Staff Paper

Cattle Producers' Participation in Market Channels in Central America: Supermarkets, Processors, and Auctions

Fernando Balsevich, Paul Schuetz, and Edwin Perez

Staff Paper 2006-01 **January 2006**

Department of Agricultural Economics
Michigan State University
East Lansing, Michigan 48824

Cattle Producers' Participation in Market Channels in Central America: Supermarkets, Processors, and Auctions

Fernando Balsevich

Michigan State University, United States, balsevic@msu.edu

Paul Schuetz
International Livestock Research Institute, Nicaragua

Edwin Perez
International Livestock Research Institute, Nicaragua

Summary. — This paper focuses on the determinants and effects of the participation of cattle producers in the supermarket channel, export processor channel, and traditional auction channel. It begins with the analysis of the market channels using qualitative data from 50 interviews of retailers, processors, auction market managers, and other key informants in Costa Rica and Nicaragua, two widely differing cases. It then analyzes patterns and supplies of producers by channel using farm level data (from the authors' survey of farmers in 2004) from 300 farms in the two countries.

Key words — Multiple market determinants, supermarkets, Central America, Costa Rica, Nicaragua, cattle producers, supply response.

ACKNOWLEDGEMENTS AND DISTRIBUTION RIGHTS: This paper is an outcome of a coordinated research program in Nicaragua, Costa Rica, and Guatemala in 2004, with the participation of the following projects and donors, in no particular order: (1) "Assistance for Trade Capacity Building in Relation to the Application of Sanitary and Phytosanitary Measures" (RAISE-SPS), funded by USAID, primed by DAI and implemented for this project by Michigan State University; (2) The "Central America Beef Project", of the International Livestock Institute (ILRI), funded by the Common Fund for Commodities; (3) "Regoverning Markets, Phase 1", a project coordinated by the International Institute for Environment and Development (IIED), the Royal Tropical Institute (KIT), and Rimisp-Centro Latinoamericano para el Desarrollo Rural, and funded by the Department for International Development (DFID) of the United Kingdom; (4) "Partnerships for Food Industry Development – Fruits and Vegetables" (PFID-FFV), funded by USAID, and implemented by Michigan State University; and (5) The Agribusiness Development Project of the Centro Internacional de Agricultura Tropical (CIAT). We thank the researchers in these projects and the above-named development assistance agencies for their support. Per agreement among the above research groups and donors, all parties have the right to distribute this paper under their own report covers (as parallel reports), acknowledging this collaborative effort and multipartite funding sources.

Cattle Producers' Participation in Market Channels in Central America: Supermarkets, Processors, and Auctions

Fernando Balsevich

Michigan State University, United States, balsevic@msu.edu

Paul Schuetz
International Livestock Research Institute, Nicaragua

Edwin Perez
International Livestock Research Institute, Nicaragua

Summary. — This paper focuses on the determinants and effects of the participation of cattle producers in the supermarket channel, export processor channel, and traditional auction channel. It begins with the analysis of the market channels using qualitative data from 50 interviews of retailers, processors, auction market managers, and other key informants in Costa Rica and Nicaragua, two widely differing cases. It then analyzes patterns and supplies of producers by channel using farm level data (from the authors' survey of farmers in 2004) from 300 farms in the two countries.

Key words — Multiple market determinants, supermarkets, Central America, Costa Rica, Nicaragua, cattle producers, supply response.

ACKNOWLEDGEMENTS AND DISTRIBUTION RIGHTS: This paper is an outcome of a coordinated research program in Nicaragua, Costa Rica, and Guatemala in 2004, with the participation of the following projects and donors, in no particular order: (1) "Assistance for Trade Capacity Building in Relation to the Application of Sanitary and Phytosanitary Measures" (RAISE-SPS), funded by USAID, primed by DAI and implemented for this project by Michigan State University; (2) The "Central America Beef Project", of the International Livestock Institute (ILRI), funded by the Common Fund for Commodities; (3) "Regoverning Markets, Phase 1", a project coordinated by the International Institute for Environment and Development (IIED), the Royal Tropical Institute (KIT), and Rimisp-Centro Latinoamericano para el Desarrollo Rural, and funded by the Department for International Development (DFID) of the United Kingdom; (4) "Partnerships for Food Industry Development – Fruits and Vegetables" (PFID-FFV), funded by USAID, and implemented by Michigan State University; and (5) The Agribusiness Development Project of the Centro Internacional de Agricultura Tropical (CIAT). We thank the researchers in these projects and the above-named development assistance agencies for their support. Per agreement among the above research groups and donors, all parties have the right to distribute this paper under their own report covers (as parallel reports), acknowledging this collaborative effort and multipartite funding sources.

Cattle Producers' Participation in Market Channels in Central America: Supermarkets, Processors, and Auctions

1. INTRODUCTION

Today in development circles interest is high in whether and how farmers can gain access to markets for high-value products such as livestock, dairy, or fruits and vegetables, and thus access dynamic urban markets and diversify production away from basic grains. Research in the past several decades on farmers' participation in markets, including the subject of this paper, livestock markets, has followed several paths.

First, several studies have been done on producers' market participation as net sellers or buyers, versus subsistence production or autarky only. Examples of such studies include Goetz (1992), Key et al. (2000), Holloway et al. (2004), and Bellemare and Barrett (2004). This research contributed to understanding the complexities of the factors moving producers from a subsistence orientation to commercial production. It has been pointed out by Pingali and Rosegrant (1995) that rural developers have a challenging task in the the transition from subsistence to commercial production systems.

Second, given market participation in cattle markets, a number of studies have focused on supply response models that incorporate the channel choice between export and domestic markets (Jarvis, 1974; Ospina & Shumway, 1979; Spreen et al., 1980; Paarsch, 1985; Rosen et al., 1994; and Aadland & Bailey, 2001).

However, the literature has not given much attention to the determinants of producers' multi-market channel choices, particularly in domestic markets. An exception is Hobbs (1997), which analyzes the determinants affecting auction market channel versus processor market channel using a sample of cattle producers in the UK.

The need for additional research, in particular in developing countries where markets are recently transforming quickly, on producers' multi-market decisions arises from the emergence of new market channels in domestic markets with different procurement structures that bring with them additional market requirements (such as quality standards and consistency) facing farmers. The geographical context for this paper provides an illustration. Since market liberalization and especially foreign direct investment (FDI) liberalization mainly in the 1990s, supermarkets have become very important buyers of food products from farmers in Latin America. Supermarkets have increased their share in urban food markets from 10-20% in 1992 to 50-60% in 2002. Moreover, leading supermarket chains have adopted modernized procurement systems shifting steadily toward direct procurement from producers, creating market conditions different from the traditional procurement methods of buying indirectly from farmers via public wholesale markets, intermediaries and processors (Reardon and Berdegué, 2002).

In addition, competition among domestic supermarket chains and the derived striving to differentiate themselves from their competitors in traditional markets, as well as domestic and international food safety crises (such as mad cow disease) and internationalization of food systems, have given birth to the dominance of private standards of quality and also safety. The emergence and race of bigger buyers such as supermarkets and export-oriented processors to

capture the gains from market differentiation have introduced changes in conditions of agro-food production (Henson and Reardon, 2005; Codron, Giraud-Héraud and Soler, 2005).

Hence, institutional change and market channel differentiation translate into different requirements for farm technology and transaction practices. Some farmers are able, because of greater human, social, organization, financial capital, to meet the requirements of the higher-value market channels, and some are not, and may be eventually left behind as markets transform.

The above-mentioned changes in certain markets and regions take the research agenda from whether farmers participate in "the" market, to in which market channel farmers' participate and with what entry requirements and with what implications for their net incomes.

In this paper we aim to contribute to the multi-market channel participation literature by exploring the factors affecting producer's market channel participation by including the supermarket market channel with other market channel alternatives such as the processing market channel (with an export orientation) and the traditional auction market channel. We compare the producers' supply determinants by market channel. The study covers Costa Rica and Nicaragua, countries of similar population (small countries of about 4 million each) but very different per capita incomes (Costa Rica 2000 GDP per capita of US$ 4,290, while Nicaragua's was only $600), and different stages of beef industry and supermarket sector development.

The paper starts by describing the cattle supply chains in Central America. We first present a conceptual framework, then we discuss, for Nicaragua and Costa Rica respectively, the methods used to collect our qualitative data on the supply chains, followed by an analysis of the processing industry procurement systems, the leading supermarket chains procurement systems,

auction markets, and a discussion of the characteristics of market channels cattle producers face. The following section treats producer characteristics by market channel, descriptively and with regression results. We use data from a farm household survey with a sample of 300 farms in Costa Rica and Nicaragua to estimate the market choice selection and supply decision. The final section presents conclusions and implications.

2. CATTLE SUPPLY CHAIN COORDINATION MECHANISMS

To set the context for what markets producers face in Central America, here we describe recent changes in the livestock markets. We first present briefly the method used to collect the data to analyze the supply chains. Thereafter, in order, we present a conceptual framework for the analysis of the supply chains, and then the qualitative analysis of beef supply chains in Nicaragua and Costa Rica. The supply chains are three: those supplying large-scale export oriented processors, supermarket chains, and auction markets.

(a) Data for the Qualitative Analysis of Supply Chains

We collected qualitative data on the three supply chains (we interchangeably use "supply chains" and "market channels" as terms) from 50 in-depth in-person semi-structured interviews with retailers and wholesalers in the modern and traditional channels, NGOs, international research institutes, group leaders and members of groups of farmers, community leaders, technical assistance providers (NGOs and extensionists) and other key informants. The interviews focused on the relations between the agents in the supply chains: (1) what agreements (oral or written) exist, and what are their "legislative functions" such as transaction product attributes and transaction requirements (product quality, price, and

consistency); (2) what were the reasons for the implemented agreements; (3) who participated in designing them; (4) who implements and enforces the agreements, such as administrative functions including cattle selection, production planning, price negotiation, delivery, reception, and distribution of payments; (5) what sanctions and incentives exist in the agreements; (6) what are the advantages and disadvantages of current and alternative coordination strategies in terms of costs, consistency, and conflicts; (6) how have the answers to these questions differed between now and five years ago. We compared and triangulated information over actors to form the composite image presented below.

