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ESSAYS ON PRODUCER'S PARTICIPATION, ACCESS AND RESPONSE TO THE CHANGING NATURE OF DYNAMIC DOMESTIC MARKETS IN NICARAGUA AND COSTA RICA

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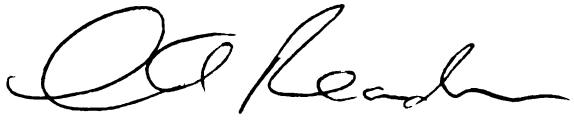

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ESSAYS ON PRODUCERS' PARTICIPATION IN, ACCESS TO, AND RESPONSE TO THE CHANGING NATURE OF DYNAMIC DOMESTIC MARKETS IN NICARAGUA AND COSTA RICA

By

Fernando Balsevich

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ABSTRACT

ESSAYS ON PRODUCERS' PARTICIPATION IN, ACCESS TO, AND RESPONSE TO THE CHANGING NATURE OF DYNAMIC DOMESTIC MARKETS IN NICARAGUA AND COSTA RICA

By

Fernando Balsevich

This dissertation analyses the relations among tomato and cattle producers and their market channels in Nicaragua and Costa Rica. The first essay analyses the relations among 145 tomato producers and three market channels in Nicaragua. It analyzes the recent development of supermarket chains, their changes in procurement systems and the implications for producers. Then it explores market channel impact on producers' profitability and technology. Results indicate that producers selling to the supermarket chains generate higher profits than producers selling to traditional markets because they are more productive. Producers selling to supermarket chains intensify the use of inputs. However, producers selling to the leading and second-tier supermarket chains use a labor-biased and capital-biased technology, respectively, as compared to the traditional channel.

The second essay 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.

This work is dedicated to Fernando Enrique, my family and friends.

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CHAPTER 1: INTRODUCTION

There have been a number of contributions in understanding the complexities of the factors of moving producers from a subsistence orientation to commercial production. Although no ambiguity seems to exist for rural developers in the importance of understanding the markets for rural products, Pingali & Rosegrant (1995) have pointed out the challenges faced in smoothing the transition from subsistence to commercial production systems.

Two sets of research studies seem to contribute to understanding the rural markets. One set relates to producer's market participation studies such as Goetz (1992), Key et al. (2000), Bellemare and Barrett (2004), and Holloway et al. (2004). Another set of studies focuses on multi-market factors as market channel determinants. Examples of the latter are Hobbs (1997) which compares the determinants of auction versus processor market channels; Ruben (2003) compares the determinants of local versus wholesale market channels.

Whether the research focus is to explore market participation determinants or multi-market determinants, the objective is to understand the factors that affect producer's access to the market or their access to a market channel. Better understanding the determinants can contribute to the actions and efforts of those actors that aim to implement market-led development strategies. It can be that the final outcome is to generate employment, increase income, reduce poverty reduction, and/or increase supplies for healthier consumer nutrition.

Rural markets are always changing and the research focus ought to keep pace in order to find better and more tailored ways to implement reasoned development interventions. An example of changes in the market that this dissertation aims to explore is the supermarket's increasing role in marketing rural products.

Note that as supermarkets in Latin America and the Caribbean(LA) moved from 10-20% participation in the urban food retail sector in 1990 to 50-60% in 2000 (Reardon and Berdegué, 2002), changes are occurring much faster than in the US and Europe (Berdegué et. al, 2005). A number of studies in LAC have been done that provide country-specific evidence of the rise of supermarkets such as Ghezan et al. (2002) and Gutman (2002) in Argentina; Farina (2002) in Brazil; Faiguenbaum et al. (2002) in Chile; Alvarado and Charmel (2002) in Costa Rica; and Schwentesius and Gomez (2002) in Mexico.

Broadly, new buyers are synonymous with new market channels for rural products. A key issue is that the literature points out that the supermarkets have stricter product and transaction requirements as compared to traditional retailers. What does this mean for rural products market access, for those aiming at increasing market access to reduce poverty levels? How will these new actors in the market impact the rural producer's markets? The research gap is twofold:

(1) Lack of inclusion of supermarket channels in studies of the determinants and effects of producers' market access; (2) Lack of empirical evidence in supermarket studies regarding impacts on producers.

The main objective of this dissertation is to contribute to cover the twofold gap mentioned in the last paragraph. Despite the increasing importance of supermarkets in

Latin American countries, however, there has been little empirical research on three issues which form the focus of this dissertation: (1) how do cattle and horticultural supply chains differ over market channels (supermarket chains, auction markets, processors and traditional markets) and what implications do these differences have for the marketing environment facing producers? (2) what are the determinants of channel (supply chain) choices of farmers; (3) what are the correlates of market channel choices and producer's technologies and net incomes?

The dissertation is composed of two essays. In the first essay, three market channels (with different stage of development) of tomatoes in Nicaragua were mapped backwards to their suppliers. Several in-depth interviews were conducted in order to understand the recent development of supermarket chains, and their changes in procurement systems. Statistical and econometric data analysis from a sample of 145 producers selling to those market channels is presented in order to draw conclusions and implications for producers.

In the second essay, six market channels of cattle producers (three in Nicaragua and three in Costa Rica) are analyzed. In-depth interviews were conducted in order to understand the recent development of supermarket chains, industry changes and in the case of Costa Rica, development of auction markets. Statistical and econometric data analysis from a sample of 300 producers is presented. The analysis focuses on the determinants and effects of the participation of cattle producers in the supermarket channel, export processor channel, and traditional auction channel.

CHAPTER 2: SUPERMARKETS, NEW-GENERATION WHOLESALERS, TOMATO FARMERS, AND NGO'S IN NICARAGUA

Abstract

Based on a survey of 145 tomato farmers, and interviews with supermarket chains, NGOs, wholesalers, and farmer organizations in 2004, this paper examines the determinants and effects of farmers' participation in supermarket channels, with and without assistance from NGOs in "business linkage" programs. It finds that absent that assistance, the farmers that work with supermarket chains tend to be the "upper tier" of small farmers, better capitalized with various assets. The smaller and less-capitalized farmers that work with supermarkets tend to do so in association with NGO assistance. Despite higher input expenditures and entry requirements, farmers in the supermarket chain earn more per hectare. The paper ends by raising the issue of whether this development program approach can be scaled up, and wrestles with the tradeoff of helping poor farmers gain access to dynamic markets, of making it affordable at a larger scale by national governments with tight budgets, and of undertaking field programs that are market-sustainable and market-responsive.

