Determinants of Small Milk Producers' Participation in Organized Dairy Value Chains: Evidence from India

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Abstract

Indian dairy industry which was highly regulated till late-1990s, has been completely liberalized and exposed to world competition. The past decade has seen rapid changes in the Indian dairy sector and there have been growing concerns on the likely impacts of these changes on smallholder producers. The present paper has analysed determinants of market channel choices of small milk producers based on farm household survey and has investigated what impacts these market channel choices may have on farmers' income and technology adoption. The study has found that though there have been emerging milk marketing channels, the traditional sector still dominates. The analysis has indicated that small dairy farmers are not excluded from the cooperatives but are excluded from the modern private sector.

Key words: India, dairy development, operation flood, smallholder producer, market participation, multinomial logit

JEL Classification: Q13, O17, D71

Introduction

From chronic shortages of milk, India has emerged as the largest milk producer in the world crossing 132.4 million tonnes in 2012-13 and per capita availability of milk increasing from about 110 grams per day in early-1970s to 299 grams in 2012-13 (GoI, 2014). This success story of milk production has been written primarily by the millions of smallholder producers, who dot the landscape of milk production in the country. Although the yields have remained quite low compared to the world average, the dairy sector has not only survived but also flourished. Several factors appear to have helped it flourish. The "Operation Flood", one of the world's largest dairy development programs, which helped to create strong network and linkages among millions of smallholder milk producers, processors and urban consumers, was an important instrument in achieving this success. It is well known that all this happened under autarky and highly regulated domestic markets. The commercial imports and exports of almost all dairy products had been banned for most of the time and processing activity had been controlled through licensing which favoured cooperatives/public sector over private sector. However, since early-1990s, India embarked upon liberal policy framework, which got reinforced with the signing of Uruguay Round Agreement on Agriculture (URAA) in 1994 and it led to fundamental changes in the Indian agri-food sector, including dairy. The state interventions and controls in agribusiness were substantially reduced and foreign direct investment (FDI) was both encouraged and facilitated. This resulted in new investments in some agri-food sectors, particularly in agro-processing. Rapid changes are taking place in the structure and governance of agri-food markets in developing countries including India. These changes include consolidation, institutional, organizational and technological transformations and multinationalization. These have brought rapid changes all the way "upstream" in the agrifood systems.

Some agribusiness and food processing companies have introduced modern procurement systems like

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contract relationship with farmers to provide basic inputs and services in return for guaranteed and quality supplies and distribution strategies that have impacted various segments of food chains. These modern supply chains provide both new opportunities (price and market stability) and new challenges (quality and food safety standards).

The socio-economic factors (income, population, tastes and preferences) on the demand side and various supply side factors such as trade liberalization, privatization and modernization of agro-processing and retailing sector are the major drivers of changes in agrifood systems. However, there have been growing concerns on the likely impacts of the rapid changes in agri-food market chains on smallholder producers in many developing countries. Modern retail chains, particularly supermarkets, have been emerging in developing countries since early-1990s (Reardon and Timmer, 2005). Rapid marketing chain changes have also occurred in food processing, wholesaling and procurement (Reardon and Timmer, 2007). The earlier studies show that increase in supermarkets could have serious distributional impacts on the backend of the market chain. For example, there are case studies in Latin America, Central and Eastern Europe, Mexico, Brazil and Kenya that suggest that mainly large and wealthy farmers benefit from the rise of demand for high-value agriculture and emergence of supermarkets (Reardon and Timmer, 2007; Berdegué et al., 2005). Because of the high transaction costs involved in dealing with millions of small farmers and difficulties in ensuring quality and food safety, it is often assumed that modern supply chains will concentrate on large and better-off farmers. As a consequence, the increase in demand for high-value agricultural commodities and the concomitant rise in supermarkets, have created concerns among the international community about the possible adverse consequences on small resource-poor farmers (Reardon and Timmer, 2007).

There are a few studies from India on the impacts of modern agri-food chains on production and marketing at farm level. Some recent studies have provided anecdotal evidence of smallholder producers' participation in modern market channels (Joshi et al., 2007; Sharma and Singh, 2007). However, these studies are restrictive in terms of geographical coverage, commodities and market channels. Some household survey based studies from other developing countries provide mixed evidence. Some studies have shown that modernization has benefited largely large farmers and excluded smallholder milk producers. On the other hand, some studies have indicated that modernization can have positive impact on smallholder milk producers.

Since Indian dairy industry, particularly the cooperative sector, has a long and successful history of linking smallholder milk producers with markets under regulated policy environment until 1990s, it is important to understand farm-level impacts of changing dairy market structures in India. The strategic issue, which this paper addresses, is: what has been the response of smallholder milk producers and processors to changing modern dairy supply chains in India? More specifically, our research questions are:

• What are the determinants of smallholder milk producers' participation in modern supply chains?

• What is the impact of this participation on growth of smallholder milk producers in terms of farmers' income, production, and technology choices?

Changing Structure of Indian Dairy Sector

Milk production is an important rural activity in India providing supplementary income, employment and nutrition to millions of rural households. With a value of output of about ₹ 167,720 crore (US$ 28 billion) during triennium ending (TE) 2012-13, it ranked first, surpassing rice and wheat combined (₹ 149,046 crore, US$ 24.8 billion), in India's agricultural sector (CSO, 2014). The output of milk and milk products has increased faster than of the crops during the past four decades. The higher income elasticity of demand for milk and milk products coupled with growing urban population, led to a rapid growth in demand, which has been met by higher rate of growth in milk production.

