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Decomposition of productivity growth among the cooperative banks in Jammu and Kashmir (India)

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This paper uses the non-parametric Malmquist productivity index to investigate the total productivity change among the cooperative banks in Jammu and Kashmir from 2004 to 2019. Analysing the peculiarities of cooperative banks' productivity is essential because if productivity has increased, it should be reflected in their performance, lower client pricing, and enhanced quality services. To examine productivity changes when choices of inputs and outputs are varied, we used two distinct approaches, the intermediation approach and the income approach. Our findings show that average TFP estimates varied widely between the cooperative banks over the years. Compared to the intermediation approach, TFP growth was significantly higher than the income approach. Further, the productivity gains were driven mainly by efficiency change rather than the technological change component. Our findings have important policy implications that can serve important use to the policymakers and regulators, allowing them to devise effective methods for the cooperative banks so that they can remain competitive and sustainable.

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Introduction

Cooperative banks are consumer-owned enterprises whose purpose is to optimise their members' consumer surplus, as opposed to profit-driven commercial banks. (Fonteyne, 2007). In India, cooperative banks are one of the oldest financial intermediaries and account for 10% of total banking assets in India (RBI, 2021). Due to their vast demographic outreach, they play a crucial role in the Indian financial system. Also, these banks have figured prominently in extending conventional banking services to the section of society (marginalised income groups from both rural and urban areas) that were previously excluded by the main commercial banking. However, despite their importance in fostering the inclusiveness of the Indian financial system, these banks have been plagued by poor financial health, owing in part not only to the operational and governance constraints but also to increased competition from commercial and small payment banks. An in-depth exploration of the issues, therefore, seems necessary for bringing innovations that can increase their efficiency and productivity that will help them to confront the present issues they are facing. Improvements in productive efficiency are identified as essential to survive and thrive in an intensely challenging banking environment. In this context, research aimed at examining these institutions' efficiency and productivity have now become appealing to strengthen their outreach and performance.

Since the enactment of the Agricultural Credit Co-operative Societies Act (1904), cooperative banking in India has gone through numerous stages. Cooperative banks experienced rapid growth in the post-independence era, partly as an outcome of official policy. Cooperative banks from the beginning have played a prominent role in contributing to financial intermediation and deepening banking penetration among the masses. Cooperative banks in India operate under a complex structure consisting mainly of urban and rural cooperative institutions. Urban cooperative banks (UCBs) are further classified based on scheduled and unscheduled cooperative banks.[1] The short-term rural cooperative sector has been classified into three tyre structures primarily consisting of the state cooperative banks (StCBs) which act as nodal agencies to the rural cooperative banks operate at the upper tyre (State level), the district central cooperative banks (DCCBs) at the middle tyre providing banking services at the district level and the primary agricultural credit societies (PACs) serve the financial needs of people at primary (village) level.

Cooperative movement in Jammu and Kashmir (India) formally started with the enactment of the cooperative Act 1913, and subsequently, the cooperative banks were established under this Act. Currently, there are nine cooperative banks operating in the state. Out of these four operate under the three-tyre rural cooperative banking structure, four urban cooperative banks and one long-term cooperative bank. At the end of March 2018, cooperative banks in Jammu and Kashmir are operating through a network of 273 branches and 18 extensions, serving a population of more than 2 million people in the state. They account for 17% of banking in the state (Cooperative Registrar J&K, 2018). These banks primarily fund the state's agricultural, housing, poultry, dairy, horticulture, floriculture, and other agriculture-related businesses, among others.

Evaluating the productivity features of cooperative banks can be very useful to policymakers and regulators since if productivity has grown, this should be mirrored in better performance and higher-quality customer service. Gains in productivity that are transferred to capital enable greater risk absorption and may be a sign of more prudent banking practices (Barros et al., 2010). According to Fiordelisi and Mare (2014), cooperative banks affect the financial stability and competition in the area in which they operate. As a result, figuring out the critical impetus behind productivity growth may be helpful. Considering the cooperative's broad geographic reach and substantial population penetration, this analysis will also help in evaluating the success or failure of policy initiatives. Alternatively, it may emphasise the importance of recognising the several tactics the cooperative employs undertake so as to be relevant in the present financial environment.

