Multinationals versus cooperatives: The income and efficiency effects of supply chain governance in India

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Selected Paper prepared for presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, 18-24 August, 2012.

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Abstract

The impact of multinational firms on the domestic agricultural sector in developing countries is controversial, in particular in India. Relying on a unique set of household-level data from the state of Punjab, we study the biggest dairy company in the world (Nestlé) in India and compare its vertical spillover effects on upstream suppliers to other market channels (informal sector and cooperatives). We find that farmers that supply informal channels are less efficient and earn less profits per dairy animal than farmers supplying the cooperative and the multinational sector. Further, we find that farmers in the multinational channel are more efficient than farmers in the cooperative channel, but equally profitable. Hence, we do not find that supplying the cooperative channel is more beneficial for local dairy farmers than supplying the multinational channel. Overall, however, dairy productivity and profitability levels are still dramatically low, with tremendous scope for dairy development.

1. Introduction

In the past decades, successive waves of liberalization all over the world have led to an increased inflow of foreign direct investment (FDI) in developing and transition countries. This has ignited a heated debate on the vices and virtues of multinationals' presence in these countries. Supporters argue that FDI is the best road to economic growth and development by relaxing capital constraints, creating employment, and the transfer of technology and know-how (UNCTAD, 2005; Reardon and Barrett, 2000). While the empirical evidence on horizontal intra-industry spillovers is mixed (Blomström and Kokko, 1998), important vertical knowledge and productivity spillovers through upstream and downstream linkages with domestic firms have been observed (Blalock and Gertler, 2008; Ivarsson and Alvstam, 2010; Jordaan, 2011). Positive vertical spillovers tend to be stronger in cases with joint domestic and foreign ownership (Javorcik and Spatareanu, 2008).

Critics however argue that multinationals locate their production processes in developing countries mainly to exploit cheap labour and lax labour and environmental standards, while hardly contributing to local development because of various kinds of tax exemptions and repatriation of profits (Beghin *et al.*, 2002).[1] A further issue is that the benefits brought by FDI may accrue disproportionally to those who are wealthy already, reinforcing societal imbalances and leaving the poor worse off (Chen *et al.*, 2011; Feenstra and Hanson, 1997). In the context of multinational agrifood firms, concerns have been raised over the potential exclusion of small suppliers because of high transaction costs and the inability to comply with stringent standard and grading requirements imposed by multinational companies (Reardon and Berdegué, 2002; Reardon and Barrett, 2000); and because multinational companies tend to increase competitive pressure in local markets, eventually leading to supply base consolidation (Farina, 2002). Other studies find, on the

[1] See Colen *et al*. (2009) for a review of the major arguments.

contrary, that FDI does not necessarily lead to supply base consolidation, and that small suppliers can be included and benefit from vertical linkages with multinational firms (Dries and Swinnen, 2004), and otherwise that rural households can benefit strongly from employment with multinational investment (Maertens *et al*., 2011). An interesting study by Stokke (2009) on FDI in the retail sector suggests that farmers may either benefit through productivity spillovers and increased demand, or remain in isolation and get stuck in a low productivity trap. However, she also argues that if supermarkets engage in supply chain development and supplier upgrading, suppliers may escape this low productivity trap leading to mutual benefits.

At the other end of the "moral" spectrum are the cooperative firms. For decades, cooperatives have been promoted based on their strong potential to contribute to equitable growth and poverty reduction (Birchall, 2004; Lele, 1981) by strengthening their members' economic position (Tchami, 2007). We focus on marketing cooperatives in this paper. Especially in developing agrifood sectors, such cooperatives are expected to help smallholders reduce transaction costs in accessing inputs, information, technology and markets for high-value products and perishables (Stockbridge *et al.*, 2003; Lele, 1981). The empirical literature shows that cooperatives have helped members to reduce transaction costs and mitigate exclusion (Berdegué, 2001; Holloway *et al.*, 2000), to comply with stringent food standards (Narrod *et al.*, 2009), and to achieve higher output prices for their members (Bernard *et al.*, 2008). Bernard and Spielman (2009) find that while the poorest farmers are often excluded from collective action, they may still benefit from positive spillover effects of the cooperatives' presence such as improved access to inputs, output markets and information.

The literature also presents a set of arguments why cooperative governance is inferior from an efficiency point of view.[2] One source of potential economic inefficiency is the pursuit of multiple objectives: apart from economic interests, cooperatives may pursue specific social and/or cultural interests, such as inclusion or employment creation (Lele, 1981). Democratic election of board members may lead to a 'skills deficit', where board members lack the required expertise or skills to effectively manage the firm (Cornforth, 2004). Efficiency losses may be particularly significant in cases where there is a misalignment between members' objectives (Hansmann, 1988), which may lead to rent-seeking behaviour (Banerjee *et al.*, 2001). Finally, government interference has also been pointed at as a cause of the failure of cooperative action (Holmen, 1990).[3] Amongst other problems, governments have been accused of intervening in the appointment of board members, and to use cooperatives to gain political support in rural areas.

There is still a lack of consensus in the literature, both on the effects of multinational investment and of cooperatives, demonstrating the need for more convincing empirical analysis. This paper uses a unique primary dataset of rural households in Punjab, a state in the North of India, which produce milk and can choose to supply to the multinational sector, the cooperative sector, and the informal sector – offering a unique opportunity to investigate vertical spillover effects of different marketing channels on farm-level performance in an extremely interesting setting. The dairy market in India is the second largest food market in the world (after the Chinese pork sector) with a volume of 100 million MT and a value of 41

[2] For example, Ferrier and Porter (1991) claim that "co-operatives are theoretically an inherently inferior form of organization."

[3] Government inference is said to be strong in the Indian cooperative sector. Kulkarni (1955) argues that "co-operation has remained a policy of the Government in India rather than a movement of the people," even though Weeraman *et al.* (1986) state that "The essence of the co-operative movement is in its non-official, self-dependent and self-reliant character… There can be no imposed cooperation… nothing can be more fatal than government control, which is the embrace of death…" In Andhra Pradesh, a state in the South of India, the state government enacted the Mutually Aided Cooperative Society Act in 1995 in order to give dairy cooperatives more autonomy and protect them from government inference (Punjabi, 2010). Some other states (such as Karnataka) have implemented similar laws. However, to our knowledge, this is not the case for Punjab.

billion US$ in 2008 (FAO, 2011).[4] Dairy is a high-value product, which is consumed more as households grow richer, and it is strongly embedded in Indian rural tradition, especially in the Northern states, where climatic conditions are favourable to milk production. In 2002, it was estimated that more than 70 million rural households derive direct income or employment from the Indian dairy sector (Sharma *et al*., 2002), including many very poor households.

Within this market, we study the activities of Nestlé, the biggest dairy multinational in the world (FIL/IDF, 2010), and compare its procurement systems with other market channels of major importance in India (in particular, the informal and the cooperative sector). Despite the size of the dairy sector in India as well as the size of the dairy multinational, very little representative and recent data exist on either. There are a few studies on dairy marketing channels in India, showing (a) the importance of the informal sector and the overall lack of quality and safety considerations (Kumar *et al*., 2011); (b) that the emerging formal private sector sources from relatively larger farmers (Sharma and Singh, 2007); and (c) that while milk cooperatives have contributed enormously to dairy development in India and pulled lots of small farmers out of poverty (Cunningham, 2009; Singh, 2009; Alderman, 1987), at present the cooperative sector does not seem to be able to match growth in the private sector (Gulati and Ganguly, 2010). However, in general these studies suffer from a number of lacunas as they use small-scale and non-representative surveys; many of them are outdated; and none of them looks explicitly at the activities of multinationals.

