Multinationals or cooperatives: does it matter to farmers? A study of the dairy sector in Punjab (India)

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1. Introduction

In the past decades, successive waves of liberalization all over the world have led to the increased inflow of foreign direct investment in developing and transition countries. This development has not gone unnoticed by researchers, policy makers, and civil society. In particular, a lively debate has ensued regarding the vices and virtues of the presence of multinationals in developing countries. While supporters argue that foreign direct investment is the best road to economic growth and development through the creation of employment and the transfer of technologies and know-how; critics argue that multinationals locate their production processes in developing countries mainly to exploit cheap labour and lax environmental standards, while hardly contributing to local development because of various kinds of tax exemptions and repatriation of profits.[1] Further concerns are that the benefits brought by foreign direct investment may accrue disproportionally to those who are wealthy already (e.g. skilled rather than unskilled labour), reinforcing societal imbalances and leaving the poor worse off.

In the view of increased globalization of agrifood supply chains, several concerns have also been highlighted in the academic literature, especially with regard to the stringent food quality and safety norms which are imposed by foreign companies operating locally and/or by overseas consumers on agricultural producers in developing countries. In particular, it is argued that these quality and safety standards would result in excessive transaction costs or capital requirements for smallholders who face important credit market imperfections (e.g. Key and Runsten, 1999; Okello et al. 2007). This would lead to the exclusion of small farmers from these high-standard supply chains and prevent them from benefiting from any surpluses that can be created within these supply chains. Furthermore, even if small farmers are included in high-value supply chains, it has been argued that large agrifood companies may be able to extract all the additional value created through their bargaining power in the chain, such that their suppliers hardly benefit from inclusion (e.g. Reardon and Berdegué, 2002; Warning and Key, 2002). However, the empirical evidence in this field is mixed, and there are studies which provide counterevidence to both arguments, by showing that small farmers can participate in high-value chains, and moreover importantly benefit from this participation (e.g. Maertens and Swinnen, 2009; Minten et al., 2009). Still, most of these studies focus on high-value products which are produced for export markets, and some critics have argued that these cases offer limited scope for scaling up.

This paper focuses on the dairy sector in India, which is the second largest food market in the world,[2] and almost exclusively focused on supplying the domestic market. Dairy is a high-value product as well, and moreover, it is strongly embedded in local agricultural traditions in India, and even more so in Punjab, the state in the North of India which is the subject of our case study and which has the highest milk production per capita in India. In 2002, it was estimated that more than 70 million rural households derive direct income or employment from the dairy sector (Sharma et al., 2002). Not surprisingly, the Indian government has kept a strong hold on the dairy market for many decades.

A study of the Punjab dairy market is of particular interest in the debate on foreign direct investment in developing countries, as the Punjab formal dairy market is currently dominated by two players: on the one hand Nestle India, a subsidiary of Nestle SA. Nestle India set up its first plant in Moga (Punjab) in 1961. On the other hand there is Milkfed, the cooperative which received extensive government support during Operation Flood, a large scale public dairy development program in the 1970s and 1980s.. Next to the formal dairy market, there is a particularly lively informal market, which is mainly focused on delivering raw milk directly to consumers, without processing.

We use a unique dataset of 1000 households, collected in 2008 and representative of the rural population of Punjab, to explore the micro-level differences between supplying a powerful dairy multinational, supplying a cooperative, owned and managed by dairy farmers, and supplying traditional channels. We first investigate whether there is any selection bias in the choice of dairy marketing channel, in other words whether the often-heard claim that multinationals prefer to work with farmers which are richer, better educated, or have a larger dairy herd size on average is supported by our data; then we look at the

[1] For a more detailed review of the arguments and the empirical evidence, see Colen et al. (2009).

[2] The dairy market in India is the second largest food market in the world with a value of 41 billion US$ in 2008 (after the Chinese pork sector which amounted to almost 48 billion US$ in 2008) (FAO, 2007), which is similar to the combined output value of rice and wheat, the two major crops in India, taken together. India produces around 100 million MT of milk per year (FAO, 2007), and is projected to reach 113 million MT in 2010-2011.

impact of marketing channel choice on the performance of dairy farmers in terms of productivity, profitability, and dairy investment.

The structure of the paper is as follows. We first briefly describe the policy and market context of the dairy sector in India, then we describe the current dairy market structure in Punjab, the state we have selected for our study. Section 4 describes the process of data collection, and section 5 provides some descriptive statistics of our data. Section 6 investigates the determinants of marketing channel choice for dairy farmers, and section 7 looks into the impacts of this choice on dairy farm performance. Section 8 concludes.

2. The dairy sector in India

After India's independence in 1947, the Indian government's policy regarding food production was based on import-substitution and protectionism (Prasad, 1988). The central government imposed quantitative restrictions on imports and exports; and imports of various food products, including milk powder and butter oil were monopolized by (or "canalized" through) parastatals (Sharma, 2004). Moreover, the dairy sector was stiffly regulated through a licensing system under the 1951 Industrial Development and Regulation Act, deterring entry for most private companies (World Bank, 1999; Jha, 2004).