(b) Conceptual Framework for Supply Chain Analysis: The Vertical Coordination Continuum

We first introduce a conceptual framework used to analyze the supply chains.

We use the Peterson, Wysocki and Harsh (PWH) model as the vertical coordination continuum analytical framework to analyze the supply chains in the study (Peterson et. al, 2001). The model aims to be a decision making tool that helps to understand how and why the agents along the supply chains (supermarkets, wholesalers, producers), choose certain strategies from a vertical coordination continuum. Several points are to remark.

First, "vertical coordination" is the configuration and control of the stages of production and marketing systems. For a specific product such as beef, this means that the vertical coordination defines the nature of the specifications by which the cattle are produced, processed, as well as who is involved and under what conditions in marketing the cattle at each link in the supply chain until they reach the final consumer. As there are potentially many stages and agents involved in production, processing and marketing of a product such as beef, there are also many relations under which the transactions take place, hence part of the vertical coordination process

are the institutional arrangements governing those relations. There are some important related questions such as who defines the institutional arrangements and the penalizations of not complying with them. An example of the "who" is "who defines the minimum weight and age of cattle that ought to be marketed?"

Second, "continuum" here is the set of choices that a given agent in a supply chain has to vertically coordinate its procurement systems (for example, procuring live cattle or processed beef). As potentially there are many ways to vertically coordinate the procurement of cattle (or processed beef), some criteria to categorize the alternatives are useful. The PWH model defines the vertical coordination continuum as an array of five groups of strategies: spot markets, specification contracts, relation-based alliances, equity-based alliances, and vertical integration, where the level of control over the vertical coordination is what defines the continuum. As firms move from spot markets towards vertical integration they increase the level of control of the vertical coordination assuring proper coordination.

Third, higher levels of control might be desirable when coordination errors are costly. Coordination errors happen for example when there is not enough supply or when the quality is not right. For example if a supermarket runs out of stock of beef or if the beef lacks tenderness, consumers may shop somewhere else, coordination errors of not having enough supplies or the proper attributes may translate into losses in sales. Coordination errors do happen, according to Williamson (1973), because of intentional opportunism of economic actors or unintentionally due to bounded rationality of estimations in production plans (under or overestimation).

Fourth, as one move from the spot market to hybrid coordination strategies to vertical integration the nature of control changes. In spot markets the intensity of control is low and the coordination mechanism is based mainly on price discovery and the decision of whether or not to

engage in the transaction. There is no establishment of coordination mechanisms beyond the transaction. This type of coordination mechanism is equivalent to auction markets. The next level of control is represented by the specification contract coordination mechanism in which the agents engaging in a transaction specify a legal contract. The established specifications in the contract are negotiated carefully, setting incentives and deliverables. Part of the contract might include the use of third parties to enforce the conditions of the contract. The third strategy is called the relation-based alliance, and as its name invokes an established "relation" in that benefits and risk are shared as well as mutual objectives identified. Parties work closely together to resolve conflicts internally and mutual control executed. In the fourth position is the equity-based alliance, which involves some level of equity capital such as joint ventures. The main characteristic is the formation of a third entity distinct from the parties that has a formal organization structure. There is financial commitment and the rights and responsibilities clearer as compared to the relation-based alliance. At the end of the continuum is the vertical integration vertical coordination mechanism. In this strategy the two parties become one organization (by a merger or acquisition) and it has total control over the transaction. Clear policies and procedures are set for the new single organization and the notion of centralization is more important than the notion of single organization as the key is to centralize control for coordination purposes.

Note that coordination strategies might differ at different levels of a supply chain. Consider a beef supply chain where there are four agents (supermarket, wholesaler, processor, and producer) and three relations (at the linkage points). On one hand, the supermarket, the wholesaler and the processor may use a relation-based alliance coordination mechanism. On the other, the wholesaler and the producer might use a spot market strategy. Strategies might differ because of the likelihood and costliness of coordination errors of each relation.

Fifth, agents in the supply chains choose their vertical coordination strategy along the continuum based on both the coordination error costs and the operating cost of a given strategy. Measuring coordination errors costs may be challenging, but PWH suggest two criteria to assess the costliness of a coordination error. On the one hand "asset specificity" is the extent to which an asset can be utilized in alternative uses. An example of this can be a cattle processing plant that has a specific type of sanitary certification but that can not be used to process other types of meats. Engaging in a relation with this processor may be the only way of having the beef process under the specified sanitary conditions. On the other hand "complementarity" is the notion that the output from combining two activities is greater than the output of each activity separately. An example of this can be that a retail store may offer organic beef only if a group of producers agree to follow organic production specifications. A retail store may not be able to offer organic production unless producers use only organic approved inputs to fertilize their prairies and follow other guidelines for organic production. Animal welfare ensuring the animals have been grown under certain conditions also represents another example. The costliness of coordination errors rises as both the asset specificity and complementarity increase.

Sixth, besides evaluating the costs associated with each coordination strategy, an agent must consider other conditions. Implementing a strategy includes conditions such as capital availability, where spot markets are associated with nearly no capital requirements while vertically integrating may entail significant capital outlays. Existence of a compatible partner may be important, to help to ensure mutual interests are achieved. Control competence entails that the partners have the necessary skills such as those needed for the type of control required in a strategy. Finally, an agent has to judge the risk/return tradeoff of shifting from one alternative to another.

(c) Beef supply chains (market channels) in Nicaragua

We start by presenting the structure and procurement systems of the processing industry. Note that in Nicaragua, the processing industry is composed of many small processors and a few recently established large-scale processors; the small processors and the large processors differ greatly in food safety aspects. Then we discuss the supermarket chains' procurement systems. Finally we discuss the auction market as a traditional channel.

Large-scale Export-Oriented Processors' Procurement Systems. First, the Nicaraguan beef processing industry has recently consolidated, and a few large-scale processors have displaced many small processors. By 2004 there were three large-scale processors left standing, with 60% of the market: MACESA, Nuevo Carnic, and San Martin. Each has a processing capacity of over 300 head per day on average. Contrast that with the situation in 1994, when there were nine large-scale processors (slaughterhouses) with a processing capacity of 150 head per day. On the other hand, according to Pomareda et al. (1997), during the mid 1990s there were 300 small processors (slaughterhouses) in the rural areas and 600 municipal small processors in the urban areas in Nicaragua, each processing only about 15-20 head a day on the intermittent days they operated. In the late 1990s, the large-scale processors increased substantially their cattle volume processed in spite of being fewer, and thus gained market share at the expense of the many small slaughterhouses which did not increase their volume (IICA-PROVIA, 2002). Moreover, several of the rural and municipal slaughterhouses closed during the late 1990s and early 2000s.

The higher efficiency of modern technologies used in the large-scale plants and changes in the international markets explain the consolidation, including the displacement of the smaller processors. Note that the three large-scale processors are HACCP- and USDA- certified, which

address international markets food safety standards. The animals' health is inspected 12 hours before being processed and also after being processed, by veterinarians from the Public Health Ministry and the Agriculture Ministry. Sick animals are not allowed to be processed and animal carcasses are inspected for "muscular cisticercosis" and internal signals of infection, parasites, and other diseases. Also, lab testing of samples is performed to know if there are implants and chemical residues above certain maximum levels. These safety checks are done because of the export orientation of bigger plants, while they are not done in the small plants focused on the local market. According to Campbell (2000) who visited two of these small processors and reports that they operate without any refrigeration, with inspection of the cattle, and contamination from previous slaughter is visible and represents a concern for public health. Pomareda et al. (1997) report that with the exception of two operators (Brasiles and Proincasa), all the small processors produce "carne caliente" ("warm meat"), a term used for the marketed beef that has not being refrigerated after the animals have been slaughtered.

Moreover, domestic market changes led by changes in supermarket chains' procurement systems accelerated the displacement of the smaller rural municipal processors. The two leading supermarket chains sell only cattle that have been processed in the bigger, HACCP-certified plants. They do not buy from the small processors because of the lack of food safety standards, lack of refrigeration, and because the quality and volume of cattle required by the chains is several times higher than the small plants processing capacity. As supermarkets gain market share in domestic retail markets, the bigger processors benefit from this growth.

Third, the large-scale export-oriented processors' cattle procurement systems rely on a list of buyers in the production regions to get their cattle. The buyers are assigned regions from where to buy their cattle. There are no minimum quality standards but there are differences in prices

paid by animal gender, weight, and age. For example, the leading processor San Martín had a group of buyers that were part of the company, but today work on their own supplying the slaughter plant. In addition, San Martín uses in times of shortfalls of animals 60 external intermediaries to buy animals. Only a few producers sell directly to the processors.

Supermarket chains' procurement systems. The share of supermarkets in food retail in Nicaragua has reached 15-20% today, and rising (Berdegué et al., 2005). Today the Nicaraguan supermarket sector is made up of two supermarket chains (with 37 stores) with about two-thirds of the market, and 23 independent supermarkets. The supermarket sector's leader is *Corporación de Supermercados Unidos* (CSU) chain with about 65% of the market (CSU is headquartered in Costa Rica, hence a regional multinational also present in Honduras) and in second-place supermarket chain (with 20% of the market) is *La Colonia*, the largest locally owned chain. They compete with hundreds of traditional retailers such as wet markets in each city and small meat stores.

The two supermarket chains operating in Nicaragua do not source cattle in the same ways.

On the one hand, "La Colonia" does not buy live-cattle either from auction markets or from producers. La Colonia buys all its carcasses and beef cuts only from the three large-scale, certified, and export-oriented processors rather than from small processing plants. By working exclusively with the large-scale processors, the chain uses higher food safety standards as compared to those found in the small scale processors. The chain centralizes its purchases of beef; however, because it has neither distribution center nor trucks, it requires the processors to deliver the beef carcasses to each store. The chain negotiates quotas with each of the three large-scale processors mainly based on price and payment conditions. Recently the chain shifted from

buying mainly from the large-scale processor “San Martin” to buying mainly from the large-scale processor “MACESA” because or more attractive payment conditions. The latter formed an alliance with the local bank “LAFISE-Bancentro” to offer to La Colonia an extension in the payment period from seven days to 30 days.[1] This latter point is particularly important, as small processors generally have a hard time weathering the long payment periods of supermarkets, but here with MACESA is a large processor who allies with a major bank to handle this financial hurdle.