Providing evidence on the impact of multinationals and cooperatives is important to feed the policy debate, especially in India, where policy makers and civil society often have a negative attitude towards foreign investment, dating as far back as to the "Quit India" movement started by Gandhi in 1942 to convince the British colonizers to leave India. Many restrictions on FDI remained in vigor in India until the 2000s; and until today, FDI is not

[4] This is roughly equal to the combined output value of rice and wheat, the two major crops in India.

allowed in agricultural production (except for tea plantations) and multi-brand retail.[5] On the other hand, the government of India has historically kept a protective grip on the dairy cooperative sector, which has been painstakingly built up with extensive government support in the 1970s and the 1980s – and this has often happened at the expense of private sector investment.

To the best of our knowledge, we are the first to use solid micro-econometric farm-level analysis to compare the efficiency and income gains for local suppliers of working with a cooperative, a multinational and the private domestic (informal) sector operating in the same region. We proceed as follows. We first provide a brief account of the dairy sector in India in Section 2, and subsequently zoom in on the dairy sector in Punjab, the North-Indian state under study, in Section 3. Section 4 describes the dataset used, as well as the methodology of data collection. Section 5 provides a set of descriptive statistics of our dataset. In Section 6, we explore the determinants of marketing channel choice and in Section 7 we investigate how marketing channel choice affects farm-level performance. Finally, Section 8 concludes.

2. The dairy sector and dairy policy in India

After India's independence in 1947, the Indian 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 (World Bank, 1999). The dairy sector was tightly regulated through a licensing

[5] For example, Vandana Shiva, a leading Indian environmental philosopher, strongly opposes 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.

system under the 1951 Industrial Development and Regulation Act, deterring entry for most private companies (World Bank, 1999).

In the 1970s the Government of India launched "Operation Flood", a large scale dairy sector development program with as main objectives (a) to make India self-sufficient in milk through the introduction of 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 was considered a relatively accessible income-generating activity for landless farmers. Operation Flood was very successful. It is often referred to as India's "White Revolution",[6] and its impact is considered to be comparable to the Green Revolution in India, lifting growth rates of milk production from an annual 0.7% at the end of the 1960s to 4.3% two decades later. 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; Cunningham, 2009).

Remarkably, in an era where hardly any (even domestic) private investment was authorized in the dairy sector, Nestlé, the largest dairy company in the world in terms of turnover (FIL/IDF, 2010), 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 Nestlé obtained this license upon the promise that the company would take the lead in the development of its milk shed by introducing improved dairy farming methods and

[6] Operation Flood consisted in establishing milk producers' cooperatives in villages all over India (but especially in irrigated areas), based on 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).

technology, increasing yields, and facilitating dairy farmers' access to credit. The strict government regulations which prevented other private companies from venturing into the dairy business, also protected Nestlé from competition, and allowed it to establish a strong village-level procurement network of collection centres to source from. As such, Nestle grew out to one of the major private sector dairy companies in India, with dairy processing plants in Moga (Punjab) and Samalkha (Haryana).[7]

This does not mean that Indian government policies have always been favourable to Nestlé. For example, in the 1970s, Nestlé S.A. was forced to reduce its foreign equity in Nestle India from 69% to 40% under the Foreign Exchange Regulation Act (FERA). 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%.

In December 1991, the dairy sector was "delicensed", as part of an important series of liberalization reforms in response to a dramatic balance-of-payment crisis in India (Aghion *et al.*, 2008). This included the abolition of the requirement for private plants to apply for a license from the Central Government prior to establishing or expanding a processing plant. However, the subsequent massive entry by the private sector into dairy processing triggered major concerns about the survival of the dairy cooperative system which had been built up with substantial government support. In response to these concerns, 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

[7] Nevertheless, Nestlé has historically suffered a rather negative reputation, mainly because of its controversial marketing campaigns of infant food, which resulted in an international boycott between 1977 and 1984. Nestlé's reputation with respect to marketing had negative spillovers on their reputation with respect to procurement. For example, George (1978) notes: "Nestlé 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 Nestlé 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."

evidence that the region they would procure from had sufficient milk surplus to justify the creation of new processing capacity. Based on this evidence, the government would demarcate a geographical area where 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 areas. This example illustrates the Government of India's protection of the dairy cooperative sector, and its distrust towards private investment in a sector which was considered so crucial to the Indian agricultural economy and its poor.

However, apart from constraining private investment in the dairy sector, the restrictions on competition were considered to have a depressing impact on milk prices and dairy profitability at the farm level (World Bank, 1999). This was a major argument for abolishing these restrictions in 2002 through an amendment of the MMPO. After 2002, the private dairy sector in India has experienced stronger growth than the cooperative dairy sector (see Figure 1). In 2002, the size of the private and the cooperative sector was approximately the same (around 30 million litre per day (LPD)). By 2010, the private sector had roughly doubled its capacity (to close to 60 million LPD), while the cooperative capacity is still less than 40 million LPD.

3. The dairy sector in Punjab

Within India, Punjab has the highest per capita milk production (0.956 kg per capita per day against a national average of 0.252 kg per capita per day in 2008 (DAHD, 2010)). This may be at least partly attributable to the favourable agro-climatic conditions in the North of India, ensuring a high availability of green fodder, a well-developed transport infrastructure to support dairy commercialisation (Chand, 1999), to the relatively high standard of living

which pushes up local demand (Staal *et al.*, 2008), and to the extensive government support that went to dairy sector development in Punjab during Operation Flood.[8]

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 have only 1 or 2 female dairy animals (DA), typically stalled in their inner courtyard, of which the first litres of production are for home consumption in the (often extended) family. Most of the bovine herd in rural Punjab is constituted of buffaloes, but there are also crossbred cows and cows of traditional breeds. Milk is marketed into three major channels. First, raw milk (without prior processing) may be sold directly to neighbouring households or to informal traders, which sell to hotels, restaurants, sweetshops, consumers, or to private milk processors (possibly through one or more intermediate traders). Dairy farmers are largely unaware of the final destination of their milk when it is marketed through these informal traders, which is why we will refer to all these together as the "informal" sector.

In the formal sector, milk is processed and packaged before being distributed to consumers. The formal dairy market in Punjab is dominated by two marketing channels: on the one hand, there is Nestlé India, a subsidiary of Nestlé SA which set up its first plant in Moga (Punjab) in 1961, and Milkfed, a dairy marketing cooperative which received extensive government support during Operation Flood.

Different sources contradict each other on the respective importance of the different channels. According to our data, 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 Nestlé (9%) (see Figure 2). In 2008, Nestlé's factory in Punjab had a capacity of around 1.2 million LPD, constituting around one third of the total officially registered private dairy processing

[8] For an overview of the districts covered by Operation Flood, see Cunningham (2009).

capacity of 3.7 million LPD (DAHD, 2008). According to their own data sources, Nestlé was collecting milk from almost 76 600 suppliers through a network of 1916 milk collection centres in Punjab in 2008. It is procuring milk in 12 out of 18 districts in Punjab, which means that its procurement area overlaps to a strong extent with the procurement area of the cooperative dairy, which is procuring from most districts in Punjab.