Supermarkets, New-Generation Wholesalers, Tomato Farmers, and NGOs in Nicaragua

1. INTRODUCTION

Driven by rising incomes and urbanization, as well as foreign investment and procurement technology changes, the share of supermarkets in food retail in Latin America rose from a mere 10-20% in 1990 to 50-60% by the early 2000s, displacing small shops and open-air markets (Reardon and Berdegué, 2002). That trend started somewhat later in Central America and has gone less far, reaching 20-40% (depending on the country) of food retail by the early 2000s, and still rising. One of the poorest countries in the region (circa 400 dollars per person GDP/capita) and a small country (four million), Nicaragua, has shared that trend, with the share reaching 15-20% today, and rising (Berdegué et al., 2005).

Food retailing in general, and tomato retailing in particular, have, until very recently, been undertaken exclusively in the "traditional retail sector" in Nicaragua. That sector is composed of many small grocery stores, local wet-markets, street vendors and retail sections of large central markets. These traditional retailers procure their produce directly from farms (when the retailers are in small towns and villages) and from the traditional wholesale markets in the main and secondary cities (Leiva, 2004).

A new set of actors in food retail in Nicaragua is at an early stage of emergence – supermarkets. In the early 1990s, supermarkets had the tiniest of niches, with only 5% of food retail; that has increased to 15 to 20% in 2003, still an early stage but the

beginning of a factor affecting food markets (Berdegué et al. 2005). The supermarket sector "took off" after the end of the revolutionary period and the liberalization of foreign direct investment (FDI). As is typical for supermarkets, their penetration of the overall food market exceeds that of their share in fresh produce retail, where they now have only about a 10% share. It is thus particularly interesting to understand the effect of the new retail channels on food markets and farmers at this early stage, for its own sake, and to form a base for observation as it grows over time.

Today the Nicaraguan supermarket sector is made up of two supermarket chains (the leader, CSU, and the second-tier chain, La Colonia) (with 37 stores) with about two-thirds of the market, and 23 independent supermarkets. The two chains are as follows. (1) CSU is *Corporación de Supermercados Unidos,* financed with Costa Rican capital, which entered Nicaragua in 1994 with 3 stores. By 2005 CSU had 30 stores targeting higher-income consumers under the label "La Union" and lower-income consumers under the label "Pali." Pali stores are 80% of the chain, and the fastest growing segment as CSU expands into lower-middle and working poor consumer markets and into secondary and tertiary cities in the provinces. CSU is part of the Central American Retail Holding Company (CARHCO), which through August 2005 (hence during our study period) was a joint venture among CSU, La Fragua (the leading chain in Guatemala) and Ahold (the third largest food retail chain in the world, based in the Netherlands), with 1.5 billion US dollars in sales and 363 stores in Guatemala, El Salvador, Honduras, Costa Rica, and Nicaragua.[1] (2) "*La Colonia*" is the largest locally owned chain. This chain grew much more slowly than CSU (the difference between a large chain in an established market vigorously investing, versus a local chain growing from the local base). It started

about the same time as CSU, went from three stores in 1990 to seven stores in 2004, and has focused only on Managua, the capital city.

The rapid rise of supermarkets, and hence changes downstream in the agrifood system, can be hypothesized to be changing market conditions facing farmers. Compared to traditional retailers, supermarkets generally have different and more demanding product and transaction requirements. Despite the increasing importance of supermarkets in Latin American countries, however, there has been little empirical research on three issues which form the focus of this paper: (1) how do horticultural supply chains differ over types of supermarket chains (leading versus second-tier) and between supermarkets and traditional markets, and what implications do these differences have for the marketing environment facing producers? (2) what are the determinants of channel (supply chain) choices of farmers (between supermarket and traditional market channels); (3) what are the correlates of market channel choices and producers' technologies and net incomes? This paper focuses on these issues, within the context of tomato growers and supermarkets in Nicaragua. The analysis is based on field interviews with supermarkets, wholesalers, and NGOs, and a representative survey of farmers.

The paper's structure follows the structure of the research questions and proceeds as follows. Section 2 focuses on the tomato supply chains in different market channels: the two supply chains to supermarkets (the leading supermarket chain, CSU, and that the second supermarket chain, La Colonia) and to the traditional market (the main public wholesale market). The section starts with a conceptual framework used to analyze the supply chains. Definitions of five levels in the vertical coordination continuum are presented - from low to high levels of control. Next we present the

method used to collect our data and describe characteristics of the three tomato supply chains. Section 3 focuses on the growers participating in the different market channels. We start by describing the characteristics (assets, technologies, net incomes) of the growers. We then present results of regressions of the determinants of market channel choice by producers and, with endogenous stratification by channel, the output supply, input demand, and technology choices made by farmers. The last section provides conclusions and discusses implications for policy.

2. THE THREE SUPPLY CHAINS

In this section, we briefly analyze the three supply chains of tomatoes (to the leading supermarket chain, to the second-tier chain, and to the traditional market). Note that we use several terms interchangeably: "procurement systems," "supply chains," and "market channels" – as these represent the same thing viewed from different perspectives – the retailer, the system analyst, and the farmer. We first present a conceptual framework that we use to analyze the nature of each supply chain's coordination mechanisms, of interest in itself and because those mechanisms in turn have an effect on the market channel conditions facing the farmers. Second, we present the three supply chains' structures, themselves outcomes of strategic coordination choices by the retailers and wholesalers, and describe changes over time that have occurred in these mechanisms.

(a) Supply Chain Analysis: The Vertical Coordination Continuum

Our conceptual model is based on the work of Peterson, Wysocki, and Harsh (2001), hereafter the PWH model. 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) make strategic choices from alternatives ranged along a vertical coordination continuum.