In the 1970s and the 1980s the Government of India implemented "Operation Flood", a large scale dairy sector development program with as main objectives (a) to make India self-sufficient in milk, by introducing new technologies to increase productivity, (b) to link rural milk suppliers to urban markets through the development of an extensive network of dairy marketing cooperatives, and (c) to eventually reduce poverty, as dairy development was seen as an effective tool to give landless farmers access to an income-generating activity which does not require huge investments.

Operation Flood was a great success in increasing India's milk production, and the same period is often referred to as India's "White Revolution".[3] Its impact is considered to be comparable to the Green Revolution in India, increasing growth of milk production from an annual 0.7% to 4.3%, and it has been applauded nationally and internationally for being "one of the world's largest rural development programs", bringing huge benefits to small and poor farmers (Singh, 2009). Shukla and Brahmankar (1999) voice the common belief at that time that "*the very existence of a cooperative strengthens the position of a village milk seller*."

In December 1991, the dairy sector was "delicensed", as a part of an important series of liberalization reforms in response to a dramatic balance-of-payment crisis in India (Aghion et al., 2008), implying that private plants did no longer need to obtain a license from the Central Government to establish a plant. However, the subsequent massive entry by the private sector into dairy processing triggered major concerns about survival of the dairy cooperative system which had been painstakingly built up with substantial government support.

In response to these claims, the government reintroduced regulation in the form of the Milk and Milk Produce Order (MMPO) in 1992. The major implication of this Order was that companies which wanted to set up a new dairy plant, or expand the capacity of existing plants had to provide convincing survey-based evidence that the region they would procure their milk from had sufficient milk surplus to justify the creation of new processing capacity, and based on that, the government would demarcate a geographical area whereas the dairy plant was allowed to collect milk (Punjabi, 2010). This restriction on competition helped existing dairy processors to protect the returns to investments in their milk procurement sheds. This example illustrates to a certain extent the protectionist stand the government of India has been taking with regard to the cooperative dairy sector in the past decades, and the distrust towards private investment in a sector which was considered so crucial to the Indian agricultural economy and its poor.

[3] Operation Flood consisted in establishing milk producers' cooperatives in villages all over India (but especially in irrigated areas), set up following the model of the "Amul" cooperative in Gujarat, which resulted from collective action by dairy farmers and turned out to be extremely successful in improving marketing options for local farmers, as well as in substantially increasing milk production in Gujarat. The National Dairy Development Board (NDDB) was founded in 1970 to coordinate Operation Flood. The necessary funds to expand and re-organize existing local cooperatives to replicate the Amul-model were obtained from the sales of skimmed milk powder and butter oil, gifted by the European Economic Community to India through the World Food Program, and sold at commercial prices in the domestic market (World Bank, 1998). Productivity increases were mostly brought about by crossbreeding local ("*desi*") cows with high productivity breeds from Europe (e.g. Jersey, Holstein).

However, the restrictions on competition also had a depressing impact on milk prices and dairy profitability, and this was used as a major argument for abolishing these restrictions in 2002 through an amendment of the MMPO. While processing capacity has been on the rise since the 1990s, so far no structural shift in this growth rate has been observed after 2002.

3. The dairy market in Punjab

Within India, Punjab boasts the highest per capita milk production (0.898 kg per capita per day against a national average of 0.231 kg per capita per day in 2004 (Gupta, 2007). Part of this is due to a very high demand for milk by consumers, part of it is due to the extensive government support that went to dairy sector development in Punjab during Operation Flood.

As has been mentioned before, the major channels for marketing raw milk in Punjab are first the informal market, which is made up by informal traders, which either sell the milk on to hotels, restaurants, sweetshops or consumers (without processing), or to private domestic milk processors (possibly through one or more intermediary traders). Dairy farmers are largely unaware of the final destination of their milk when it is marketed through these informal traders. Second, there is the formal market, where milk goes for processing, either by cooperative processing plants, or by Nestle. According to our estimates, the informal market has the largest market share in Punjab, procuring 65% of the milk surplus in the state, followed by the cooperative (26%) and Nestle (9%). Interestingly, only half of the total milk production is sold, which reveals the fact that most rural households produce first for their own subsistence, and only sell whatever is left after that.