The cooperative channel under study is the Punjab State Cooperative Milk Producers Federation Ltd., popularly known as Milkfed - or by its brand name, Verka. It is a marketing cooperative and was founded in 1973 under the Punjab State Cooperative Act, and 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, which are central collection points where farmers deliver their milk to. In 2007, Milkfed reportedly had a network of almost 6,000 milk collection centres in the state of Punjab, through which they procured from around 360,000 milk suppliers (Milkfed, 2008). Some milk unions are said to perform better than others, notably the Ludhiana and Ropar milk unions (Gupta *et al.*, 2006). The joint capacity of the cooperative processing plants in Punjab amounted to 1.5 million LPD in 2008 (Milkfed, 2008).

4. Data

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), the South-West (Bathinda, Faridkot, Ferozepur, Moga and Muktsar), the South-East (Mansa, Patiala, Sangrur), and the Central region (Fatehgarh Sahib, Ludhiana, Ropar) (see Figure 3). In each of these regions one district was

selected at random, with the probability of selection being proportional to the district's population share within that region, in order to avoid oversampling of households in smaller districts. All villages in these districts were stratified according to the marketing channels operating in that area, based on their appearance in a list of procurement villages provided by Nestlé and in a list of procurement villages provided by some of the district-level cooperatives[9] if available and otherwise on their proximity to cooperative sector cooling plants.[10] We selected at random 15 "Nestlé" villages, 15 "cooperative" villages, 5 villages where both companies were expected to operate, and 15 villages where none of them were expected 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 according to a stratified random sampling strategy based on a prior village census. More precisely, households were classified into categories based on the number of DA they owned (0 DA; 1-2 DA; 3-10 DA; >10 DA) and on the marketing channel they were selling their milk into. This sampling strategy allowed for oversampling of Nestlé and cooperative suppliers and of large and medium-size dairy farmers – as the majority of milk suppliers in Punjab have less than 3 DA. The set-up of the sample allows extrapolating statistics to the level of the state of Punjab, by using proper weighing factors. The selected households were 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.

5. Descriptive statistics

[9] If these were not available, we based the stratification on the village's proximity to cooperative sector chilling plants.

[10] These are plants where milk is collected from milk centres and cooled down prior to being transferred to the processing factory.

(a) Production structure

Table 1 shows some basic descriptives of our sample as well as how it relates to the rural population of Punjab, using proper weighing factors. The first major observation is that 63% of the surveyed population keeps at least 1 DA.[11] 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 owning DA is 2.3. Most of the bovine herd in rural Punjab is constituted of buffaloes (81.2%); next come crossbred cows (15.8%) and finally cows of traditional breeds (3.0%).[12]

Interestingly, while more than 60% of rural households are producing milk, only 36% are selling milk. This means that 40% of the milk-producing households are doing so merely for their own subsistence, and that only half of total milk production is sold in Punjab. Furthermore, Table 2 shows that 50% of the milk produced and 35% of the milk sold is produced by households with only 1-2 DA. Only 5.5% of the total volume of milk is procured from households with more than 10 DA, who represent 0.7% of the milk sellers.

(b) Channel choice

The bulk of the sales are into informal channels (Table 1): almost 75% of the milk-selling households sell directly to consumers or to informal milk traders – representing 32% of total sales. Only 25% of the milk-selling households are supplying formal channels: 6% sell to Nestlé; the cooperative accounts for the remaining 19%.

There are no contracts (not even oral agreements) between dairy farmers and formal buyers with respect to milk delivery in Punjab. In other words, if there are other marketing channels available in the village, farmers have the option of switching channels. Farmers

[11] 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.
[12] These figures are expressed in shares of total number of female adult dairy animals.

often can choose whom to sell to on a daily basis (and sometimes do, especially if multiple buyers offer them services such as advance payments).[13] However, most farmers tend to sell each day to the same buyer, often driven by personal ties. Figure 4 reflects that the major reasons for buyer choice were related to trust and timely payments. In particular, 65% of informal sector suppliers, 75% of cooperative sector suppliers, and 68% of multinational sector suppliers state that honesty and trustworthiness of the buyer is a crucial determinant of buyer selection.

Milk prices are less important. Only 15% of the suppliers in the multinational channel and 9% of suppliers in the informal channel report to choose their buyer according to the milk price he offers. In the cooperative channel, this even drops to a mere 3%.[14]

When considering non-price factors and services offered by buyers, timely payments emerge as a major reason for buyer selection, as stated by 71% of informal sector suppliers, 75% of cooperative sector suppliers, and 79% of multinational sector suppliers. Almost 54% of the multinational suppliers report that the fact that their buyer offers advance payments is a crucial determinant of their buyer choice. For the alternative marketing channels, this is the case for almost 40% of suppliers. Finally, 11% of multinational sector suppliers report the fact that the buyer offers support to upgrade to commercial dairy farms is important; as compared to 6% of informal sector suppliers and less than 4% of cooperative sector suppliers.

Interestingly, Nestlé scores better than the other channels for all indicators, except for buyer honesty and trustworthiness, where the cooperative sector scores better.

[13] In the few cases where suppliers were found to be selling into multiple channels in our survey, we classified them into their "major" marketing channel, in particular the marketing channel they were selling the largest share of their milk surplus to.

[14] This is confirmed by some additional evidence. When asked whether suppliers would switch to an alternative buyer they know of in their village if he/she would offer 1 additional Rs/L milk, around 25% of the respondents say they would; while over 50% they would not even switch for an additional 5 Rs/L milk (i.e. for an approximately 30% higher price) – with the main reason being the fact that they suspect the other buyer to be dishonest. This shows the importance of trust factors in establishing trade relationships in Indian rural markets – possibly outweighing small price advantages in the selection process. We further tested price differences by channel for buffalo milk. T-tests report that there are no significant differences in milk prices between the different channels.

Table 3 presents statistics on channel choice according to farm size. A first observation is that small milk suppliers do not seem to be excluded anywhere. 67.5% of informal channel suppliers, 49.1% of cooperative channel suppliers, and 38% of the multinational channel suppliers have less than 3 DA. Only 3.6% of the multinational suppliers have more than 10 DA. Still, this is relatively high compared to the general population where the share of suppliers with more than 10 DA amounts to 0.7% (see Table 2). Contrary to conventional wisdom (e.g. Cunningham, 2009), the descriptive statistics suggest that the cooperative sector has seemingly moved away from smaller farmers over time as they source from a similar supply base as the multinational sector.

Further, we look at the level of asset ownership of suppliers, as it may be 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 – are supplying more often to the informal and to the multinational channel, rather than to the cooperative channel. In particular, 24.8% of the informal channel suppliers and 19.8 % of the multinational channel suppliers are landless, as compared to 13.9% of the cooperative sector suppliers. Moreover, rural households with larger landholdings have a stronger representation amongst cooperative channel suppliers than in any other dairy marketing channel: 41.3% of the cooperative sector suppliers are large farms (defined as more than 5 acres of cropping land), as compared to 30.8% for the multinational channel and 20.1% for the informal channel.

Hence, the descriptive statistics suggest that (a) despite the enormous quantities produced and consumed in India and despite fast growth of the dairy sector over the last decade, the sector is still largely informal; (b) production is concentrated in (very) small farms, and all channels source from these small farms; (c) the multinational sector sources

more often from suppliers with larger dairy herds; and (d) the cooperative sector sources more often from suppliers with larger landholdings. The extent of these selection effects will be verified through regression analysis below.