In this paper, we evaluate the total factor productivity (TFP) among the cooperative banks in Jammu and Kashmir for the period 2004–19 using the DEA Malmquist productivity index. Our research contributes to the existence of knowledge in multiple ways. To our knowledge, this is the only study among Indian states that measures their total factor productivity among cooperative banks and then decomposes it into economically meaningful components. Given their unique ownership and management structure, productivity will help us in understanding to what extent banks are responsible for efficiently allocating funds to their members/clients to finance their requirements. Significant improvement in performance will be achieved if these banks are able to convert savings and deposits into outputs such as loans. Second, we examine how the TFP index varies across the cooperative bank's organisational structure. Third, we also decompose TFP change into technological, scale, and technical efficiency changes to determine the source of productivity change. Last, this study also assists in identifying sources of inefficiencies in cooperative banks, which will allow banks and states to design effective strategies to maintain their competitiveness in the financial market.

This paper's remaining sections are organised as follows: In the following section, we shall examine the efficiency and productivity of banks and cooperative banks in particular. In the section "Data and methodology", the methodology and input/output specifications are described briefly. The findings and analysis are reported in the section "Findings and analysis". We have summarised our conclusion in the section "Conclusion".

Literature review

During the past two decades, significant research has developed while evaluating the productivity and efficiency of banks using the non-parametric data envelopment analysis (DEA) and parametric stochastic frontier analysis (SFA). Although, the majority of such studies have only focused on the financial intermediaries of advanced countries with the strong financial system (see Berger and Humphrey, 1997; Mukherjee et al., 2001; Casu and Girardone, 2006; Barros et al., 2010, among others), however, lately such studies have gained increased focus in the developing countries as well (Gilbert and Wilson, 1998; Banker et al., 2010; Widiarti et al., 2017; Tekin et al., 2021, among others). Nevertheless, for various diverse regulatory measures, including various consolidation and deregulation initiatives, the bulk of this research has produced paradoxical and conflicting results.

It is vital to recognise that the majority of research on banking efficiency and productivity analysis in India concentrates on commercial banks. A number of studies have analysed these banks by focussing on the impact of financial deregulation on performance (Bhattacharyya et al., 1997; Kumbhakar and Sarkar, 2003; Das and Ghosh, 2009; Zhao et al., 2010; Casu et al., 2013, among others), diversification and banking performance (Gulati and Kumar, 2011; Ray and Das, 2010; Zaman and Bhandari, 2021, among others), convergence in bank performance (Kumar and Gulati, 2011; Casu et al., 2013; Zaman and Bhandari, 2020), and ownership performance nexus (Sarkar et al., 1998; Mohan and Ray, 2004; Bhandari, 2014, Zaman et al., 2022, among others). The contradictory findings in these studies may be attributed

to variations in inputs and outputs employed, methodology used (parametric or non-parametric), different sample periods, functional form, behavioural assumptions (such as production, profit, and cost function), among others.

Although numerous studies have looked at the performance of commercial banks while the cooperative banks' productivity and efficiency have gotten less attention. Even among the cooperative banking efficiency studies, the majority of these studies are confined to the USA and European countries. Using bank-level data from German cooperative banks, Lang and Welzel (1996) found all banks experience TFP growth, though the TFP gains were higher for smaller banks in the sample. Molyneux and Williams (2005) evaluated the productivity growth of cooperative banks in Europe for the period 1996–2003 and found that the majority of cooperative banks showed an improvement in overall productivity ranging between 3% and 6%. Barros et al. (2010) estimated and decomposed the productivity growth for a sample of cooperative banks operating in ten European union member states and found that the average annual productivity growth rate was 2.59%. While investigating the TFP growth among the Greek cooperative banks between 2000 and 2005, Pasiouras and Sifodaskalakis (2010) found that the TFP growth was lower in the case of the *intermediation approach* (3%) compared to the *production approach* (6.6%). Further, Pokharel and Featherstone (2021) investigated the productivity of agricultural cooperative banks in the United States and found productivity of 34% from 2005–14. While most of the studies view that productivities are driven by technological change (Barros et al., 2010; Pokharel and Featherstone, 2021), others attribute productivity gains to efficiency change (Pasiouras and Sifodaskalakis, 2010). Recently, using an input distance function approach Arandara and Takahashi (2022) examines the economic performance of cooperative banks in Sri Lanka and found cumulative TFP decreased rapidly during the sample period, which was attributed mainly to deterioration in scale change.