Milk production was more or less stagnant during the 1950s and 1960s and annual production growth was negative in many years (Figure 1). The per capita availability of milk declined which concerned the policy makers. During the second-half of the 1960s, the Government of India made major policy changes in the dairy sector. Milk production in rural milksheds through milk producer cooperatives and movement of processed milk to urban demand centres became the
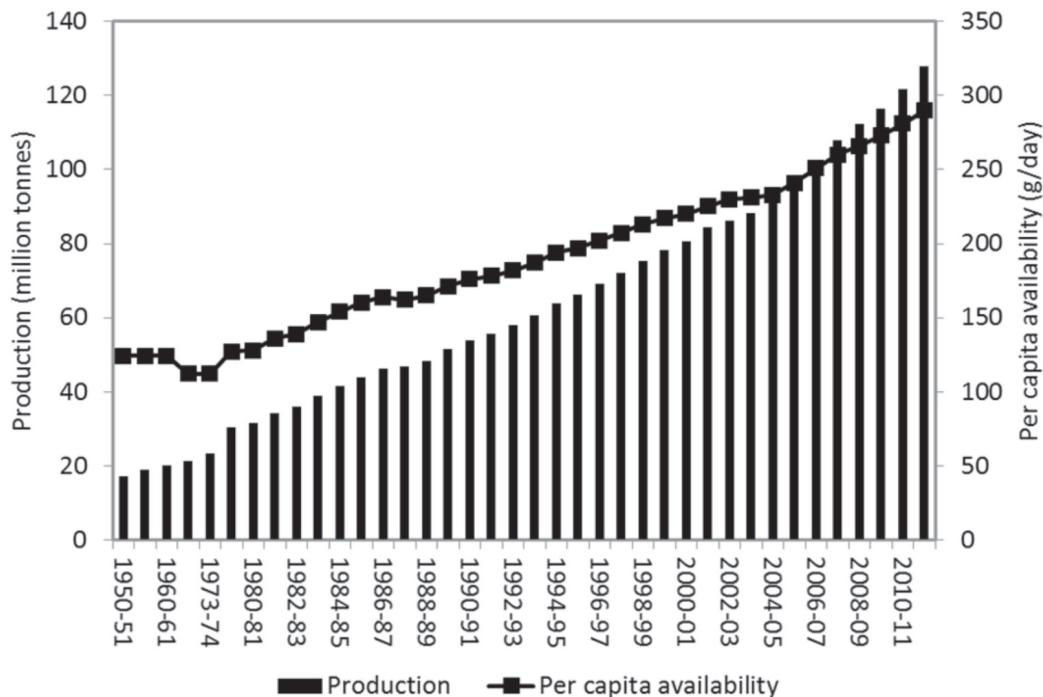
Figure 1. Trends in milk production and per capita availability of milk in India: 1950-51 to 2012-13
Source: GoI (2014)

cornerstone of government policy for dairy development. This single policy initiative of the government gave a boost to dairy development through (i) linking-up rural producers with the urban consumers through pricing, procurement, processing and marketing, which reduced transaction costs, and (ii) large public investments in the milk processing sector (milk procurement centres, chilling plants, milk processing and product manufacturing plants) through cooperatives, which acted as a catalyst to bring about the white revolution in the country (Figure 2).

The performance of Indian dairy sector over the past four decades has been extremely impressive. The milk production in the country has increased from about 22 million tonnes (Mt) in early-1970s to 132.4 Mt in 2012-13 with an average increase of about 4.5 per cent per annum, which in comparison to world's rate of about 2 per cent, is much higher. Though India has become the largest milk producing country in the world, its position in terms of per capita availability is one of the lowest. The per capita availability of milk was about 124 grams/day in 1950-51, and declined to 112 grams/day in 1970-71. But, the dairy sector took a leap forward after 1970-71 and per capita availability of milk increased to about 290 grams/day in 2011-12.

Policy Environment

The main weakness in the pre-Operation Flood Programme (OFP) was the lack of an adequate marketing link between the rural producer and the urban consumer. The OFP sought to forge this link through the cooperative structure. The Operation Flood (OF) programme was launched in 1970-71 and dairy development through producers' cooperatives and milk production based on milksheds was promoted in the rural areas. The first phase of the programme, termed as Operation Flood Phase I lasted from 1970-71 to 1980-81.

The second phase of the programme was implemented from 1978-79 to 1984-85. There was a transition period of two years, 1985-86 and 1986-87 before the OF Phase III began in 1987-88 and ended in April 1996. The decision to promote dairy development through cooperatives was based on a number of considerations, chief among which was that dairying would be a means to provide an additional source of employment and income to small and marginal farmers as well as the landless labourers in rural areas. Once the decision to adopt the cooperative structure as a means for dairy development was taken,
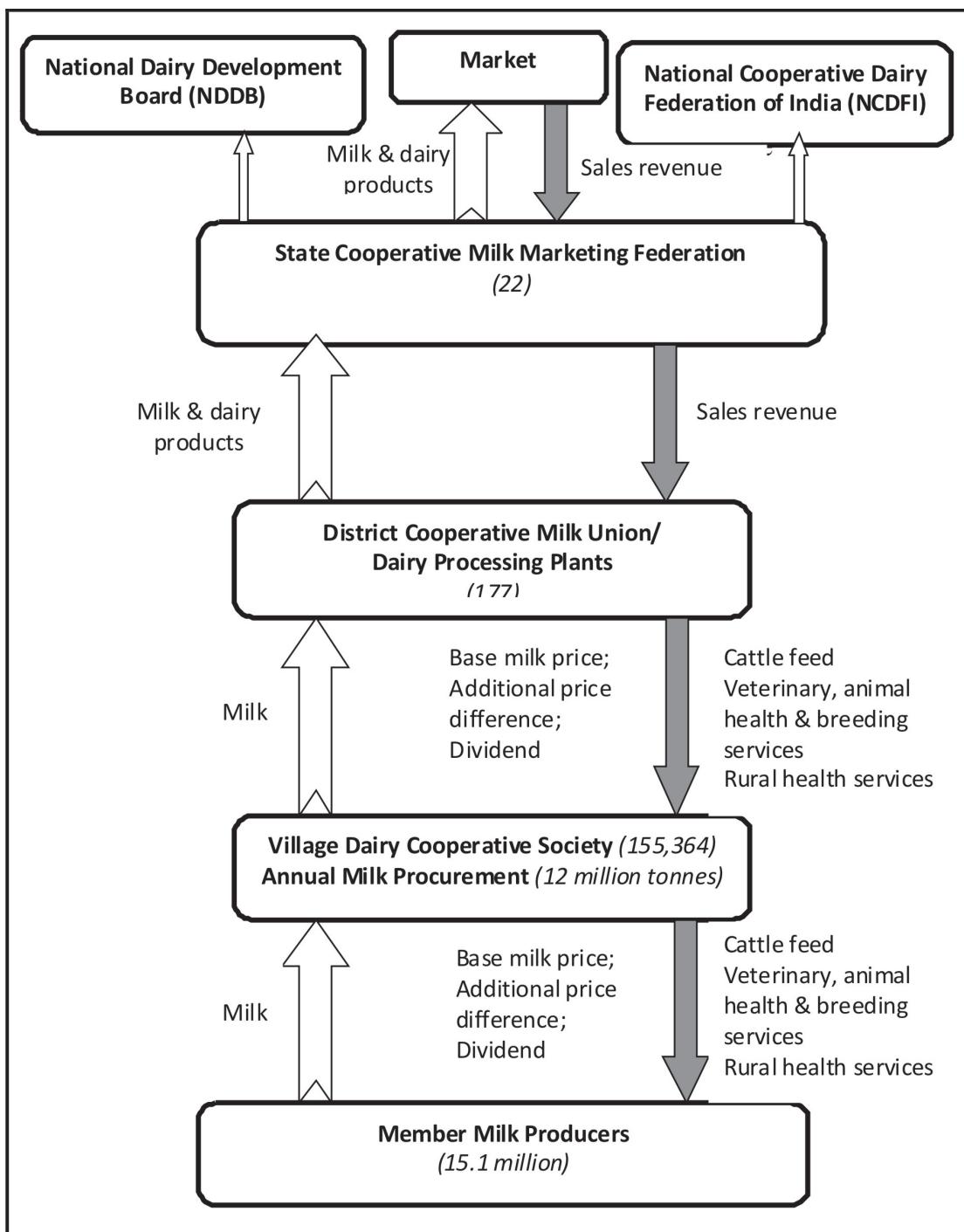
Figure 2. Three-tier "Anand Pattern" of dairy development in India
Source: GCMMF (2012) and NDDB (2013))