(c) Productivity and profitability

Next, we look at productivity and profitability. For productivity, we only use data on buffalo productivity (as buffalo is the dominant dairy animal type in the region under study, and to avoid using biased indicators by mixing different animal types). For profitability, we use net income per DA, calculated as the value of total milk production per year (using self-reported milk prices if available, and otherwise estimated milk prices,[15] minus the production costs directly associated with dairy production (external labour, purchased fodder and concentrate feed, veterinary costs, and an imputed value for self-cultivated green fodder and family labor). Table 4 presents the descriptive statistics. Overall, yields and profitability levels are dramatically low. In particular, the average yield per female adult buffalo is 3.8 LPD, and the average profit per female adult DA is as low as 187 US$ per year.[16] Although the differences are small, productivity and profitability are slightly higher in the dairy cooperative channel as compared to the multinational channel. Productivity and profitability are lowest in the informal channel. However, the t-tests show that these differences are not statistically significant.[17]

However, the true extent of this effect requires verification through a two-stage regression, controlling in the first stage for potential endogeneity bias resulting from selection into the different channels. In particular, if there is a farm-level determinant of efficiency

[15] Missing milk prices were estimated as the average local price (at the village level, and, in exceptional cases (0.5% of the cases), at the district level.

[17] The reported t-statistics are based on an adjusted Wald-test, which is considered to perform better in case survey weights are used (see Sribney, 2005).

which at the same time increases the farm's propensity of supplying a specific marketing channel, the impact of supplying that particular marketing channel on productivity may be overestimated if we do not control for selection bias in the first stage.

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

The choice of the marketing channel reflects a selection process which can either be buyer-driven – 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) – or result from self-selection – or a mix of both. In this section, we investigate how the probability of supplying to a specific channel varies across individuals as a function of relevant individual characteristics.

(a) Methodology, variables and hypotheses

First, we investigate the (observable) determinants of the selection process into different marketing channels using a multinomial probit model for those districts (Ludhiana and Ferozpur) where suppliers can choose between three different channels: the multinational (Nestlé), the cooperative dairy (Milkfed), and the informal channels (which we group together); and a binomial probit model for those districts (Amritsar, Hoshiarpur, and Mansa) where suppliers choose between supplying the cooperative dairy (Milkfed) and the informal channels.

In both regressions, we use as explanatory variables a set of village-level characteristics as well as a set of household-level characteristics. The village-level characteristics comprise measures for village population size, the distance to the nearest town, as well as district dummies. These are expected to affect the local market structure.

However, the expected sign of this effect is not clear. If larger villages have more milk surplus, they may attract a higher presence of formal market channels (i.e. the multinational and the cooperative). If larger villages have more net consumers of milk, the demand for raw milk through the informal market may be higher. Similarly, a shorter distance to the nearest town may mean a better connection to urban consumers, promoting informal marketing; however, it may as well mean a closer vicinity to the processing factories, which would increase the likelihood of marketing through formal channels.

The household-level variables include dairy herd size as an indicator for productive capital, and its square term, to allow for nonlinear effects. Past research has described several cases where farm efficiency was reported to first decline, and then rise with increasing farm size (e.g. Helfland and Levine, 2004; Carter and Kalfayan, 1989; Feder, 1985). In addition, the regression controls for household socio-economic characteristics, in particular a dummy reflecting whether the household carries a BPL or an Anthodaya ration card;[18] as well as a dummy indicating whether the household belongs to a scheduled caste (SC) or a scheduled tribe (ST), which are historically considered as socially disadvantaged population groups.[19] Our hypothesis is that carrying a ration card may increase the likelihood that a household will sell into the cooperative channel, where political connections may matter. SC or ST status may or may not cause exclusion from certain marketing channels. A measure for household

[18] The BPL ("Below Powerty Line") card and the Antodaya card are ration cards which entitle supposedly poor households to subsidized food (as well as a number of other social benefits), and hence they may be interpreted as a measure of poverty; however, this ration card system has been repeatedly criticized for bad targeting (e.g. Hirway, 2003; Swaminathan, 2008). In particular, Swaminathan estimates that in Punjab, not even 1 out of 4 of the households living below the poverty line own a ration card, while 93% of the households holding BPL or Antodaya cards are living above the poverty line. Hirway (2003) argues that rich and powerful households often pressurize the village head to be included in BPL lists, and Besley *et al.* (2012) as well as Markussen (2010) suggest that BPL ownership is correlated with "personal political opportunism" or in other words political capital in the village.

[19] Historically, certain social groups in India have been reported to be suspicious of drinking milk which had been procured from lower caste groups, supposedly based on hygienic grounds. While one of the virtues of the 'Amul' model of cooperatives supposedly was the fact that it abolished any distinctions between suppliers based on caste and religion (see e.g. Bhawuk *et al*., 2009), other studies find that households from scheduled castes and tribes are still discriminated against by dairy cooperatives; and that households with larger land ownership are favoured (e.g. Basu and Chakraborty, 2008).

short-distance mobility (a dummy for whether the household owns a bicycle or a motorbike) is included, as bike ownership is expected to increase participation in formal channels, which do not usually offer the service of milk collection at the doorstep, while informal channels often do. Finally, a measure for household alternative productive assets (acres of land owned) is included. This should reveal whether there is any selection on asset ownership or not.

(b) Regression results

The results in Table 5 show that in those districts where the multinational is present, a larger dairy herd size corresponds with a higher probability of selling to Nestlé and to the informal channel. This implies that small dairy farms are more likely to supply their milk to the cooperative. However, these selection effects are quite moderate and should be put in perspective. In fact, almost 40% of the multinational suppliers have less than 3 DA; and more than 95% have less than 10 DA (see Table 3).

The smaller the village population, the higher the likelihood that milk producers sell their milk into informal channels, suggesting that the multinational and cooperative source more milk from larger villages, which may offer more milk surplus.

All else equal (including land ownership), households who hold a ration card are more likely to supply to the cooperatives than to the multinational. If we take the arguments by Besley *et al.* (2012) and Markussen (2010) for granted, this could reflect the importance of political connections in the village in accessing the cooperative channel.[20] While we do infer that suppliers are less likely to supply to the cooperative when lacking political connections, a possible interpretation of this observation is that those with the required political connections

[20] Anecdotal evidence indeed suggests that cooperative membership is influenced by village politics; and some of the farmers suggested that they would not sell their milk to the cooperative for that reason.

derive more benefits from supplying the cooperative, which could therefore increase their propensity to supply the cooperative.

Further, larger land ownership increases the likelihood of supplying the cooperative in this setting in the Punjab – which is consistent with Basu and Chakraborty's (2008) earlier finding that households with larger land ownership are favoured by cooperatives.

In those districts where the multinational is not procuring milk (Table 6), the main factors in selection are ration card ownership and SC/ST status. More precisely, belonging to SC or ST increases the likelihood of selling milk to the informal channel, while ration card ownership increases the likelihood of selling milk into the cooperative channel – as was the case in the other districts.

7. Impact of channel choice on performance

Next, we consider the impact of channel choice on two performance variables, in particular productivity (the log of yield per buffalo in litre of milk per day produced) and profitability (the log of net income per dairy animal).[21]

In order to estimate the impact of channel choice on the considered performance indicators, while controlling for potential endogeneity of selection into treatment (in our case, the 'treatment' consists of the selected marketing channel), we use treatment effects models with exclusion restrictions. For those districts where channel choice is a binary variable (notably Amritsar, Hoshiarpur, and Mansa), we use a standard treatment regression using full maximum-likelihood estimation to control for endogeneity bias (Cong and Drukker, 2000). For those districts where suppliers can choose between three different channels, we make use of an estimation framework proposed by Deb and Trivedi (2006) which allows for the

[21] Details on how these are calculated are presented in Section 5.

estimation of a continuous outcome equation with endogenous selection on a multinomial treatment variable.