As for as India is concerned, Feroze (2012) analysed the technical efficiency of DCCBs in Kerala from 2005 to 2009 whereby he found that the source of inefficiencies in the DCCBs stem from the managerial inefficiency and inappropriate size of the DCCBs. Bhatt and Bhat (2013) examined the technical efficiency of cooperative banks in Jammu and Kashmir (India) and argued that their dismal performance is associated with rising transaction costs and nonperforming assets. In a study on urban cooperative banking in India, Ghosh and Ansari (2018) examine the correlation between performance and board characteristics. After controlling for different factors, they found that board size has no impact on the performance of these financial intermediaries. In another study, Gaurav and Krishnan (2017) investigated the performance of DCCBs and recommended that the efficiency of these institutions can be enhanced by the implementation of sophisticated technology and by upgrading risk management practices. Recently, examining the technical efficiency of scheduled UCBs in India, Raju (2018) found relatively higher average efficiency in conventional banking activities such as advances and loans compared to non-conventional fee-based activities. Furthermore, Zaman et al. (2022) looked at the technical efficiency of rural cooperative banks in India from 2013 to 2019. Their findings revealed a constant decline in the technical efficiency of rural cooperatives. The above studies have mainly highlighted the efficiency of cooperative banks; however, there is a scarcity of studies evaluating the productivity of cooperative banking in India. This study contributes to the existing literature by measuring and decomposing total factor productivity change among the cooperative banks in Jammu and Kashmir using the Malmquist index.

Data and methodology

Data and specification of outputs and inputs. Our sample includes balanced panel data for eight cooperative banks operating in Jammu and Kashmir for the period 2004–2019.[2] Individual bank-level data is culled out from the National Federation of State Cooperative Banks (NAFSCOB) database, which supplies all the relevant variables for rural cooperative banks, including all three DCCBs (*Anantnag District Central Cooperative Bank, District Central Cooperative Bank Baramulla, and Jammu District Central Cooperative Bank*) and *Jammu and Kashmir State Cooperative Bank*. The financial data for the remaining four urban cooperative banks (*Citizens Cooperative Bank, Devika Cooperative Bank, Kashmir Mercantile cooperative Bank, and Urban Cooperative Bank Anantnag*) was taken from the individual banks' income and balance sheet statements.

Selection of inputs and outputs in banking has always remained a fundamental challenge in empirical banking analysis. An asset and a liability may be considered as output or input due to their subjective nature of usage. However, there is a long-standing debate in the banking efficiency literature about whether to treat "deposits" as input or output because of their dual role. For example, it may be treated as an input since it acts as a raw material for producing loans, or alternatively, it can be considered as output since this is the channel through which banks facilitate payment services to their clients (Berger and Humphrey, 1997). Because of these complexities, three approaches have predominantly been used in the banking literature while selecting the bank's inputs and outputs: *production, intermediation* and *income approach*.[3] Under the *production approach* banks are principally regarded as service providers to customers while as, in the *intermediation approach* banks are seen as intermediating agencies between savers and investors. Furthermore, under the *income approach,* banks are considered as business units with the sole purpose of generating income from their operating cost. Berger and Humphrey (1997) argue that the intermediation approach is more appropriate when the objective is to measure bank-level efficiency while the production approach is more suitable when the objective is to estimate branch-level efficiency. Overall, the appropriateness of these approaches varies as banks undertake various functions simultaneously. However, since our objective is to measure bank-level performance and to examine the robustness of our results under alternative approaches, the present study uses (a) intermediation approach and (b) the income approach. Under the intermediation approach, *investments* and *advances* are regarded as outputs whereas *deposits* and *operational expenses* are considered as inputs. However, in the income approach, *interest expenses* and *operational expenses* are considered as inputs while the relevant outputs are *interest income* and *other income*. The summary statistics of various inputs and outputs for the approaches are reported in Table 1.

