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Research note

Economic impact of cooperative membership on dairy farmers in Manipur: a propensity score matching approach

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Abstract This study assesses the impact of dairy cooperatives on yield, technical efficiency and price of milk, and also on income and employment levels using the propensity score matching (PSM) technique. The findings show that dairy cooperatives did not make any significant contribution in improving milk yield, technical efficiency, price and net income in Manipur. However, these helped employment generation for the dairy households in the state. This indicates inherent weaknesses in the functioning of dairy cooperatives and suggests the need for strengthening forward and backward linkages for providing adequate support services to the member farmers.

Keywords Dairy cooperatives, Milk yield, Price, Technical efficiency, Net income, Employment

JEL classification Q12, Q13

1 Introduction

From acute scarcity in the 1960s and 1970s, India is now self-sufficient in milk production. Milk production that had hardly exceeded 25 million tons until 1980, increased to 165.40 million tons in 2016-17, lifting the daily per capita availability from 110 g/day to 355 g/day. This tremendous achievement in milk production is termed as 'White Revolution' and is attributed to the growth of 'dairy cooperatives' that provided farmers an assured market and support services. In 2016-17, there were 1.77 lakh village dairy cooperatives procuring 15.62 million tons of milk from 16.3 million farmers in the country (NDDB 2017).

In spite of the significant expansion, the regional spread of dairy cooperatives has been uneven. Of the total milk procured by these, more than three-fourths comes from the states of Gujarat, Maharashtra, Karnataka, Tamil Nadu and Rajasthan. The eastern and north-eastern states have remained neglected by the White Revolution. The north-eastern states[1] together contribute 0.19% to the total milk procured by the cooperatives as against their contribution of 0.71% in the total milk production (NDDB 2017). More than 52% of the population of Manipur depends on agriculture and allied activities for its livelihood (GoM 2016). Livestock, especially dairy animals, are one of the important components of the farming systems in the state. This paper assesses the impact of dairy cooperatives on yield, price and technical efficiency in milk production and also on income and employment in the Indian state of Manipur located in it the north-east, and explores the prospects for expansion of dairy cooperatives in the region.

2 An overview of dairy sector in Manipur

Consumption of milk and milk products in Manipur is low. Nonetheless, with the increasing per capita income and changing lifestyle, the demand for milk and milk products is on the rise (Feroze et al. 2010). Preponderance of small landholdings and limited scope for livelihoods in non-farm sector renders dairying a more important source of livelihood for farmers in the

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[1] The 8 north-eastern states of India are Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura.

state. In 2015-16, there were 561 registered primary dairy cattle breeding and rearing societies in the state, the highest being in Imphal-east district (135) and lowest in Tamenglong district (8), with a total membership of 15845 (GoM 2016). The Manipur Milk Producers' Cooperative Union is the apex body of dairy cooperatives under which the primary Dairy Cooperative Societies (DCS) function.

In 2016-17, the total milk production in Manipur was 78.82 thousand tons, of which crossbred and local cows contributed 40.38 thousand tons and 24.30 thousand tons, respectively. The per capita availability of milk was low, at 75 g/day. In the same year, the number of in-milk crossbred and local cows was 15.74 thousand and 45.49 thousand, respectively, with a corresponding milk yield of 7.03 kg/day and 1.46 kg/day (GoI 2017).

3 Data and methodology

3.1 Data

The paper is based on primary data collected from farm households in four districts, two each from the plains (Bishnupur & Thoubal) and hill (Senapati & Churachandpur) regions of the state in 2014-15. The districts were selected purposively because of existence of relatively higher number of functional Dairy Cooperative Societies (DCS). In all, 12 villages were selected from these districts, and after a complete enumeration of all the dairy farmers a total of 240 households (120 cooperative members, and 120 non-members) were selected for further inquiry.

3.2 Analytical framework

Several studies have assessed the impact of dairy cooperatives on production, yield, price of milk, income and employment of dairy farmers (Kumar & Sharma 1999; Meena 2008; Singh 2012) and reported their positive impact on these parameters. Nonetheless, most of these studies have just compared these indicators for those associated and not associated with cooperatives. These approaches, although simple, do not overcome the selection bias. Others have applied the Heckman two-step procedure (Sharma et al. 2009; Rather 2013) and the instrumental variable approach (Train 1994) to overcome the selection bias. Both these procedures impose linear functional form, and finding appropriate instruments is difficult (Foster 2003; Mendola 2007; Mishra et al. 2016). In this paper, we use a matching technique, the Propensity Score Matching (PSM) to estimate the causal treatment effects, which is widely used in impact assessment studies (Dehejia & Wahba 1999; Imbens & Wooldridge 2009; Francesconi & Heerink 2010; Chagwiza et al. 2016; Bayan 2018).

