AMALGAMATION PERIOD

State	Karnataka				Andhra Pradesh			
Period	Pre-Merger MPI-FE				Pre-Merger MPI-FE			
DMU	99/00*	00/01*	01/02*	02/03*	99/00*	00/01*	01/02*	02/03*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	6.072	0.178	1.169	1.001	0.78	1.03	1.09	1.03
2	10.391	0.105	1.016	1.018	1.05	0.95	1.12	0.94
3	3.905	0.190	1.170	0.906	1.17	0.99	0.93	0.80
4	4.336	0.250	1.030	0.821	1.08	1.06	1.02	0.93
5	3.020	0.403	1.273	0.854	0.85	1.05	0.86	1.12
6	1.820	0.671	0.935	1.021	1.07	1.09	1.21	1.18
7	0.832	1.206	0.962	1.022	0.99	1.14	0.92	1.00
8	1.906	0.756	0.971	1.079	1.25	0.98	0.96	0.91
9	1.010	0.925	0.913	1.019	1.08	1.10	1.20	1.00
10	0.903	1.402	1.160	0.999	1.20	1.20	0.95	1.00
11	0.622	1.738	1.140	0.906	0.93	0.92	1.20	1.10
12	1.223	0.917	1.134	0.873	1.04	0.98	1.09	1.08
13	0.715	1.702	1.034	0.922	1.21	1.00	1.03	0.53
14	-	-	-	-	1.45	0.84	0.98	1.07
15	-	-	-	-	1.13	0.99	1.03	0.94
16	-	-	-	-	0.64	1.35	1.02	1.14

(Contd.)

TABLE 4. CONCLD.

State	Karnataka				Andhra Pradesh			
Period	Pre-Merger MPI-FE				Pre-Merger MPI-FE			
DMU	99/00*	00/01*	01/02*	02/03*	99/00*	00/01*	01/02*	02/03*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Pre Merger								
MPI-Mean	1.91	0.58	1.06	0.95	1.04	1.04	1.04	0.97
TFP†	91.4	-42.4	6.5	-4.6	3.91	3.66	3.52	-2.74
Period	Post Merger MPI				Post Merger MPI			
DMU	07/08*	08/09*	09/10*	10/11*	07/08*	08/09*	09/10*	10/11*
1	1.143	0.983	0.998	0.944	1.347	0.906	1.040	0.992
2	1.127	0.892	0.896	1.026	0.991	1.076	0.998	1.031
3	0.992	0.798	0.973	1.111	1.195	0.913	0.981	0.869
4	1.076	0.902	1.133	1.141	1.142	1.112	0.980	1.045
5	0.973	0.990	0.938	1.116	1.239	1.263	1.031	1.125
6	0.950	0.745	1.105	1.022	-	-	-	-
Post Merger								
MPI-Mean	1.04	0.88	1.00	1.06	1.18	1.05	1.01	1.01
TFP	4.06	-11.96	0.36	5.76	17.66	4.57	0.56	0.86

Source: Author's calculation. *All values under the column are significant at 5 per cent level of significance.
†TFP in the table above has been obtained from the corresponding MPI value using the relation TFP=(MPI-1)*100.

Mann Whitney's Test Results (TFP-Financial Efficiency)

In regard to the sample RRBs of Karnataka, the results of the Non parametric Mann Whitney's Test showed no significant difference (U = 7.5, p = 0.89) in MPI scores and in TFP scores (U= 7.0, p = 0.89) in regard to financial efficiency across the period of amalgamation. As regards the sample RRBs of Undivided AP, the results of the Non parametric Mann Whitney's Test as well indicated no significant difference (U = 6, p = 0.69) in MPI scores and in TFP scores (U= 8.0, p = 1.00) in regard to financial efficiency across the period of amalgamation (Table 5). In other words, total factor productivity (TFP) in regard to financial efficiency for the sample RRBs of Karnataka and Undivided AP remained invariant across the period of their amalgamation despite the wide-ranging fluctuations in TFP scores especially in case of Karnataka RRBs in the pre-merger period.

## On Total Factor Productivity (in Regard to Financial Inclusion) of RRBs

As in case of financial efficiency, for the sample RRBs of Karnataka, one finds that the trend graph of the MPI in regard to efficiency witnessed sharp fluctuations, exhibiting negative TFP rates of growth with consecutive negative TFP growth between 2001 and 2002. Contrastingly, for the RRBs of Undivided AP, barring the year 2011, the trend graph of MPI in regard to efficiency across the amalgamation remained though largely stable and non-negative but, exhibited low to marginal rates of growth in regard to TFP (Figure 2). Table 6 in the Appendix section, gives the RRB-wise details on MPI and TFP values in regard to financial inclusion for the sample RRBs of Karnataka and Undivided AP.