(a) Methodology, variables and hypotheses

Deb and Trivedi's procedure is implemented in the Stata command *mtreatreg* and uses a latent factor structure to accommodate selection into treatment; and maximum simulated likelihood to jointly estimate the treatment and outcome equations. While the procedure was originally developed for estimation of outcome variables with a negative binomial distribution, variants exist for continuous and binary outcome variables as well. The advantage of using treatment regression methods over propensity score matching techniques, is that the latter requires the assumption of unconfoundedness (Becker and Ichino, 2002), which only holds if there is no selection on unobservables – which would be a very strong assumption in this case. In case this assumption is violated, it is more appropriate to use an IV-estimation method, such as the treatment effects regression. We include as a set of exclusion restrictions the variables ration card ownership, bicycle ownership, and the logarithm of owned land.

In the (first stage) selection equation, we control for the same set of variables as in our previous regressions reported in Table 5 and Table 6. In the (second stage) outcome equation, we control for a set of village-level characteristics. We control for the average village milk price (as reported during focus interviews with village elders) which is expected to have a positive impact on dairy profits. In addition, we include the same set of village-level characteristics as in the selection equation. We also control for a set of household-level characteristics, such as the age and education level of the household head (and their square terms). Farm performance may be expected to show an inverted U-relationship with age and education. A higher age will lead to more experience and improve farm performance; but if

the household head is too old, he may be less willing to upgrade his productive capital or to invest in new technologies resulting in a worse performance. Similarly, better education may lead to better farm performance, but from a certain level of education onwards farmers may find alternative income generating opportunities more rewarding, and hence divest time from agriculture. We control for SC/ST status, to investigate whether potential discrimination effects may result in worse farm-level performance. We control for the area of land under cultivation, which may have positive spillovers on farm-level productivity, e.g. because of a better availability of fodder; and for the share of crossbred cows, as an indicator for the level of technological innovation at the farm. This is assumed to positively affect (buffalo) yields and profitability. Finally, as in the selection equation, we control for dairy herd size and its square term, as this may as well have an impact on farm efficiency and profitability (e.g. Feder, 1985).

(b) Regression results

Table 7 reports the results for impact of channel choice on productivity. The test for exogeneity of the selection equation indicates that selection is not exogenous and hence that it is appropriate to use a two-stage estimation framework. The reported values for the inverse Mills' ratio (λ) suggest that there is a positive correlation between the error terms in the first and the second stage for traditional channels, and negative correlation for the multinational channel. This means that without controlling for selection bias in the first stage, the coefficient on the traditional channel dummy would have been upward biased; while the coefficient on the multinational channel dummy would have been downward biased. Hence, dairy farmers which are inherently more efficient based on unobserved characteristics select into the informal channel, while the reverse is true for those dairy farmers supplying the multinational channel.

Controlling for selection effects, the treatment regression indicates clear differences in productivity between the three channels. There is a significant positive impact on productivity of supplying the multinational channel (as compared to the cooperative channel) in those districts where the multinational is present (Table 7). Second, farms supplying to the cooperative channel have a significantly higher productivity than farms supplying to informal channels. More precisely, dairy farms who are selling into the informal channel are estimated to have 23% lower yields; while dairy farms selling into the multinational channel are estimated to have 21% higher yields as compared to the cooperative channel.[22]

Another determinant of productivity is the level of technological innovation (proxied by the share of crossbred cows). Productivity is convex in herd size, implying that a larger herd size depresses productivity (up to a certain herd size, as the square term of herd size is positive)[23]. The impact of supplying the cooperative on productivity is even stronger in those districts where the multinational is not present (Table 8): suppliers to the cooperative have 67% higher yields than suppliers to informal channels. The inverse relationship between herd size and yields is confirmed as well. In addition, regional effects matter, and the education level of the household head has the opposite effect on dairy productivity as was expected. The area of land under cultivation matters in those districts where the multinational is not present, hinting at positive spillovers on dairy production from crop cultivation.

Second, we look at the impact of channel choice on profitability per dairy animal. In this case, the likelihood ratio test for joint exogeneity is less conclusive: there is no evidence of selection on unobserved variables which are correlated with profitability into the

[22] Note that the correct interpretation of the coefficient β of a dummy variable in a loglinear regression as a percentage change of the dependent variable is $(e^{\beta} - 1) * 100$ – which can be approximated by $\beta * 100$, especially at lower levels of β. As our coefficients are relatively high, we do not use the usual approximation.

[23] The turning point is at 17 DA, implying that for a farm with at least 17 DA, yields increase with increasing herd size.

multinational channel, while there is such evidence for positive selection into the informal channel.

If we correct for selection bias, we find that in all districts, informal channels perform worse on profitability per DA (by 58%). The multinational channel does not perform significantly different from the cooperative channel on profitability per DA. As expected, a higher average milk price increases profits from dairy production in all districts. In those districts where the multinational is not present, suppliers to the informal channel also have lower profitability (by 69%). A higher village-level milk price and a further distance to the nearest town increase profitability, and district-level effects play a role as well. Finally, SC/ST status reduces profitability of dairy production, potentially pointing at discrimination.

(c) Summary and discussion

In summary, we find that supplying to the cooperative channel and to the multinational channel increases dairy productivity and profitability compared to informal channels. Hence this suggests that there are positive vertical spillovers from both the cooperative and the multinational sector on upstream suppliers. A possible reason may be that both of these channels use farm programs to support farmers who want to upgrade technology or expand herd size. The nature of these farm programs range from providing credit in the form of advance payments, over subsidized feed and veterinary care, to preferential loans to buy new animals. Earlier literature has shown that such farm programs have important positive impacts on herd size and productivity (see e.g. Van Herck *et al.*, 2012; Dries *et al*., 2009; Dries and Swinnen, 2004).

Supplying to the multinational channel increases dairy productivity compared to the cooperative channel, but results in comparable levels of profitability. Hence, we do not find

that supplying the cooperative channel is more beneficial for local dairy farmers than supplying the multinational channel.

The diverging results on productivity and profitability may be due to the fact that (i) we only focus on productivity of buffaloes, the dominant animal type, but we have not looked at productivity of traditional cow breeds and crossbred cows (for reasons of data scarcity) and (ii) profitability takes many more factors into account than productivity alone, such as prices and production costs (for labour, fodder and concentrate feed, and veterinary costs). Further research is needed to generate more insights into this matter.

8. Conclusions and implications

In this paper, we study the procurement systems of the largest dairy multinational (Nestlé) in India and compare these with other market channels of major importance in India (in particular, the informal and the cooperative sector). Contrary to what is sometimes claimed in the literature and by advocacy groups in India, we do not find that multinational channels exclude small farmers and we find little differences between procurement systems of the cooperative and the multinational sector. While our econometric analysis suggests that small dairy farms are more likely to supply the dairy cooperative than the informal or the multinational channel, the differences in size of supplying farms are small, illustrating the overall backyard structure of the sector in India. Qualitative statements by supplying farmers illustrate how the multinational is overall better perceived than cooperatives or informal channels, with respect to price offered, reliability of payments, and the provision of credit.

When exploring the impact of channel choice on performance (in particular productivity and profitability at the farm-level) relying on a treatment regression model, we find that farmers that supply informal channels are less efficient and earn less profits per dairy animal than farmers supplying the cooperative and the multinational sector. Further, we find that farmers in the multinational channel are more efficient than farmers in the

cooperative channel, but equally profitable. Hence, we do not find that supplying the cooperative channel is more beneficial for local dairy farmers than supplying the multinational channel.