On the other hand, by contrast, the leading chain CSU buys from “Industrias Carnicas Integradas” (“Integrated Meat Industries”) (ICI) all its cattle. CSU and ICI are based in Costa Rica and part of the same holding company. CSU started to work with ICI because it could monitor easily ICI and get consistent supplies of beef from it, and thus meet CSU’s safety and quality standards. That would let CSU focus on retail expansion growth strategies while ICI reduces beef procurement costs and it would be able if needed to supply CSU stores in other countries in the region.

ICI in turn has invested in trucks and a distribution center in Managua, the capital city of Nicaragua, and from there it coordinates its deliveries to CSU stores. ICI established contracts to use the plant of one (San Martin) of the three large-scale export oriented processors, to process all the animals ICI procures. ICI does not buy cuts or carcasses from the processor but instead pays for the slaughtering service. ICI and San Martin have implemented some changes in the way beef is marketed in the domestic market, replacing the typical half carcasses by beef boxes. San Martin in turn has collaborated in the implementation of such changes in the domestic market. ICI then minimizes the beef processing requirements both at its distribution centers and at CSU stores.

ICI in turn buys live-cattle directly from 130 producers listed in their preferred supplier program, an implicit contract relationship. Only in cases of shortage do they make up the shortfall with purchases of cuts from the three large-scale processors. In 2004 they also had a herd of 1200 animals managed by a farmer near the plant, so they had some own production to supplement purchased supply when there are shortfalls in the latter.

The CSU-ICI buyers have developed their own procurement system in which producers are enlisted based on their commitment to meet quality standards and transaction requirements which are different from those of the export-oriented processors. For example, ICI buys animals the carcasses of which should weigh a minimum of 212 Kg, which is 15% higher than what is required by the export processors. Also, ICI buys only steers which is the animal category with the highest quality - while the export processors buy other animal categories of lower quality such as cull cows. Hence ICI has higher quality requirements than the export-oriented processors. Producers in the preferred supplier system must sell other animal categories, considered of lower quality, such as cull cows, to alternative market channels.

Note that ICI's sales are not limited to CSU domestic stores but it also exports to supermarkets of CSU in Costa Rica and has supply contracts with La Fragua (the other leading chain in Central America, based in Guatemala, with which CSU is in joint venture) in Honduras (Dispensa Familiar, Paíz), El Salvador (Dispensa San Juan) and Guatemala (Paíz and HiperPaíz). An example of ICI's regional procurement and marketing capacities is that during 2003 only 25% of what ICI bought in Nicaragua was sold in Nicaragua, and 75% was sold to its international subsidiaries and foreign customers in the region. These transactions are all taking place within the multinational regional chain the Central American Retail Holding Company, CARHCO (CSU, La Fragua, and until 2005, global retailer Ahold, and now, Wal-mart instead of

Ahold). ICI in Nicaragua actually “exports” (to stores in the same joint venture regional chain) more animals than it provides to the CSU stores in Nicaragua itself: for example, while ICI Nicaragua exports 2800 animal carcasses to El Salvador it sells to its Nicaraguan CSU stores 1200 per month.

Auction markets as an alternative market channel. First, consider that both ICI and the large-scale export-oriented processors do not rely on cattle auction markets to buy their animals. They mentioned that sanitary conditions are not optimal; hence animals may get sick or hurt when bought from there. A second reason is that they often had difficulties because the quantities and quality of animals sold fluctuated too much, and they would have to find alternative cattle sources because of their high volume requirements. A third reason is that the auction market had an extra-cost that requires paying seller and buyer commissions to the auction management equivalent to 5 to 10% of the value of the transactions. Note that there was only one auction market in operation in Nicaragua during our study period.

Second, what is traded in the Nicaraguan auction market is subsequently processed in the small processors and sold in traditional retailers. This is further corroborated by the fact that the large-scale processors do not provide the slaughtering service to any other agents or firms than ICI, which eliminates the possibility that the buyers at the auction market process their animals at the large-scale processors. On the other hand this does not necessarily mean that everything processed in the small plants is traded at the auction market, and indeed there is likely to be an important volume of cattle bought from the farms, then processed in the small plants and sold to traditional retailers. Nevertheless, what is traded in the auction market is then in the domain of the small plants and traditional retailers.

Third, then it must be that the reasons why the large-scale processors and ICI do not buy from the auction market, does not stop the buyers in the auction market to source from there, then take it to a small processing plant and then to a traditional retailer. Lower sanitary conditions, higher fluctuations in quality and volume are tolerated or not an impediment to the buyers that go to the auction market and the extra cost paid (commission) may be trade-off for the costs associated with searching costs with getting their volume requirements directly from some farms.

(d) Beef supply chains (market channels) in Costa Rica

Compared to Nicaragua, in Costa Rica, the processing industry is more concentrated, traditional retailers' process their cattle under safer sanitary conditions, there are more supermarket chains operating with a higher share of urban food markets, and there are many auction markets. Hereafter, we present the structure and procurement systems of the processing industry, procurement systems of supermarkets chains and auctions markets.

Large-scale Export-Oriented Processors' Procurement Systems. First, the processing industry is much more concentrated than in Nicaragua. In the beef processing industry there are three major processors (Coopemontecillos, Arreo S.A. and Mataderos del Valle S.A.), which process 80% of the total national cattle slaughtered in Costa Rica. The first two have HACCP and USDA certifications, which are standards, designed for food safety procedures (such as monitoring for the presence of salmonella and E-coli in processed beef) and implemented mainly to target international market food safety concerns.

Second, the major processors started focused on export markets but have shifted toward the domestic market over time. Costa Rica exported 50% of its production during the 1960's and

1970's; that share fell to less than 10% in the 2000s. The decline in exports may be linked to the decline in the Costa Rican national female cattle stock and decline of the competitiveness of the sector relative to the Nicaraguan cattle sub-sector. Exports are not that important for the Costa Rican industry now in terms of volume, but when processing carcasses some portions may easily be sold in the international market (i.e. less valuable lean cuts transformed in the US in hamburgers by blending them with US fatty cuts). Some cuts are difficult to sell in the domestic market and the processors may end up with high quantities of inventories. Costa Rica's two major processors (Arreo and Montecillos) consider it very strategic to maintain the possibilities of selling to both the domestic and international markets.

Third, beside these three national-level plants, there are three regional plants and 12 smaller rural plants, which in the 1970s were more numerous (Pomareda, 2004) – hence more like Nicaragua at present. The smaller plants process less than 1,000 head per month and do not have the proper sanitary and hygienic conditions (Perez, 2004). The decline in rural plants seems to be a consequence of changes in food safety perceptions by the consumers, as well as enforcement of safety standards by government (which is more capable of enforcing such standards than in Nicaragua). These food safety forces drove changes in both supermarket chains' and small butcher shops' procurement systems: because of the low hygienic standards of the small processors they shifted to the larger processors. Moreover, economies of scale gave the larger plants a competitive edge over the smaller plants.

Fourth, the three major processors buy their cattle from producers, with the processors' assigning regional buyers in production zones. The processors use similar standards to those recently developed by the Costa Rican Livestock Association (CORFOGA)**.** Processors link the standards to economic incentives to reward producers for higher quality animals, which are

younger and heavier animals, animals with reduced fat content and good muscle formation. They do not establish a minimum weight requirement nor only buy a single animal category, which lets a given producer sell all his/her animal categories to this market channel. Processors also require the animals to be delivered free of diseases and parasites.

Supermarket chains' procurement systems. Note first that in Costa Rica the supermarkets' share in urban food markets was 50% in 2002 (Alvarado & Charmel, 2002) while their participation in beef retail markets was 35% (CORFOGA, 2002). The supermarket chains face fierce competition from 1,389 butcher shops (traditional retailers for beef). However, the supermarket growth has been significant in the past decade as shown by the increase from 113 stores in 1990 to over 317 stores in 2003 (Alvarado, 2003; Perez, 2004). There are butcher shops in the urban open markets and in urban residential areas. The food safety of butchers' beef is similar to that of the supermarkets, because, in contrast with Nicaragua, in Costa Rica the gap between processor's food safety used by the supermarket sector and the traditional retailers is smaller because the processing industry is highly concentrated and there are fewer smaller operators. Also, in Costa Rica butchers can take their animals to the large-scale processing plant and pay a fee for the slaughtering service, which is not the business practice in Nicaragua as we mentioned before with the exception of ICI.

Second, supermarket chains have two types of procurement systems. In the second tier, supermarket chains such as MEGASUPER, Supercompro, Periféricos, and PriceSmart rely entirely on their relations with three major processors to buy their beef cuts and carcasses. In this procurement system, supermarket chains and the processors work together to define product standards and transaction requirements. Then the processors are free to design and govern as they see fit their cattle procurement systems and their relations with producers. The supermarket

chains no not engage in direct relations or transaction with producers, and they rather use, de facto and indirectly, the standards imposed by the processors on the producers. This is equivalent to the La Colonia supermarket chain we presented in the Nicaragua section.

Third, in the first tier, supermarket chains such as Automercados and CSU have developed procurement systems in which they buy the cattle directly from producers. Automercados has a preferred supplier system of 40 producers that supply all its cattle requirements. This supermarket chain also owns a farm that is used to leverage their negotiation position against producers and it is also used to supply the cattle in times when competition is high for cattle. Interestingly, the chain has an internal department that handles cattle transactions with their producers. The chain has contracts with two of the major processors to process the cattle and deliver beef cuts to its seven stores. The chain started to buy directly from producers because they wanted to ensure they were buying high quality beef (steers) instead of low quality (cull cows) and the best way for them to do that was to buy their animals. However, this high-end chain now buys more beef cuts than live animals, because their further processing (in the store) capabilities are very small. By buying specific cuts, they avoid inventories of unsold cuts (they order what they sell).

CSU relies on its dedicated wholesaler Industrias Carnicas Integradas (ICI) to get its beef cuts supplies. Recall that ICI is part of the same holding company that owns CSU. ICI buys its cattle supplies from approximately 53 producers that are in their preferred supplier list. ICI maintains a relation under a contract with two of the major processors (CoopeMontecillos and Arreo) to slaughter the cattle.