TABLE 5. AVG. TRENDS IN MPI (FIN. EFF) and TFP (FIN. EFF.) FOR SAMPLE RRBS

State	Karnataka		Andhra Pradesh	
Phase	No. of RRBs		No. of RRBs	
Pre Merger	13		16	
Post Merger	6		5	
Year	MPI-FE*†	TFP-FE	MPI-FE*	TFP-FE
(1)	(2)	(3)	(4)	(5)
99/00	1.91	91.37	1.039	3.91
00/01	0.58	- 42.41	1.037	3.66
01/02	1.06	6.45	1.035	3.52
02/03	0.95	- 4.61	0.973	- 2.74
07/08	1.04	4.06	1.177	3.91
08/09	0.88	- 11.96	1.046	3.66
09/10	1.00	0.36	1.006	3.52
10/11	1.06	5.76	1.009	- 2.74
Mean				
Entire Period	1.011	1.06	1.04	3.86
Premerger	1.03	2.85	1.02	2.05
Post Merger	0.99	- 0.70	1.06	5.70
Median	1.02	2.21	1.04	3.59
Standard Deviation	0.38	37.99	0.06	2.98
Skewness	1.75	1.73	1.839	- 1.43
Kurtosis	4.76	4.73	4.660	- 0.01
	Test Statistics			
Mann-Whitney U	7.50	7.00	6.00	8.00
Wilcoxon W	17.50	17.00	16.00	18.00
Z	- 0.145	- 0.29	- 0.58	0.00
Asymp. Sig. (2-tailed)	0.885	0.77	0.56	1.00
Exact Sig. [2*(1-tailed Sig.)]	0.89	0.89	0.69	1.00

Source: Author's calculation, *All values under the column are significant at 5 per cent level of significance.
    †The bias-corrected MPI values in the table were computed using the 'Bootstrapped Mechanism' under the MPI approach using the FEAR package (Wilson, 2009b).
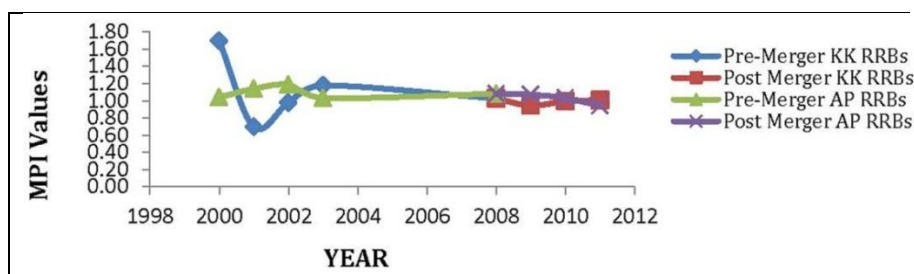
Source: Author's calculation.
Figure 2. Trends in MPI-Incl for Sample RRBs.

Mann Whitney's Test Results (TFP-Inclusion)

In regard to the sample RRBs of Karnataka, the results of the Non parametric Mann Whitney's Test showed no significant difference (U = 7.0, p = 0.89) in MPI scores and in TFP scores (U= 7.0, p = 0.89) in regard to financial inclusion across the period of amalgamation. In regard to the sample RRBs of Undivided AP, the results

TABLE 6. RRB-WISE MPI-INCL†. ESTIMATES ACROSS THE AMALGAMATION PERIOD

State	Karnataka				Andhra Pradesh			
Period	Pre-Merger MPI				Pre-Merger MPI			
DMU	99/00*	00/01*	01/02*	02/03*	99/00*	00/01*	01/02*	02/03*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	3.729	0.319	0.894	1.437	0.833	1.147	1.143	1.07
2	6.811	0.195	0.931	1.149	1.042	1.051	1.163	1.11
3	2.439	0.300	1.120	1.152	1.000	1.096	1.156	0.92
4	2.865	0.402	0.957	1.124	1.150	1.100	1.266	1.04
5	2.316	0.543	0.968	1.293	0.893	1.073	0.989	1.25
6	1.533	0.818	1.144	0.972	1.159	1.225	1.562	0.80
7	0.949	1.190	1.100	1.157	0.977	1.113	1.178	0.90
8	1.478	0.917	0.972	1.192	1.316	0.988	1.130	1.08
9	1.023	1.004	0.926	1.080	1.075	1.123	1.026	1.18
10	1.088	1.368	1.090	1.111	1.092	1.269	1.027	1.14
11	0.908	1.296	0.890	1.237	0.934	1.021	1.275	1.20
12	1.189	0.978	0.856	1.325	1.022	1.116	1.205	0.96
13	0.916	1.376	0.932	1.149	1.361	1.177	1.400	0.85
14	-	-	-	-	1.163	1.115	1.272	1.04
15	-	-	-	-	1.077	1.087	1.199	1.09
16	-	-	-	-	0.741	1.656	1.134	1.04
Pre Merger MPI-Mean	1.70	0.69	0.98	1.18	1.04	1.14	1.19	1.03
TFP‡	69.8	- 30.6	- 2.1	17.8	4.03	13.93	18.77	3.37
Period	Post Merger MPI				Post Merger MPI			
DMU	07/08*	08/09*	09/10*	10/11*	07/08*	08/09*	09/10*	10/11*
1	1.17	0.89	1.08	0.94	1.18	1.01	1.01	1.10
2	0.90	0.84	1.01	0.94	0.98	0.93	1.37	0.73
3	1.03	1.01	0.89	1.13	1.08	1.00	0.97	0.81
4	1.18	0.95	1.18	1.03	1.14	1.17	0.91	1.06
5	1.03	1.15	0.88	1.01	1.05	1.29	0.96	1.08
6	0.91	0.86	0.95	1.01	-	-	-	-
Post Merger MPI-Mean	1.03	0.94	0.995	1.01	1.08	1.07	1.03	0.94
TFP	2.79	- 5.59	- 0.48	0.80	8.12	7.06	3.17	- 5.81

