Determinants, Costs, and Benefits of Small Farmer inclusion in Restructured Agrifood Chains: A Case Study of Dairy Industry in India

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Introduction

Since 1991, the Government of India has liberalized its markets leading to fundamental changes in the agri-food sector. The structural adjustment and stabilization programs substantially reduced controls and state interventions in agricultural sector and foreign direct investment (FDI) was both encouraged and facilitated. This resulted in new investments in some sectors of the Indian agri-food system, particularly in food processing and retail distribution. 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 transformation and multinationalization. These changes are occurring very quickly in many developing countries and are bringing rapid changes in the organizational, institutional and technological practices all the way "upstream" in the agrifood systems.

Some agribusiness and food processing companies, often as part of their own restructuring, have introduced modern procurement systems like contract relationship with farmers to provide basic inputs in return for guaranteed and quality supplies and distribution strategies that have impacted institutional, organizational and technological aspects of agri-food supply chain. These modern supply chains provide both new opportunities (price and volume stability) and new challenges (quality and food safety standards, continuous supply). 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 major drivers of changes.

There have been growing concerns on the likely impacts of the rapid changes in agri-food market chains on smallholder producers in the developing countries. Modern retail chains, particular supermarkets, have been emerging in many developing countries since early nineties (Reardon et al., 2005). Rapid marketing chain changes have also occurred in food processing, wholesaling and procurements (Reardon and Timmer, 2007). Previous studies show that increase in supermarkets could have serious distributional impacts in downstream 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 with dealing with millions of small farmers and difficulties in ensuring quality and food safety, it is often assumed that supermarkets 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 concern among the international community about the possible adverse consequences on small, poor farmers (Reardon and Timmer, 2007).

There are few studies from India on the impacts of rising supermarket and other marketing chain changes 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, 2007). However, these studies are restrictive in terms of geographical coverage, commodities and market channels. Some household survey based studies from other developing countries provided mixed evidence. Some studies showed that modernization has benefited largely large farmers and excluded smallholder producers. On the other hand some studies indicated that modernization can have positive impact on smallholder producers.

This paper contributes to the literature on farm-level impacts of changing dairy market structures in India. The strategic issue, which this paper addresses, is: what has been response of smallholder producers and processors to changing modern dairy supply chains in India? More specifically, our research questions are:

(i) "What are determinants of smallholder dairy farmer participation in modern supply chains?" Key hypotheses to be tested include: small and poor producers are often excluded from the modern market channels; market infrastructure, incentives, risks have significant effects on farmers' marketing decisions and choices; institutional factors such as farmers' associations facilitate their participation in modern marketing chains.

(ii) "What is the impact of this participation on growth of smallholder producers in terms of farmers' income, production, technology choices, etc.?" Major hypotheses to be tested include: there are significant impacts of farmers' marketing choices on their income, scale of operation/herd size, and technology adoption.

The dairy sector in India provides an interesting case study for different reasons. First, India is the largest producer of milk in the world contributing about 15 percent of the world milk production (MoA, 2006). However, the organized dairy industry accounts for about 15 percent of the milk produced and less than 1 percent in global trade for dairy products. Second, the per capita availability of milk in India is low compared with world average and nutritional requirement, creating opportunity as well as need to strengthen dairy sector from nutritional point of view. Third, given the low level of processing, several players are making forays in the dairy market. New players evincing interest in this space include the global majors such as Danone, LandoLakes and Kraft Foods. Among the existing players, besides Nestle ramping up its dairy business, Coca-Cola, Pepsico, Reliance Retail, Bharti, etc. intend to foray into the liquid milk market, while the domestic co-operatives- Gujarat Cooperative Milk Marketing Federation Ltd. (Amul) and NDDB (Mother Dairy) are looking at possibilities in global markets to improve profit margins. Furthermore, the combination of lower milk supplies in neighboring markets in South and South East Asia and Middle-East and the implementation of regional and free trade agreements provides growth opportunities for the Indian dairy sector. The paper is structured as follows:

In the next section, an overview of changing structure of dairy industry in India is presented. Section three briefly discusses the data sources and sampling methodology. Section four discusses conceptual approach, econometric model specification and estimation methods and results on participation of smallholder dairy producers in the restructured markets. Section five summarizes key findings, concludes and provides broad policy recommendations.