Nevertheless, when comparing performance across different marketing channels, it is important to emphasize that the absolute levels of productivity and profitability of dairy enterprises are generally still low. As informal channels hardly offer any assistance programs to suppliers, formal channels such as the multinational and the cooperative channel may both play a crucial role in offering the required incentives, technologies, and support programs for commercial dairy farms to develop.

Moreover, so far, little attention is being paid to food safety and quality in the dairy supply chains in India (Kumar *et al.*, 2011). However, changes may be imminent, as strong income growth in India increasingly triggers awareness of food safety issues. We expect that before stringent quality standards can be enforced, the dairy sector will need to undergo structural change, as quality management is extremely difficult with the current production structure. Such processes of change have been observed in the dairy sectors of other parts of the world, such as Eastern Europe (Dries *et al*., 2009); Latin America (Farina, 2002) and China (Mo *et al*., 2011; Jia *et al*., 2012) and are known to be extremely transformative, with important farm-level effects.

9. References

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Tables

Table 1: Description of the sample

			Sample		Population	
		unit	mean	st.dev.	mean	st.dev.
% keeping dairy animals in 2008		%	80,8		63,4	
% producing milk		%	78,9		60,4	
Nr of female adult DA (for hh with DA)		nr.	**3,9**	**4,0**	**2,3**	**0,1**
	% in milk	%	61,8		66,0	
	% crossbred cows	%	20,9		15,8	
	% cows of traditional breeds	%	3,0		3,0	
	% buffaloes	%	76,1		81,2	
Size distribution of herds	0 female adults	%	19,2		36,6	
	1 - 2 female adults	%	27,2		46,2	
	3 - 10 female adults	%	49,2		16,9	
	10+ female adults	%	4,4		0,3	
% selling milk		**%**	**61,8**		**36,0**	
	to multinational channel	%	31,4		5,6	
	to cooperative channel	%	29,9		19,3	
	to traditional channels	%	38,7		75,2	
Yield per buffalo		LPD	3,7	1,8	3,8	0,2
Total dairy profits		$/year	1,075	2,812	651	86,6
Dairy profits per animal		$/year	192,8	328,7	211,1	33,0

Source: Authors' own survey

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
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

Source: Authors' own survey

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

A. Milk supplier profile per marketing channel (according to livestock holdings)						
	Multinational channel		Cooperative channel		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 (according to land holdings)						
	Multinational channel		Cooperative channel		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
medium farmers (2-5 acres)	19,1	35,6	25,6	27,8	38,6	36
large farmers (> 5 acres)	30,8	41,1	41,3	51,1	20,1	33,8

Source: Authors' own survey

Table 4: Descriptive statistics on performance of milk sellers, channel-wise

		Informal		Cooperative		Multinational		AVG	
	unit	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Dairy herd size	(nr of DA)	2,70	0,20	3,23	0,37	4,06	0,24	2,88	0,17
Land ownership	(acres)	4,20	0,60	8,37	2,26	4,72	0,63	5,03	0,76
Productivity	(LPD per buffalo)	3,75	0,21	4,02	0,20	3,79	0,14	3,81	0,17
Profitability	(USD per DA per year)	171,08	54,83	251,32	56,82	182,85	35,50	187,15	48,30

T-tests for significance of differences (Adjusted Wald test)

		F-statistic	p-value
Productivity	Informal sector vs. cooperative sector	1,09	0,30
	Cooperative sector vs. multinational sector	0,90	0,35
	Multinational vs. informal sector	0,03	0,87
Profitability	Informal sector vs. cooperative sector	1,98	0,17
	Cooperative sector vs. multinational sector	1,07	0,31
	Multinational vs. informal sector	0,03	0,86

Source: Authors' own survey
Note: The reported t-statistics are based on an adjusted Wald-test, which is considered to perform better in case survey weights are used (Sribney, 2005).

Table 5: Regression results for channel choice in presence of multinational

Multinomial probit regression: Marketing channel choice (base category: cooperative channel)		
Determinants choice informal channel	Coeff.	Z-stat
Village-level characteristics		
log(village population)	-1.06 **	-2.28
log(distance to nearest town)	-0.07	-0.16
Ludhiana district	0.32	0.67
Household-level characteristics		
dairy herd size	0.18 **	2.00
(dairy herd size)²	-0.01 *	-1.87
SC/ST (yes=1)	-0.14	-0.41
BPL/Anthodaya ration card (yes=1)	-0.44	-1.23
bicycle ownership (yes=1)	-0.38	-1.26
log(owned land)	-0.19	-1.15
constant term	8.65 **	2.55
Determinants choice multinational channel		
Village-level characteristics		
log(village population)	-0.28	-0.62
log(distance to nearest town)	-0.62	-1.42
Ludhiana district	-0.29	-0.61
Household-level characteristics		
dairy herd size	0.10 **	2.34
(dairy herd size)²	-0.00 ***	-2.85
SC/ST (yes=1)	-0.47	-1.00
BPL/Anthodaya ration card (yes=1)	-0.68 *	-1.65
bicycle ownership (yes=1)	0.23	0.62
log(owned land)	-0.26 **	-1.96
constant term	4.36	1.28
N	428	
Wald Chi2	139,31	
P > Chi2	0,000	

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

Note: Standard errors are clustered at the village level.
Source: Authors' own survey

Table 6: Regression results for channel choice in absence of multinational

Probit regression: Determinants choice informal channel (base category: cooperative channel)	Coeff.	Z-stat
Village-level characteristics		
log(village population)	-0.07	-0.16
log(distance to nearest town)	-0.31	-1.00
Hoshiarpur district	-0.38	-0.76
Mansa district	-0.26	-0.44
Household-level characteristics		
dairy herd size	0.12	0.76
(dairy herd size)²	-0.01	-1.24
SC/ST (yes=1)	0.74 *	1.68
BPL/Anthodaya ration card (yes=1)	-0.94 ***	-2.91
bicycle ownership (yes=1)	-0.48	-1.33
log(owned land)	-0.03	-0.16
constant term	1.88	0.48
N	177	
Wald Chi2	31,21	
P > Chi2	0,00	
Pseudo-R^2	0,10	

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

Note: Standard errors are clustered at the village level
Source: Authors' own survey

Table 7: Second stage regression results: channel-wise performance in presence of multinational

	log(yield per buffalo)			log(dairy profits per animal)		
	Coeff.		Z	Coeff.		Z
Informal channel	-0.26	***	-4.18	-0.86	***	-4.85
Multinational channel	0.19	***	2.81	-0.00		-0.02
Village-level characteristics						
village milk price	0.02		1.43	0.03	**	2.00
log(village population)	0.07		0.72	-0.05		-0.41
log(distance to nearest town)	-0.12		-1.29	-0.00		-0.02
Ludhiana district	0.00		0.03	-0.02		-0.13
Household-level characteristics						
education level hh head (years)	0.00		0.21	-0.02		-0.55
(education level hh head)^2	-0.00		-0.70	0.00		0.20
age hh head (years)	-0.01		-0.65	0.04		1.43
(age hh head)^2	0.00		0.73	-0.00		-1.36
SC/ST (yes=1)	0.12		0.86	0.22		1.30
log(cultivated land)	0.05		1.58	0.01		0.16
share of crossbred cows	0.45	***	3.60	0.06		0.27
dairy herd size	-0.09	***	-4.12	0.03		1.10
(dairy herd size)^2	0.00	***	4.15	-0.00		-0.15
constant	0.97		1.11	7.87	***	6.24
lnsigma	-1.73	***	-5.13	-0.39	**	-2.40
lambda_trad	0.37	***	7.17	0.73	***	5.05
lambda_multinat	-0.23	***	-13.38	-0.04		-0.98
LR-test exogeneity of sel.eq.	18.81			2.25		
P-value LR-test	0.00			0.32		
N	393			326		

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

Source: Authors' own survey

Note: The base category is the cooperative channel. These outcome equations are jointly estimated with the selection equation in Table 5. Standard errors are clustered at the village level.