the government policies were formulated to support dairy cooperatives. Large public investments were made in the milk processing and marketing infrastructure through cooperatives. To promote domestic production under cooperatives, it was protected from cheap imports through various import restrictions such as quantitative restrictions, canalization of imports on the one hand and competition within the organized sector was restricted through licensing.

In the early-1990s, the Government of India introduced major trade policy reforms, which favoured liberalization of all sectors of economy and dairy sector was no exception to this. The dairy industry was de-licensed in 1991 with a view to encourage private investment and flow of capital and new technology in the sector. The competition from the organized private sector was immediate in the form of sharp increase in capacities for milk processing, especially in areas where milk availability was relatively significant. Within a year of delicensing, over 100 new dairy processing plants came up in the private sector. However, due to political pressures, the Milk and Milk Products Order (MMPO) was promulgated in 1992 under the Essential Commodities Act of 1955, which regulated milk and milk products production and procurement in the country. The Government of India finally repealed the provision of registration under the MMPO for setting up milk processing and milk product manufacturing plants in 2002 and Foreign Direct Investment (FDI) in dairy processing sector was also allowed. These policy shifts fully exposed the Indian dairy sector to the forces of open market and led to significant changes in structure of dairy processing in the country.

The milk processing and marketing sector witnessed significant expansion and new investments in the 2000s. The number of milk processing plants in the private sector increased from 403 in 2002 to 765 in 2011 (about 90% increase), while the number of cooperative milk processing plants increased from 212 to 263 (24% increase) during the same period (GoI, 2013). In contrast, the number of public sector plants declined from 63 in 2002 to 37 in 2011. The total installed capacity of private sector has increased from 32.4 million litres (ML) per day in 2002 to about 73.3 ML/day in 2011, while in cooperative sector it increased from 28.3 ML/day to 43.3 ML/day. At the national level, the total number of dairy processing plants increased from 678 in 2002 to 1065 in 2011 and installed capacity increased from about 73 ML/day to 120.5 ML/day in 2011. However, the cooperatives witnessed an increase in average installed capacity per plant from 134 thousand litres in 2002 to 164.5 thousand litres per day in 2011. On the other hand, in the case of private sector, a marginal decline in average capacity per plant (from 98 thousand litres to 95.8 thousand litres per day) was witnessed. The possible reason for increase in installed capacity in cooperatives

sector could be their long presence in the sector and strong backward linkages with milk producers to have consistent supplies of raw milk, while in case of private sector, most of these players were new entrants and were not willing to make big investments at the first go due to lack of assured supply of raw milk. Recently, many national and global players have entered the dairy processing sector and it is expected that these large companies will make huge investments. However, the question which is bothering policy planners and other stakeholders is *"will entry of corporates guarantee balance between market forces and societal concerns in rural India"*?

There is a general fear also that foreign and domestic retail biggies and modern supply chains will push a large section of farmers, in particular smallholder producers out of the market as they may fail to meet the quality threshold requirements and transaction costs are also high in coordinating supplies from large number of small producers compared to a few large farms. Small farms are also constrained financially for making necessary investments in infrastructure and post-harvest activities. However, there is also a feeling that currently organized sector accounts for about 30 per cent of the total milk marketed, making the sector much more attractive to new entrants. With the entry of new players, share of organized sector is expected to almost double in the next one and half decades (Sharma and Singh, 2007). Given this scenario, the timing for entry of big retailers and other dairy companies and their impact on Indian dairy sector, particularly on smallholder milk producers, who form the backbone of sector, is worth watching.