2. Changing Structure of Indian Dairy Sector

Before 1991, dairy processing sector was controlled by the government through licensing and mainly reserved for the cooperatives. About 128,799 dairy cooperative village societies, involving about 13.4 million farmer members had been organized by March 2008 to supply milk to processing firms (NDDB, 2008). From 1991, as part of domestic economic reforms and commitments to the WTO, the Indian dairy sector was liberalized in a phased manner. On the supply side, the dairy sector was deregulated and trade was increasingly liberalized. Following decontrol of the dairy sector in 1991, many private players entered the market and set-up milk-processing facilities, mostly in milk surplus areas. Some of the private sector plants also adopted cooperative model by creating informal contracts with local farmers and providing various inputs and services to the farmers. However, in 1992 due to pressure from industry some restrictions were brought back under the Milk and Milk Products Order (MMPO 1992). The second major development in the Indian dairy sector policy was removal of restrictions on import and export of dairy products in mid-nineties.

These changes were expected to have major impacts on structure of milk production and upstream segments of dairy value chain. The structure of dairy processing has changed considerably during the last decade. The number of private dairy processing plants has increased significantly, e.g. number of

milk processing plants in private sector has increased from 250 in 1996 to 403 in 2002 (about 10% increase per year), while number of cooperative milk processing plants increased from 194 to 212 (nearly 1.5% increase per year) during the same period. In contrast number of plants under other category (government milk schemes, government owned plants and mother dairies) decline from 65 in 1996 to 63 in 2002 (Sharma and Singh, 2007 and MoA, 2006). The total installed capacity of private sector has increased from 24.4 million litres per day in 1996 to 32.4 million litres per day in 2002 (about 5.4% increase per annum), while in cooperative sector installed capacity increased from 24.2 million litres to 28.3 million litres per day during the same period (2.9% increase per year). However, cooperatives witnessed an increase in average installed capacity per plant from 125 thousand litres per day in 1996 to 134 thousand litres in 2002 and average installed capacity of government owned plants and mother dairies experienced significant increase (112 thousand litres per day to 193 thousand litres between 1996 and 2002). On the other hand, in private sector plants a marginal decline in average capacity per plant (from 98 thousand litres to 80 thousand litres per day) was witnessed. The possible reason for increase in installed capacity in cooperatives and government plants 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 are new entrants and are not willing to make big investments at first go due to lack of assured supply of raw milk.

Due to pressures from different quarters, government amended the MMPO and removed all restrictions on setting up new milk-processing capacity in March 2002. In addition Foreign Direct Investment (FDI) in dairy sector was allowed in early 2000s. These policy shifts fully exposed the Indian dairy sector to the forces of open market. The milk processing and marketing sector witnessed significant expansion and new investments in the 2000s. The number of milk processing plants in private sector increased from 403 in 2002 to 493 in 2006 (5.6% increase per year), while number of cooperative milk processing plants increased from 212 to 246 (nearly 4% increase per year) during the same period. In contrast number of plants under other category (government milk schemes, government owned plants and mother dairies) declined from 63 in 2002 to 50 in 2006. The total installed capacity of private sector has increased from 32.4 million litres per day in 2002 to 46.1 million litres per day in 2006 (about 7% increase per annum) and in cooperative sector installed capacity increased from 28.3 million litres to 36.6 million litres per day during the same period (4.8% increase per year). At the national level, total number of dairy processing plants has increased from 678 in 2002 to 789 in 2006 and installed capacity has increased from about 73 million litres per day to 98 million litres per day in 2006.