Vertical coordination can be defined as the configuration and control of the stages of production and marketing systems – including the specifications asked of the producer (such minimum size and color of the fruit) by which the tomatoes are produced, who is involved (such as whether farmer delivers direct to the supermarket or via an intermediary), and under what marketing conditions (such as payment terms) until the tomatoes reach the final consumer. As there are potentially many stages and agents involved in production and marketing of a product such as tomatoes, there are also many relations under which the transactions take place. Characterizing vertical coordination mechanisms thus also involves identification of the institutional arrangements (what they are, such as whether a spot or contract relation, who defines them, and the incentives put in place to implement them, such as price premia) governing those relations.

The continuum refers to the set of choices that a given agent in a supply chain has to vertically coordinate its procurement system (for example, procuring tomatoes). As there may be many ways to vertically coordinate the procurement of tomatoes, some criteria to categorize the alternatives may be 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 – moving from the least intensity to the greatest intensity of vertical coordination.

As coordination intensity increases, so does the nature of monitoring and control. (1) The least intensive coordination is the spot market, where the coordination mechanism is based mainly on price discovery and the decision of whether to engage in the transaction, and there is no coordination mechanism beyond the transaction. This typifies an auction market. (2) In the specification-contract coordination mechanism, agents agree to a legal contract, the specifications of which set incentives and deliverables, as well as use of third parties to enforce the contract. (3) The relation-based alliance establishes a relation between the agents in which benefits and risk are shared and mutual objectives identified. Parties collaborate in conflict resolution and monitoring. (4) The equity-based alliance involves some financial commitments between the parties (such as equity capital investment in a joint venture), and the formation of a third entity distinct from the parties that has a formal organizational structure. (5) The most intensive coordination is vertical integration, where the two parties become one organization (by a merger or acquisition) which has full control over the transaction, with clear rules and centralized control.

There are several salient determinants of the choice by supply chain actors of the coordination intensity on the above spectrum.

First, agents' coordination choices depend on costs incurred from coordination errors. Agents tend to want more intense vertical coordination the more if coordination errors (for example, quality or volume supplied is inadequate) are costly (for example in foregone sales). Coordination errors can occur because of intentional opportunism of economic actors or unintentionally due to bounded rationality of estimations in production plans (Williamson, 1973).

The cost of coordination errors is a function of two things. (1) "Asset specificity" refers to the extent to which an asset used in the activities of a given actor, is specific to meeting the requirements of the buyer downstream in the chain. If a producer uses packing equipment that is designed for the specifications of a given buyer (say a supermarket chain), and difficult to use to pack for other clients, that asset is specific, and coordination errors harming access to the client means under use or non-use of a costly asset. Or a producer may have to enter a relation with a wholesaler who has a packing plant with the needed equipment to pack for that supermarket chain, and coordination errors between the farmer and the wholesaler then block the farmer from access to the chain. (2) "Complementarity" refers to complementary actions by several actors in the supply chain, which then require coordination for any given action to be profitable. For example, if a supermarket chain starts an "organic vegetables category" in its produce section, it requires investments by farmers in organic practices, and vice versa. Over-capacity in organic production without a downstream agent to sell to the niche market segment who buys organic produce, or over-capacity at the marketing end, both spell coordination errors.

Note that the costliness and likelihood of coordination errors may differ over segments of the supply chain, and thus within a supply chain one may observe different coordination intensities/mechanisms. For example, in a tomato supply chain where there are three agents (supermarket, wholesaler, and producer) and two relations (supermarket-wholesaler and wholesaler-farmer). The supermarket and wholesaler may choose a relation-based alliance, while the wholesaler and farmer might relate in a spot market.

Second, agents' coordination choices depend on the cost of implementing a given coordination strategy. These costs are varied and a function of the product, the market, and the relation; an example is contract monitoring capacity investments (such as in agronomists to check producer practices or an on-site lab to check pesticide residues on fruit received), or skill acquisition to meet production or post-harvest standards.

Finally, the agents weigh the above two sets of costs (costs of coordination errors and costs of strategy implementation), against the returns (and the distribution of returns, hence the risks) of one or another strategy. Unless they have experience with both, or try both simultaneously, they can only estimate the *likelihoods* of such events taking place, given the (always limited) information they have about the other participants and other exogenous factors.

(b) The Three Tomato Supply Chains' Structures

For the analysis of the three tomato supply chains, we undertook a rapid appraisal of the market channels in a field study in July/August 2004. This involved thirty semi-structured interviews with the two supermarket chains, several traditional retailers, wholesalers serving the supermarket chains and several serving only the traditional market, NGOs providing technical and other assistance to growers, and producer groups. Besides dwelling on the basic information concerning transactions (who, what, where, when), the interviews with retailers and wholesalers treated in depth the "how" questions bearing on the coordination mechanism: (1) the use (or not) of contracts, verbal or written, formal or informal? And the history of the coordination mechanisms used; (2) the terms of the contracts, in terms of prices, attributes required (such as quality standards, delivery times and volumes); (3) the

reasons for the agreements, in terms of the kinds of costs and benefits discussed above for alternative coordination mechanisms versus the one chosen; (4) the way the contracts are implemented (who designs, who implements, how products are selected, how prices are negotiated, how delivery and payment take place, and so on); (5) how the agreements are enforced.

Table 1 summarizes the structures of the three supply chains, including for each segment (defined as a transaction, say producer with wholesaler, or wholesaler with retailer) of the three supply chains the coordination mechanism(s). The following discussion follows the structure and points of Table 1.

Leading Supermarket Chain's (CSU) tomato supply chain. CSU sources all its produce from Hortifruti, a specialized, dedicated wholesaler. Hortifruti is also itself a regional multinational operating in the same countries as CSU (Costa Rica, Nicaragua, and Honduras) and is in the same Costa Rican holding company as CSU. Hortifruti is a new-generation wholesaler that started its local Nicaraguan subsidiary operations in the mid 1990s. We call Hortifruti and its ilk "new-generation wholesalers" because of their differences from traditional wholesalers in their contractual or semi-contractual relations with clients, dedication to the supermarket sector (and other modern food industry clients such as fast food chains), and tendency to go beyond mere spot market relations with farmers. The new-generation wholesaler procures, selects and sorts, and packs for the supermarkets, and delivers to the recently started distribution centers of the chain. Often they also stock supermarket shelves as well.