The study focuses on five outcome indicators: milk yield, price of milk, technical efficiency, farm income and employment. Technical efficiency was estimated using Data Envelopment Analysis (DEA) approach.

The first step in PSM is to estimate the predicted probability that a household is a member of a dairy cooperative society, also known as the propensity score obtained through the probit or logit model. We use the standard logit model (0=untreated and 1=treated) to obtain propensity score (Rosenbaum & Rubin 1983).

$pr\ (X_i) = P\ (Z=1|X_i)$

where, $pr\ (X_i)$ is the propensity score of the i^{th} individual; $P\ (Z=1|X_i)$ is the probability of treatment given the observable covariates (X) of i^{th} individual.

The balancing test was done to ensure that the differences in covariates of two groups in the matched sample have been eliminated. For this, Rosenbaum & Rubin (1985) suggest that the Mean Absolute Standardized Bias (MASB) between the treated and control groups should be not more than 20%. Sianesi (2004) compares Pseudo R^2 and p-values of the likelihood ratio test of the joint insignificance of all regressors obtained from the probit or logit model before and after the matching. Specifically, after matching there should be no systematic difference in the distribution of covariates of the two groups. Hence, the Pseudo R^2 or p-values of the likelihood ratio should be insignificant.

Several combinations of covariates were tried, including higher order and interactions terms, for the balancing test. However, only the combination of age, education, size of landholding, ratio of crossbreds to total milch cows and experience in dairying satisfied the test; hence these covariates were selected for obtaining the propensity score.

We employed three matching algorithms: Nearest Neighbour Matching (NNM), Kernel Based Matching (0.01) (KBM) and Caliper Matching (0.01) (CM).

These matching techniques differ in the way the neighborhood of each treated individual is defined, how the common support is handled, and how the weights are assigned to the neighbors. The average treatment effects on treated (ATT) are computed by restricting the matches to the households with propensity scores that fall in the area of common support:

$ATT = E(Y_i^1 - Y_i^0)$

where, *ATT* is the average treatment effects on treated; $E(Y_i)$ is the expected value of the impact indicator; 1 represents the treated, 0 otherwise.

4 Results and discussion

4.1 Descriptive statistics

A description of the variables included in the analysis is presented in table 1. The average age of members and non-members of cooperatives did not differ significantly. About 11% household-heads amongst members of DCS were illiterate as compared to 15% amongst non-members. A majority of the respondents from DCS member-households (32.5%) and non-member households (27.5%) had attained schooling up to middle level. The Pearson's Chi square test, however, shows no significant difference in the education level of the two groups.

The average size of landholding was higher for DCS members (0.66 acres) as compared to that of non-members (0.56 acres), but the difference is not statistically significant. On the other hand, average years of dairying experience and ratio of exotic to total milch cows show a significant difference, both being higher for DCS member farmers.

4.2 Determinants of participation in DCS

Results of the logistic regression (see, table 2) show that the age of the household-head has a significant negative influence on the probability of a household being associated with dairy cooperatives. On the other hand, the probability of being a member of DCS is higher for those who are more experienced in dairying profession and have a higher adoption of technology

Table 1. Summary statistics of selected variables

Variable	Members	Non-members	t-statistic (p-value)
Age of household-head (years)	43.63	44.73	-1.523
	(0.929)	(0.831)	(0.130)
Education of household head (no.)			
Illiterate	13	18	3.637[@]
	(10.83)	(15.00)	(0.457)
Primary	29	29	
	(24.16)	(24.16)	
Middle	39	33	
	(32.50)	(27.50)	
High school & intermediate	27	21	
	(22.50)	(17.50)	
Graduation and above	12	19	
	(10.00)	(15.83)	
Land holding size (acre)	0.66	0.56	1.085
	(0.072)	(0.051)	(0.279)
Dairying experience (years)	17.54	15.36	2.975
	(0.864)	(0.605)	(0.004) ***
Ratio of crossbred to total milch cows	0.691	0.361	7.623
	(0.029)	(0.031)	(0.000) ***

Figures in parenthesis indicate standard error
*** denotes significance at 1% level.
[@] Pearson's Chi- square
Source: Authors' estimates.