When going into slightly more detail about Nestle's history in Punjab, it is remarkable that in an era where hardly any (even domestic) private investment was authorized in the dairy sector, Nestle, the second dairy company in the world after Danone (Euromonitor, 2007), obtained a government license for establishing an Indian subsidiary, allowing it to set up a dairy plant in Moga (Punjab) in 1961. Anecdotal evidence suggests that Nestle obtained this license upon the promise that the company would take the lead in development of its milk shed by introducing improved dairy farming methods and technology, increasing yields, and facilitating dairy farmers' access to credit.[4] Interestingly, the strict government regulations which prevented other private companies from venturing into the dairy business, also protected Nestle from competition, and allowed it to establish a strong village-level procurement network of collection centers to source from. In 2008, Nestle India had a capacity of around 1.2 million liters of milk per day (LPD), constituting around one third of the total officially registered private dairy processing capacity of 3.7 million LPD (DAHD, 2008) and equivalent to 75 % of the officially registered cooperative processing capacity of 1.6 million LPD in Punjab.

Nestle has historically suffered a rather negative reputation regarding philantropy, mainly because of its controversial marketing campaigns of infant food, which resulted in an international boycott between 1977 and 1984. Nestle's reputation with respect to its marketing strategies had negative spillovers on their reputation with respect to its procurement strategies. For example, George (1987) notes: *"Nestle frequently notes its loans to farmers for purchases of one kind or another, repayment being 'deducted from milk purchases' by the company. It is not clear whether a Nestle supplier must accept all 'improvements' proposed by the company. However, one may assume that farmers, large or small, are probably not in a position to refuse such loans, once the company has become the only possible customer for milk and other produce."*

This reflects a more general negative attitude of policymakers and of civil society in India towards foreign investment, dating as far back as from the "Quit India" movement started by Gandhi in 1942 in a quest to convince the British colonizers to leave India. For example, Vandana Shiva, a leading Indian environmental philosopher, strongly opposes to the investment by multinationals in developing countries and advocates protection of farmers against multinationals, as dependence on multinationals would "increase the cost of agriculture manifold". In one of her manifests, Shiva (2007) also argues that agrifood and retail companies should not be allowed to source directly from farmers, as poor farmers stand to be exploited by large corporations with strong bargaining power. In general, many restrictions on foreign direct

[4] Under the FERA (Foreign Exchange Regulation Act), Nestle S.A. had to reduce its foreign equity in Nestle India from 69% to 40% FDI in the 1970s, but after 1991 the cap on foreign equity in food processing companies was gradually lifted and currently the share of foreign ownership in Nestle India amounts to 61%.

investment (FDI) remained in vigor in India until the 2000s – and until today, FDI is not allowed in e.g. agricultural production (except for tea plantations) and multi-brand retail.

The cooperative channel under consideration is the Punjab State Cooperative Milk Producers Federation Ltd. (Milkfed).[5] It was founded in 1973 under the Punjab State Cooperative Act, and was integrated in the national dairy cooperative framework established during Operation Flood in 1983. All dairy cooperative plants in Punjab are part of the same state-level Cooperative Federation, which overlooks the 11 district-level milk unions, which in turn coordinate the village-level milk producers' societies. Milkfed currently reports to have a network of almost 6500 milk collection centres in the state of Punjab, whereas they procure from around 365 000 milk suppliers (Milkfed, 2010). Some milk unions are said to perform better than others, notably the Ludhiana and Ropar milk unions.

4. Data and methodology

The data used for this study were collected in the summer of 2008. One thousand households were interviewed in 50 rural villages dispersed over 5 districts in Punjab. Punjab was divided in 5 regions: the North-West (Amritsar and Gurdaspur), the North East (Hoshiarpur, Jalandhar, Kapurthala and Nawanshahar) and in each of these regions one district was selected (at random, whereas the probability of selection was proportional to its rural population share within that region).

All villages in these districts were stratified according to the marketing channels present based on (a) their appearance in a list of procurement villages provided by Nestle and (b) their appearance in a list of procurement villages provided by district-level cooperatives if available and otherwise on their proximity to cooperative sector chilling plants. Based on this categorization, we selected at random 15 "Nestle" villages, 15 "cooperative" villages, 5 villages where both companies were assumed to operate, and 15 villages where none of them were assumed to operate. These 50 villages were spread over the 5 selected districts, resulting in a final selection of 6 villages in the district of Amritsar, 6 in Hoshiarpur, 14 in Ludhiana, 18 in Ferozpur, and 6 in Mansa.

In each village, 20 households were selected and surveyed in detail about their general characteristics, their income generating activities and expenditures, and in particular on dairy production practices, and use of input and output markets. The selection was commensurate with a random stratification strategy based on a prior village census of dairy farm size and milk marketing channel, mostly to allow oversampling of Nestle and cooperative suppliers and of large and medium-size dairy farmers (with more than 10 female adult dairy animals (DA) and between 3 and 10 DA respectively) – as the majority of milk suppliers in Punjab have less than 3 DA.