The coordination mechanism used between CSU and Hortifruti corresponds to a hybrid of the "equity-based alliance" and "vertical integration" mechanisms discussed above. Full vertical integration requires centralization of operations between the companies, which is not the case between CSU and Hortifruti. Full equity-based alliance implies a third entity to manage transactions between the companies – again, not the case between CSU and Hortifruti, who deal directly. The relation differs from the other supply chain relations we study mainly because it involves equity linkages between the parties.

Initially, from its entry in Nicaragua in 1994 to the coming of Hortifruti in 1998, CSU sourced directly from traditional wholesalers (in the wholesale market). Moreover, even Hortifruti, once it became the source for CSU's produce, also relied heavily on the wholesale market for several years, before establishing direct relations with producers in the early 2000s. There were thus two consecutive shifts, for common reasons relating to the need to reduce coordination costs: (1) CSU's shift from wholesale market to Hortifruti, and (2) Hortifruti's shift from sourcing from the wholesale market (as a temporary strategy as it set up a sourcing system similar to what it already had in Costa Rica) to sourcing mainly directly from farmers.

What initially drove the choice of CSU (and initially, Hortifruti) to source from the traditional wholesale market? The latter sold and sells large volumes, aggregating from over thousands of tiny farms across Nicaragua, draws from across regions so there was at least a small degree of "season stretching", and sells the gamut of produce grades.

However, the main problem with the traditional wholesale market, leading to the main coordination error, is that there is extremely sharp seasonality of availability of a given product, relative to the constant need of the retailer. This relates to what we can term farmers' and traditional wholesalers' "supply-period asset specificity". Moreover, even when product was available, the quality (commercial grade based on appearance such as size, blemishes, and color) was perceived as highly inconsistent over traders and over time within the market. Working with many small brokers also led the retailer to a perception of what we translate as congestion costs. CSU and then Hortifruti felt that the traditional brokers did not perceive a need or incentive to cooperate in meeting the quality specifications, which requires classification. Hortifruti noted that around 2000, when they shifted toward sourcing from farmers, there were significant gains in cutting out the market middleman in terms of costs.

Around 2000, faced with the limitations of the wholesale market, CSU turned to Hortifruti and Hortifruti initiated new practices and made investments, and turned to direct relations with farmers. The changes made were as follows, implemented progressively over the past several years.

First, CSU and Hortifruti agreed to a set of private quality standards and transaction attributes, specified in writing in manuals that are a de facto contract between them. The standards relate to produce quality (minimum size, form, ripeness, insect and mechanical damage, color, and firmness) and transaction requirements (packing, volumes, and consistency). Those private standards were brought from their Costa Rican headquarters, adapted to the Nicaraguan consumers, and agreed to in writing by the companies. Each company then made investments in asset specificity.

CSU trained its personnel to enforce the standards at each store when Hortifruti delivers the produce and also CSU has personnel at Hortifruti's distribution centers supervising the standards and the orders for each store. Hortifruti has one person at each CSU store ensuring that produce inventory does not run low, providing produce display advice, helps in stocking the shelves and forecasting needs and replenishing orders. That is, Hortifruti acts as a "channel captain" for CSU's produce section. This reduces product and time waste for both companies and improves the quality for the consumer, thus expanding the market.

Second, Hortifruti made substantial investments to centralize product reception. It built two distribution centers (DCs), one in Managua (the first production zone and area of most stores) and one in the northern city of Sebaco (the other main production zone). Hortifruti then delivers produce from the DCs to the stores.

Third, for various products, Hortifruti gradually developed since 2000 a preferred supplier system similar to its Costa Rican operation. In the case of tomatoes, it "listed" 43 suppliers who supply all of their tomatoes. This is a small group, but supermarket produce retailing is just starting in Nicaragua. They still go to the wholesale market and import from Costa Rica and Guatemala to fill any shortfalls.

There are several reasons they moved to the system of buying directly from preferred suppliers locally. (1) It saves transport costs that had been incurred in their importing from their preferred suppliers in Costa Rica. (2) They can work out production calendars with the suppliers to get more even seasonal flows of product, solving the dearth/glut cycle they faced in the wholesale market. (3) They can provide price incentives and technical assistance as a "private good" the investment in which is

repaid by having contractually captive suppliers. That also then repays asset specificity on each side. (4) It cuts out wholesaler margins thus saving costs, hence Hortifruti itself becomes the only wholesale link and captures the profit from that.

The relation between Hortifruti and the preferred suppliers is an informal contract (a verbal agreement and a list maintained over time); it is a contract in the sense of Hueth et al. (1999), where a contract is defined broadly as an agreement where there are costs (reputation, coordination, and other) incurred should one or the other party break off transactional relations. In Table 1, this is indicated as a Specifications Contract strategy.

The contract includes standards for product quality, and specification of transaction attributes (such as timing and volumes of deliveries). Hortifruti only accepts tomatoes that meet CSU's standards; farmers have to grade their tomatoes, and deliver the top (commercial) grade to Hortifruti and (himself/herself) sell the "seconds" to the wholesale market or alternative markets. Hortifruti pays a price some 10% above the wholesale market price (controlling for quality), essentially as a reward for the grading labor done by the farmer. Note that on the one hand Hortiftuti watches the public wholesale market prices and pays a premium to avoid that its producer sell the tomatoes to brokers or other buyers because of temporary high prices (moral hazard), but on the other hand, Hortifruti secures a minimal price that would help a farmer stay in business when prices at the wholesale market are low.