Methodology. Productivity has originally been defined as a ratio of output generated to the input used in the single input-output instance. The inputs and outputs are aggregated in the multiple input-output situations to get a scaler productivity value. However, to obtain a relative change in a firm's productivity, an index must be built for the present time in comparison to a base period. There are two sorts of productivity indexes: positive and normative. Positive measures are those in which production technology is not required. Two popular positive indicators explored in the literature are the Fisher productivity index and the Tornqvist productivity index, however, information on input and output prices is necessary for their computation. Since price information is rarely available in any production database, the

Table 1 Summary statistics of inputs and outputs (amount in Indian rupees).

Variables/Year		2004	2009	2014	2019
Panel A: Model I (intermediation approach)					
Outputs					
Investments	Mean	198,000,000	272,000,000	673,000,000	1,240,000,000
	Std. dev.	381,000,000	399,000,000	1,070,000,000	2,120,000,000
	Min	503,830	486,830	486830	12100000
	Max	1,120,000,000	1,030,000,000	3,140,000,000	6,200,000,000
Advances	Mean	750,000,000	1,250,000,000	1,210,000,000	1,560,000,000
	Std. dev.	1,110,000,000	1510000000	1270000000	1,230,000,000
	Min	26,500,000	58,300,000	184,000,000	284,000,000
	Max	3,160,000,000	4,230,000,000	3,980,000,000	3,780,000,000
Inputs					
Deposits	Mean	1,490,000,000	2,170,000,000	3,640,000,000	3,290,000,000
	Std. dev.	1,820,000,000	2,600,000,000	4,530,000,000	4,970,000,000
	Min	41,200,000	104,000,000	278,000,000	76,200,000
	Max	5,360,000,000	7,660,000,000	13,700,000,000	15,100,000,000
Operating expenses	Mean	37,200,000	55,800,000	93,000,000	156,000,000
	Std. dev.	41,500,000	64,100,000	98,100,000	174,000,000
	Min	779,045	2,149,101	8,660,239	14,500,000
	Max	128,000,000	197,000,000	295,000,000	513,000,000
Panel B: Model II (income approach)					
Outputs					
Interest income	Mean	128,000,000	185,000,000	328,000,000	372,000,000
	Std. dev.	150,000,000	207,000,000	384,000,000	410,000,000
	Min	3,738,250	10,900,000	24,800,000	51,400,000
	Max	424,000,000	592,000,000	1,130,000,000	1,210,000,000
Other income	Mean	4,069,306	6,731,020	10,600,000	18,500,000
	Std. dev.	5,898,886	12,700,000	10,600,000	27,000,000
	Min	69,965	301,822	213,133	263,553
	Max	16,000,000	37,800,000	29,800,000	83,500,000
Inputs					
Interest expenses	Mean	87,900,000	132,000,000	232,000,000	269,000,000
	Std. dev.	109,000,000	150,000,000	272,000,000	307,000,000
	Min	2,450,925	5,003,265	14,000,000	22,400,000
	Max	321,000,000	433,000,000	792,000,000	949,000,000
Operating expenses	Mean	37,200,000	55,800,000	93,000,000	156,000,000
	Std. dev.	41,500,000	64,100,000	98,100,000	174,000,000
	Min	779,045	2,149,101	8,660,239	14,500,000
	Max	128,000,000	197,000,000	295,000,000	513,000,000

Source: Author's own calculations based on data extracted from the NAFSCOB database as well as individual bank balance sheets and income statements.

Malmquist productivity index (MPI) based on (Caves et al., 1982) became quite popular in the empirical literature. The MPI is a normative assessment that requires knowledge of the benchmark production technique. In addition, parametric-based Divisia index is also used in the literature to measure the productivity of DMUs. Following Sufian (2008), Zhao et al. (2008) and Pasiouras and Sifodaskalakis (2010), we use the non-parametric data envelopment analysis (DEA) based Malmquist productivity index to assess changes in the productivity of the Jammu and Kashmir cooperative banks. DEA is a linear programming-based approach introduced by Charnes et al. (1978), popularly known as the CCR model. The CCR model assumes constant returns to scale (CRS) in the technology, free disposability of outputs and inputs and convexity of production possibility set. The CCR model was further extended to variable returns to scale (VRS) technology by Banker et al. (1984) and is popularly known as the BCC model. One important advantage of non-parametric models (e.g., DEA) over parametric models is that the DEA practitioner need not require a particular functional form on production, cost, or profit function in determining the most efficient banks from the sample. The frontier, which is created by connecting the linear combinations of the sample's best practice banks is used to measure the performance of the individual bank. Further, compared to parametric models, DEA is able to cope with small sizes (Fernandes et al., 2018), which is important as the sample size in our study is small. The input-oriented technical efficiency of the *i*th bank with VRS technology (BCC model) is calculated by solving the following mathematical programming problem (LPP):