Table 8: Second stage regression results: channel-wise performance in absence of multinational

	log(yield per buffalo)			log(dairy profits per animal)		
	Coeff.		Z	Coeff.		Z
Informal channel	-0.67	***	-3.51	-1.17	***	-2.62
Village-level characteristics						
village milk price	0.00		0.53	0.10	*	1.76
log(village population)	-0.06		-0.52	0.05		0.17
log(distance to nearest town)	0.26	***	4.12	0.76	***	5.06
Hoshiarpur district	0.18		1.22	0.48		1.56
Mansa district	0.24	**	1.97	0.93	***	4.06
Household-level characteristics						
education level hh head (years)	-0.05	**	-2.06	-0.03		-0.56
(education level hh head)^2	0.01	**	2.23	0.00		0.90
age hh head (years)	-0.00		-0.08	-0.03		-1.38
(age hh head)^2	0.00		0.17	0.00	*	1.74
SC/ST (yes=1)	0.08		0.80	-1.13	**	-2.29
log(cultivated land)	0.07	*	1.96	0.04		0.27
share of crossbred cows	-0.11		-0.80	-0.28		-1.04
dairy herd size	-0.07	*	-1.92	-0.14		-1.21
(dairy herd size)^2	0.00		1.51	0.01		1.54
constant	1.39	*	1.72	6.24	***	2.94
athrho	0.85	**	2.41	0.82	**	2.15
lnsigma	-0.82	***	-6.19	-0.20		-1.50
Wald test exogeneity of sel.eq.	5.79			4.62		
p-value Wald test	0.02			0.03		
N	158			130		

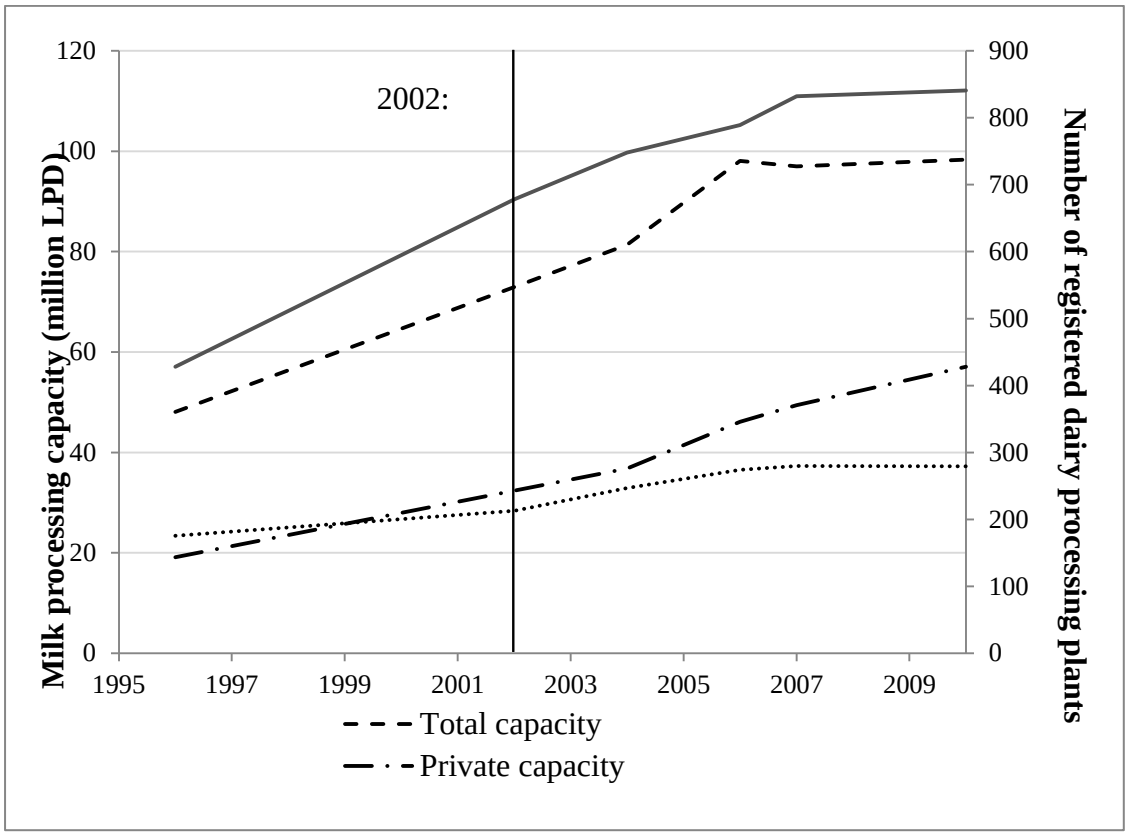
* p<0.10, ** p<0.05, *** p<0.01

Source: Authors' own survey

Note: The base category is the cooperative channel. These outcome equations are jointly estimated with the selection equation in Table 6. Standard errors are clustered at the village level. The Wald test of independent equations rejects the hypothesis of zero correlation between errors in the selection and outcome equations at 1% and hence selection into treatment is indeed endogenous.