To support the farmers' capacity to meet the above contract requirements, Hortifruti does several things. (1) Hortifruti provides some technical assistance to its farmers - through its agronomists who visit the farmers to recommend tomato varieties

(for shelf-life), irrigation systems and water sources, and crop calendar planning (for quality and consistency and multicropping to facilitate availability throughout the year and avoid the glut/dearth cycle of the traditional market and farmer), use of stakes and strings (for color) chemical doses and types and other practices to meet their quality standards.). (2) Hortifruti also provides some selected credit (for new entrants), and transport of the crop (although it provides price incentives for farmers to use their own transport).Taken together, the technical assistance, credit, and transport "grants" form an interesting example of "tied" credit based on delivering output to Hortifruti, and is thus an inter-linkage of technical assistance and credit markets, the output market, and the wholesale sector, addressing idiosyncratic market constraints facing the farmers[2]. However, the method of addressing market failures (for example, lack of credit and technical assistance) for this specific group of farmers is based essentially on donor funding, external to the resources of the firms and farms involved. In other situations where this occurs (outside projects) it is often the client firm with "deep pockets" that finances the same sort of actions.[3] This latter case in fact forms part of the situation in the relation between farmers and Hortifruti, this time mediated and facilitated by NGOs, as follows.

While Hortifruti provides the (limited) above assistance, in reality the great majority of the assistance facilitated/arranged by Hortifruti for its preferred suppliers is actually delivered by yet another set of actors, the non-governmental organizations (NGOs). The NGOs provide services of extension (technical assistance) and financial services (grants for equipment and loans) to many of the farmers (the smaller farmers, as shown in the next section) on Hortifruti's supplier list. Hortifruti "pays"(in kind, not

in cash) the NGOs by providing information on market requirements and needs, planning together to reduce coordination failure risk, and agreeing to buy product from these farmers, which in turn increases the probability of the NGO's program success, defined as successfully implementing their "farmer to market linkage" programs.

In sum, in the upstream link, wholesaler-farmer, for the leading retailer's supply chain, Hortifruti has shifted from sourcing from the spot market to use of a preferred supplier relation, to better coordinate the timing and quality of supplies from the farms in order to reduce coordination errors related to supply shortfalls and waste from poor quality, and to avoid the transaction costs of re-selecting (often necessary after buying from the wholesale market) or selecting from mixed grade purchases from the farm (as they buy only the high grade and the farmers have to do the selection labor themselves).

Second-Tier Supermarket Chain (La Colonia) tomato supply chain.

Although La Colonia has fewer stores than CSU, La Colonia's stores tend to be bigger and target higher-end consumers, and at the moment of our study both chains sourced a similar total volume of tomatoes – but La Colonia used a different procurement system.

First, La Colonia uses a mixed system of produce procurement, partly centralized (using their headquarters in the main store as the distribution center), and partly decentralized (each store sourcing separately). The chain was considering an investment in (but at the time of our study did not yet have) a distribution center, a costly investment. (We gathered that the chain considered there to be competitive pressure to adopt distribution technologies of the leading chain.) The centralized system is used for products of higher value (where quality monitoring is important) and of

large volumes (such as tomato) where centralized reception allows for economies of scale in handling and distribution.

Second, La Colonia uses several wholesalers per main product, with some wholesalers purveying several products. Table 1 shows that the chain works with two preferred-supplier wholesalers for tomatoes; they fit our definition of new-generation wholesalers. The coordination mechanism between La Colonia and the two wholesalers can be characterized as a "relation – based alliance vertical coordination strategy," with no equity exchange involved. La Colonia set the standards and quantities to be supplied by each wholesaler and the amount received from each wholesaler depends on the volume they can supply at the standard required. The two wholesalers have long (7 and 13 years) worked with La Colonia, but the relation changed markedly around 2000. The main shift was from relatively loose application of standards (using the wholesalers more nearly as just selected traditional wholesalers) to more strict standards (emulating those of CSU/Hortifruti) and stricter enforcement including discounts for low quality and temporary reduction of quotas as castigation.

Third, La Colonia's two tomato wholesalers traditionally just bought from other wholesalers in the wholesale market in Managua and sorted for different clients. But since around 2000 they have developed a preferred-supplier system with 26 farmers from which they get the great majority of their product (filling in shortfalls from wholesale market). The wholesalers select the best grade tomatoes from these farmers and then sell the seconds (at a price 20-30% lower than the firsts) to the wholesale market. We characterize this coordination strategy as a hybrid between a specifications contract and a relation-based alliance, in transition toward the latter.

Why did the wholesalers move to this new coordination arrangement? The wholesalers explained to us that the transaction costs are smaller buying directly from farmers and then sorting, than buying from brokers in the wholesale market and then sorting. Importantly, in order to reduce as much as possible the transaction costs, the wholesalers have an incentive (and we show in the data analysis that indeed they do) to work with farmers that are somewhat larger and more capitalized than the traditional farmers, in order to have a greater probability of getting lots of top grade fruit from any given farmer. (They do not have NGOs working with them to help smaller farmers to fit that profile.) Also, they note that the new arrangement reduces risk: price fluctuates a lot in the wholesale market, leading to sudden losses, while they can have a more stable price agreed with the farmer.

Why did the farmers accept this new coordination arrangement? The farmers working in this system can get a good price and reduce transaction costs and risk working with traditional brokers. This system is less demanding of the farmers because the wholesalers buy the gamut of grades and sort, while in the Hortifruti system the farmers themselves have to find brokers to buy their seconds.[4] Moreover, the two wholesalers help the farmers by facilitating (as a third party) the provision of input credit to the farmers via market-based deals with the input suppliers. The wholesalers have alliances with input firms; they have a credit line with the firms who in turn provide inputs to the farmers; the wholesalers guarantee payment (hence the wholesale contract is the "collateral substitute" for the input credit of the input firm to the farmer). The arrangement is that of "tied credit" in that the farmers have then to deliver their tomatoes only to the wholesalers. This is an interesting example of inter-linked credit-

input-wholesale markets to overcome idiosyncratic market constraints for the farmers (who lack collateral to get the inputs) such as credit and technical assistance.

Given that La Colonia's and CSU-Hortifruti's systems share some similarities, why doesn't La Colonia use Hortifruti, or CSU use La Colonia's two wholesalers? La Colonia likely needs to be differentiated from CSU, and Hortifruti is connected to CSU in the holding company and in other countries. Note in sum both chains use of preferred supplier lists (long term relations), as well as linking the output and credit market (in various ways, direct and indirect) and facilitating farmers with some credit and technical support. The main differences are that farmers have to sort for Hortifruti, and get NGO technical assistance in the Hortifruti chain, and get credit from private sources with the La Colonia system, and from NGO sources as well as from the wholesaler in the Hortifruti system.