CSU-ICI buys cattle because they are able to maintain the required carcass quality and also secure their needs. In the past, and depending of the seasonal supply, the processing industry did

not maintain standards on the carcasses they sold to CSU-ICI, and the same happened with certain valuable cuts (tenderloin).

CSU-ICI's use volume of cattle is very large and the major processors compete with each other to get the contract to slaughter the cattle for ICI. In the contract, ICI's producers send the cattle to the two major processors directly and ICI will get back from the processors only the beef cuts and not the byproducts. Interestingly, it is the processors that end up paying CSU because the value of byproducts is higher than the value of the slaughtering service. If ICI is facing some cattle shortage situation or need to leverage its negotiation position with the major processors, it requests its Nicaraguan subsidiary to send animal carcasses.

CSU and ICI outsource the slaughtering because it does not give any added value (only to maintain food safety achieved by the export standards). Slaughter is "subsidized" by the need to attract a large volume of cattle. It is cheaper to outsource than to build (and operate) a slaughterhouse. On the other hand, the slaughterhouses need large volumes for the use of subproducts like bone- and blood flour, skins and hides. That is why they offer services to butchers and ICI. The supermarkets use certified plants for hygiene and quality reasons.

Also, in Costa Rica, ICI, besides having distribution centers, also has a processing plant in Alajuela (near the capital, San Jose) where it further processes the beef by cutting, marinating, and processing others products that are sold under four "private label" brands for the CSU chain (La Hacienda, Lonja, Suli, and Sabemas).

As with the ICI in Nicaragua, ICI Costa Rica is also involved in CARHCO's regional procurement system – it delivers its products to CSU stores in Costa Rica and also sells to La Fragua stores in El Salvador and supermarkets in Nicaragua, Honduras, and Guatemala. Note that ICI's plant is HACCP certified and also has the Costa Rican green ecological seal "Sello

Verde de Bandera Ecológica" because of its environmental friendly technologies such as waste water treatment.

Auction markets as an alternative market channel. First, note that there are many more auction markets in Costa Rica than in Nicaragua. Interestingly, while at the beginning of the 1980s Costa Rica had nearly no auction markets, currently there are 16 auction markets in different regions of the country. Also, the nature of the transactions in the auction markets has evolved over time. The Costa Rican Government's decree 26.920 of 1998 regulates the operations in auction markets establishing procedures such as minimum health sanitary conditions, public cattle weight measurement and price transparency (SIDE, 2004). Auction markets replaced a non-transparent system of intermediaries. There are still a lot of intermediaries in the system but the auction system skyrocketed because it satisfies the needs of the small producers who sell each on average three animals in the auction markets and it gives price transparency and immediate payment to producers. Producers sell mainly heifers, cows, and calves in the auction markets.

Second, the growing importance of auctions in Costa Rica is mainly associated with farm size and cost of animal transport. In order to have a low (per head) transportation cost to a slaughterhouse, it is required to have more than 10 head to sell at the same time. Usually farmers, with the exception of those specialized in finishing operations ("engordadores") sell one or two head at a time at auction markets near their farms. Just in the Guanacaste region of 10,000 square km, there are seven auction markets. At the auction markets, buyers of cattle for slaughtering consolidate trucks and ship them to slaughterhouses.

Third, another aspect of auctions (Costa Rica) is that the type of animal sold are culled cows/bulls for slaughter (not that good quality), usually purchased by small butchers or intermediaries supplying small butchers, but very seldom there are sold good quality steers for slaughter. The latter are sold directly to the processing industry and supermarkets. Also, most cattle finishing operations avoid auctions for selling their finished cattle (where there are not many buyers for this type of animal). Only during short periods during extreme scarcity does one see the industry or supermarkets buying at auctions.

Fourth, butcher shops buy mainly from auction markets. These markets work mainly as a spot market and the main requirements for sellers (producers) is to deliver healthy animals. Subsequently, butcher shops request the major or the smaller processors to slaughter the cattle and the shops pay a fee for the service. Note that in Costa Rica the large-scale processors offer the slaughtering service for a fee to butchers.

(e) Linking Descriptive Analysis with Vertical Coordination Model

We present in Table 1 a summary of different coordination mechanisms strategies a producer faces when selling to auction markets, to large-scale export-oriented processors, or to supermarket chains. The new relations and partnerships that have emerged increase the level of control over their coordination mechanisms and reduce coordination errors in supplies of cattle, ensure better beef quality at competitive costs. We also know that as one moves from traditional markets (auction markets as a proxy) to large-scale processors to supermarket chains (with preferred supplier lists) the set of product standards and transaction requirements become stricter and more direct.

Our general hypothesis is that producers' capacities affect their ability to sell to each of the market channels and that their supply's capacities and incentives vary by market channel. Producers selling to the three market channels are expected to differ in their assets, human capital skills and are expected to have some impact in their farms technology.

3. PRODUCER CHARACTERISTICS BY MARKET CHANNEL

We stratified our farmer sample by supply chains so as to ensure our sample would contain producers selling to the supermarket chains. We conducted in-depth and in-person structured survey with 300 cattle producers randomly selected from a list of producers selling to the three market channels in Nicaragua and to the three market channels in Costa Rica. A complete list of producers was obtained from buyers: (1) in Nicaragua 180 producers that sell to ICI, to the leading processor San Martin and to the auction market near Managua (2) 120 producers in Costa Rica that sell to ICI, to the leading processor Arreo, and to an auction market in the Guanacaste region. From those lists we randomly selected 10 percent of the producers so the number of sampled units in each stratum is proportional to the size of the stratum. We collected our data during June and July of 2004.

We start this section by focusing on salient results presented in Table 2**.**

First, note that the farms which sell directly to supermarkets and large-scale plants tend to be animal-finishers that have the larger farms. Moreover, when comparing the overall farm size by market channel we observe that producers selling to the supermarket channel are larger than those selling to the processor channel and traditional channel. Also, the differences in the overall farm size among the market channels are also reflected in both cattle stock and in cattle sales, hence reflecting the obvious fact that bigger farms with more cattle can sell more.

There is a basic reason for the fact that larger farmers tend to be on the preferred supplier lists of the supermarkets and big processors. The small livestock producers have not sufficient area to fatten (finish) animals and they sell calves or young steers to the finishers. Note that in Nicaragua the 96,994 livestock farms that operate in the country have on average 31 Ha and 27 head and in Costa Rica the 30,850 farms have on average 40 ha and 37 head (National Agricultural Census of Nicaragua in 2001 and in Costa Rica in 2000). It is worth mentioning that if we compare our sample with national average it is significantly biased towards the bigger farms. That bias is mainly among the auction farmers which one expects to be nearer the national average size, but are larger because they are located near and supplying to the most important urban areas rather than the smaller farms supplying the smaller cities and towns and rural areas. Moreover, note that in Costa Rica the differences over the strata are bigger and the supermarket procurement systems has been in place for almost 20 years while in Nicaragua it has been for less than five years.

Second, cattle producers selling to the supermarket channel are more specialized in beef and finishing production levels as compared to cattle producers selling to processor and auction market channels. Also, the differences over strata in degree of specialization are smaller in Nicaragua than Costa Rica. This, combined with the sharper size differences, suggests (we surmise) that the market changes are inducing differentiation over farms. On the one hand, those producers that are specialized in milk production have nearly no presence in the supermarket channel, which makes sense as they only sell calves to other producers and their tiny presence in sales of animals for slaughtering purposes is due to their cull cows' sales, which are lower quality animals not bought by ICI. On the other hand, as producers that sell to the supermarket channel focus their operations in delivering the large transaction volumes (that our interviews

show are increasing over time), they are in the need to shift away from cow-calf operations and specialize in finishing operations given limited resources.

These differences reflect two specific aspects. The producers selling to supermarket buyers are more specialized in finishing operations and over time we surmise that their role will be more important as the "market gatekeepers" to the fast growing supermarket market channels. Those producers not selling to the supermarket channel will become suppliers of calves and young steers ready to enter stocking and finishing operations, respectively.

Also, producers selling to the supermarket channel specialize more in finishing operations because cow-calf operations require significant investments in cows and in land to produce the quantities of calves and steers that are required by the market channel. This adjustment reflects both limited capital resources and a reallocation of factors to deliver steers for slaughtering purposes.

Third, as shown in Table 3, cattle producers selling to processors sell on average the highest share of their cattle volume to this channel. They are followed by the producers selling to the supermarket channel. Producers selling to auction markets present the lowest level of specialization in or reliance on this market. However, note that all three groups of producers sell to multiple market channels which show the rather complex market activities of a producer. In both Nicaragua and Costa Rica, producers selling to the processor channel sell on average 80% of their volume to this channel; producers selling to the supermarket channel sell on average 65% of the volume to supermarket buyers; producers selling to traditional channels sell on average 47% of the volume to auction markets. As they can only sell steers to the supermarkets in a continuous way, in order to sell other animal categories of lower quality (which represent on average 35% of their sales) they must find alternative markets channels such as auction markets,

intermediaries, butchers and processors. Producers selling to processors sell a higher share of their volume to processors as this channel will buy all animal categories, hence it is more flexible in terms of quality and does not necessarily force produces to fin alternative markets. The producers in auction markets are the least dedicated which reflects their “spot market” mode in which they market their cattle (flexibly adapting to their cattle composition and prices and demands).

Here, for the purposes of classification, we note that producers selling to the processing market channel also sell to multiple markets but by our definition are thus classified only if they do not sell to supermarket buyers. Also, producers selling to auction markets sell to multiple markets but do not sell to either supermarket buyers or processors.

Fourth, as expected because of its higher intensification of livestock production, the extraction rate is higher in Costa Rica as compared to Nicaragua. The extraction rate, and thus intensification, in Costa Rica is much higher for the supermarket channel, followed by the processor channel, and third the traditional channel. In Nicaragua the three market channels show about the same level of extraction in the three channels, which reflect that as land is cheaper in Nicaragua and extensification (extensive, land-using systems) is – still - more attractive than intensification.

Fifth, a higher share of producers selling to the supermarket channel buy more steers as compared to producers selling to processors and traditional markets in order to fulfill their buyer’s transaction requirements.