The restructuring of individual dairy industry segments, mainly in production, procurement and processing, is occurring in simultaneous and interdependent ways, *albeit* at different rates and in different ways across states. Major challenges facing primary producers and their economic organizations in negotiating market access conditioned by liberalization and modernization include technological, organizational and financial demands placed on small-scale farmers. It is important to analyse the changes in procurement patterns for milk as a result of the policy changes and identify major determinants of farmers' marketing channel choices and impacts of market restructuring or farmers' marketing choices on farm

income and technology choices. In order to investigate some of these issues, the present study was undertaken in four states, namely, Punjab, Haryana, Uttar Pradesh and Gujarat, which have strong presence of modern (coops and private) as well as traditional sector and major restructuring in dairy markets is taking place in these states.

Data Sources and Sampling Procedures

To study the impact of changing market structure on market channel choice, scales of operations in milk production, livelihoods and welfare of rural households, one needs a sample containing a sufficient number of households representing various scales of operations, geographical regions, and market channels. This section briefly outlines the survey design followed to select the regions/states, and sample households and methods employed to collect field data. The data used in this study come from a survey of 390 households in nine districts of four leading milk producing states having well-developed infrastructure and mix of milk marketing channels.

Sampling Methodology

The major objective of the study was to understand the patterns and determinants of smallholder producers' strategies and responses to restructured dairy channels and effects of participation in different marketing channels, traditional/informal and organized (cooperatives and private) in different milk-producing regions in India that reflect significant differences in structure of the industry. The stratified random sampling procedure was used to select the states, districts, talukas and villages. The largest milk-producing region in India is northern region, followed by western region, both accounting for over two-third of total milk production. In terms of number of dairy processing plants also, the west zone had the largest number (428 — 102 in cooperative and 291 in private sector), followed by North region with 372 plants (56 in cooperative and 315 in private sector) on 31 March, 2011.

The study was conducted in four states, namely, Gujarat from Western region and Haryana, Punjab and Uttar Pradesh from Northern region, which are well developed and leading milk-producing states and represent different forms of organizational structure.

In Gujarat, success in dairy development programme has largely been achieved through cooperatives and is considered as one of the most successful models of dairy development, whereas Haryana, Punjab and Uttar Pradesh are dominated by the private sector (organized and traditional) and presence of cooperatives is limited to few pockets of the states (Table 1).

At the second stage, a similar stratified random sampling procedure was used to select districts. The number of districts, however, differed by the type of state and market structure. Specifically, four districts from Gujarat, two districts from Haryana, one district from Punjab and two districts from Uttar Pradesh were selected on the basis of milk production potential and presence of various players in the market. In total nine districts were selected for the present study. Then following a similar stratified random process, 49 villages were selected, keeping in view the scale differences and types of marketing arrangements existing in the study area.

Sample Size and Composition

Given the central importance of participation of smallholder milk producers in restructured dairy market channels in the study, efforts were made to select a representative sample of households representing various size categories of households, types of marketing channels, changing structure of dairy sector, etc. In order to analyze the response of milk producers to modernization of dairy sector, we focused on three major marketing channels, viz. organized cooperatives, organized private sector, and traditional/unorganized sector. Farmers who live away from village/catchments of organized sector processing plants/collection centres and/or are not members of these organizations, are constrained to selling their milk in informal/traditional markets. Farmers who live inside the catchments of organized dairy processing plants, have an additional option of selling to organized sector. For a given village, we have four types of farmers: (i) farmers who have chosen to supply milk to the cooperatives (hence participation in modern channel), (ii) farmers who have chosen to sell milk to organized private sector (modern channel), (iii) farmers who have chosen to supply milk to traditional channels such as milk vendor, sweet shop, or directly to consumer, contractor, etc., and (iv) farmers who supply milk to multiple channels like

Table 1. Dairy cooperatives and modern private sector presence in the major milk-producing states of India

Milk procured by coops (% of production) – TE 2012-13	% of milk output procured by coops in the state – TE 2012-13	Share in total milk procured by coops – TE 2012-13	Share in national milk production – TE 2012-13	Share of organized private sector installed capacity in the state in 2011	Traditional sector
Above national average (≥7.1%)	*Strong coops* Gujarat (37.0), Karnataka (29.0), Maharashtra (13.7), Tamil Nadu (11.8), Kerala (10.6)	*72.5%* Gujarat (36.6), Karnataka (14.7), Maharashtra (10.8), Tamil Nadu (7.7), Kerala (2.7)	*26.9%* Gujarat (7.7), Karnataka (4.3), Maharashtra (6.6), Tamil Nadu (5.4), Kerala (2.1)	*Weak to moderate organized private sector* Gujarat (6.3), Karnataka (10.1), Maharashtra (58.8), Tamil Nadu (56.8), Kerala (23.4)	*Weak to moderate presence*
Below National average (<7.1%)	*Moderate coops* Odisha (6.8), Bihar (6.2), Andhra Pradesh (4.9), Rajasthan (4.8). Punjab (4.3), Madhya Pradesh (3.1),	*22.9%* Odisha (1.1), Bihar (3.9), Andhra Pradesh (5.5), Rajasthan (6.1), Punjab (3.9), Madhya Pradesh (2.4)	*34.1%* Odisha (1.3), Bihar (5.2), Andhra Pradesh (9.4), Rajasthan (10.6), Punjab (7.5), Madhya Pradesh (6.4)	*Weak to moderate organized private sector* Odisha (12.5), Bihar (36.4), Andhra Pradesh (72.6), Rajasthan (58.1), Punjab (78.2), Madhya Pradesh (80.0)	*Moderate to strong presence*
	Weak coops Haryana (2.6), West Bengal (1.7), Uttar Pradesh (0.8)	*4.1%* Haryana (1.6), West Bengal (0.8), Uttar Pradesh (1.7)	*34.7%* Haryana (5.2), West Bengal (3.7), Uttar Pradesh (17.5)	*Strong organized private sector* Haryana (82.0), West Bengal (58.4), Uttar Pradesh (90.1)	*Strong presence*

Source: NDDB (2013); MoA (2013)

coops and private, coops and traditional, private and traditional, etc.

Finally, based on the above mentioned criteria and discussion with various stakeholders including the government officials, coops, private sector players, village leaders, a stratified random sample of 390 households consisting of 146 farmers from Gujarat, 85 from Haryana, 90 from Punjab and 69 from Uttar Pradesh representing three marketing channels, cooperatives, organized private sector and traditional was drawn. After cleaning, 374 observations remained for analysis.