Table 2. Determinants for cooperative membership

Variables	Coefficient	Marginal effect
Age	-0.068**	-0.017
	(0.028)	
Education	-0.016	-0.004
	(0.138)	
Landholding	-0.049	-0.0122
	(0.214)	
Ratio of crossbred to total milch cows	2.706***	0.676
	(0.442)	
Dairying experience	0.077**	0.019
	(0.032)	
Constant	0.332	
Number of observations	240	
LR Chi^2 (5)	58.644***	
Prob > Chi^2	0.000	
Pseudo R^2	0.176	

*** and ** denotes significance at 1 and 5%, respectively
Figures in parenthesis indicate standard error
Source: Authors' estimates.

(i.e., the ratio of crossbred to total milch cows). Education and landholding size do not have a significant role in explaining the membership of DCS.

4.3 Impact of dairy cooperatives

The balancing tests for the individual covariates for NNM, KBM and CM are shown in table 3. The tests show that bias for all covariates is less than 20% after matching, which is desirable. Further, table 4 reveals appropriateness of the model as a whole. The Pseudo R^2 drops significantly to 1.4, 1.1 and 0.9%, respectively for NNM, KBM and CM after matching, from 17% before matching. The p-value is also not significant after matching. The MASB reduces from 29% before matching to 7.4, 8.1 and 6.5%, respectively for NNM, KBM and CM after matching. The low Pseudo R^2, insignificant p-values of the likelihood ratio test, low standardized biases and high reduction in the total bias after matching suggest that the specification of propensity is successful in terms of balancing the distribution of covariates between members and non-members of DCS.

Table 3. Balancing test of individual covariates

Variable	Unmatched (UM) Matched (M)	% bias		
		Nearest neighbour	Kernel	Caliper
Age	UM	-12.3	-12.3	-12.3
	M	15.1	12.5	12.2
Education	UM	1.4	1.4	1.4
	M	0.7	-3.7	2.8
Landholding	UM	13.5	13.5	13.5
	M	7.1	12.1	6
Ratio of crossbred to total milch cows	UM	100.2	100.2	100.2
	M	6.5	7	3.7
Dairy farming experience	UM	16	16	16
	M	7.8	5.1	8

Table 4. Balancing test of the model

Test	Before matching	After matching		
		Nearest neighbour	Kernel	Calliper
Pseudo R^2	0.177	0.014	0.011	0.009
LR^2 (p-value)	58.87	4.51	3.73	3.01
	(0.000)***	(0.478)	(0.589)	(0.699)
Mean standardized bias	28.7	7.4	8.1	6.5
Total bias reduction (%)	-	74.22	71.78	77.35

*** denotes significance at 1% level.

Using the propensity scores generated through the logit model we find the region of common support. This is the region in which the values of propensity scores of both member (treated) and non-member (control) are present and satisfy the common support condition. After observations are matched, the unmatched comparison units (if any) are discarded and are not directly used in estimating the treatment impact. Individuals in the group who do not find a suitable match are termed as "Treated off-support" while the members who find a suitable match indicates "Treated on-support".

In case of Nearest Neighbour and Kernel Matching techniques, the number of member and non-member observations are same (120 each) meaning that all the member observations find a match and there are no Treated off-support observations (figure 1).

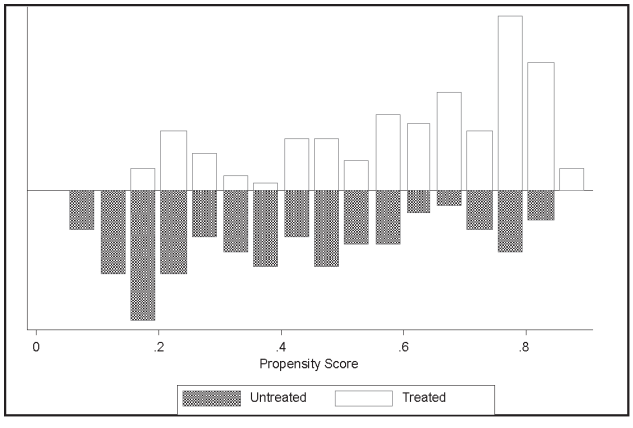

Figure1. Propensity score distribution and common support (Nearest neighbour and Kernel matching)

However, in the case of Caliper matching, 116 members find a match, meaning that four observations are Treated off-support and discarded during the analysis (figure 2).