Source: Author's calculation, *All values under the column are significant at 5 per cent level of significance.
†Incl-represents Inclusion or Model 2 under the present study. ‡TFP in the table above has been obtained from the corresponding MPI value using the relation TFP=(MPI-1)*100.

of the non-parametric Mann Whitney's Test showed no significant difference (U = 4.5, p = 0.34) in MPI scores and in TFP scores (U= 4.0, p = 0.34) as well in regard to financial inclusion across the period of amalgamation. In other words, total factor productivity (TFP) in regard to financial inclusion for the sample RRBs of Karnataka and Undivided AP remained largely invariant across the period of their amalgamation despite the wide-ranging fluctuations in TFP scores especially in case of Karnataka RRBs in the pre-merger period (Table 7).

VI

RESULTS AND CONCLUSION

The results reveal that impact on the RRB amalgamation on technical efficiency has been largely invariant in regard to financial efficiency and financial inclusion

TABLE 7. AVG. TRENDS IN MPI (INCL) and TFP (INCL) FOR SAMPLE RRBS

State	Karnataka		Andhra Pradesh	
Phase	No. of RRBs		No. of RRBs	
Pre Merger	13		16	
Post Merger	6		5	
Year	MPI-Incl*†	TFP-Incl	MPI-Incl*	TFP-Incl
(1)	(2)	(3)	(4)	(5)
99/00	1.70	69.77	1.04	4.03
00/01	0.69	- 30.59	1.14	13.93
01/02	0.98	- 2.12	1.19	18.77
02/03	1.18	17.77	1.03	3.37
07/08	1.03	2.79	1.08	8.12
08/09	0.94	- 5.59	1.07	7.06
09/10	1.00	-0.48	1.03	3.17
10/11	1.01	0.80	0.94	- 5.81
Mean				
Entire Period	1.036	3.56	1.06	6.35
Premerger	1.08	7.96	1.10	9.83
Post Merger	0.99	- 0.67	1.03	2.99
Median	1.01	0.16	1.06	5.55
Standard Deviation	0.29	28.84	0.08	7.44
Skewness	1.56	1.59	0.14	0.10
Kurtosis	3.93	3.99	0.54	0.58
	Test Statistics			
Mann-Whitney U	7.00	7.00	4.50	4.00
Wilcoxon W	17.00	17.00	14.50	14.00
Z	- 0.29	- 0.29	- 1.02	- 1.16
Asymp. Sig. (2-tailed)	0.77	0.77	0.31	0.25
Exact Sig. [2*(1-tailed Sig.)]	0.89	0.89	0.34	0.34

Source: Author's calculation. *All values under the column are significant at 5 per cent level of significance.
†The bias-corrected MPI values in the table were computed using the 'Bootstrapped Mechanism' under the MPI approach using the FEAR package (Wilson, 2009b).

among the sample Regional Rural Banks (RRBs) pertaining to Karnataka and Undivided Andhra Pradesh. Also the total factor productivity (TFP) in regard to financial efficiency and financial inclusion for the sample RRBs of Karnataka and Undivided AP remained invariant across the period of their amalgamation notwithstanding the wide-ranging fluctuations in TFP, along with negative TFP rates of growth especially in case of Karnataka RRBs in the pre-merger period (Table 5 and 7). The above findings in terms of fluctuations in TFP may be attributed to frequent and wavering state policy revisions over the latter half of the 2000s in the norms pertaining to bank-intermediation in general, and redefining of priority sector lending norms in particular in favour of those with an overtly commercial, urban bias at the policy-level. This had effectively vitiated the prospects of sustainable rural institutional lending for RRBs at the branch-level as evidenced from the negative correlations between technical efficiency (TE) scores in regard to financial efficiency and inclusion for certain years in the post-merger period as in case of Karnataka RRBs (Table 3).