5. Descriptive statistics

Notwithstanding Punjab's high per capita milk production, the dairy sector in Punjab is still largely a matter of backyard production: as everywhere in India, most of the milk suppliers keep only 1 or 2 female dairy animals (DA) on their inner courtyard, of which the first litres of production are meant for home consumption in the (often extended) family. Table 1 shows some basic descriptives of our sample, and how it relates to the population under study, which consists of all rural households in Punjab. The first major observation is that 63% of the population under study keeps at least 1 DA.[6] Almost half of the population (46%) holds 1-2 DA, while a little over 17% keeps more than 2 female adult DA. As a result, the average number of female adult DA amongst households which own DA is 2.3. Most of the (female) bovine herd in rural Punjab is constituted of buffaloes (80.5 %); next come crossbred cows (16.9 %) and finally cows of traditional breeds (2.6%).

Interestingly, while more than 60% of rural households are producing milk, only 34.6% are selling milk. This means that more than 40% of the milk-producing households are doing so merely for their own subsistence. When considering the profile of a typical milk seller (see Table 2), our data reveal that almost 63% of the milk selling households have only 1-2 DA. Moreover, 50% of the milk produced and 35% of the milk sold in the population under study is produced by households with only 1-2 DA. Only 5.5% of the milk sold comes from households with more than 10 DA, who constitute only 0.7% of the milk sellers.

[5] Milkfed is often also referred to by its brand name, Verka.

[6] This is roughly in line with what data from the Indian Human Development Survey 2005 suggest, namely that 57% of the rural households hold at least one milch animal.

Our data show that the bulk of the sales are still into unorganized channels: almost 76% of the milk-selling households continue to supply unorganized dairy marketing channels, consisting of direct sales to consumer or to traditional milk middle-men. These traditional milk middle-men may sell the milk on to formal dairy processors, but most farmers are not aware of what these traders do with the milk they procure. Only 24% of the milk-selling households are supplying to organized dairy marketing channels, of which roughly one quarter goes to Nestle; and the remainder goes into the cooperative channel.

Next, as it is often argued that multinational companies are more inclined towards working with larger and/or more resource-rich farmers, we look into the descriptive statistics on channel choice. A first observation is that small milk suppliers do not seem to be excluded anywhere: while they are more represented in informal channels (67.5% of total suppliers) and in the cooperative channel (49.1% of total suppliers), even the multinational channel counts 38% of suppliers in the category of 1-2 DA. Only 3.6% of the multinational suppliers have more than 10 DA; however, this is relatively high as this category only constitutes 0.7% of the general population of milk sellers (see Table 2).

Further, we also look at the level of asset ownership of the suppliers, as it is often argued that even if modern marketing channels do work with very small farmers, they would usually select the most resource-rich amongst the small farmers (e.g. Maertens and Swinnen, 2009). Surprisingly, the lower part of Table 3 shows that the landless rural households – which are usually considered as the poorest of all – have a stronger representation amongst the multinational suppliers than amongst the cooperative channel suppliers, and rural households with larger landholdings have a stronger representation amongst cooperative channel suppliers than in any other dairy marketing channel. Moreover, the majority of total milk procured in the cooperative channel seems to be coming from farmers owning more than 5 acres of land.

These descriptive statistics seem to suggest that there might be some selection based on dairy herd size into the multinational channel, but for the same reasoning also into the cooperative channel. Similarly, there could be some selection into the cooperative channel based on asset ownership, in the sense that landless households are underrepresented in the cooperative channel. The true extent of this selection can however only be verified through a treatment model estimation, which allows us to control for other characteristics, such as some regional variables.

6. Exclusion of small farmers? The determinants of channel choice

There is a broad range of economic literature on the determinants of channel choice. We can distinguish buyer-driven selection on the one hand – implying that the buyer chooses a certain type of suppliers to work with (e.g. the ones that have lower transaction costs to deal with, better access to capital to do the required complementary investments, or even a lower bargaining power such that lower procurement prices can be applied). On the other hand, there may be self-selection by the supplier, implying that the supplier chooses his marketing channel based on his own perceptions on the benefits he can get out of each marketing channel. Especially the latter aspects often gives rise to endogeneity problems in assessing the impact of marketing channel choice on several performance indicators such as productivity, profitability, and investment by suppliers in their agricultural enterprise. If we want to assess this impact, we must in a first stage determine the major factors driving channel selection, and in a second stage use estimate the impact on performance, while correcting for the identified selection bias. Table 4 shows the first-stage multinomial regression for channel choice. The three channels we distinguish are (a) the multinational, Nestle; (b) the cooperative dairy, Milkfed; (c) the traditional channels. In the regression, we control for (a) productive capital (dairy herd size and its square, to allow for potential nonlinearities); (b) household human capital characteristics (the household head's education level and age and their respective square terms), (c) household social capital characteristics (a dummy for whether the household belongs to the sikh community, which is the dominant religion in Punjab; a dummy indicating whether the household belongs to a scheduled caste or a scheduled tribe, which are the population groups which have historically been suppressed by other groups, and this is still reflected in social relationships in the village today; and finally whether the household carries a BPL card or not. This is a card which entitles the household to subsidized food, and rather than a measure of poverty, today it should probably be rather interpreted as a measure of local political connections) We also include (d) a measure for household alternative productive assets (acres of land under cultivation), (e) a measure for household short-distance mobility (a dummy for whether the

household owns a bicycle or a motorbike) and (f) some village level characteristics (distance to the nearest town, the log of total village population, and district dummies).