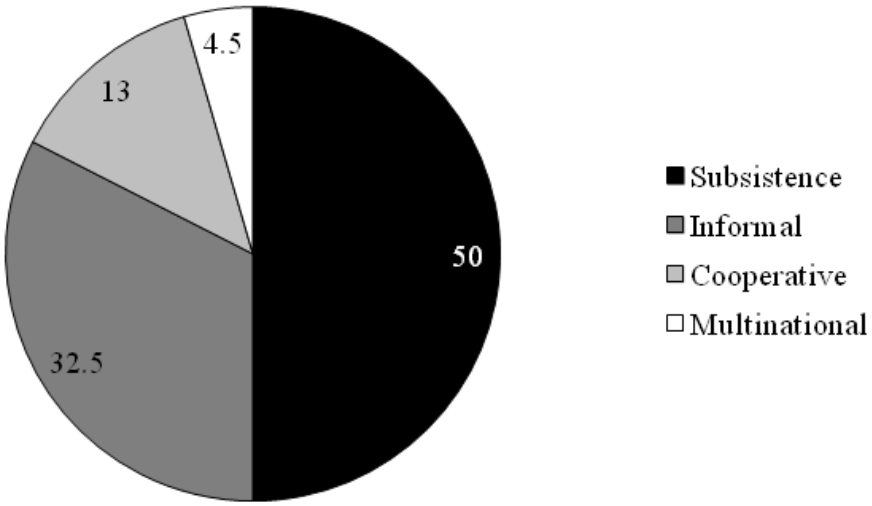
Figures

Figure 1: Trends in Indian dairy processing facilities throughout liberalization



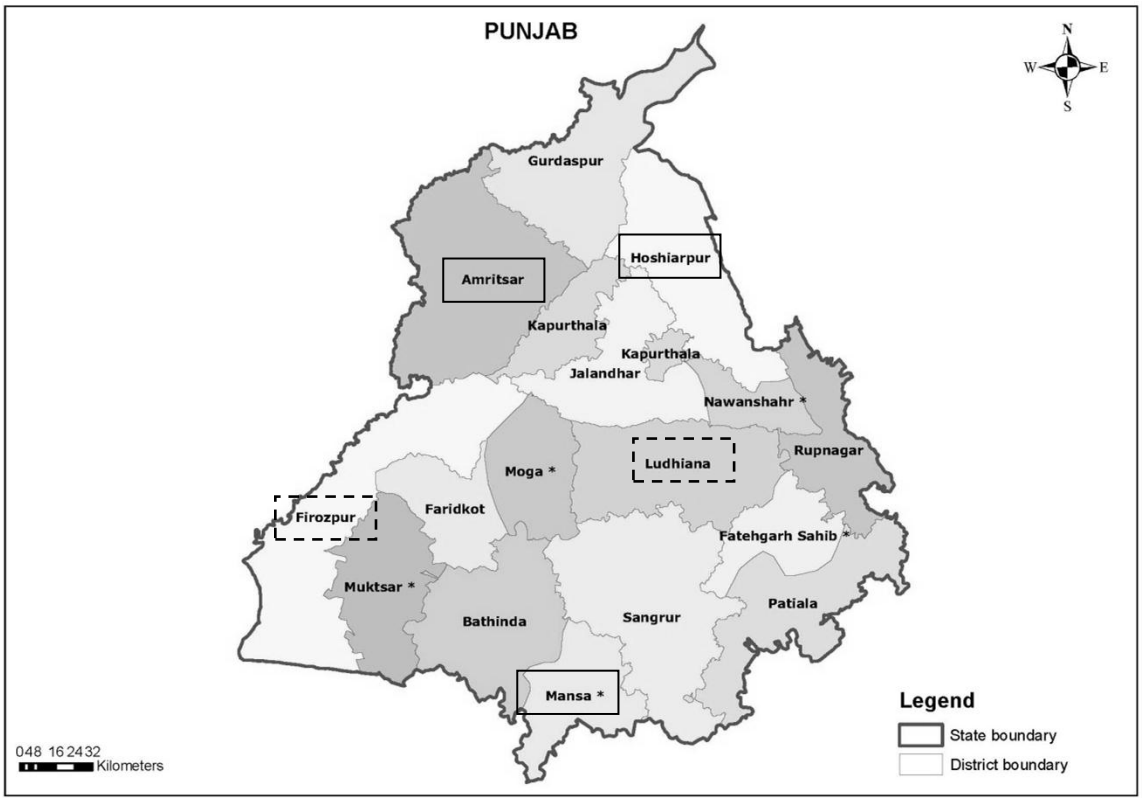
Source: Gupta (2007), DAHD (2010)

Figure 2: Dairy market structure in Punjab (in share of milk sales)



Source: Authors' own survey

Figure 3: Sample districts



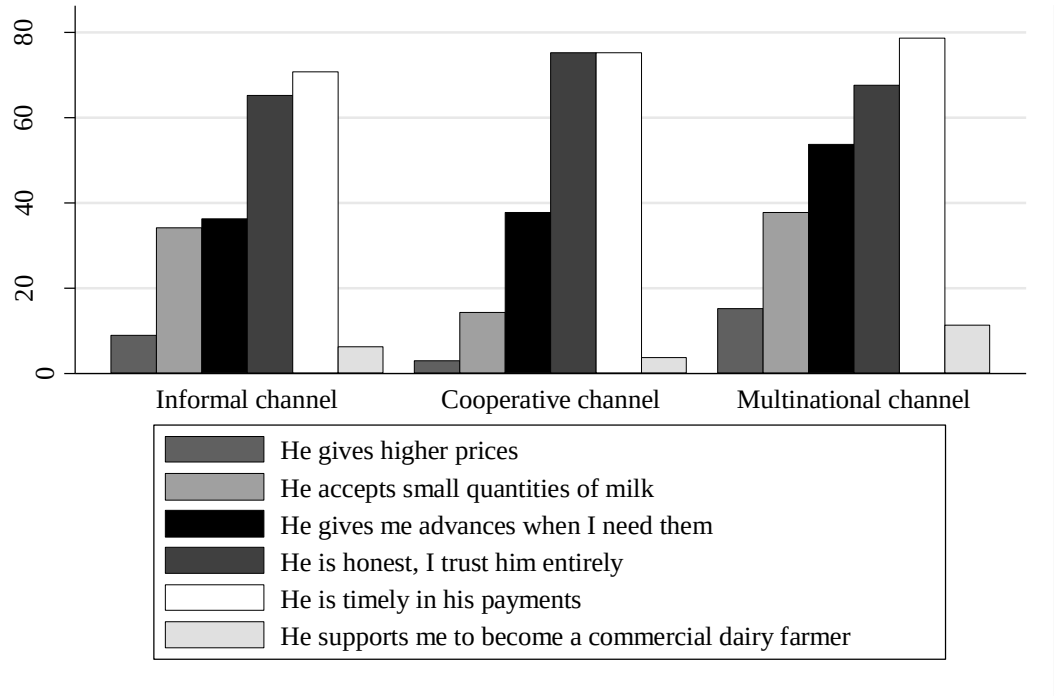
sample district without multinational suppliers

sample district with multinational suppliers

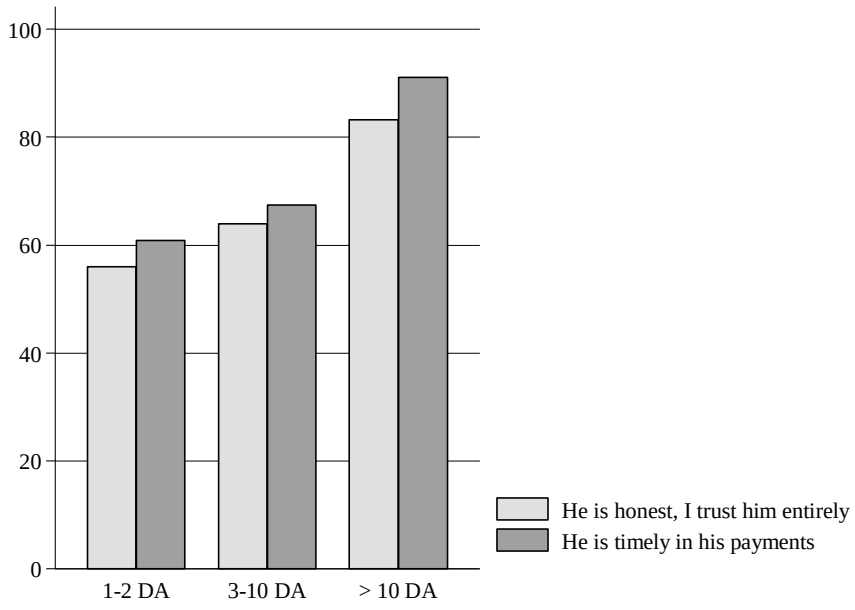
Note: Nestlé's main dairy processing plant is located in Moga. The sample districts where Nestlé is procuring milk are Firozpur and Ludhiana (both bordering Moga). Nestlé is also procuring from a small number of dairy farmers in Amritsar, but as they only represent a minor fraction of total dairy farmers in Amritsar, they do not show up in our sample.
Source: NIC (2011)

Figure 4: Reasons for buyer choice

(a) Aggregate response rate (in % of farmers indicating the specified reason to be of major importance)



(b) Response rate by farm size



Source: Authors' own survey