$$\begin{aligned} &\textbf{Minimize}\ \theta_i \\ &s.t: \\ &\sum_{g=1}^{N} \lambda_g x_{mg} \le \theta_i x_{mi} \qquad for\ all\ m = 1, 2, \ldots, p \\ &\sum_{g=1}^{N} \lambda_g y_{ng} \ge y_{ni} \qquad for\ all\ n = 1, 2, \ldots, q \\ &\sum_{g=1}^{N} \lambda_g = 1 \\ &\lambda_g \ge 0 \qquad for\ all\ g = 1, 2, \ldots, N \end{aligned} \tag{1}$$

Equation (1) is solved N times once for each individual bank. Input-oriented technical efficiency of the *i*th bank is given by $TE_{io}^{vrs} = \theta^*$, and takes a value between 0 and 1.

The Malmquist TFP index calculates the difference in productivity between the two periods. For each bank, changes in TFP are computed independently. The distance from the frontier is reciprocal to the input-oriented TE score obtained in

Eq. (1). Suppose the input-output bundles be (x^{t1}, y^{t1}) and (x^{t2}, y^{t2}) at two periods $t1$ and $t2$. Then the MPI of period $t2$ taking period $t1$ as the base, with reference to $t1$ period technology, is defined as the ratio of Shephard's input distance functions.[4]

Alternatively, input-oriented MPI with reference to $t2$ period technology is defined as

$$MPI^{t1}\left(x^{t1}, x^{t2}, y^{t1}, y^{t2}\right) = \frac{D^{t2}_{crs}\left(x^{t1}, y^{t1}\right)}{D^{t2}_{crs}\left(x^{t2}, y^{t2}\right)}$$

Assuming constant returns to scale, Färe, Grosskoph, Lindgren, and Roos (hereafter, FGLR) (1992) decompose the MPI as the product of two economically meaningful components, namely efficiency change (EC) and technological change (TC) components, as follows:

$$\mathrm{MPI}\left(x^{t1}, x^{t2}, y^{t1}, y^{t2}\right) = \underbrace{\left[\frac{D^{t1}_{crs}\left(x^{t1}, y^{t1}\right)}{D^{t2}_{crs}\left(x^{t2}, y^{t2}\right)}\right]}_{\text{ECH}} \times \underbrace{\left[\frac{D^{t2}_{crs}\left(x^{t2}, y^{t2}\right)}{D^{t1}_{crs}\left(x^{t2}, y^{t2}\right)} \frac{D^{t2}_{crs}\left(x^{t1}, y^{t1}\right)}{D^{t1}_{crs}\left(x^{t1}, y^{t1}\right)}\right]^{\frac{1}{2}}}_{\text{TCH}}$$

While efficiency change (ECH) reflects the catching-up process, technological change (TCH) illustrates how near or far a firm has gone to the "best practise" frontier. With an effort to accommodate (more general) VRS technological specification, Färe, Grosskopf, Norris, and Zhang (hereafter, FGNZ) (1994) extended this decomposition into three components as follows:

$$\underbrace{\left[= \frac{D^{t1}_{crs}\left(x^{t1}, y^{t1}\right)}{D^{t2}_{vrs}\left(x^{t2}, y^{t2}\right)}\right]}_{\text{PECH}} \times \underbrace{\left[\frac{D^{t2}_{vrs}\left(x^{t2}, y^{t2}\right)}{D^{t2}_{crs}\left(x^{t2}, y^{t2}\right)} \times \frac{D^{t1}_{crs}\left(x^{t1}, y^{t1}\right)}{D^{t1}_{vrs}\left(x^{t1}, y^{t1}\right)}\right]}_{\text{SCH}} \times \underbrace{\left[\frac{D^{t2}_{crs}\left(x^{t2}, y^{t2}\right)}{D^{t1}_{crs}\left(x^{t2}, y^{t2}\right)} \times \frac{D^{t2}_{crs}\left(x^{t1}, y^{t1}\right)}{D^{t1}_{crs}\left(x^{t1}, y^{t1}\right)}\right]^{\frac{1}{2}}}_{\text{TCH}}$$