The major factors driving the choice for the cooperative marketing channel, seem to be ownership of a BPL card – reflecting political connections at the village level; and two village level characteristics, namely the distance to the nearest town and the log of total population. This suggests that the cooperative is more successful in procuring from relatively larger villages which are further away from the larger towns. This may be related to the presence of a higher milk surplus, as the density of dairy farmers is assumed to be higher and less milk is channelled through the nearby towns, where the prospect of direct sales of raw milk to consumers may offer better prices than sales to a milk collection center for industrial processing. As far as herd size is concerned, the size of the coefficients suggest a convex relationship between dairy herd size and the likelihood of supplying the cooperative channel. However, the first order term is insignificant; and the second order term is statistically significant but its economic significance is rather weak. As a result, our data do not allow for a conclusive statement on the impact of herd size on participation in a cooperative channel. Bicycle or motorbike ownership has a weak positive impact on participation in the cooperative channel. Bike ownership is expected to increase participation in formal channels, as these do not usually offer the service of milk collection at the doorstep, while traditional channels often do. Contrary to what has been argued by Basu and Chakraborty (2008), we do not find evidence from selection on land size.

Conversely, the major factors driving participation into the multinational channel are district dummies, ownership of a bicycle or a motorbike; and kinship to the a scheduled tribe or scheduled caste. The impact of the district dummies is overarching, and this can be explained by the fact that amongst the sample districts, Nestle is mostly procuring in Ferozpur and Ludhiana. As argued before, bike ownership can be associated with higher mobility, and lower dependence on doorstep collection by traditional milkmen. Finally, there is the connection to a scheduled caste or tribe, which has a negative impact on selection into the multinational channels. This might reflect a historically recognized discrimination of this social group, whereas milk consumers were quite suspicious of drinking milk which had been procured from lower caste groups, most probably based on hygienic grounds. Though of a considerably smaller size order than the district dummies, the marginal effects of the two latter factors are far from negligible (resp. 55% and -46% of the mean of the independent variable). Interestingly, there does not seem to be any impact of herd size; hence our data do not support the often-heard claim that multinationals work exclusively with large farmers.

7. Impact of channel choice on performance

Next, we consider the impact of channel choice on a series of performance variables, in particular productivity (the log of yield per buffalo in liters of milk per day produced), profitability (the log of net income per dairy animal),[7] and investment in dairy enterprise (log of total dairy-related investment in the past 5 years, including cattle sheds, livestock, equipment). The descriptive statistics provided in Table 5 suggest that productivity and investment in formal channels are higher; but profitability not necessarily. It is also remarkable that overall, yields and profitability levels are dramatically low. In particular, the average yield per female adult buffalo per day is 3.5 L, and the average profit per female adult DA is as low as 95 US$ per year. This average figure covers a lot of negative figures, especially for households with only 1-2 DA. While average dairy investment is much higher in the multinational channel, the observed standard errors are very high as well, pointing at a large variation between individual suppliers.

In order to formally disentangle the impact of channel choice on the considered performance indicators, we make use of an estimation framework proposed by Deb and Trivedi (2006) and allows for the estimation of a continuous outcome equation with endogenous selection on a multinomial treatment variable. We also perform some robustness checks with a series of common propensity score matching techniques. On the one hand, we use as propensity scores the estimated probabilities coming out of the multinomial logit channel choice model estimation (MNLP); on the other hand we use propensity scores which are calculated through binary probit estimation for each respective channel (BPP). According to Lechner (2002), these two methods to calculate propensity scores should produce similar results. For both types of propensity scores, we apply two types of matching: Mahalanobis matching (MM, through the stata

[7] Note that net income is the value of total milk production per day per animal, minus the production costs (averaged out over the year).

command psmatch2) and kernel matching with bootstrapped standard errors (KM, through the stata command attk). The results are reported in Table 7 and Table 8 respectively.

First, we look at the impact of channel choice on productivity. The treatment regression suggests a significant positive impact on productivity of both supplying to the cooperative and to the multinational channel. The order of this impact is around 20% for each. Further important determinants of productivity are herd size. Productivity is convex in herd size, in that a larger herd size depresses productivity (up to a certain herd size, as the square term of herd size is positive). Each acre of additional land cultivated increases productivity with 0.6%. This may suggest certain complementarities between cropping and dairying, e.g. through improved availability of fodder, as it is a common practice to feed livestock on crop residues. Moreover, some of the cultivated land could be devoted to green fodder, with even better yield impacts. Through KM, no significant effects of channel choice are detected. Through KM, we do find a significant effect of channel choice on productivity (irrespective of whether we match on MNLP or BPP scores). The average effect on the treated of supplying to the cooperative channel is estimated to be around 7- 8%. There is no significant impact of supplying to the multinational channel.