Recently, many national and global players signaled plans to enter the sector and it is expected that these biggies will make huge investments. For example, Reliance (an Indian company) plans to procure milk directly through its collection centre networks mostly in Punjab (high potential state) and likely to be expanded to Rajasthan and Andhra Pradesh. Existing players, Amul, Nestle, Mother Dairy, etc. are also planning capacity expansions. 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 also general fear 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 mostly 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 percent of total milk marketed, making the sector much more attractive to new entrants. With entry of new players, share of organized sector is expected to almost double in the next one and half decade (Sharma and Singh, 2007). Given this scenario, the timing for entry of retail biggies and other dairy companies and their impact on Indian dairy sector particularly on smallholder producers, who form the backbone of sector, is worth watching.

It is evident from the results of meso-report (Sharma and Singh, 2007) that 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. The study identified 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. The study pointed out that it is important to analyze changes in procurement patterns for milk as a result of the recent policy changes and also know whether large scale producers have cost advantages and higher efficiency that will lead to the displacement of smallholders under a liberalized market. In order to investigate some of these issues micro-level 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 are major restructuring in agrifood markets is taking place in these states.

3. Data Sources and Sampling Procedures

This section briefly describes the sampling design of the household survey used in the study. Using the sample of milk producing households, a market participation model is estimated to explain why some households engage in particular marketing channel say formal organized sector whereas others do not. The section also focuses on identifying factors that significantly increase the level of participation in modern supply chains by households.

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 comes from a survey of 390 households in nine districts of four leading milk producing states, namely, Gujarat, Haryana, Punjab and Uttar Pradesh, 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 market 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. Northern region is the largest milk-producing region in India followed by western region, both accounting for over two-third of total milk production. In terms of number of dairy processing plants also, north zone has the largest number (356 with 73 in cooperative and 280 in private sector), followed by western region with 247 plants (89 in cooperative and 119 in private sector) on March 31, 2006.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 milk cooperatives and is considered as one of the most successful models of dairy development whereas Haryana, Punjab and Uttar Pradesh are dominated by private sector and presence of cooperatives is limited to few pockets of the states (Table 1).

At second stage, after the sample states were chosen, 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.

Table 1 Dairy Cooperatives and Modern Private Sector presence in the Major Milk Producing States in India

Milk procured by coops (% of production) – TE 2004-05	*% of milk output procured by coops- states – TE 2004-05*	*Share in total milk procured by coops – TE 2004-05*	*Share in national milk production – TE 2004-05*	*Share of private dairy plants in 2006*	*Traditional sector*
Above national average	***84.9% (Strong coops)*** Gujarat (30.4), Karnataka (19.9), Maharashtra (16.3), Tamil Nadu (11.6), Kerala (6.7)	***69.6%*** Gujarat (29.1), Karnataka (12.8), Maharashtra (14.9), Tamil Nadu (9.3), Kerala (3.5).	***26.9%*** Gujarat (7.3), Karnataka (4.6), Maharashtra (7.2), Tamil Nadu (5.3), Kerala (2.5).	***34.8 (31.9)*(Moderate Organized Private Sector)*** Maharashtra (25.3), Karnataka (2.6)	***Moderate Presence***
Below National average	***24.2% (Moderate coops)*** Andhra Pradesh (5.5), Rajasthan (5.6). Bihar (3.7), Madhya Pradesh (2.0),Orissa (4.4), West Bengal (3.0)	***18.8%*** Andhra Pradesh (5.4), Rajasthan (6.8). Bihar (2.3), Madhya Pradesh (1.9),Orissa (0.7), West Bengal (1.7)	***34.1%*** Andhra Pradesh (7.9), Rajasthan (9.1). Bihar (4.6), Madhya Pradesh (7.1),Orissa (1.2), West Bengal (4.2)	***11.7 (14.6)*(Weak Organized Private Sector)*** Rajasthan (3.5), Madhya Pradesh (3.1), Andhra Pradesh (2.8), West Bengal (2.1)	***Weak – Moderate Presence***
	8.3% (Weak coops) Uttar Pradesh (1.8), Punjab (4.0), Haryana (2.5)	***10.8%*** Uttar Pradesh (4.4), Punjab (4.5), Haryana (1.9)	***34.7%*** Uttar Pradesh (19.3), Punjab (9.5), Haryana (5.9)	***52.1 (50.7)* (Strong Organized Private Sector)*** Uttar Pradesh (33.7), Punjab (10.3), Haryana (8.0)	***Strong Presence***