Thus, FGNZ decomposes the efficiency change component of FGLR further into two components: pure efficiency change (PECH) and scale change (SCH) components, i.e., (ECH = PECH × SCH). If MPI takes the value greater (less) than one, it indicates positive (decline) TFP growth from the period $t1$ to the period $t2$ while on the other hand, a value equal to unity stands for no change in TFP. Likewise, each of these components may take the value more than, less than or equal to unity, indicating the improvement, worsening or stagnation of the component in question respectively.

Findings and analysis

The average annual total factor productivity change (TFPH) and its individual components namely efficiency change (ECH) and technological change (TCH), pure efficiency change (PECH) and scale change (SCH) for years 2004–2019 are shown in Tables 2 and 3. In Table 2, Panel A displays the outcomes of Model I (intermediation approach), while Panel B displays the outcomes of Model II (income approach). We use the DEAP programme (Coelli, 1996) for doing all of our computations. Since TFP and all of its components are relative to the previous year, therefore estimates for 2004 are not available. The empirical results suggest large variations in the estimates of TFP and its components across banks as well as over the years. Moreover, Model I (intermediation approach) and Model II (income approach) produced different sets of productivity estimates.[5] The results were relatively higher in the income approach compared to intermediation approach.

The results of Model I (*intermediation approach*) show a marginal increase in TFP growth by 0.6% during the entire sample period of 2004–2019. Productivity growth was found to be driven by ECH (5.8% per year) rather than TCH (−4.9% per year). Cooperative banks in J&K experienced consistent productivity growth from 2005 to 2010; however, there has been productivity deterioration since 2011. One possible reason for the deterioration in the performance of these cooperative banks since 2011 can be attributed to the high rise in non-performing loans (NPA), which in turn led to a rise in operating costs. In fact, at the end of March 2019, the NPA to advance ratio of these cooperative banks was exceedingly more than 25% (NABARD, 2019). Further, the decomposition of the ECH into two components reveals that PECH increased by 3.3% solely due to managerial activity, whereas scale efficiency increased by 2.4%. In Jammu and Kashmir, cooperative banks were operating on a cost-effective basis implying that cooperative banks were operating at an economical scale during this time.

In line with the results of Model I, in Model II (income approach), cooperative banks in J&K registered a much higher annual TFP growth of 5.5% over the sample period. Again, when looking at the source of TFP growth, we found TFP was driven by the efficiency change component (7.1%). There has been a deterioration in technical change (−1.4%). The deterioration in the technological change component in both models can be attributed to their reluctance in adapting to new technologies. Cooperatives' reluctance in embracing new technologies and implementing the core banking solutions (CBS) system may be because of the lack of staff training and the absence of hands-on professional management in such banks which inevitably has been a significant barrier to their development.[6] Although most of the commercial banks have already completed the

Table 2 Total factor productivity change (summary of annual means)[a,b].

Year	ECH	TCH	PECH	SCH	TFPCH
Panel A: Model I (intermediation approach)					
2005	1.241	1.074	1.124	1.105	1.333
2006	1.075	1.132	1.044	1.029	1.217
2007	0.975	1.143	0.980	0.995	1.115
2008	1.044	1.026	1.056	0.988	1.071
2009	0.978	1.120	0.987	0.991	1.095
2010	1.179	0.941	1.088	1.084	1.110
2011	1.157	0.806	1.094	1.057	0.932
2012	1.058	0.926	1.037	1.021	0.979
2013	1.110	0.874	1.062	1.045	0.970
2014	1.050	0.842	1.024	1.025	0.885
2015	0.997	0.951	1.007	0.990	0.948
2016	0.996	0.748	0.951	1.047	0.745
2017	0.993	0.951	1.001	0.991	0.944
2018	1.042	0.870	1.023	1.019	0.907
2019	1.013	0.964	1.027	0.986	0.977
Mean	1.058	0.951	1.033	1.024	1.006
Panel B: Model II (income approach)					
2005	1.608	0.829	1.615	0.996	1.333
2006	1.191	1.141	1.186	1.004	1.359
2007	1.061	1.100	1.061	1.000	1.167
2008	0.924	1.081	0.924	1.000	0.999
2009	1.033	0.980	1.033	1.000	1.012
2010	0.961	1.033	0.961	1.000	0.992
2011	1.098	0.917	1.098	1.000	1.007
2012	1.091	0.847	1.091	1.000	0.923
2013	0.832	1.304	0.832	1.000	1.085
2014	1.166	0.827	1.166	1.000	0.964
2015	1.094	0.858	1.094	1.000	0.939
2016	1.092	0.932	1.092	1.000	1.018
2017	1.040	0.996	1.040	1.000	1.035
2018	1.041	1.010	1.041	1.000	1.051
2019	0.995	1.050	0.995	1.000	1.045
Mean	1.071	0.986	1.071	1.000	1.055