Second, we look at the impact of channel choice on profitability per dairy animal. The multinomial treatment regression suggest again that both supplying to the cooperative and the multinational channel increases profitability per animal, though the cooperative channel has an effect which is twice the size and of higher statistical significance than the multinational channel. The model suggests that supplying to the cooperative channel increases profitability per dairy animal by up to 66%, while supplying to the multinational channel increases profitability by 33%. If we look at the ATT estimations through MM, the cooperative channel is reported to enhance profitability by 29%; while the effect of the multinational channel is insignificant. The results obtained through KM are roughly similar: the cooperative channel is estimated to increase yearly profitability per dairy animal by 19 – 22 %, depending on whether we match on MNLP or on BPP scores. No significant impact of the multinational channel is reported.

Finally, we turn to investment in dairy in the past five years. Here, the treatment regression suggests that supplying to the cooperative channel increases investment in dairy up to 4.5 times. Supplying to the multinational channel does not have a significant effect. Other important determinants of dairy investments are (unsurprisingly) dairy herd size. Also the level of education of the household head shifts the level of investment upwards. The impact of supplying the cooperative channel is however not reflected in the ATT estimated through MM. It is, to some extent, reflected in the ATT estimated through KM, but then only if we use BPP scores for matching.

In summary, though the treatment regression suggests that supplying to the cooperative and to the multinational channel have positive impacts on dairy animal productivity as well as profitability, and that supplying to the cooperative channel has a positive impact on investment in dairy farming; the evidence provided by our dataset does not seem to be conclusive about each of these results. In particular, the ATT estimations through propensity score matching only confirm the positive impact of supplying to the cooperative channel, and they only confirm this when we use kernel matching methods. The expected positive impact of modern marketing channels on profitability and productivity is thus only partially confirmed. A potential reason for the low impact of the multinational channel on dairy profitability, can be found in the generally disproportionally high costs of concentrate feed (on a per animal basis) for dairy farmers supplying to the multinational channel. These fail to translate into substantially higher yields, maybe because of the lack of other complementary factors such as e.g. the availability of green fodder.

8. Conclusion

Contrary to what the literature and our descriptive statistics would suggest, we do not find hard evidence of selection on herd size or assets by modern milk marketing channels in Punjab, nor by the cooperative, nor by the multinational channel. A relevant observation in this respect may be the fact that the Indian dairy system has not made the transition to a fully-fledged quality management system yet. No official microbial count limits are imposed in India. As incomes grow however, consumers are expected to be increasingly conscious about food quality and safety (Vandemoortele et al., 2010). This may result in more stringent food safety and quality regulations in the future, with potentially important repercussions on milk production systems. This does not seem to be a major concern at this point in time yet, however, as it

seems demand for milk is currently outperforming supply in terms of growth, and eliminating small dairy farmers would leave an insurmountable gap between demand and supply of milk.

We do find some evidence of selection through social capital indicators, which is unsurprising in the Indian context, where the selection of trade partners is still very often driven by trust and based on existing social networks. Further, we find some evidence that supplying to the cooperative channel increases dairy productivity, profitability and investment in dairy business. There is some evidence that supplying to the multinational channel increases dairy productivity and profitability as well, but these effects are not robust to any of the alternative treatment effects estimation methods we use.

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Table 1: Description of the sample

			Sample		Population	
		unit	**mean**	**st.dev.**	**mean**	**st.dev.**
% keeping dairy animals in 2008		%	80.8		63.1	
% producing milk		%	78.9		60.7	
Nr of female adult DA (for hh with DA)			**3.9**	**4.0**	**2.3**	**1.8**
	% in milk	%	61.7		69.5	
	% crossbred cows	%	20.9		16.9	
	% cows of traditional breeds	%	3.0		2.6	
	% buffaloes	%	76.2		80.5	
Size distribution of herds	0 female adults	%	19.2		36.9	
	1 - 2 female adults	%	27.3		45.9	
	3 - 10 female adults	%	49.1		16.9	
	10+ female adults	%	4.4		0.3	
% selling milk		**%**	**61.4**		**34.6**	
	to multinational channel	%	30.9		5.8	
	to cooperative channel	%	29.5		17.9	
	to traditional channels	%	39.6		76.3	

Source : own survey data

Table 2: Importance of different categories of farmers in Punjab dairy sector

A. Categories according to livestock holding (nr of female adult DA)

	% milk producers	% milk production	% milk sellers	% milk sales
1-2 DA	72.9	49.7	62.8	35.0
3-10 DA	26.7	47.1	36.5	59.5
>10 DA	0.4	3.2	0.7	5.5