NOTES

1)   Contemporary regulatory wisdom on the imperative towards adoption of regulatory standards were aimed at enhancing banking systems and procedures to international standards and also simultaneously fortifying their financial positions thereby enabling them to withstand competition in an rapidly liberalising market-economy.

2)   By the end of the 1970s, the rural finance architecture in India-comprised of three different institutions for providing rural credit-which is often described as the "multi-agency approach". These include the scheduled commercial banks (both public and private), the 3-tiered cooperative bank structure and the Regional Rural Banks or the RRBs (Srinivasan, 2016).

3)   Among the many reform measures that were introduced include recapitalisation of state-owned banks to enhance their capital bases to international standards, public listing of state-owned banks for widening of ownership, thereby induction of 'market discipline' along with phased introduction of new private sector banks and expansion in the number of foreign bank branches provided for new competition' in bank management and greater transparency in via enhanced disclosure norms (Mohan, 2005).

4)   The state policy obsession on 'profitability' and 'prudential banking' under the 'market-led economic liberalisation model in the 90s led to significant policy changes in rural banking, viz., interest rate deregulation, dilution and gradual phasing out along with a periodic revision of priority sector norms, extension of prudential norms (meant for commercially-oriented banks) to rural term-lending institutions, viz., the RRBs and other DFIs (Swaminathan and Ramachandran, 2004).

5)   Also lending and investment decisions of banks are usually known to conform broadly to the 'market principles of sound banking' and the 'competition rule'. Their lendings constraints are designed to 'ensure that their borrowers repay their debts' while their investment preferences are bound by lure of profit considerations on the one hand, and the fear of their rivals exploiting the available advantage on the other. Thus, objectives of rural financial institutions governed by such 'principles of banking' in a liberalised environment would more often than not function in contravention to long-run objectives of development (Bhaduri and Nayyar, 1996, pg 65).

6)   Evidence of bank disintermediation during the period has been illustrated by accentuated informalisation of credit markets on the one hand, as well as the drastic decline in number of borrowal accounts in the small borrowal category for all the informal sectors viz. agriculture, small scale industries (SSI), along with a decline in share of agriculture in total bank credit, credit-deposit (henceforth, C-D) ratios in the rural and semi-urban branches of all major banks in this period (Swaminathan and Ramachandran, 2004; Srinivasan 2016).

7)   In the recent phase of consolidation which began in October 2012, by merger of RRBs across sponsor banks within a State, the number of RRBs has further reduced to 64 as on March 2013 with over 17,856 branches in 635 districts notified in 26 states (ibid, 2016).

8)   In DEA literature, the measure of technical efficiency corresponding to constant returns to scale (CRS) assumption is generally referred as overall technical efficiency (OTE) which captures the efficiency due to both managerial and scale effects. It is worth noting here that the CRS assumption is only appropriate if all DMUs are operating at an optimal scale. When DMUs are not operating at optimal scale, i.e. variable returns-to-scale (VRS) prevails, the overall technical efficiency (OTE) can be decomposed into pure technical efficiency (PTE) and scale efficiency (SE). The PTE measure provides a sort of managerial efficiency i.e., the capability of the management to convert the inputs into outputs. However, the SE measure indicates whether the DMU in question is operating at optimal scale size or not. For details see Cooper *et al*. (2000).

9)   Technical efficiency (TE) generically, is defined in terms of the output maximisation for the given level of inputs and/or input minimisation for the given level of targeted output. Under the present study we use both the input-output 'production approach' (by selecting 'total income per branch as the proxy for evaluation of financial efficiency or FE) as well as the 'intermediation approach' (by selecting 'total business per branch as the proxy for evaluating Inclusion efficiency) under the standard DEA literature to estimate the TFP of RRBs across the period of their amalgamation.

10) The results discussed in the present study as a 'Working paper' is part of a similar study exercise undertaken for a larger sample of RRBs at the All-India level. Thus this study limits itself to the findings obtained for the RRBs pertaining to the states of Karnataka and Undivided Andhra Pradesh only as illustrated under Table 1.

11) Under the study 'Total Income per branch', the proxy variable for 'financial efficiency' includes Interest and Non Interest income is being considered over all other variables as it is a holistic and inclusive proxy considering that it encapsulates within itself, intermediation income (i.e. Interest Income) and non-intermediation sources of income (viz. investment income).

12) All the input and output variables considered under the study were computed using the year-wise balance sheets of the respective sample RRBs for both sub-periods across the period of their amalgamation.

13) All the input and output variables considered under the study were computed using the year-wise balance sheets of the respective sample RRBs for both sub-periods across the period of their amalgamation.

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