Econometric Model and Estimation

Given that we have formulated the channel selection as a three-alternative choice (coops, private and traditional), we have applied multi-nomial logit model estimating marketing channel choice problems with mixed continuous and discrete dependent variables. The econometric approach used is two-step procedure with channel choice first and then model the correlate behaviours with endogenous stratification of the sample into the channel strata, controlling for the conditional probability of inclusion in a given channel. According to the rational choice theory, we assume individuals rank mutually exclusive alternative marketing channels in order of utility and will choose the channel with maximum expected utility given their socio-economic and demographic characteristics, and relevant resource constraints.

The producer's market channel choice can be conceptualized using a random utility model (RUM). The RUM is particularly appropriate for modeling discrete choice decisions such as between market channels. It is indirect utility function where an individual with specific characteristics associates an average utility level with each alternative market channel in a choice set. In our sample, most of the members of cooperative dairy sector did not sell raw milk to other channels; members of private dairy company did not sell to cooperatives or traditional channel and producers from traditional channel did not sell to cooperatives or private dairy plant. However, a very few producers in our sample, who sold raw milk to multiple channels were dropped from the analysis. The selected producers were mapped into three mutually exclusive channels, the cooperatives, private dairy plants and the traditional channel.

The Model

Consider a sample of individuals indexed by $i = 1, \ldots\ldots., N$, and let $j = 0, 1, \ldots., J$ be the feasible choices of an individual, i.e. y_i equals j if individual i chooses alternative j. Each alternative is associated with some random utility:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad (i = 1, \ldots., N \text{ and } j = 0, 1, \ldots., J) \quad \ldots(1)$$

where, V_{ij} is the observable part of the utility that is typically assumed to be a linear function of observable characteristics x_i plus additional variables that solely reflect the individual's preferences over market channel choices, such that

$$U_{ij} = x_i \beta_j + \varepsilon_{ij} \quad \ldots(2)$$

where x_i is the vector of individual characteristics, β_j is the choice specific parameter vector, and ε_{ij} is the unobserved random component. The individual chooses the alternative with the highest utility, U_{ij}.

Let y_i ($y_i = 1, \ldots., N$) indicate the choice made by producer i. The producer is assumed to select the choice that gives him/her the maximum utility. Assuming that ε_{ij} error-terms are distributed according to Type I extreme-value distribution, it can be shown that the conditional probability of individual i choosing alternative j is given by Equation (3):

$$\Pr(y_i = j) = \frac{\text{Exp}(x_i \beta_j)}{\sum_{j=1}^{J} \text{Exp}(x_i \beta_j)}, \quad j = 0,1,\ldots., J \quad \ldots(3)$$

Estimation Method

We used a two-stage approach to specify our random utility model. In the first stage, the market channel participation decision was modelled and in the second stage the effect of market channel choices on household income and productivity was studied.

The first stage market channel choice is specified as per Equation (4):

$$M_{ij} = \beta_j X_i + \varepsilon_{ij} \quad \ldots(4)$$

where, M_{ij} is a vector of the marketing choices ($j = 1$ for coops; 2 for private and 0 for traditional channel) of the ith farmer, β_j is a vector of channel-specific parameters and ε_{ij} is the random-error of estimation.

X_{ij} is a vector of producer characteristics that together reflect the incentives, risks, capacity variables

and other shifters influencing the producer's indirect utility, hence his/her market channel decision, and includes the following variables (Table 2 for variable description):

AGE is the number of years of the head of household. We hypothesize that age of household head will be negatively related to modern market channel choice and income which means that the older household-head is less likely to participate in modern channel and has less income. Younger farmers tend to be more enterprising, fast decision-makers and have capacity to adopt new managerial systems and technologies.

EDUCATION refers to years of schooling of the household-head. We expect education to favour entry into the modern market channels as it would facilitate adoption of new technologies and management practices. Education and age are also indicators of management capabilities.

MEMBERSHIP is proxy for social capital and we hypothesize that there is a positive relationship between membership to an association/cooperative/organization and participation in modern markets. Collective action allows small farmers to pool/aggregate their inputs/outputs to achieve economies of scale that enables them to access inputs and services and negotiate for better prices for their outputs.

HERDSIZE represents the overall herd size of dairy animals. It can be considered proxy for financial capability and production capacity of a farmer. We expect a positive effect of this variable, as it is linked to marketable volume considered desirable (by the buyer) as it reduces transaction costs.

RISK is measured as a coefficient of variation (CV) of milk prices received by farmers. Price risk is likely to be negatively related with market choices, which means the higher the risks, the more likely a farmer is to participate in modern market channel.

ROAD is the distance to a paved road measured in kilometres and is expected (as a measure of transaction costs facing the producer as well as infrastructure) to negatively affect choice of the modern channel.

We have tried household's distance from nearest market (MARKET), establishment of new milk collection/chilling centres in post-delicensing

(COLLECTION CENTRE), and distance from milk collection centre as instrumental variables in the farmers' marketing channel choices. We assume that these variables do not have any direct impact on farmers' milk production, but may have indirect impact on marketing channel choices.

MARKET is the distance to a market measured in kilometres (as a measure of transaction costs facing the producer). Longer distance to the market is expected to have positive effect on modern market channel participation.

NEW COLLECTION CENTRES is the number of new processing facilities/milk collection centres set up in the village in post-liberalization period). Setting up of new facilities is expected to have a positive effect on choice of modern channel.

DISTANCE FROM MARKET is proxy for access to alternative markets and we expect to have a negative association with modern market channel participation.

We used multinomial logit regression using the weights to estimate the determinants of market channel choice equation because this model fits multiple discrete choice variables. The multinomial logit model results were then used to construct the selection-correction term (Inverse Mills Ratio) following the standard procedure suggested by Dubin and McFadden (1984) in order to estimate impact regression equations using a simple OLS regression in the second stage.