[a]Value <1 implies decline, while a number >1 shows growth.
[b]TFPCH = ECH*TCH; ECH = PECH* SCH.

Table 3 Total factor productivity of Jammu and Kashmir Cooperative Banks.

Bank	ECH	TCH	PECH	SCH	TFPCH
Panel A: Model I (intermediation approach)					
Anantnag Central Cooperative Bank[a]	1.035	1.017	1.035	1.000	1.052
Central Cooperative Bank Baramulla[a]	0.984	0.929	0.984	1.000	0.913
Citizens Cooperative Bank	1.105	1.028	1.105	1.000	1.136
Devika Cooperative Bank	1.063	1.003	1.063	1.000	1.066
Jammu and Kashmir State Cooperative Bank[a]	1.082	0.984	1.082	1.000	1.065
Jammu Central Cooperative Bank[a]	1.020	0.942	1.000	1.020	0.961
Kashmir Mercantile Cooperative Bank	1.000	0.870	1.000	1.000	0.870
Urban Cooperative Bank Anantnag	1.187	0.851	1.000	1.187	1.010
Mean	1.058	0.951	1.033	1.024	1.006
Panel A: Model II (income approach)					
Anantnag Central Cooperative Bank[a]	1.074	1.008	1.074	1.000	1.083
Central Cooperative Bank Baramulla[a]	1.091	1.007	1.091	1.000	1.099
Citizens Cooperative Bank	1.111	0.996	1.111	1.000	1.107
Devika Cooperative Bank	1.000	0.979	1.000	1.000	0.979
Jammu and Kashmir State Cooperative Bank[a]	1.111	1.076	1.111	1.000	1.195
Jammu Central Cooperative Bank[a]	1.103	0.944	1.103	1.000	1.041
Kashmir Mercantile Cooperative Bank	1.083	0.923	1.083	1.000	0.999
Urban Cooperative Bank Anantnag	1.000	0.959	1.000	1.000	0.959
Mean	1.071	0.986	1.071	1.000	1.055

[a]Denote the rural cooperative banks while the rest are urban cooperative banks.

process of CBS, cooperative banks in the state are still striving to establish such processes fully. The decomposition of ECH into two components suggests that PECH increased by 3.3 percent whereas SCH was relatively flat during the sample period. Thus, over the years the gap between the best and least performing banks came down. In other words, inefficient seems to *catch-up* with efficient banks. Further, in contrast to the intermediation approach, a clear temporal pattern of TFPH did not emerge in the case of the income approach. Our results showed some coherence with those of Pasiouras and Sifodaskalakis (2010), who similarly noted inconsistent outcomes while assessing the productivity of Greek cooperative banks. They discovered that cooperative banks' productivity in the intermediation model somewhat decreased by 3%, whereas their productivity increased by 6% in the production method. Our findings also support the findings presented by Bhatt and Bhat (2013), Gaurav and Krishnan (2017), and Raju (2018), supporting the need for innovative approaches to enhance cooperative banks' productivity and efficiency.