Note in Table 3 that a higher percentage of producers selling to the supermarket channels buy steers to finish and resell as compared to producers selling to the processor and traditional channels. As the supermarket channel only buys steers, if producers selling to this market

channel were to depend only on their own calf production, this would require enormous investments in cows and land even for big farms. As only 50% of the calves born on average are male, in order to guarantee sufficient numbers of finished animals, the producers would have to buy steers from different sources. Note that we focus most of the discussion on steer sales as this is the only animal category sold to the supermarket channel and other animal categories are sold to other market channels. Producers selling to the supermarket channel are required to increase their cattle supplies in order to meet the growth in demand of their supermarket buyers.

Also, note that in Nicaragua the most important source of steers purchased (for finishing operations) by producers selling to the supermarket channels are direct from other producers. As there is only one auction market located near the capital city, producers selling to the supermarket channel need to travel on average more than four times as far as do producers in Costa Rica in order to buy animals from auction markets. Also, it is possible that producers in Nicaragua are unable to buy good quality young steers from the auction market.

Sixth, although there is no price difference – for a given type of animal and quality – over the market channels paid to producers, the main payoff to a given channel is related to the quality sold to it, and there are distinct differences over the producer groups in quality. Table 3 shows that the animals sold to supermarkets are of higher quality. Better quality means younger and heavier animals. In Costa Rica, the genetics of the animals allow the production of heavier animals and thus larger cuts of meat. In Nicaragua fattening operations have been very extensive on natural and unimproved pasture using compensatory growth mechanisms. This has led to older steers at slaughter (four years and above) which results simply in tough meat. Therefore, reducing age at slaughter means improving quality because the meat is thus tenderer for the consumer. It is not then surprising that in Nicaragua the main focus of producers selling to

supermarket channels has been a reduction of the age (that is, taking fewer years to reach a certain weight required) of the animal sold for slaughtering.

Lastly, an issue that deserves more attention is the potential link between the weight quality requirement and animal purchases. Our data in both countries support the fact that producers selling to the supermarket channel buy heavier animals from other producers for their finishing operations with already 300 kg rather than weaned calves steers with 1 year. This finding indicates that the (heavy-) weight requirements are being passed along the chain to other producers that operate cow-calf and stocking operations.

4. ECONOMETRIC MODELS TO EXPLAIN MARKET CHANNEL PARTICIPATION AND STRATA SUPPLY DIFFERENCES

We use a two-stage model in which the first stage is market channel choice and the second is output supply. Recall that we have discussed at the beginning of the previous section the method and data used. In the first stage we conceptually frame the producer's market channel choice using a random utility model (RUM), which we consider appropriate for the producer's decision of whether or not to be part of the supermarket chains preferred supplier list, of whether to be part of a large processor supply chain or not. The model is estimated using a multinomial logit model with two equations, one for producers selling to the supermarket chain, one for those producers selling to the large-scale processor and the traditional supply chain is used as the base. Then, we briefly discuss the main results. Second, we estimate the output supply functions of the producers selling to each supply chain separately but control for the producer's conditional

probability of being part of a supply chain by including the inverse mills ratio (IMR) calculated from the first stage. Then we perform a Chow test and lastly we interpret the results.

(a) Random Utility Model to Determine Producer Channel Choice

We assume that cattle producers select their market channels and supplies based on their expected utility. The RUM provides a framework that fits well the producer's market channel selection as it models discrete choice decisions. The RUM resembles an indirect utility function where an individual with specific characteristics associates an average utility level with each alternative with some characteristics in a choice set. A producer i observes N market channels, that is, based on our supply chain analysis above, the producer can be listed in one of the three supply chains, that of the leading supermarket chain CSU or that of the leading large-scale processor or the producer can sell to the auction market. A producer can only be part of one of the three supply chains. The producer's utility from participating in market channel j is represented by U_{ij}. The producer makes a marginal benefit-marginal cost calculation based on the utilities achieved by selling to a market channel or to another.

(1) $$\mathbf{U_{i(j=k)} = \beta_{j=k} X_{ij} + \varepsilon_{ij}} \qquad \forall \mathbf{j \in N}$$

We can not observe directly the utilities (or the difference between benefit and cost) but the choice made by the producer reveals which one provides the greater utility (Greene, 2000). A producer selects market channel j=k if

(2) $$\mathbf{U_{i(j=k)} > U_{i(j\neq k)} \forall j \in N}$$

Where U_{ij} denote a random utility associated with the market channel j=k, and let $\boldsymbol{\beta}_{\mathbf{j=k}}\mathbf{X}_{\mathbf{ij}}$ be an index function denoting the producer' average utility associated with this alternative. The second term $\boldsymbol{\varepsilon}_{\mathbf{ij}}$ denotes a random error which is specific to a producer's utility preference (McFadden, 1976).[2]

Now, in our implementation model, market channel choice is modeled with a two equation system (j=1, 2) as:

(3). $\mathbf{Y}_{\mathbf{ij}} = \boldsymbol{\beta}_{\mathbf{j}}\mathbf{X}_{\mathbf{ij}} + \boldsymbol{\varepsilon}_{\mathbf{ij}}$

Where in the first equation Y_{ij}=1 if producer chooses the CSU-ICI market channel (Leading supermarket chain), 0 otherwise. In the second equation Y_{ij}=1 if producer chooses to sell to the large-scale processor market channel (Arreo or San Martin), 0 otherwise. The Auction market channel is the base category for both equations. $\boldsymbol{\beta}_{\mathbf{j}}$ is a vector of channel-specific parameters. $\boldsymbol{\varepsilon}_{\mathbf{ij}}$ is the error term assumed to have logistic distribution with mean 0 and variance 1. X_{ij} is a vector of producer characteristics influencing the producer's indirect utility, hence its market channel decision and it include the following variables:

Cattle producer market channel participation is hypothesized to be affected by the following explanatory variables: AGE, EDUCATION and EXPERIENCE which are the age (years), education (four categories as: no schooling, primary school, high school studies and university studies) and experience in cattle production (years) of the producer, respectively. These variables reflect producer's human capital capacity to understand technologies that improve cattle quality and transaction requirements and may help a farmer to enter the

supermarket preferred supplier list. Examples are the use of artificial insemination or summer feeding practices (when prairie supply is low).

HOUSEHSIZE is the number of members living in the household. DEPENDR is the dependency ratio measured as the number of members in the household with less than 15 years or above 64 years over the total number of members in the household. FEMALE is equal to one if the producer is a female and zero otherwise. These three variables combined represent labor structure availability in the household. These variables are hypothesized to have a positive effect as we expect that the supermarket and processing market channels use more intense production systems than the traditional channel and require more labor for activities such as vaccination, and prairie rotation practices.

FARMSIZE is the overall farm size in hectares and it is the sum of land owned, land obtained for usufruct, rented in, land sharecropped in, less the sum of land rented out and land sharecropped out. Overall farm size reflects land availability for cattle production which is closely related to the producer's capacity to finish cattle, have bigger cattle stocks and sell more cattle to bigger and fast growing buyers that require more cattle. This variable does not only affect the farmer capacity to enter the supermarket market chain but also its capacity to remain on it. IMPPRAIRI is the percentage of improved prairies over total prairies. As cattle producers usually replace natural prairies (e.g. jaragua) by improved prairies (e.g. Brizantha, Decumbens, Tanzania) their supply of pasture increases. This variable is an indicator of prairie quality and also indicates a producer's capacities to shorten the time span in which an animal can be ready for slaughtering purposes, that is, it increases the cattle producer capacity to sell younger and heavier animals, which are better paid and also are preferred by the large-scale processors and supermarket chains with preferred supplier lists.

STOCK is the sum of all cattle categories such as bulls, oxen, heifers, steers, cows, and female and male calves. FESTOCK is the percentage of female cattle over total cattle included to control the stock capacity to supply steers. BREEDT is the percentage of animals that are rather tropical type and not crossbred with other Boss Taurus breeds (similar as in Holloway et al., 2004) such as Angus, Holstein, and Jersey that have higher productivity levels and higher quality. Although there is no explicit requirement from the buyers, this variable is expected to influence the producer's capacity to sell higher quality animals to the supermarket channel. This is because the tropical breeds are less efficient and take longer to reach their slaughtering stage, in particular when feeding practices are poor, hence quality may not conform to buyers' specifications. Note that farmers make control their female cattle stock and breed rather in the long run, and so they affect the farmer's access to market channels that require higher quality.

ROAD is the distance to asphalted road measured in kilometers. ELECTRIFICATION is a dummy variable that represents farm's access to electrification which may constrain certain capacities in production such as cutting machines. EXTENSION is another dummy variable that represents availability of extension services, which determines the producers' access to production techniques such as sanitary services and marketing options. The three variables capture farm's access to infrastructure and we hypothesized that the larger the first the less likely is a cattle producer to sell to supermarket channels and the availability of the latter two will increased the cattle producers' probability of selling to the supermarket channel. COSTARICA is a dummy equal to one if the cattle producer is in Costa Rica and zero if it is located in Nicaragua and it expected to capture differences in the industry and retail sector between the two countries.

We present in Table 4 the market channel choice estimation results.

First, overall farm size is a highly significant determinant of market channel participation in the supermarket and in the processor market channels. As the farms increase their operations they are more likely to sell to these two market channels. The magnitude of overall farm size is about ten times larger for producers selling to the supermarket channel as compared to producers selling to the processor channel. This suggests that the supermarket preferred supplier list favors bigger farms that can deliver more quantities of cattle.

Second, if a producer is located in Costa Rica, his/her odds to sell to the supermarket channel and processor market channels are lower as compared to a producer located in Nicaragua. This is because there are fewer producers in the preferred supplier system of the leading supermarket chain and of the major processor in Costa Rica. Also, the development of the auction markets in Costa Rica indicates that producers have greater access to other market channels. Lastly, the development of the supermarket sector and processing industry may indicate that their quality standards are stricter and it is harder in Costa Rica to sell to these market channels as compared to Nicaragua, where these market channels are just initiating the introduction of private quality standards.

Third, the asset specificity of prairies and cattle stock breed does not affect significantly the probabilities of producers' selling to the supermarket and processing channel. One would think that these variables would affect positively their capacity to deliver the supplies, and the quality required by the buyer's technical specifications (minimum weight and maximum age), hence favor the access to the supermarket preferred supplier list.