Effects of Market Channel Choices on Farm Income

Farmer's market channel choices were hypothesized to have impact on various technological and economic parameters, such as income and productivity. The income and productivity functions were estimated, again endogenously, stratifying for the three market channels. Since the separation of producers by market channel introduces a bias derived from an endogenous stratification on market channel, this bias needs to be corrected. The regression equations were estimated for the group accessing modern channels and those accessing traditional channels. The estimator used in this production function was Inverse Mills Ratio (IMR) as a regressor calculated from multinomial logit function for the market choice presented before.

Table 2. Variables for the marketing channel choice model

Variable	Unit	Type of variable
Marketing channel choice	Coops, organized private, traditional channels	Multinomial (1,2,3)
Age of household-head	Number of years	Continuous
Educational level of household-head	Number of years	Continuous
Membership	Membership to a Farmers' Association/Coops	Binary (0,1)
Distance to metalled road	km	Continuous
Herd size in 2002	Number of dairy animals	Continuous
Provision of veterinary services	Yes/No	Binary (0,1)
Price risk (%)	Coefficient of variation (%)	Continuous
Distance to milk collection centre	km	Continuous
Distance to main market (km)	km	Continuous
Milk collection centres set up in post-2002 period	Yes/No	Binary (0,1)

Source: Survey data

For the second set of research questions related to impacts of farmers' marketing choices, M_j, and their impacts on farmers' income, yield and technology (Y_{ij}), we have specification given by Equation (5):

$$Y_{ij} = \beta_0 + \beta_1 \text{ AGE} + \beta_2 \text{ EDUCATION} + \beta_3 \text{ MEMBERSHIP} + \beta_4 \text{ ROAD} + \beta_5 \text{ PRICERISK} + \beta_6 \text{ VETSERVICES} + \beta_7 \text{ HERD} + \beta_7 \text{ IMR}_1 + \beta_8 \text{ IMR}_2 + \eta_{ij}$$

…(5)

where, Y_{ij} is a set of variables that are hypothesized to be affected by the farmer's marketing choices (M_{ij}). In the study, we identify the following impact variables: (i) dairy income (₹/dairy animal/household/day), and (ii) milk yield (litres/day). β_is are the estimation parameters and h_{ij} is the error-term of the second stage estimation.

Results and Discussion

Determinants of Market Channel Choice – Multinomial Logit Estimates

The estimates of first-stage channel selection results of Heckman procedure (multinomial logit coefficients and marginal effects of market channel choice) are presented in Table 3. Three instrumental variables are included in the first-stage estimation that are not part of second-stage estimation for identification (Hamilton and Nickerson, 2003). The first variable (new milk collection centres set up in post-2002 regime) meures the impact of abolition of milkshed area requirement under the Milk and Milk Products Order (MMPO). The second instrumental variable is distance from market, which captures marketing opportunities available to a milk producer. The third instrumental variable is distance from new milk collection centre which has facilitated access to new market opportunities. While these factors/ developments have facilitated access to market, their effects are similar among different types of milk producers/market players. These factors have not directly affected milk production because no *a priori* advantages have resulted for any of the producers. Because they represent industry level developments over time that all producers/industry players face, they are appropriate instruments.

The traditional market channel was chosen as the base category and all coefficients on traditional channel were set to zero. The marginal effects were evaluated using the sample means of all variables. An important feature is that the sum of the marginal effects of any variable on all the three channels should be zero by definition. The parameters of this model can be interpreted as effects on the probability of selecting cooperatives/modern private channel of an infinitesimal change in each independent continuous variable and the discrete change in the probability for dummy variables.

The model was found highly significant and could correctly predict about 80 per cent of the observed outcomes. Almost all the parameters hads the expected sign, with varying degree of significance.

Table 3. Multinomial logit estimates of the milk marketing channel choice equation

Independent variables	Multinomial logit coefficient estimates		Marginal effects		
	Coops	Private sector	Coops	Private sector	Traditional sector
Constant	-6.7403***	-4.7790***	-	-	-
	(1.8332)	(1.938)			
Age (years)	-0.0312	-0.1021***	-0.0007	-0.0021	0.0028
	(0.0308)	(0.0380)			
Education (years)	0.283***	0.2356***	0.0063	0.0047	-0.0110
	(0.0900)	(0.0840)			
Membership (Yes =1; No = 0)	3.1138**	2.9361*	0.0761	0.0588	-0.1349
	(1.5321)	(1.7831)			
Distance from road (km)	0.6378***	0.8134***	0.0155	0.0164	-0.0319
	(0.1800)	(0.1809)			
Herd-size (No.)	-0.1091*	0.0205	-0.0027	0.0005	0.0022
	(0.0564)	(0.0534)			
Veterinary services (Yes =1; No = 0)	6.0371***	2.4850**	0.1492	0.0479	-0.1972
	(0.8636)	(1.0174)			
Price risk (%)	1.1056***	1.0184***	0.0270	0.0204	-0.0474
	(0.2404)	(0.2636)			
Distance from milk collection centre (km)	-0.2963***	-0.6503***	-0.0070	-0.0132	0.0202
	(0.0868)	(0.1483)			
Distance from market (km)	-0.1093*	-0.1114*	-0.0028	-0.0023	0.0004
	(0.0550)	(0.0657)			
Post-2002 milk collection centre (Yes =1; No = 0)	1.9279	3.2080*	0.0463	0.0651	-0.1114
	(3.1378)	(1.7977)			
Number of observations	374				
log likelihood function	-93.3967				
Restricted log likelihood	-315.1223				
Chi^2	443.4512				

Notes: Figures within the parentheses show standard errors; ***p <0.01, **p <0.05, *p <0.10.
The dependent variable is market channel choice: M_k = 1 for cooperatives, M_k = 2 for organized private and M_k = 0 for traditional channel. Traditional channel is used as base category.