We now show the individual bank-level productivity of J&K cooperative banks. Table 3 shows the average TFP change by the bank over the period of our analysis. A closer look at Panels A and B reveals a large difference in mean TFP estimates in the two models. TFP growth was discovered to be greater while using the income approach as opposed to the intermediation approach. The average annual TFP growth during our sample period for Model I (intermediation approach) was 0.6 %, whereas, in the case of Model II (income approach), productivity grew by an impressive 5.6% per annum. Again, the decomposition of MTFP across various components shows that productivity growth for the industry was mainly driven by improvement in the efficiency component (5.7% in Model I and 7.1% in Model II) whereas there was a deterioration in the technological change component in both the models. These results show the conservative risk-taking attitude of cooperative banks towards high-quality technological innovations that significantly affect their overall productivity. Further, the results show that Citizens Cooperative Bank, Devika Cooperative Bank and Anantnag Central Cooperative Bank were among the top four performing banks in both the models whereas Central Cooperative Bank Baramulla, Jammu Central Cooperative bank and Kashmir Mercantile Bank were the worst performing banks. The probable reason for their worst performance can be ascribed to the fact that these DCCB banks (Central Cooperative Bank Baramulla, Jammu Central Cooperative bank) have a higher wage bill burden (*Share of payments and provisions for employees in Total Expenses*) than UCBs (Citizens Cooperative Bank, Devika Cooperative Bank), which pushes up their operating expenses and in turn affects their productivity adversely. Lastly, while decomposing ECH into PECH and SCH, it can be observed from both models that most of the cooperatives were operating on an efficient scale.

Conclusion

In India's financial system, cooperative banks play a crucial role. Despite their importance, the efficiency and productivity of these banks have been a great concern to policymakers. Thus, examining the productivity of cooperative banks could assist in finding inefficiencies, allowing regulators and policymakers to devise effective methods for the cooperative banks so that they can remain competitive and sustainable in the current financial market. This paper investigates the productivity of cooperative banks in Jammu and Kashmir over the period 2004–2019. We use the DEA-based Malmquist index to investigate the total factor productivity, efficiency change and technological change among cooperative banks. We use two alternative approaches viz., *intermediation approach* and *income approach* to see how total factor productivity estimates vary when selecting different inputs and outputs. Our results indicate a significant difference in average TFP estimates amongst banks over the years. When compared to the *intermediation approach*, TFP estimates were found to be greater when using the *income approach*. Further, the productivity gains in both models were driven mainly by efficiency change rather than technological change components, confirming the robustness of our results.

Our research has significant policy implications. As we observed that the gains achieved in catching up by efficiency change were not followed by the best-practice operation shown by the technological change in both models. Therefore, implying the need for investing in technology and establishing technology-sharing arrangements that can help boost cooperative banks' productivity. Also, the cooperative banks' guarded attitude towards quality technical innovations, risk management abilities,

financial product complexity, and increased risk exposure may not always translate into increased productivity. With these factors in mind, regulators and policymakers may develop appropriate measures aimed at enhancing cooperative banks' productivity. However, if balance sheet operations are carried around without the assistance of these operations, the cooperative banks' productivity capacity will eventually degrade, as has happened in the case of rural cooperative banks in our study.

A limitation of our study is that we have used the non-parametric DEA approach, which is based on mathematical programming and does not consider the possibility of error structures affecting the study. Nevertheless, our study pays the way for future research that could compare the productivity growth of cooperative and commercial banks, examine the cost, and profit efficiency of cooperative banks, and investigate the relationship between corporate governance and productivity. Also, it would be interesting to examine the managerial impact in identifying productivity variations among cooperative banks.

Data availability

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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Notes

1 Scheduled banks in India are defined as banks that are included in the second schedule of the Reserve Bank of India Act, 1934. Apart from scheduled cooperative banks, scheduled commercial banks also feature in the same act.
2 The financial year 2004 encompasses the months of April 1, 2003, to March 31, 2004, and so on.
3 For a detailed description of the specification of inputs and outputs, see Berger and Humphrey (1992).
4 Input distance function $D(x_i, y_i) = \max\left[\theta : \left(\frac{x_i}{\theta}, y_i\right) \in \Psi_{vrs} \text{ or } \Psi_{crs}\right]$, where Ψ_{vrs} *and* Ψ_{crs} denote the production possibility set assuming VRS and CRS technology, respectively, Shepherd (1953, 1970).
5 The variation in mean TFP estimates under both these approaches can be justified since in a DEA framework statistical noise is not separated from efficiency and these efficiency scores are sensitive to extreme observations in the sample.
6 CBS is the process under which the information relating to the customer's account is stored in the central server of the bank instead of the branch server in which the customer holds his/her account.

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The authors declare no competing interests.

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