**: shows % share in total capacity in organized private sector*

Source: NDDB (2008), MoA (2006)

Third, after the sample districts were selected, a similar stratified random process was used to select villages. In total we interviewed farmers in 49 villages from nine districts in selected states. The main focus in selecting the village was to represent 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 market channels in the study, efforts were made to select a representative sample of households representing various 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, namely, 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 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, households were selected from the sample villages. A stratified sample of 390 households consisting of 146 farmers from Gujarat, 85 from Haryana, 90 from Punjab and 69 from Uttar Pradesh was drawn. After cleaning, 374 observations remained for analysis. Sample selection was done randomly, except that an effort was made to include statistically significant sub-samples of milk producers representing different marketing channels and sizes for each of the region.

4. Econometric Model and Estimation

It is known that farmers' decision of supplying one market or another is categorized as a function of the set of incentives and capacity variables that allow the fulfillment of technological requirements. In this section we discuss the econometric model used to test hypothesis of exclusion and/or inclusion of dairy farmers from market restructurings and impacts of farmers marketing choices on income, employment and technology.

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 behaviors 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, a member of cooperative dairy society did not sell to other channels; a member of private dairy company did not sell to cooperatives or traditional channel and a producer for traditional channel doest not sell to cooperatives or private dairy plant. There were few producers in our sample, who sold their produce to multiple channels

were dropped from the analysis. Producers are mapped into three mutually exclusive channels, the cooperatives, private dairy plants and the traditional channel.

Random Utility Model

Let decision-maker I choose from a set of mutually exclusive alternatives, j = 1, 2, …., J. The decision-maker obtains a certain level of utility U_{ij} from each alternative. The discrete choice model is based on the principle of that the decision-maker chooses the outcome that maximizes the utility. The producer makes a marginal benefit-marginal cost calculation based on the utility achieved by selling to a market channel or to another. We do not observe his/her utility, but observe some attributes of the alternatives as faced by the decision-maker. Hence, the utility is decomposed into deterministic (V_{ij}) and random (ε_{ij}) part:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \qquad \forall_{ij} \in N \qquad (1)$$

Since ε_{ij} is not observed, the decision-maker's choice can not be predicted exactly. Instead, the probability of any particular outcome is derived. We can not observe directly the utilities (or the difference between benefit and cost) but the choice made by the producer reveals which one provides the greater utility (Greene, 2000).

A producer selects market channel j=1 if

$$U_{ik} > U_{ij} \forall_j \neq k \qquad (2)$$

Where U_{ik} denotes a random utility associated with the market channel j=k, and V_{ij} is an index function denoting the producer' average utility associated with this alternative. The second term ε_{ij} denotes a random error which is specific to a producer's utility preference (McFadden, 1976).

Now, in our implementation model, market channel choice is modeled as:

$$M_{ij} = \beta_j X_{ij} + \varepsilon_{ij} \qquad (3)$$

Where M_{ij} is a vector of the marketing choices (j = 1 for coops; 2 for private and 0 for traditional channel) of i^{th} farmer, β_j is a vector of channel-specific parameters. ε_{ij} is the error term assumed to have a distribution with mean 0 and variance 2.