The Traditional Retailers' Tomato Supply Chain. We take the supply chain to the main public wholesale market in Managua as typical and also by far the point of greatest traded volume of tomatoes in the country.[5] There are 10 tomato wholesalers operating in this market.

The traditional wholesalers by definition sell only to traditional retailers. Between traditional retailers and the wholesalers, the relations are a typical spot market - price discovery, then decide whether to make transaction. We asked the wholesalers why they do not sell to the supermarket chains. Several answers were common. (1) They do not want to spend the time sorting tomatoes or monitoring farmers who would sort the tomatoes. (2) They do not want product rejections (discounts) from the chains and the

transaction costs these imply. (3) They also do not want to experience the delay in payment (receiving the product and then paying the supplier say in several weeks) which is the typical practice of supermarket chains. (4) Many felt the supermarket chains are still too small and buy relatively small volumes – thus implying high average fixed costs dealing with them.

Wholesalers buy either from rural brokers (who source from farmers in rural areas) or farmers who come to the market, again only under spot relations. Whether directly to wholesalers or to a rural broker, farmers in the traditional channel merely sell ungraded (and with no standards imposed) their tomatoes, for an average price (the same traditional system as one sees in many developing countries). The wholesalers sell the tomatoes to retailers either ungraded or in some cases graded by quality (size and degree of damage).

Finally, in the traditional retailer supply chain analysis note that traditional wholesalers and retailers appear not to face costly coordination errors from spot market relationships given that their customers probably care more about price than quality in the purchasing decision, and both CSU and La Colonia supermarket chains are strategically committed to differentiating themselves in the market place thus increasing complementarity and asset specificity in their respective supply chains.

3. PRODUCERS IN THE THREE MARKET CHANNELS

The above section showed that the interface between the buyer (the retailer/wholesaler combination) and the farmer is different in each of the three supply chains, and thus the three market channels facing the farmer. The grades and standards,

as well as the transaction attribute requirements (communicated through and enforced by coordination mechanisms) of the two supermarket chains taken together (although the two chains have substantially different market channels leading to them) are more demanding than the traditional channel, and all else equal, one would expect farmers with greater capacity selling to them (size and/or the various forms of capital such as human, financial, physical, and organizational). That hypothesis is of course balanced against the point made above that the supermarket channels also provide various forms of assistance and support that taken together are more than can normally be accessed by traditional farmers. The hypothesized effects of the vector of capacity variables are ambiguous in that larger/more-capitalized farmers might be drawn to the supermarket channel (and welcomed to it) for its greater rewards coupled with greater demands, but the smaller farmers might also be drawn because of the channel's greater provision of support such as technical assistance and credit. Such ambiguity suggests the need for empirical work to test the hypothesis that greater farmer capacity (land or capital or both) determines access, and once the channel is accessed, technological behavior. The answer to this issue is crucial for development debates in the region, as policymakers want to know whether the emerging supermarket channels are inclusive of small and poor farmers, or sidestep them, and if necessary what type of upgrading efforts may be needed to help small producers' access supermarket channels.

In turn, one would expect that the technology, output supply, and input demand choices of farmers will differ over channels. A hypothesis is that in general the modern channel farmers will be more capital-using in order to meet quality and consistency requirements, based on a similar hypothesis presented by Key and Runsten (1999) for the

processing sector in Latin America. It is of course possible that smaller farmers can substitute "sweat equity" (labor) for capital and thus participate in the modern channel, for example picking weeds instead of using herbicides, watering by hand instead of using irrigation, and so on. The possibility of substitutability in factors (labor by capital) is central to the policy debate because if the smaller farmers can participate in modern channels, even with low capital but strong arms, the effects of the transformation of food markets may yet be inclusive rather than exclusive.

This section tests the above hypotheses, essentially asking how, among the channels, the participating farmers differ – in the farm characteristics reflecting mainly capacity variables that determine their channel choice, in the technology and input demand and output supply choices given their channel choice, and the net returns to their choices.

The section proceeds as follows. First we discuss the data, survey, and sample. Second, we descriptively lay out findings concerning producer characteristics in the various channels, and the net payoffs to their choices. Third, we use the endogenously stratified sample to test for differences, in turn, in technology and in output supply/input demand behavior.

(a) Data and sample

From our qualitative interviews we learned that the supplier lists of the supermarket chains contained few farmers compared to the many traditional channel farmers. We thus did a reasoned sample based on the supermarket suppliers' population and the traditional channel population. We obtained the lists of farmers selling to the wholesalers of the two supermarket chains, and selected that whole universe; this

included all 43 producers selling tomatoes to the CSU channel, and all 26 growers selling to the La Colonia channel, for a total of 69 "supermarket channel farmers." Further, we sampled at random 76 growers chosen from a list of 300 producers supplied by a random sample of two of the 10 wholesalers in the Managua wholesale market. We limited the traditional-channel population to 300 so we could have a sampling error of 10% with a probability of 90%.

The data are from a farm survey conducted June-July 2004. Each interview lasted about one-two hours and posed quantitative and categorical questions concerning household and farm characteristics and production, organizational, and transactions behavior, as well as qualitative questions concerning their perceptions of the alternative market channels.

(b) Farm Characteristics, Technology Use and Profits

In this section, we first present salient characteristics of the producers selling to the three supply chains (recall that we use that term now interchangeably with market channels as the latter is the supply chain viewed from the farmer perspective). Besides stratifying the sample by market channel, we also divide it into farmers working with NGOs and those not. This further stratification, rarely seen in the literature, allows us to see what sorts of farmers, in each channel, participate in the market free of donor-supplied assistance. That is a crucial issue in the policy debate because the debate will take different directions over the next few years whether one finds that the smallest farmers can participate in the modern channels only if (heavily) assisted.

The subsection draws on three tables: Table 2 shows the characteristics of the farms; Table 3 shows breakdowns of production costs; Table 4 summarizes technology and profit indicators. Several salient points emerge.