The multinomial logit analysis shows very interesting results. The most important finding of the market channel participation results is that herd-size is significantly important determinant of market channel participation in modern market channels, but with different imapcts. For example, in the case of organized private dairy market channel, there is a positive impact of herd-size on market participation, i.e. as herd-size increases, farmers shift supplies to organized private dairy channel. In contrast, in the case of cooperatives, this relationship is negative, thereby indicating that as herd-size increases, farmers shift away from cooperatives to other channels. The possible explanation for this behaviour could be that farmers receive the same price in cooperatives, irrespective of quantity of milk supplied to coops, while in the case of private dairies and even traditional market channels, large producers get price incentive/higher price because of higher bargaining power as well as lower transcation costs for buyers. The results clearly show that modern private dairy plants and traditional channels preferred supplies from large farmers that can supply more quantitites of quality milk and smallholder milk producers are excluded from these channels.

As expected, age of household-head is negatively related to the participation of dairy farmers in modern channels and is statistically significant in the private

dairy channels. A one year increase in age is predicted to raise the probability of being in traditional channel, but reduces the chances of being in other two channels. In the case of education the results show a statistically significant postive impact in case of both coops and private dairy chain.

The membership of a farmers' group/association/cooperatives significantly determines smallholder dairy producers' participation in modern markets. The membership is positively related to market choice, that means if a farmer is a member of farmers' group/association/cooperatives, he/she is likely to participate in modern markets. The relationship is much stronger in the case of coops, which shows strength of dairy cooperatives in India. It is also known that collective action enables small farmers to attain better bargaining power, and economies of scale and reduces transcation costs. The results show that the majority of farmers in cooperative market channel, produce their milk individually (as economies of scale in milk production are almost absent), but market collectively (as economies of scale in marketing and processing of milk are very significant).

Interestingly, selling to modern marketing channels is positively correlated with the distance from paved road, which indicates that those milk producers located in areas with less road connectivity, may still be part of modern marketing channels. From our qualitative discussions with traditional marketing channel operators, we learnt that many organized dairy plants (coops as well as private) have set up milk collection centres mainly in rural areas, while traditional channel operators procure milk from areas near to urban centres to reduce transportation costs and exploit market opportunities in big cities.

Price risk is another important impediment to market entry, as well as to adoption of improved technologies and investment in productive assets, thereby compounding the market participation effects. Lower prices, greater price risk, or both will typically discourage smallholders' market participation. Price risk has a significant effect on modern market channel participation. Reported figures indicate that price risks appear to positively affect entering the modern channel, i.e. as price risk increases, farmers tend to shift to modern channels due to transparent and stable pricing policy being adopted by both coops and organized private dairies. The traditional channel players pay marginally higher price to milk producers during lean season, but inter-seasonal price fluctuations are high and sometimes they disappear from the market during period of high-production (flush season). As expected, provision of veterinary services is predicted to raise probability of being in cooperatives and/or organized private marketing channel.

Milk collection centres set up in post-delicensing period (post-2002)) turned out to be a significant determinant of market channel participation. The coefficient was positive and statistically significant in case of organized private dairy farmers, but non-significant in the case of coops. The possible explanation for this pattern could be that many private companies have set up milk processing plants in post-liberalization era, when milk-shed area[1] requirement was abolished, which attracted dairy farmers from traditional channel as well as from coops to the private sector plants.

Distance to milk collection centre is neagtively related with modern market channel participation, which indicates that as distance of milk collection centre increases, farmers tend to sell their output to traditional marketing channel as most of the traditional channel players collect milk from farmer's doorsteps.

The probability of selecting modern channels rises with increase in distance from market; however its influence is insignificant in the case of coops, but statistically significant in the private sector channel. This significant positive impact may be explained by the fact that there has been increasing trend of private dairies procuring milk directly from farmers through milk collection centres or through agents.

Impacts of Market Channel Choice on Farm Income and Milk Yield

The second stage model estimated the gross dairy income and yield by generating Inverse Mills Ratio (IMR) of this multinomial logit model and including it as an explanatory variable in the estimation of impact regressions. Following the standard Heckman model, the Mills ratio was included an explanatory variable to

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[1]   The milkshed was an area geographically demarcated by the registration authority for the collection of milk by the holder of a registration certificate, which restricted collection of raw milk from the designated milkshed (exclusive rights) and did not allow milk collection from outside it.

control for self-selection bias in the second stage OLS model. Three sets of second stage OLS models estimated were for coops, private channel and traditional channel.

One of the main shortcomings of the multinomial logit model is that it is based on the so-called independence of irrelevant alternatives (IIA) assumption that the error components in the choice model are independently and identically distributed (Hausman and McFadden, 1984; Small and Hsiao, 1985). Although the IIA assumption is very restrictive, the multinomial logit model remains widely used in empirical studies estimating polychotomous discrete variables due to its computational ease, i.e., the probability of choosing each potential outcome can be easily expressed and the resulting log-likelihood function can be maximized in a straightforward fashion (Hilmer, 2001).

For our study, we believe that it is critical to have three marketing channel choice set (as opposed to a set of binary choices) in order to throw clear light on the issues of India's dairy market that have not been examined in earlier studies. For that reason, we decided to use multinomial logit model. However, we conducted Small-Hsiao test (Small and Hsiao, 1985) and found that the IIA assumption holds. We were not surprised with the results because in our sample a member of the cooperative dairy marketing channel did not sell to other channels; a member of the private dairy company did not sell to cooperatives or traditional channel and a producer for traditional channel did not sell to cooperatives or private dairy plant.