X_{ij} is a vector of producer characteristics that together reflect the incentive, risks, and capacity variables and other shifters influencing the producer's indirect utility, hence his/her market channel decision, and includes the following variables (Table 1 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 have less income. Younger farmers tend to be more enterprising, fast decision makers and capacity to adopt new managerial systems and technologies.

EDUCATION refers to years of schooling of the household head. We expect education to favor entry into the modern market channels as it would facilitate adoption of new technologies and management practices. Education and age 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 represent overall herd size of dairy animals in 2002 to avoid endogenous problem. It can be considered proxy for financial capability and production capacity of 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 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 kilometers and is expected (as a measure of transaction costs facing the producer as well as infrastructure) to negatively affect choice of the modern channel.

Table 2 Variables for the Marketing Channel Choice Model

Variable	*Unit*	*Type of variable*
Marketing Channel Choice	Coops, organized private, traditional channel	Multinomial (1,2,3)
Age of Head of Household	Number of years	Continuous
Educational Level of Head of Household	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

We have tried household's distance from nearest market (MARKET), establishment of new milk collection/chilling centres in post-2002(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 impacts on farmers' milk production but they may have indirect impacts of marketing channel choices.

MARKET is the distance to a market measured in kilometers (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 CENTES is number of new processing facilities/milk collection centres set up in the village in post liberalization period (after 2002). Setting up of new facilities is expected to have positive effect on choice of modern channel.

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

We used multinomial logit regression using the weights discussed earlier to estimate the determinants of market channel choice equation because this model fits multiple discrete choice variables. The multinomial logit model results will then be used to construct the selection-correction term (Inverse Mill's ration) for individuals selecting into each channel (Green 2000). In the second stage the Inverse Mill's ratio will be included in the impact regression estimation to control for selection bias.

Effects of Market Channel Choices on Income, Employment and Technology

Farmer's market channel choices are hypothesized to have significant or not significant impacts of various technological and economic parameters, such as income, productivity, employment and technology (breed composition). Here we estimate income, employment and technology functions, 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 need to be corrected. The regression equations are estimated for the group accessing modern channels and those accessing traditional channels. The estimators used in this production function uses Inverse Mills' ratio (IMR) as a regressor calculated from multi-nomial logit function for the market choice presented before.

For the second set of research questions related to impacts of farmers' marketing choices, M_j, and their impacts on farmers' income, employment, and technology (Y_{ij}), we have the following specifications:

$$Y_{ij} = \beta_0 + \beta_1 \text{ AGE} + \beta_2 \text{ EDUCATION} + \beta_3 \text{ MEMBERSHIP} + \beta_4 \text{ ROAD} + \beta_5 \text{ PRICERISK} + \beta_6 \text{ VETSERVICES} + \beta_7 \text{ HERD} + \beta_7 \text{ IMR} + u_{ij} \quad (4)$$

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 (Rs./dairy animal/household/day); ii) milk yield (litres/day); iii) employment (hours/litre of milk); technology (%age of crossbred cows in dairy herd). β_i are the estimation parameters.

We estimate the system for each market channel independently using a Zellner's seemingly unrelated regression (SUR) model to exploit potential correlation across errors in four impact equations.

5. Economometric Analysis Results

Determinants of Market Channel Choice – Multinomial Logit Estimates

In this section we examine the determinants of marketing decision of milk producers. 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) meaures the impact of aboloition 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 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.

Tradional market channel is chosen as the base category and all coefficients on traditional channel are set to zero. The marginal effects are evaluated using the sample means of all variables. An important feature is that the sum of the margional effects of any variable on all the three channels should be zero by definition. The parameters of this model can be interpretedd as the effcets 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 is highly significant and correctly predicts about 80 percent of the observed outcomes. Almost all the parameters have the expected sign, with varying degree of significance.