First, the great majority of growers for CSU-Hortifruti are assisted by NGOs - although half of the tomato volume bought by Hortifruti is from non-NGO-assisted growers. This shows a key point: in an "unassisted externally" situation, the leading supermarket chain relies on farmers who can sell a larger volume each of tomatoes, and works with smaller growers with NGO support. We noted in section 2 that the NGOs act as a technical assistance arm for the leading chain – but not just any "generic" technical assistance (as might be got, if it is even available, from extension), but technical assistance geared to helping the smaller farmers meet the specific norms of Hortifruti. The NGOs helped growers to form cooperatives (or assisted in improving organization for those already in groups), seen in the high degree of association participation of the assisted-growers as compared to the others. This was necessary given a fact that leaps out from Table 2: the average tomato area of the assisted is four times smaller (and produces 13 times less volume of tomato) than the average non-assisted grower. The NGOs thus work with producers that are somewhat poorer with smaller outputs, via assisting their coops with substantial credit and technical assistance, to raise incomes and help them diversify away from basic grains.

By contrast, very few growers for La Colonia are assisted by NGOs, and where they are, the assistance targets production activities and is not delivered in an "alliance relationship" (which is the term for the NGO relationship with the coops assisting Hortifruti) to help farmers enter the supermarket-market *per se*. Yet the tomato area of

the average farmer among the few La Colonia NGO-assisted farmers is four times that of the assisted farmers selling to CSU. That is, the assisted and unassisted farmers selling to La Colonia are already large enough (in tomato production) to qualify for the preferred supplier lists of the wholesalers for La Colonia. Recall from Section 2 that the wholesalers for La Colonia arrange credit from private input suppliers (who also give technical assistance at least for their chemicals) to the farmers.

Second, the overall farm size of producers selling to both supermarket chains is not statistically significantly different from those selling to the traditional market. Indirectly this suggests that farm size is not an entry requirement. In any case, farmers in Nicaragua selling vegetables, including tomatoes, to the local market, whether modern or traditional, tend to be small, so supermarket chains and wholesalers are basically limited to working with the spectrum of what can loosely be classed as small farmers, who in fact vary sharply in terms of capital, crop composition (hence tomato area), and even farm size substrata within the small farm base. This kind of differentiation over small farmers has for several decades been noted in the Latin American literature (see Schejtman 1996).

However, the tomato production scale (tomato area) of producers selling to La Colonia is much bigger than farmers in the traditional market; by contrast, the farmers in the Hortifruti/CSU channel, in particular the small, assisted growers, have much smaller volume per farm, compared with the traditional channel farmers. At first glance, this difference in implied-required-scale of farmers between the two supermarket chains is striking. But a second look removes the surprise: the assisted growers are grouped (with NGO help and guidance) into three cooperatives each of which acts as a medium supplier; the NGOs even work with the coops and Hortifruti on planning of output (cropping

calendar). The picture that emerges is then that each of the supermarket chains ends up sourcing from the larger-stratum of small farmers or coops delivering a volume as large as a medium farmer would deliver. Seen that way, the striking point is rather that the supermarket chains rely on suppliers (individually or collectively) who sell them substantially larger volumes per supplier than could be got from the traditional farmers.

Third, a crucial point is that the non-assisted growers for La Colonia are in many ways similar to the non-assisted growers for CSU as compared to NGO-assisted growers selling to both chains. The non-assisted growers of both chains also tend to be more specialized, as they produce much higher volumes on a much higher share of an average farm, compared to the NGO-assisted growers. Interestingly, the Non-NGO assisted growers also tend to be less experienced in tomatoes but more educated as compared to the NGO-assisted growers. They tend to have tractors and vehicles and other indices of capitalization, relative to the NGO-assisted growers. This is a key result as it indirectly provides the scenario of what types of producers are able to sell to the supermarket chains with and without NGO assistance. It reflects that without the support/subsidy provided by the NGOs, supermarkets tend to source from growers who have more capital, are less experienced but more educated, and are more specialized in commercial horticulture.

Fourth, as shown in Table 3, growers that are in the preferred supplier list of supermarkets have 30% higher production costs than those selling to traditional channels only. After breaking down the cost expenditures of non-labor variable inputs into prices and quantities, we see that the CSU channel growers have higher fertilizer use (quantities) but lower use (from 1/3 to 2/3 less) of quantities of other toxic chemicals (insecticides, fungicides, herbicides) than the other supermarket channel - but both chains' growers

have higher than the traditional channel, thus confirming Thrupp et al. (1995) argument about modern retail (in her work it is developed country retailers importing fruit from Central America) driving higher pesticide use in countries with a limited regulatory and almost non-existent enforcement capacity, such as Nicaragua. The fact that the cash outlays are higher is explained by Hortifruti's requiring the farmers to use certain kinds of chemicals, and those kinds have higher prices, reflected in the higher outlay than the other channels. Note that producers selling to Hortifruti, both assisted and non-assisted producers, received technical assistance concerning chemical use to meet CSU's quality standards – and both groups tend to use similar quantities of chemicals per hectare, except for fertilizers and insecticides - but that their use is substantially different from the quantities used by the producers selling to La Colonia and traditional market channels.

Fifth, however, Table 4 shows that within the CSU/Hortifruti channel, the unassisted farmers have 30% lower production costs than the NGO-assisted producers, who have the highest fertilizer, seed, irrigation energy, and labor costs of any producer group. Given that we control for channel in making this comparison, it appears due to the NGOs' technological package recommendations, geared to minimizing risk of not meeting standards.

Sixth, producers selling to CSU use substantially more labor days per hectare because of the additional requirements as compared to producers selling to La Colonia and to the traditional markets. This was expected and can be safely attributed to Hortifruti's agronomists recommendations to improve product quality such as more intense pest control techniques (reduce insect damage) and labor allocated to use stakes

and strings (important for color), labor requirements of timely harvest techniques (when tomatoes meet the standards) and labor used in grading the tomatoes.