Fourth, human capital and labor availability do not have significant effects. The only two variables significant only for the processor channel are education and dependency ratio. Results indicate that more education reduces the probabilities of selling to the processor market

channel. Higher dependency in the household increases the probabilities of selling to the processor market channel. Lastly, the only infrastructure variable that affects positively the probabilities of selling to the processor market channel is electrification.

(b) Market Channel Output Supply functions

As mentioned, we use a two stage approach to specify our model. In the first stage the model uses a random utility model to frame the market channel decision choice and here we present the second stage of quantities supplied. Note first that some of the previous work exploring the set of factors affecting the decisions of market participation and the quantities traded include Goetz (1992) in coarse grain markets in the southeastern region of Senegal, and Holloway et al. (2004) for milk producers in Ethiopian markets. Using data from Kenya and Ethiopia on livestock markets, Bellemare and Barrett (2004) model the two decisions comparing sequential and simultaneous decisions and find that these decisions are made sequentially rather. In our work, we estimated such decisions (participation, and quantity supplied) as both simultaneous and sequential and did not find major differences between the model results. We do however, prefer the two stage approach because it helps to control the conditional probability of a producer of being in a channel and it potentially control unobservable characteristics that might generate self-selection problems, hence we present the model and report results of the two stage (sequential) estimation.[3]

In this section we estimate the output supply function of cattle (or marketing supply function). We derive the equations from the profit function using Shephards Lemma and obtain the following two marketing supply functions:

$$\mathbf{Y_{ji(males)}} = \delta_{\mathbf{j}} + \delta_{\mathbf{j}}\mathbf{P_m} + \delta_{\mathbf{j}}\mathbf{W_m} + \delta_{\mathbf{j}}\mathbf{K_{ij}} + \delta_{\mathbf{j}}\lambda_{\mathbf{ij}} + \eta_{\mathbf{ij}} \quad (4)$$

$$(5) \qquad \mathbf{Y_{ji(female)}} = \alpha_{\mathbf{j}} + \alpha_{\mathbf{j}} \mathbf{P_m} + \alpha_{\mathbf{j}} \mathbf{W_m} + \alpha_{\mathbf{j}} \mathbf{K_{ij}} + \alpha_{\mathbf{j}} \lambda_{\mathbf{ij}} + \eta_{\mathbf{ij}}$$

Where the i^{th} producer sells to the j^{th} market channel represented as mentioned before by the leading supermarket chain, large-scale processor, and auction market supply chains. $Y_{ij(males)}$ are male cattle sales and $Y_{ij\ (female)}$ are female cattle sales measured in number of heads sold for slaughtering purposes. Note that we disaggregated the animal categories following previous work that provides insights on how the supplies may change depending on how the supply model is specified. For example, Jarvis's (1974) seminal work stressed the need for an econometric model to disaggregate by animal categories because cattle are considered consumption and capital goods depending on their age and sex. The disaggregating is further discussed in Aadland and Bailey (2001) where the ranchers problem is specified taking into account if the animal category is fed or unfed.

P is the average price of cattle measured as US$ per head. It includes two prices, STEERP is the average price of male cattle sales and COWP is the average price of female cattle sales in the municipality where producers are located. W represents the vector of input prices, however it only includes the variable LANDP, which is the average land price of buying one Ha (US$/Ha/municipality). Other input prices were not possible to include since lack of variation or because producers tend to use a high variety of inputs, which we did not have prices for. K is the vector of fixed factors and shifters that include the following previously defined (in the first stage) variables: AGE, EDUCATION, EXPERIENCE, HOUSEHSIZE, DEPENDR, FEMALE, FARMSIZE, STOCK, ROAD, ELECTRIFICATION, EXTENSION and COSTARICA. $\lambda_{1i}, \lambda_{2i}$ are the inverse mills ratio (IMR) calculated from the first stage used to control for the producers' conditional probability of being in a channel.[4] $\delta_{\mathbf{j}}, \alpha_{\mathbf{j}}$ are the estimation parameters and η_{ij} is the error term. We estimate the system for each market channel independently using a Zellner's

seemingly unrelated regression (SUR) model to exploit potential correlation across the errors in the three equations.

Table 5 presents the results for the marketing equations estimations. Elasticities are rather small as expected in the short run and are in line with economic theory and previous aggregate model results. There are four significant results that appear most relevant.

First, supply elasticity of males with respect to cattle stock of producers selling to the three market channels are similar and equal to 0.08 and for female cattle supplies it is nearly zero. This finding is not unusual since cattle stocks decisions involve long term periods as shown by the rather abundant literature on cattle cycles, which indicate that cattle stock varies smoothly over times showing peaks intervals of approximately five years. The cattle cycles in part have been linked to biological production functions. Our model suggests that in the short run supplies marketed of male cattle and much less that of female cattle may not increase substantially depending on cattle stocks levels and much less by their overall farm size. Producers may not sale their current cattle stocks to increase their current supplies, and as expected this is more important for female cattle considered capital goods. Also, the estimated parameters, suggest that producers selling to the three supply chains do not differ much in their capacities and technologies to increase their supplies with increases in their cattle stock. That, however, does not mean that cattle stock levels are rather important to increase their supplies. On the other hand, producers may use other strategies to increase their supplies such as buying more animals from other producers rather than slaughtering their current stock. As suggested by the descriptive analysis, in relative terms more producers selling to the supermarket chains do buy animals to finish as compared to producers in the other supply chains and they are more specialized in finishing operations. The inelastic supplies of male and female cattle supplies

with respect to cattle stock, possibly helps to explain why producers in the supermarket chain are more specialized in finishing operations and buying more cattle from other producers as compared to producers in the large-scale processors and auctions markets supply chains. More research will be required with times series data in order to validate these results.

Second, results show that producers selling to the supermarket channel have a price supply elasticity of male sales that is four times bigger than the price elasticity of producers selling to the processor channel and 12 times bigger than producers selling to auction markets. We expected this result because producers selling to the supermarket chain are required to meet the quantities demanded, which is a requirement for being in the preferred supplier list. Now, there are a few things to consider, we may not safely claim that producers respond exclusively to the price increases. The price increases could mainly reflect seasonal price increases, but the producers selling to the supermarket chains are literally forced (or risk themselves to be de-listed) to supply the required quantities of cattle. This is indeed the main advantage of the more integrated supply chain developed by the supermarket chains since they can ensure their cattle supplies in times of scarcity and with the plus of getting the higher quality animals. This is of course most important for male cattle because the chains do not buy the female cattle, considered of lower quality (cull cows). We think that producers selling to the supermarket chains have specialized in finishing operations and stimulate other markets such as buying from other producers in Nicaragua and from auction markets in Costa Rica, in order to respond to the chains minimal supplies requirement (transaction), which is rather most important in times of supply scarcity. The chains ensure a smooth supply of cattle meeting their stricter quality requirements while the producers in their preferred supplier list benefit from selling continuously over the year (and increasing their market over time) but they have

to adjust and innovative in their strategies to stay in the supply chain. There seems to be indeed important potential positive effects over cattle markets, since the finishing operations may become important buyers of cattle from other producers or from auction markets, where the latter have skyrocket in Costa Rica at the same time supermarkets skyrocket.

Third, the supply elasticity of female sales with respect to the female cattle price is only significant and negative for producers selling to the processor channel. Here we make a tiny contribution to support the negative short run price elasticity of female cattle (capital goods) and position ourselves in the already long debate of whether short run price supply elasticity are positive or negative.

Fourth, there is a marginal absolute increase in the supplies of steers as a result of an increase in the cattle stock, overall farm size, and the price of steers for cattle producers selling to the supermarket channel. That is on average two times bigger than the marginal absolute increase of cattle producers selling to the processor and auction markets. This is a reflection of course, of bigger farms entering the preferred supplier list of the chains as compared to producers in the processing and auction market supply chains.

5. POLICY IMPLICATIONS

Policy implication 1: Supermarket effects on the auction markets. The supermarket chains procurement systems shifted away from auction markets to avoid the additional brokering cost (5%) and avoid sub-optimal sanitary conditions and animals handling (stress). The effects of the rise of supermarket chains on auction markets need more research as even when the chains shifted away from auction markets, their number in Costa Rica have increased substantially. On the other hand, more producers selling to the supermarket chain ten to buy cattle and their main

source in Costa Rica are the auction markets. Our results in Nicaragua indicate that the producers selling to the supermarket chain use as the main source of cattle other producers, which may indicate just the absence of auction markets. Several other authors have indicated the positive effect of developing auction markets in Nicaragua, which possibly may replace the intense trading activity between producers in Nicaragua. Auction markets may help to reduce the transaction costs of trade between producers, also provide higher transparency in price determination, and may help the traditional butchers in Nicaragua as is the case in Costa Rica.

Policy implication 2: Supermarket effects on the beef processing industry. As supermarkets buy cattle carcasses or process their animals in large-scale HACCP certified processors, the effects on the beef processing industry indirectly accelerate the disappearance of smaller processors with insufficient food safety processing capabilities both in Costa Rica and Nicaragua. Supermarket chains' investment in distribution centers and HACCP processing plants for further processing are increasing their capacities as compared to traditional butchers. Also, supermarket chains have become competitors for cattle which affect major processor procurement systems and also affect auction markets.

Policy implication 3: Supermarket chains have introduced several changes in the beef procurement systems as compared to traditional butcheries. Some supermarket chains rely on a dedicated wholesaler to handle all cattle/beef operations or may have an internal department that undertakes this role. The supermarket chains have implemented higher quality standards when buying from cattle producers in order to improve the quality of their beef cuts. Also, the leading chains have developed a preferred supplier system in order to buy from cattle producers rather than from the major processors and only contract with the processor to slaughter the cattle.

The change in coordination strategy offers the advantages of getting enough supplies of cattle during seasonal scarcity periods and with the right quality. Producers benefit from an increasing year-around market that offers competitive prices.

Policy implication 4: Producer's market channel determinants and supplies. Results show that when producers sell to the supermarket channel they face similar determinants as when selling to major export-oriented processors. Overall farm size is an important determinant and raises questions as what will happen as the supermarket sector grows and gain participation in the domestic markets. Second, the supply elasticity and absolute marginal response of producers selling to the supermarket channel are higher as compared to producers selling to processor and auction market channels. This potentially is a result of the buyer year around supply requirements. Third, producers in the supermarket supply chains tend to be more specialized in finishing operations which seems to be a reflection of the adjustment that they need in order to remain in the chains preferred supplier list. Subsequently they will become important buyers of cattle from other producers.