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

case of organized private dairy market channel, there is 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 case of coops this relationship is negative, thereby indicating that as herd size increases, farmers shift away from coops to other channels. The possible explanation for this behaviour could be that farmers receive the same price in coops irrespective of quantity of milk supplied to coops, while in 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 and smallholder milk producers are excluded from these channels.

As expected age of head of household is negatively related to the participation of smallholder dairy farmers in modern channels and is statistically significant in 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 case of education the results show a statistically significant postive imapct in case of both coops and private dairy chain.

Membership to a farmers' group/association/cooperatives significantly determines smallholder dairy producers participation in modern markets. Membership is positively realted to market choice, that means if a farmer is a member of farmers' group/association/cooperatives is likely to participate in modern markets. The relationship is much stronger in 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, economies of scale and reduce transcation costs. The results show that majority of farmers in cooperative market channel, farmers produce their produce 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 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 quailitative dsicussions 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 smallholder market participation. Price risk has 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. 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-liberalization period (post-2002)) turned out to be significant determinant of market channel participation. The coefficient was positive and statistically significant in case of organized private dairy farmers but non-significant in case of coops. The possible explanation for this pattern could be that many private companies set up milk processing plants in post-liberalization era, when milk-shed area requirement was abolished, which attracted dairy farmers from traditional channel as well as from coops to private sector plants.

Distance to milk collection centre in neagtively correlated 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 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 case of coops but statistically significant in 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.

Table 3 Multinomial Logit Estimates of the Milk Marketing Channel Choice Equation

Independent Variables	*Mlogit Coefficient Estimates*		*Marginal Effects*		
	Coops	*Private*	*Coops*	*Private*	*Traditional*
Constant	-6.7403*** (1.8332)	-4.7790*** (1.938)	-	-	-
Age (years)	-0.0312 (0.0308)	-0.1021*** (0.0380)	-0.0007	-0.0021	0.0028
Education (years)	0.283*** (0.0900)	0.2356*** (0.0840)	0.0063	0.0047	-0.0110
Membership (yes =1; no = 0)	3.1138** (1.5321)	2.9361* (1.7831)	0.0761	0.0588	-0.1349
Distance from Road (km)	0.6378*** (0.1800)	0.8134*** (0.1809)	0.0155	0.0164	-0.0319
Herd Size (number)	-0.1091* (0.0564)	0.0205 (0.0534)	-0.0027	0.0005	0.0022
Veterinary Services (yes =1; no = 0)	6.0371*** (0.8636)	2.4850** (1.0174)	0.1492	0.0479	-0.1972
Price Risk (%)	1.1056*** (0.2404)	1.0184*** (0.2636)	0.0270	0.0204	-0.0474
Distance from Milk Collection Centre (km)	-0.2963*** (0.0868)	-0.6503*** (0.1483)	-0.0070	-0.0132	0.0202
Distance from Market (Km)	-0.1093* (0.0550)	-0.1114* (0.0657)	-0.0028	-0.0023	0.0004
Post-2002 Milk Collection Centre (yes =1; no = 0)	1.9279 (3.1378)	3.2080* (1.7977)	0.0463	0.0651	-0.1114
Number of observations		374			
Log likelihood function		-93.3967			
Restricted Log likelihood		-315.1223			
Chi^2		443.4512			

a. Notes: Figures in 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.

We generate the Inverse Mill's Ratio (IMR) of this multinomial logit model and then include it as an explanatory variable in the estimation of impact regressions.

Impacts of Market Channel Choice on Income, Employment and Technology

Table 4 provides the second-stage impact results using gross dairy income, milk yield, employment and share of crossbred animals as dependent variables. Ideally, our dependent variable should be *net* dairy income. Unfortunately, accurate data on the value of some of inputs are difficult to obtain. This is particularly true of inputs for which markets are not well developed, such as labor, home

grown feeds and fodder and in some cases costs data are missing. As a consequence we use *gross* dairy income per animal per household as dependent variable in second stage of heckman model.