B. Categories according to landholding (acres land owned)

	% milk producers	% milk production	% milk sellers	% milk sales
landless	26.5	17.4	22.7	14.6
small farmers (< 2 acres)	14.8	12.3	17.1	12.6
medium farmers (2-5 acres)	33.3	33.6	35.8	33.9
large farmers (> 5 acres)	25.4	36.7	24.4	38.9

Table 3: Importance of different categories of farmers in each marketing channel

A. Milk supplier profile per marketing channel (in %, according to livestock holdings)

	Multinational		Cooperative		Informal channels	
	suppliers	milk procurement	suppliers	milk procurement	suppliers	milk procurement
1-2 DA	37.8	17.9	49.1	25.1	67.5	41.2
3-10 DA	58.5	61.6	49.9	68.6	32	55.6
>10 DA	3.6	20.4	1.0	6.3	0.5	3.2

B. Milk supplier profile per marketing channel (in %, according to land holdings)

	Multinational		Cooperative		Informal channels	
	suppliers	milk procurement	suppliers	milk procurement	suppliers	milk procurement
landless	19.8	8.6	13.9	7.7	24.8	18.2
small farmers (< 2 acres)	20.2	14.7	19.1	13.4	16.4	12.0
medium farmers (2-5 acres)	19.1	35.6	25.6	27.8	38.6	36.0
large farmers (> 5 acres)	30.8	41.1	41.3	51.1	20.1	33.8

Table 4: Multinomial regression results for selection into marketing channel

	Regression results		Marginal effects		
	Coef.	Rob. SE	dy/dx	SE	X
Cooperative channel					
dairy herd size	-0.105	0.079	-0.023	0.015	4.425
(dairy herd size)²	0.007 *	0.004	0.001 **	0.001	39.331
education household head	-0.019	0.078	0.001	0.016	5.423
(education household head)²	0.002	0.007	0.000	0.001	50.117
age household head	-0.046	0.053	-0.015	0.011	50.180
(age household head)²	0.000	0.001	0.000	0.000	2669.754
member of sikh community	0.552	0.497	0.138	0.084	0.936
member of SC/ST community	-0.233	0.328	-0.021	0.069	0.165
BPL card holder	1.150 ***	0.240	0.268 ***	0.051	0.289
cultivated land (acres)	0.003	0.014	0.002	0.003	6.962
ownership bicycle or motorbike	0.524 *	0.308	0.075	0.063	0.855
distance to town	0.035 ***	0.012	0.008 ***	0.003	10.307
log(population in village)	0.534 ***	0.197	0.101 **	0.042	7.601
Ferozpur	0.074	0.271	-0.347 ***	0.040	0.342
Ludhiana	-0.604 **	0.264	-0.396 ***	0.044	0.365
constant	-4.366 **	2.031			
Multinational channel					
dairy herd size	-0.015	0.081	0.004	0.008	4.425
(dairy herd size)²	0.005	0.004	0.000	0.000	39.331
education household head	-0.093	0.075	-0.012	0.010	5.423
(education household head)²	0.007	0.006	0.001	0.001	50.117
age household head	0.085	0.065	0.014	0.009	50.180
(age household head)²	-0.001	0.001	0.000	0.000	2669.754
member of sikh community	-0.426	0.412	-0.103	0.076	0.936
member of SC/ST community	-0.643 **	0.317	-0.067 **	0.033	0.165
BPL card holder	0.063	0.267	-0.062 **	0.031	0.289
cultivated land (acres)	-0.018	0.014	-0.003	0.002	6.962
ownership bicycle or motorbike	0.883 ***	0.325	0.080 **	0.035	0.855
distance to town	0.001	0.018	-0.002	0.002	10.307
log(population in village)	0.352	0.283	0.017	0.037	7.601
Ferozpur	5.355 ***	1.011	0.837 ***	0.063	0.342
Ludhiana	4.532 ***	1.013	0.770 ***	0.079	0.365
constant	-9.417 ***	2.705			
Nr obs.	605				
Wald chi2(30)	133.59				
P-value	0.000				
Pseudo-R^2	0.190				

* p<0.10, ** p<0.05, *** p<0.01

Traditional channel is the base outcome

Table 5: Performance according to dairy marketing channel

	Dairy herd size (Nr. of DA)		Productivity (LPD per DA)		Profitability ($ per DA per yr)		Dairy investment ($ in past 5 ys)	
Channel	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
traditional	3.9	0.2	3.3	0.1	97	28	219	32
cooperative	3.7	0.2	4	0.2	92	132	333	52
multinational	5.9	0.9	3.6	0.2	88	97	1834	1306
Total	4	0.1	3.5	0.1	95	45	359	99

Note: The reported figures are weighted population averages.