Table 4 provides the second-stage impact results using gross dairy income and milk yield per animal as dependent variables. Ideally, our dependent variable should be *net* dairy income. Unfortunately, accurate data on the value of some of the inputs are difficult to obtain. This is particularly true of inputs for which markets are not well developed, such as labour, home grown feeds and fodder and in some cases costs data

Table 4. Impact of milk market channel choice on gross dairy income and milk yield, 2006

Variable	Cooperatives		Private sector		Traditional sector	
	Income	Yield	Income	Yield	Income	Yield
Constant	85.172***	5.967***	54.903***	3.155***	76.853***	4.571***
	(13.808)	(1.000)	(15.612)	(1.043)	(26.844)	(1.691)
Age	-0.290*	-0.024**	-0.013	-0.011	0.680*	0.045*
	(0.167)	(0.012)	(0.324)	(0.022)	(0.399)	(0.025)
Education	0.014	0.014	0.804**	0.087*	-0.431	-0.016
	(0.364)	(0.026)	(0.396)	(0.046)	(0.943)	(0.059)
Membership	10.948**	0.734**	-3.689	-0.233	-36.187	-2.133
	(4.892)	(0.354)	(12.666)	(0.819)	(30.522)	(1.923)
Distance from road	-3.334***	-0.227***	-0.844	-0.075	-1.313	-0.067
	(1.057)	(0.077)	(0.955)	(0.064)	(1.585)	(0.100)
Price risk	-1.612**	-0.077	2.863***	0.206**	-8.519**	-0.524*
	(0.779)	(0.056)	(1.176)	(0.079)	(4.428)	(0.279)
Veterinary service	42.547***	3.278***	1.467*	0.093	4.185	0.275
	(8.382)	(0.607)	(0.521)	(0.569)	(20.298)	(1.279)
Herd-size	-3.421***	-0.258***	-0.109	-0.012	2.404**	0.167**
	(0.624)	(0.045)	(0.265)	(0.018)	(1.162)	(0.073)
λ_1	-17.301**	-1.382***	-3.305**	-0.109*	20.456	1.178
	(5.293)	(0.383)	(1.090)	(0.047)	(26.238)	(1.653)
λ_2	5.470	0.389	2.663	0.160	-9.625	-0.671
	(4.062)	(0.294)	(4.286)	(0.286)	(21.195)	(1.335)
Number of observations	197	197	69	69	105	105
R^2	0.324	0.349	0.332	0.391	0.131	0.127

Note: Figures within the parentheses show standard errors; ***p <0.01, **p <0.05, *p <0.10.

are missing. As a consequence, we used gross dairy income per animal per household as dependent variable in the second stage of Heckman model.

The coefficient of the estimated Inverse Mills Ratio is significant in cooperatives and private channel models. The significant of the coefficient of this variable reveals importance of allowing selectivity into different marketing channels.

The coefficient estimates in Table 4 were used to determine whether and how household characteristics, incentives, farm size and other factors affect farm income. The results indicate that age had a negative and statistically significant impact on income and milk yield per animal for cooperatives and although age also had a negative impact on income and yield for modern private channel, that impact was not statistically significant. In the case of traditional channel, impact of age was positive and statistically significant. The education of farmer and the size of farm were also important factors influencing income and yield. Farmers, who had more years of formal education, had higher income and productivity on modern channels (cooperatives and private), which supports our hypothesis. As modern channels demand minimum quality standards from the producers, traditional channels are not so strict about quality issues. Educated producers are more capable of meeting the standards. Membership had a significant positive impact on income and yield in the case of cooperatives, but was not statistically significant in the case of modern private and traditional channels.

As expected, distance from road had a negative effect on income for all channels. Herd-size had a negative effect on milk yield per cow and income for cooperatives and private channels, indicating inverse relationship between farm-size and productivity. The possible explanation for this inverse relationship could be that managerial efficiency of small farms has been able to offset scale efficiencies, if any. Provision of veterinary services had a positive effect on yield and income for all marketing channels, but was statistically significant for cooperatives only as coops have very strong backward linkages with producers and provide breeding, animal health care and extension services to its producer members. Price risk had a negative effect on farm income and yield in both modern and traditional channels.

Conclusions and Policy Implications

In response to structural transformations taking place in the Indian dairy sector mainly in the processing segment, the present paper has identified the determinants of market channel choices of milk producers based on farm household survey. It has also investigated what impacts these market channel choices may have on farmers' income and technology adoption. The major findings related to a set of research questions in this study are summarized below:

There have been emerging modern marketing channels, but the traditional sector is still dominant in milk. Farmers sell nearly 70 per cent of their milk to traditional channels. The share of modern organized sector is growing but at a slow pace. The rapid restructurings of downstream dairy processing and to some extent, wholesale and retail markets have not penetrated into farm procurement. Overall, farmers selling their milk directly to modern channel account for nearly 30 per cent of marketed surplus. The dominant share of traditional channel is an indication of a very competitive and cost-effective traditional market in linking producers and consumers and may be high transaction costs of modern channels with millions of small producers. However, the issue of hygiene and quality of milk being sold through traditional channel requires an attention.

The analysis has indicated that small dairy farmers are not excluded from the cooperatives but excluded from the modern private sector channel. There is an evidence of herd-size affecting the farmer's choices of selling their milk to modern channels. In the case of coops, large farmers are opting out and shifting to either modern private sector or traditional sector as they receive price incentive for large milk volumes. Large farmers have better opportunity to participate in modern private sector channels. Age and education are also important determinants of marketing channel choice in the case of modern private sector. Young and more educated farmers have better chances of inclusion in the modern private sector channel. Market infrastructure such as road, provision of veterinary services, distance from milk collection centre, markets, price risks, etc. are found to have significant effects on farmers' marketing choices.

The results of Heckman model have shown that education, membership of producers' association/

cooperatives, provision of veterinary services, and herd-size have a significant impact on cooperative marketing channel farmers' income while in the case of modern private sector, education and price risk have significant impact on income. For the traditional market channel farmers, dairy income is significantly determined by price risk, and herd-size. The modern market channel farmers have higher dairy income than traditional channel farmers, which is explained by higher yields obtained by modern channel farmers, but they receive lower prices than traditional market channel farmers.

The traditional milk markets being still dominant in India, policies that engage with and improve these marketing channels mainly in terms of milk quality and safety, are likely to be most appropriate for small-scale milk producers, milk market agents and consumers. The results have revealed that organized private dairy sector prefers to work with large milk producers due to issues of high transaction costs and milk quality. Hence, reducing transaction costs (through institutions), improving milk quality and safety through training and extension programmes for dairy farmers and improving milk marketing infrastructure are critical for capacity building of smallholder milk producers to compete in the market place and with large-scale producers.

Acknowledgements

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