The Inverse Mills' Ratio corrects the error terms in the impact equations to achieve consistent and unbiased estimates. Justification for the Heckman procedure is found in the Table as the Inverse Mill's Ratio coefficients are significantly positive in case of modern channels, indicating a positive selection into modern marketing channels. It is also interpreted as unobserabed characteristics of one marketing channel influencing income relative to the other channels. The Heckman results suggest that overall influence of marketing channel choice on income is driven in part by an endogenous selection process.

The coefficient estimates in Table 2 are used to determine whether and how household characteristics, incentives, farm size and other factors affect farm income. The results of Table indicate that age is not statistically significant for traditional marketing channel, but is negative and significant for modern channels ($p<0.1$). The results also indicate that education as hypothesized positive performance effect for 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 food safety and quality issues. Educated producers are more capable of meeting the standards. Membership has significant positive impact on income in case of cooperatives but is not statistically significant in case of modern private and traditional channels. As expected distance from road has a negative effect on income for all channels but is statistically non-significant. Herd size has a negative effect on income for cooperatives indicating inverse relationship between farm size and income. 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 has positive effect on income for all marketing channels but is significant for cooperatives only as coops have very strong backward linkages with producers and provide breeding, animal health care facilities and extension services to its producer members. Price risk has negative effect on farm income in case of coops and traditional channels but positive and significant for organized private channel. The Heckman results suggest that overall the influence of marketing channel choice on income is driven in part by an endogenous selection process.

The results of impact of milk market channel choice on human labor employment, milk yield and share of crossbred dairy animals are discussed below:

Table 4 Impact of Milk Market Channel Choice on Gross Dairy Income, employment, milk yield and share of improved breeds, 2006

	Income			*Employment*		
Variable	*Coops*	*Private*	*Trad.*	*Coops*	*Private*	*Trad.*
Constant	88.5739 (11.6835)	52.501 (13.9558)	86.859 (21.894)	0.5064 (0.0953)	0.1713 (0.1782)	0.6152 (0.0988)
Age	-0.2961*** (01570)	-0.1477** (0.0992)	0.5398 (0.3438)	0.0022*** (0.0012)	0.0206* (0.0038)	0.00205 (0.0015)
Education	0.1030 (0.3324)	0.9400 (0.7541)	-0.5017 (0.884)	0.0115* (0.0027)	-0.0024 (0.0096)	0.0018 (0.0039)
Membership	16.8618* (4.827)	-1.2633 (11.1385)	-33.1126 (29.2065)	-0.1694* (0.0394)	-0.3731* (0.1422)	-0.2866** (0.1318)
Distance from Road	-1.2063 (1.0376)	-0.8109 (0.9121)	-0.8446 (1.5082)	0.0125 (0.0084)	-0.0031 (0.0116)	-0.0047 (0.0060)
Price Risk	-0.9054 (0.7694)	3.6395* (1.2663)	-9.0901** (4.093)	0.0295* (0.0062)	-0.0786* (0.0161)	-0.041** (0.0184)
Veterinary & Feed Service	11.2941* (3.9958)	1.4543 (3.6369)	0.9201 (17.821)	-0.1609* (0.0326)	-0.1253* (0.0464)	-0.2068** (0.0804)
Herd Size	-2.7676* (0.6256)	-0.1050 (0.1781)	2.305** (1.1101)	-0.0366* (0.0051)	-0.0071* (0.0022)	-0.0373* (0.005)
IMR	15.6060* (2.6012)	3.6501* (1.8929)	8.869 (12.2952)	-0.0588* (0.0212)	-0.2553* (0.0497)	-0.035 (0.0554)