Table 6: Results of the second stage (outcome) regression

Outcome variable	Buffalo productivity	Profitability per animal	Investment in dairy
cooperative channel	**0.20208** *	**0.66084** ***	**4.48102** ***
	0.104469	0.180102	0.644641
multinational channel	**0.21992** ***	**0.32818** *	**-0.409**
	0.074035	0.184068	1.184736
dairy herd size	**-0.0743** ***	**-0.0145**	**0.33435** ***
	0.016833	0.018616	0.08856
(dairy herd size)²	**0.00246** ***	**0.00027**	**-0.0035** **
	0.00073	0.000303	0.001625
education household head	**-0.0094**	**-0.0105**	**0.33162** **
	0.014729	0.031812	0.137296
(education household head)²	**0.00062**	**-0.0006**	**-0.0183**
	0.001341	0.002769	0.0113
age household head	**-0.0048**	**-0.0088**	**0.08586**
	0.009731	0.019448	0.094648
(age household head)²	**5E-05**	**5.6E-05**	**-0.0007**
	0.000091	0.000195	0.000915
cultivated land (acres)	**0.0055** **	**0.01745** ***	**-0.0163**
	0.002165	0.005199	0.028762
distance to town	**0.00118**	**0.00694**	**-0.0387**
	0.002947	0.00563	0.043629
constant	**1.42737** ***	**9.10819** ***	**-1.4891**
	0.272028	0.494188	2.533985
lnsigma	**-0.9018** ***	**-0.274**	**0.31564**
	0.084208	0.188893	0.281274
λ(cooperative)	**-0.0844**	**-0.5207** ***	**-4.6688** ***
	0.124887	0.174651	0.126777
λ(multinational)	**-0.1614** *	**-0.2186**	**0.33954**
	0.083386	0.20148	1.660901

Note: Significance is expressed as *** for $p < 0.01$; ** for $p < 0.05$ and * for $p < 0.1$

Table 7: Results ATT estimation through Mahalanobis matching (MM)

1. Impact on log(daily productivity per dairy animal)

	Sample	Treated	Controls	Difference	S.E.	T-stat
Cooperative	Unmatched	1.31332608	1.20003644	0.11328964	0.04299941	2.63
MNLP	ATT	1.31332608	1.25493626	0.05838982	0.06870805	0.85
BPP	ATT	1.31332608	1.26753627	0.04578981	0.05951675	0.77
Multinational	Unmatched	1.25469281	1.22373824	0.03095456	0.04259165	0.73
MNLP	ATT	1.25469281	1.26337553	-0.00868272	0.06765431	-0.13
BPP	ATT	1.25469281	1.3263767	-0.07168390	0.06499797	-1.10

2. Impact on log(yearly profitability per dairy animal)

	Sample	Treated	Controls	Difference	S.E.	T-stat
Cooperative	Unmatched	9.3483115	9.09262461	0.255686893	0.099692243	2.56
MNLP	ATT	9.3483115	9.16277478	0.185536724	0.162167937	1.14
BPP	ATT	9.3483115	9.0625847	0.285726804	0.144285767	**1.98**
Multinational	Unmatched	9.16789314	9.17224507	-0.00435193	0.100886345	-0.04
MNLP	ATT	9.16789314	9.24536356	-0.07747042	0.155724919	-0.50
BPP	ATT	9.16789314	9.26362106	-0.09572792	0.146695443	-0.65

3. Impact on log(investment in dairy in past 5 years)

	Sample	Treated	Controls	Difference	S.E.	T-stat
Cooperative	Unmatched	4.61029004	3.52987783	1.08041221	0.42753193	2.53
MNLP	ATT	4.61029004	4.68712905	-0.07683902	0.69733329	-0.11
BPP	ATT	4.61029004	3.73560205	0.87468799	0.67522749	1.30
Multinational	Unmatched	3.24400304	4.13197619	-0.88797315	0.42246666	-2.10
MNLP	ATT	3.24400304	3.65711095	-0.41310791	0.64776432	-0.64
BPP	ATT	3.24400304	3.52547076	-0.28146772	0.64459331	-0.44

Note: S.E. does not take into account that the propensity score is estimated.

Table 8: Results ATT estimation with the kernel matching method (KM)

		N treatm.	N contr.	ATT	SE	T-stat
1. Impact on log(daily productivity per dairy animal)						
Cooperative	MNLP	181	424	0.072	0.040	**1.802**
	BPP	181	424	0.083	0.041	**2.036**
Multinational	MNLP	190	415	0.020	0.050	0.397
	BPP	190	415	0.030	0.044	0.686
2. Impact on log(yearly profitability per dairy animal)						
Cooperative	MNLP	181	424	0.186	0.107	**1.736**
	BPP	181	424	0.219	0.098	**2.224**
Multinational	MNLP	190	415	0.047	0.113	0.412
	BPP	190	415	0.068	0.119	0.571
3. Impact on log(investment in dairy in past 5 years)						
Cooperative	MNLP	181	424	0.150	0.552	0.272
	BPP	181	424	0.840	0.453	**1.854**
Multinational	MNLP	190	415	-0.539	0.468	-1.152
	BPP	190	415	-0.626	0.616	-1.016