REFERENCES

Aadland, D. & Bailey, D. (2001). Short-Run Supply Responses in the U.S. Beef-Cattle Industry. *American Journal of Agricultural Economics, 83* (4), 826-839.

Alvarado, I. and Charmel, K. (2002). The Rapid Rise of Supermarkets in Costa Rica: Impact on Horticultural Markets. *Development Policy Review, 20* (4), 473-485.

Berdegué, J., Balsevich F., Flores L., and T. Reardon. (2005). The Rise of Supermarkets in Central America: Implications for Private Standards for Quality and Safety of Fruits and Vegetables. *Food Policy, 30* (3): 254-269.

Bellemare M. F. and C. B. Barrett, (2004). An Ordered Tobit Model of Market Participation: Evidence from Kenya and Ethiopia. *American Journal of Agricultural Economics*.

Bourguignon, F., Fournier, M. & Gurgand, M. (2004). Selection Bias Corrections Based on the Multinomial Logit Model: Monte-Carlo Comparisons. *Département Et Laboratoire D'économie Théorique Et Appliquée, DELTA*. Working paper No 2004-20. Paris, France.

Campbell, R. (2000). Analysis of the Nicaraguan Meat Processing Industry. *Chemonics International Inc.* Report for USAID, Managua, Nicaragua.

Codron, J.M., E. Giraud-Héraud and L.G. Soler, (2005). Minimum quality standards, premium private labels, and European meat and fresh produce retailing. *Food Policy, 30* (3), 270-283.

Cosslett, S. R. (1981). Efficient Estimation of Discrete-Choice Models. *Structural Analysis of Discrete Data*. Cambridge, Massachussetts: MIT Press.

Dubin, J.A. & D.L. McFadden. (1984). An Econometric Analysis of Residential Appliance Holdings and Consumption. *Econometrica, 52* (2), 345-362.

CORFOGA, 2002. Estudio de Mercado de Hábitos de Consumo de la Carne. *Corporación Ganadera (CORFOGA)*. Costa Rica. http://www.corfoga.org, accessed March 14, 2005.

Greene, W.H. (2000). *Econometric Analysis*. New Jersey: Prentice Hall.

Goetz, S.J. (1992). A Selectivity Model of Household Food Marketing behavior in Sub-Saharan Africa. *American Journal of Agricultural Economics*, Vol. 74 (2), 444-452.

Henson, S. and T. Reardon (2005). Private agri-food standards: Implications for food policy and the agri-food system. *Food Policy Review, 30* (3), 241-253.

Hobbs, J. (1997). Measuring the Importance of Transaction Costs in Cattle marketing. *American Journal of Agricultural Economics, 79* (4), 1083-1095.

Holloway, G., C. B. Barrett and S. Ehui, (2004). Bayesian estimation of the double hurdle model In The Presence Of Fixed Costs. *Journal of International Agricultural Trade and Development*..

IICA-PROVIA, (2002). Estudio de la cadena de comercialización de la carne bovina. *Instituto Interamericano de Cooperación para la Agricultura (IICA).* Mimeo. Managua, Nicaragua.

Jarvis, S.L. (1974). Cattle as Capital Goods and Ranchers as Portfolio Managers: An Application to the Argentine Cattle Sector. *The Journal of Political Economy*, 82 (3), 489-520.

Key, N., Sadoulet, E. and de Janvry, A. (2000). Transactions Costs and Agricultural Household Supply Response. *American Journal of Agricultural Economics*, Vol. 82 (2), 245-259.

McFadden, D. (1976). "Quantal Choice Analysis: A Survey". *Annals of Economic and Social Measurement, 5* (1976), 363-390.

Manski, F. C. & S.R. Lerman (1977). The Estimation of Choice Probabilities from Choice Based Samples. *Econometrica, 45* (8), 1977-1988.

Ospina, E. & Shumway, C.R. (1979); Disaggregated Analysis of Short-Run Beef Supply Response. *Western Journal of Agricultural Economics 4* (2), 43-59

Paarsch, H.J. (1985). Micro-Economic Models of Beef Supply. *The Canadian Journal of Economics, 18* (3), 636-651.

Pérez, E. (2004). *El Acceso de pequeños y medianos Ganaderos de Carne a Mercados Dinámicos: El caso de Costa Rica.* Mimeo, International Livestock Research Institute. Managua, Nicaragua.

Peterson, H.C., A. Wysocki, and S.B. Harsh. (2001). Strategic choice along the vertical coordination continuum. *International Food and Agribusiness Management Review*, 4 (2001), 149-166.

Pingali, P.L. & Rosegrant, M.W. (1995). Agricultural commercialization and diversification: processes and policies. *Food Policy*, 20 (3), 171-185.

Pomareda, C., Brenes, E. and L. Figueroa (1997). La Industria de La Ganadería de Carne Bovina en Nicaragua: Condiciones de Competitividad. CEN 541. *Centro Latinoamericano de Competitividad y Desarrollo Sostenible (CLACDS) del INCAE*. San José, Costa Rica.

Pomareda, C. (2004). Adjustments in the livestock sector to Supermarkets' Strategies: The case of Costa Rica. *Paper presented at FAO International Seminar on Structural Change in the Livestock Sector: Social and Environmental Implications for Policy Making*. Bangkok, Thailand.

Precios Mensuales de la Carne por Minorista y Mayorista (2003, 2004). Sistema de Información de Precios y Mercados (SIPMA). *Ministerio Agropecuario y Forestal de la Republica de Nicaragua (MAGFOR)*. http://www.magfor.gob.ni; accessed March 14, 2005.

Reardon, T. & Berdegue, J.A. (2002). The Rapid Rise of Supermarkets in Latin America: Challenges and Opportunities for Development. *Development Policy Review, 20* (4), 317-34.

Rosen, S., Murphy, K.M. & Scheinkman, J.A. (1994). Cattle Cycles. *The Journal of Political Economy, 102* (3), 468-492.

SIDE. (2004). La Experiencia de las Subastas Ganaderas en Costa Rica: Beneficios para los Pequeños Ganaderos. *Servicios Internacionales para el Desarrollo Empresarial S.A. (SIDE)*. San José, Costa Rica.

Spreen, T.H., Bruce, A.M. & White, T.K. (1980). Modeling the Cattle Subsector: A Demonstration in Guyana. *Canadian Journal of Agricultural Economics, 28* (1), 17-32.

Williamson, O.E. (1973). Markets and hierarchies: some elementary considerations. *American Economic Review* 63, 316-325.

Table 1: Vertical Coordination Strategies in the Beef Supply Chains

Supply chain transactions	Vertical Coordination Strategy				
	Spot Market	**Specifications Contract**	**Relation - based Alliance**	**Equity - based alliance**	**Vertical Integration**
NICARAGUA					
In the First Supply Chain (supermarket):					
1) Between CSU (leading supermarket chain) & ICI (Specialized wholesaler)				**X**	
2) Between ICI (Specialized wholesaler) & Processor.			**X**		
3) Between ICI & Producers.		**X**			
In the Second Supply Chain (export-oriented):					
1) Between Export Markets, Second supermarket chain, and Processor owned stores & Large-scale processors*			**X**		
2) Between Large-scale processors & Regional buyer	**X**				
3) Between Regional buyer & Producers	**X**				
In the Third Supply Chain (traditional)**					
1) Between Traditional retailers & Small plant processor	**X**				
2) Between Small plant processor & Auction Market	**X**				
3) Between Auction Market & Producers	**X**				
In COSTA RICA					
In the First Supply Chain (supermarket):					
1) Between CSU (leading supermarket chain) & ICI (Specialized wholesaler)				**X**	
2) Between ICI (Specialized wholesaler) & Two Processors.			**X**		
3) Between ICI & Producers.		**X**			
In the Second Supply Chain (export-oriented):					
1) Between Export Markets, Supermarket chain, and Processor owned stores & Large-scale processors*			**X**		
2) Between Large-scale processors & Producers	**X**				
In the Third Supply Chain (traditional)**					
1) Between Traditional retailers/Butchers & Processor	**X**				
2) Between Processor & Auction Market	**X**				
3) Between Auction Market & Producers	**X**				

Notes: * Some processors do have their own retail stores reflecting a vertical integration coordination mechanism at that level of the supply chain, however their other coordination strategies remain as most important ** There can be one or multiple intermediaries at multiple stages of the supply chain.

Table 2: *Farm and Producer Characteristics*

	Nicaragua			Costa Rica			Sig	Sig
	Supermarket	**Processor**	**Auction**	**Supermarket**	**Processor**	**Auction**	**Nica**	**CR**
Sample (N)	58	75	34	14	32	61		
Age of producer (years)	47.2	46.8	48.9	50.0	52.9	49.4		
Experience with cattle (years)	19.2	25.0	25.4	22.1	24.7	28.2	a,b	
Producer education **(1)**	1.9	1.8	1.7	1.4	1.1	1.6		
Female producer (%)	7	5	3	12	9	8		
Dependency ratio (%) **(2)**	31	46	33	14	32	26	a	a,c
Household size (Members) **(3)**	4.3	4.9	5.9	3.4	3.5	3.0	a,b,c	
Overall farm size (hectares) **(4)**								
Current. (% used for cattle production)	464 (93)	452 (89)	261 (89)	463 (87)	182 (74)	81 (84)	b,c	a,b,c
Five years ago.	403	400	289	427	174	71	b,c	a,b,c
Change (%)	15	13	-10	8	4	14		
Production purpose and level (% of producers) **(5)**								
Double purpose (beef and milk)	81	95	79	21	16	44		b,c
Milk Production specialization	2	3	3	0	3	10		-
Cow-calf operation	45	47	35	50	53	44		
Stocking operation	67	60	56	100	69	52		
Finishing operation	90	77	41	100	66	38	b,c	a,b,c
Cattle stock (Head) **(6)**	410	374	303	767	183	101		
Monthly gain in weight (Kg./month/steer)	11.6	11.4	11.9	16.9	14.2	14.2		
Receives technical assistance (extension) (%)	24	29	15	7	22	41		
Credit (US$) **(8)**	1,730	2,701	717	-	-	-	a,c	-
Distance to market (Km) **(9)**	225	222	57	155	103	37	b,c	
Distance to asphalted road (Km)	8	10	7	4	5	6		
Has truck as means of transport (%)	100	77	68	100	41	57		a,b
Has electricity (%)	45	60	44	100	100	95		