Number of observations	198	70	106	198	70	106
R^2	0.38	0.41	0.34	0.31	0.61	0.65
	Yield			*Crossbred Cows*		
	Coops	*Private*	*Trad.*	*Coops*	*Private*	*Trad.*
Constant	6.0587 (0.8503)	2.9946 (0.928)	5.2401 (1.3791)	-15.8075 (7.7654)	20.959 (13.4828)	3.5896 (7.2020)
Age	-0.0231** (0.0114)	0.0076 (0.0198)	0.0356 (0.0216)	0.1064 (0.1044)	-0.5425** (0.289)	-0.0028 (0.1131)
Education	0.0239 (0.0241)	0.09581*** (0.0515)	-0.0212 (0.0556)	0.1636 (0.2209)	-0.1632 (0.7286)	0.3499 (0.2907)
Membership	1.1923* (0.3513)	-0.0771 (0.7406)	-1.9274 (1.8397)	9.5875* (3.2082)	22.1604** (10.761)	-0.5047 (9.6070)
Distance from Road	-0.0669 (0.0755)	-0.0608 (0.0665)	-0.0373 (0.095)	0.2248 (0.6896)	-0.7305 (0.8812)	-1.7627* (0.4961)
Price Risk	0.0226 (0.0560)	0.2588* (0.0842)	-0.5608** (0.2578)	0.6129 (0.5114)	2.5892** (1.2234)	1.3415 (1.3463)
Veterinary & Feed Service	-0.9991* (0.2908)	0.1546 (0.2418)	0.1079 (1.1225)	9.7613* (2.6558)	2.2575 (3.5136)	5.5041 (5.862)
Herd Size	-0.2106* (0.0455)	-0.9992 (0.0118)	0.1601** (0.0699)	2.7758* (0.4158)	0.619* (0.172)	0.8391** (0.3651)
IMR	1.189* (0.1893)	0.2628 (0.2588)	0.5431 (0.7744)	-2.422 (1.7289)	8.8087** (3.761)	-9.0078** (4.0443)
Number of observations	198	70	106	198	70	106
R^2	0.42	0.47	0.58	0.43	0.48	0.70

a. Notes: Notes: Figures in parentheses show standard errors; *** p <0.01, ** p <0.05, * p <0.10.

Herd size has a statistically significant negative effect on employment in all channel farmers, indicating that increase in herd size replaces labor with machinery. Membership does have significantly negative effect on employment. Age of head of household has positive effect on employment in case of both modern and traditional channel farmers but is statistically significant in case of modern channel farmers. Price risk has negative impact on employment generation in dairy sector.

Age has statistically significant negative effect on proportion of crossbred dairy animals in case of modern private sector channel farmers indicating that young farmers adopt modern technologies more compared with older farmers. Membership has a positive effect on adoption of crossbreeding technology in case of modern market channel farmers. Provision of veterinary services also has positive impact on crossbreeding technology on both market channel farmers but is statistically significant in case of coops and organized private channel farmers.

Education and membership have positive impact on milk productivity while age has negative or non-significant impact on productivity. Herd size has inverse relationship with milk productivity in case of modern channel farmers. Price risk also has negative impact on productivity.

6. Conclusions

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

Dairy Market Restructurings

There have been emerging modern marketing channels but traditional sector is still dominant.

Farmers sell nearly 85 percent 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 market have not penetrated into farm procurement. Overall, farmers selling their milk directly to modern channel account nearly 15 percent of marketed surplus. 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, issue of hygiene and quality of milk being sold through traditional channel requires an attention.

Determinants of Farmers' Marketing Choices

Small dairy farmers and poor are not excluded from the cooperatives but excluded from modern private sector channel. There is an evidence of size of herd affecting the farmer's choices of selling their produce to modern channels. In 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 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, milk collection centres, price risks, etc. are found to have significant effects on farmers' marketing choices.

Impacts of Marketing Restructurings and Marker Channel Choices on Farmers

The second stage results of Heckman model show that education, membership of producers' association/cooperatives, provision of veterinary services, and herd size have significant impact on cooperative marketing channel farmers' income while in 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.

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