It emerged that the members of DCS realized higher milk yield and higher net income as compared to non-members (Table 5). Members of DCS also were more engaged in dairying in terms of higher employment. These differences are statistically significant. The technical efficiency in dairying was pretty much similar for members and as well as non-members of DCS. It was only the price of milk that was in favour of non-members. As the effects of confounding factors have not been controlled for, these results cannot be used

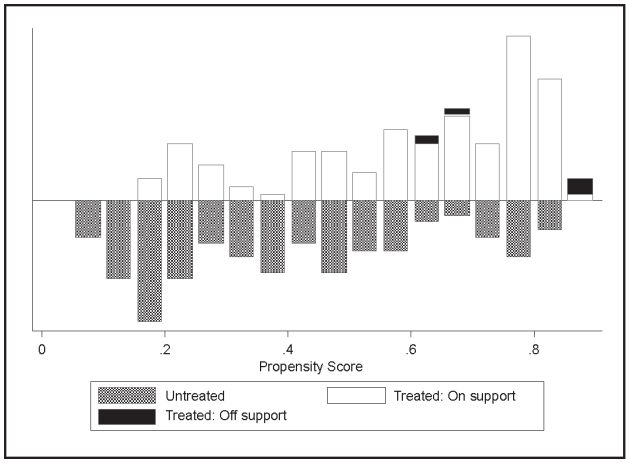

Figure 2. Propensity score distribution and common support (Caliper matching)

for inference regarding the impact of cooperative membership on economic performance. Hence, we estimate the impact through application of PSM and the results are reported in table 5.

The ATT value for milk yield was not much large and much different across different matching techniques. This implies that dairy cooperatives have not made any significant impact on milk yield. This finding is contrary to that of Chagwiza et al. (2016) and Bayan (2018), who found a positive impact of dairy cooperatives on milk yield. The non-members received significantly higher price than the members. The technical efficiency, however, did not differ significantly between members and non-members of DCS. Abate et al. (2013) have found significant impact of agricultural cooperatives on technical efficiency of their members, while Addai et al. (2014) did not find any such difference.

Participation in DCS did not have a significant impact on members' annual net income, while it had positively impacted the employment. This result is in conformity with that reported in Kumar and Sharma (1999), Singh (2012) and Bayan (2018).

For non-members, a higher price is probably because of the direct sales of milk to consumers rather through intermediaries. Nonetheless, the advantage offered by the DCS in the form of marketing services may compel farmers to participate and sell even at a lower price. A likely reason of the positive impact on employment could be that members of DCS have larger proportion

Table 5. Impact of dairy cooperative society on dairy farmers

Outcome	Members	Non-members	t-test (p-value)	ATT		
				NN	Kernel	Caliper
Milk yield (L/animal/day)	8.97 (0.302)	6.20 (0.363)	5.957 (0.000)***	1.30 (0.72)	1.41 (0.69)	1.35 (0.71)
Price (Rs/L)	27.62 (0.146)	28.84 (0.063)	-8.23 (0.000)***	-1.28 (0.208)***	-1.31 (0.181)***	-1.24 (0.21)***
Technical efficiency (%)	88.53 (1.030)	88.54 (0.952)	-0.006 (0.995)	0.22 (1.99)	-0.18 (1.93)	-0.02 (1.98)
Net income (Rs/household/ annum)	9035.84 (1079.605)	4405.65 (584.92)	3.576 (0.000)***	2188.81 (2538.01)	1768.72 (2244.84)	2640.80 (2535.38)
Employment (man-days/ household/ annum)	162.85 (5.824)	118.91 (6.092)	5.234 (0.000)***	40.20 (14.16)***	37.55 (11.94)***	43.48 (13.97) ***

*** denotes significance at 1%
Paired t-test critical t-value at α=1%, 238 d.f. = 2.60
Figures in parenthesis indicate standard error

of crossbreds in their herd which require better care. The non-adoption of quality feed and scientific management practices are the probable reasons for the non-significant difference in yield and net income. Besides, low adoption of improved breeds, one of the major constraints in dairy farming in Manipur is the unavailability and inaccessibility to quality feed (Singh et al. 2012).

During the survey, it was found that many members of dairy cooperatives have not been provided services other than the procurement of milk. The inability of the cooperative societies to create an impact on dairying indicates that there may be some inherent weaknesses in their functioning. One reason for this may be that many of the DCS were at an early stage of development.

5 Conclusion and policy implications

The study found that cooperative membership did not have any significant impact on milk yield, price, technical efficiency and annual net income. However, there was a positive and significant impact on employment. Forward and backward linkages should be strengthened for providing adequate support services in the form of veterinary health care, breeding services, feed, extension services and remunerative prices to the members so as to promote intensive dairy farming. Collaboration with the state veterinary departments, research institutions and other non-government agencies will serve useful means of delivery of services, promotion of locally suitable improved breeds, etc. Effective support services will help increase membership of DCS, herd size and its yield; hence, milk procurement of the cooperatives.

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