Notes: (1) Education is equal to 0 if no education, equal to 1 if any primary education, 2 if any secondary education, 3 if any education in university, 4 if any graduate education; (2) Dependency ratio is the number of members in the household younger than 15 years and older than 65 years over total household size times 100; (3) Household size is the total number of family members living in the producer's household (during the last 6 months); (4) Overall farm size is the sum of land owned plus land obtained for usufruct plus rented in plus sharecropped in less the sum of land rented out and land sharecropped out (year production season 1998 & 2003); (5) In this study, production levels were defined as: Cow-calf operation is the production of calves, Stocker: raising calves until 300 kg. and, Finishing operations are those that take young animals from 300 kg. until 500-550 Kg. (slaughtering weight) and/or finish cull animals in order to sell them to be processed. (6) Cattle stock is the sum of all cattle categories such as Bulls, oxen, heifers, steers, cows, female and male calves. (8) Credit received during 2003-2004 for both investment and operating capital needs; (9) Distance to market is the kilometers to the channel buyer (auction, processor, and supermarket)

Table 3: ***Producers' sales and purchases of cattle by channel***

	Nicaragua			Costa Rica			Sig	Sig
	Supermarket	**Processor**	**Auction**	**Supermarket**	**Processor**	**Auction**	**Nica**	**CR**
Quantity of cattle sales (average) (1)								
Male sales (Head)	152	167	59	449	75	31	a,c	a,b,c
Female sales (Head)	21	29	37	55	25	9	a	a,b,c
Share of sub-channel by volume (%)	65	88	43	63	73	52		
Share other sub-channels - volume (%)	35	12	57	37	27	48		
Quantity sold per unit of land in livestock production (extraction)	**0.4**	**0.5**	**0.4**	**1.3**	**0.7**	**0.6**		
Farms by market channel (% of producers) (2)								
Buyers that export live animals (%)	14	11	9	0	0	2		
Auctions (%)	5	8	100	21	100	100	b,c	a,b
Intermediaries (%)	22	20	12	43	28	17		b
Butchers (%)	12	7	12	36	11	7		
Supermarket buyers (%)	100	0	0	100	0	0	-	-
Processors (%)	34	100	0	21	100	0	a	a
Price per head (average) (3)								
Male sales (US$/head)	289	310	308	379	369	358		
Female sales (US$/head)	291	297	319	312	317	327		
Age and weight of steers sold								
Age (months)	34	35	30	31	29	27	b,c	
Weight (Kg)	413	402	354	535	417	384	a,b,c	a,b,c
Farms that buy steers (% of farms) (4)	79	59	35	100	47	36		
Source of steers								
From another producer (%)	79	59	35	57	19	25	a	a,b
From Intermediaries (%)	19	16	9	57	3	13		a,b
From Auction Markets (%)	3	1	6	79	47	36		a,b

Notes: (1) These sales represent total cattle destined for slaughtering purposes. The female category includes mainly cows and heifers are included whenever sold for slaughtering purposes to reflect its beef value and not its reproductive value or genetic value. Also the male sales include mainly steers and it includes bulls whenever sold for slaughtering purposes. The share of sub-channel by cattle sold is the share of quantity sold to the supermarket channel or to the processor channel or to the auction channel divided by total cattle sold measured in head. (2) The percentages do not add to 100% because producers sell to multiple market channels their different types of animals (e.g. producers selling steers to supermarkets, may also sell cows to auction markets). Also, for simplicity we do not disaggregate animal categories by market channel. (3) We asked prices so they reflect averages in the region and are not channel specific (4) We asked animal purchases only for finishing operations and used only the steer animal category.

Table 4: *Producers' market channel determinants*

	Number of obs =	300
Wald chi2 (30) = 228.55	Prob > chi2 =	0.0000
Log pseudo-likelihood = -146.19968	Pseudo R2 =	0.4361
Covariate	**Supermarket**	**Processor**
Age of farmer	(0.01)	(0.01)
	(0.02)	(0.02)
Female producer	-0.61	-1.09
	(1.23)	(0.79)
Producer education	-0.33	-0.411**
	(0.23)	(0.19)
Experience in cattle production	0.00	0.01
	(0.02)	(0.02)
Household size	-0.08	0.02
	(0.12)	(0.11)
Dependency ratio	0.20	1.342**
	(0.70)	(0.61)
Overall farm size	0.049***	0.005***
	(0.010)	(0.049)
% of improved prairies	-0.734	-0.004
	(0.65)	(0.55)
Cattle stock	0.0010	0.0001
	(0.009)	(0.001)
% of Indigenous breed only	0.004	0.005
	(0.007)	(0.006)
% of female cattle stock	-0.011	0.002
	(0.009)	(0.008)
Electrification	0.332	1.158*
	(0.736)	(0.665)
Distance to asphalted road (Km).	-0.01	0.01
	(0.02)	(0.02)
Extension service	-0.26	-0.48
	(0.51)	(0.42)
Costa Rica	-1.909***	-2.126***
	(0.73)	(0.70)

Standard errors in parentheses
* Significant at 10%, ** significant at 5%, *** significant at 1%.

Table 5: *Producers' supplies by market channel*

Parameter Estimates	Supermarket		Processor		Traditional	
	Male Cattle supplies	**Female Cattle supplies**	**Male Cattle supplies**	**Female Cattle supplies**	**Male Cattle supplies**	**Female Cattle supplies**
Age of farmer	-3.955*	-1.859**	-1.975*	0.21	-1.24	-0.43
	(2.12)	(0.76)	(1.08)	(0.73)	(1.01)	(0.77)
Female producer	-147.50	56.89	-78.42	-21.36	-89.376	48.40
	(127.30)	(45.79)	(63.24)	(42.60)	(66.30)	(35.13)
Producer Education	-40.112	-17.20**	-27.11	-17.39	-28.93	-33.853*
	(33.86)	(8.58)	(18.41)	(12.40)	(23.06)	(17.50)
Experience in Cattle Production	1.84	1.10	1.21	0.27	0.28	-0.10
	(2.00)	(0.72)	(1.16)	(0.78)	(0.88)	(0.66)
Household Size	9.66	-5.25	3.34	8.71	18.973***	-7.39
	(13.55)	(4.87)	(9.70)	(6.53)	(6.84)	(5.19)
Dependency Ratio	397.8***	102.97**	36.03	-2.47	203.77***	72.43
	(129.19)	(46.47)	(66.73)	(44.95)	(66.09)	(50.14)
Overall Farm Size	0.06**	0.048*	0.04***	-0.02**	0.07*	-0.06
	(0.03)	(0.03)	(0.015)	(0.01)	(0.04)	(0.11)
Cattle stock	0.19*	0.194***	0.189*	0.03	0.322***	0.133*
	(0.11)	(0.06)	(0.10)	(0.07)	(0.10)	(0.08)
Electrification	142.466*	66.822**	59.07	37.43	130.15**	114.9***
	(80.89)	(29.09)	(47.12)	(31.74)	(53.34)	(40.47)
Distance to asphalted road (Km)	1.52	0.19	-0.44	0.00	0.00	-0.87
	(2.12)	(0.76)	(1.24)	(0.83)	(1.98)	(1.50)
Extension service	-42.89	35.114**	-47.14	-13.10	-31.45	-5.72
	(48.45)	(17.43)	(35.19)	(23.70)	(29.87)	(22.67)
Costa Rica	149.996**	-31.18	-11.46	-89.43	68.44	54.80
	(69.68)	(25.06)	(86.22)	(58.08)	(55.20)	(41.89)

Land Price	-0.048*	-0.026***	0.01	0.00	0.00	0.00
	(0.03)	(0.01)	(0.02)	(0.01)	(0.00)	(0.00)
Price of Steers	0.45*	0.03	0.17**	0.11	0.20**	-0.09
	(0.25)	(0.13)	(0.09)	(0.13)	(0.10)	(0.15)
Price of Cows	-0.43	-0.07	0.05	-0.29**	0.20	-0.08
	(0.39)	(0.07)	(0.21)	(0.14)	(0.16)	(0.12)
millsp1	78.23**	-20.61	26.18	-2.18	57.22***	-23.13*
	(37.86)	(13.62)	(18.68)	(12.58)	(16.17)	(12.27)
millsp2	-127.06**	58.78***	-1.14	-20.55	-57.66**	40.26*
	(57.97)	(20.85)	(40.03)	(26.96)	(27.91)	(21.18)
Constant	247.23	87.59	214.43	-159.44	-22.99	75.01
	(276.60)	(99.49)	(168.58)	(113.56)	(144.97)	(109.99)
R2	0.71	0.44	0.44	0.21	0.83	0.29
Observations	75		124		161	
Elasticities (selected)						
Overall Farm Size	0.02	0.00	0.01	0.00	0.01	0.01
Cattle stock	0.08	0.01	0.08	0.00	0.08	0.01
Price of Steers	0.31	0.00	0.07	0.01	0.02	0.01

Notes: Standard errors in parentheses. * Significant at 10%, ** significant at 5%, *** significant at 1%.

[1] Note that the local bank LAFISE-Bancentro is co-owner of the large-scale processor "MACESA".

[2] In the first stage, because we collected the data in a two stage procedure (first purposive, second stage random) using an endogenous stratification approach we estimate the multinomial logit model using the Weighted Estimation Sampling Maximum Likelihood (WESML), developed by Manski & Lerman (1977).

[3] To estimate our model we use a two stage Heckman procedure approach, where in the first stage we estimate the market channel participation using multinomial logit model and in the second stage we estimate cattle supplies by using a seemingly unrelated regression (SUR) system controlling for selection bias of unobservable characteristics in the first stage (producers skills, risk) and conditional probability of being in a market channel.

[4] We calculate from the first stage multinomial model the Inverse Mills Ratios (IMR) to correct for selection bias as suggested by following the standard procedures such as in Dubin and McFadden (1984) and Bourguignon et al. (2004) in order to estimate in the second stage the unbiased marketing supply equations using the Zellner's seemingly unrelated regression (SURE).