Note that producers selling to CSU use a more labor-intensive technology as compared to producers selling to La Colonia and to traditional markets. By contrast, producers selling to La Colonia use a capital-intensive technology, relative to those selling to CSU and to traditional markets. This is in part because of the additional labor tasks requested by the buyer as noted above, and because producers selling to CSU-Hortifruti face cheaper labor as shown in Table 3. This may be due to CSU producers' closer location to urban centers where population densities are higher and labor may be more available, compared to producers selling to La Colonia and traditional markets. Also, La Colonia producers have more members of the household with off-farm jobs which may compete for labor time and at the same time provide own-liquidity for capital investments on farm.

Seventh, as shown in Table 4, profit per hectare is substantially higher for both supermarket channels compared to the traditional channel; for the sample-weighted average, supermarket-channel farmers earn 65% more profit per hectare. A small advantage in prices paid by supermarkets, and a large advantage in average yields, compensates for the higher outlays for inputs. Note that La Colonia suppliers earn 56% more profit per ha than those supplying CSU. However, comparing non-NGO-assisted growers in each, one finds only a 12% difference. What drives the difference between these results? On the one side, experience seems to play an important role in explaining the difference between the two chains Non-NGO-assisted growers as La Colonia producers have on average 13 years of experience while the CSU have only slightly

above two years. Non-NGO-assisted farmers, desired by the chains for their prowess and capital, have much higher yields than the NGO-assisted farmers. However, even the NGO-assisted farmers earn 14% higher profits than the traditional growers, but doing so depends on the general assistance and credit they receive from NGOs plus their ability to pay 36% higher input costs up front, a significant capital entry barrier.

(c) The Determinants of Producer Channel Choice

This subsection and the next treat the determinants of grower market-channel choice, and the correlates of those choices (technology, and output supply and input demand). We use a two-stage approach with channel choice first (in this subsection), and then (in the next subsection) model the correlate behaviors with endogenous stratification of the sample into the channel strata, controlling for the conditional probability of inclusion in a given channel.

The producer's market channel choice can be conceptualized using a random utility model (RUM). The RUM is particularly appropriate for modeling discrete choice decisions such as between market channels. It is essentially an indirect utility function where an individual (with specific characteristics) associates an average utility level with each alternative (such as a market channel) in a choice set.

In our context, a producer for the traditional channel does not sell to the supermarket channels; a producer for one supermarket chain does not (in practice) sell to the other but does generally sell his/her seconds to the traditional channel as well, and here is categorized as a grower selling in one of the supermarket channels. Hence there

are three mutually exclusive channels into which producers are mapped, the CSU/Hortifruti channel, the La Colonia channel, and the traditional market channel.

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 utility achieved by selling to a market channel or to another.

$$(1) \quad U_{ij} = \beta_j X_{ij} + \varepsilon_{ij} \qquad \forall j \in N$$

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

$$(2) \quad U_{ik} > U_{ij} \forall j \neq k$$

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

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

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

Where in the first equation $Y_{i1}=1$ if producer chooses the CSU-Hortifruti market channel (Leading supermarket chain), 0 otherwise (which is equivalent to $Y_{i1} = 1$ if $U_{i1} > U_{ij} \forall j \neq 1$). In the second equation, $Y_{i2}=1$ if the producer chooses the La Colonia market channel, 0 otherwise. The Managua public wholesale market channel is the base category for both equations. β_j is a vector of channel-specific parameters. ε_{ij} is the error term assumed to have a logistic distribution with mean 0 and variance 1.

X_{ij} is a vector of producer characteristics that together reflect the incentive and capacity variables influencing the producer's indirect utility, hence his/her market channel decision, and includes the following variables:

(a) FARMSIZE: the overall farm size in hectares; this is measured as the sum of land owned plus usufruct, rented-in, and sharecropped-in land, minus the sum of rented-out and sharecropped-out land in the cropping season of 2004. We expect a positive effect of this variable, as it is linked to marketable volume considered desirable (by the buyer) as it reduces transaction costs.

(b) LIVESTOCK is the quantity of livestock owned by the producer and is used as a proxy for household non-land wealth, and hypothesized to positively affect choice of the supermarket channel.

(c) TRUCK is a dummy variable equal to one if the producer has a truck and 0 otherwise. This variable increases the capacity of the producer to deliver

tomatoes to the supermarket distribution centers according to a specific delivery schedule and possibly from distant regions.

(d) ROAD is the distance to a paved road measured in kilometers, expected (as a measure of transaction costs facing the producer) to negatively affect choice of the supermarket channel.

(e) ELECTRICITY is a dummy variable equal to one if the producer has access to electricity, 0 otherwise.

(f) HOUSEHOLDSIZE is the number of members in the household during the last six months. DEPENDENCYRATIO is the dependency ratio is the number of members in the household with less than 15 years or older than 65 years over total household size. FEMALE is equal to one if the producer is a female, 0 otherwise. AGE is the number of years of the producer. These variables reflect characteristics and the availability of the labor in the household. All else equal, we expect more adult labor to favor selection of the supermarket channel as the various extra steps (relative to the traditional channel) in production and post-harvest require more labor. Gender and age are included as proxies of the producer's indirect utility preferences.

(g) EDUCATION and EXPERIENCE are the years of schooling and the years in tomato production of the producer. We expect them to favor entry into the supermarket channels, which are more demanding in coordination of field and post-harvest activities and chemical use.

We use a multinomial logit regression to estimate the equations because of its simplicity and because it is a model that fits multiple discrete dependent choice variables. We estimated it using the weights suggested by Manski and Lerman (1977) and Cosslett (1981) to correct for sampling bias.[6]

The market channel participation results are presented in Table 5. Several significant findings emerge.

First, importantly, overall farm size was not a significant determinant of selling to the supermarket chains. This contradicts our expectation that farm size would be a key determinant. But looking back at Table 2, one sees that more than farm size, the degree of specialization in tomatoes is important. This coincides with qualitative discussions with the wholesalers who want farmers committed to tomato farming (and thus also with asset specificity which makes them more committed to the relationship with the buyers...). Moreover, as we noted above, smallness of the farm's output is balanced by the associations among tiny farms.

Second, choosing the CSU/Hortifruti channel is positively correlated with more education and negatively correlated with experience. The education result is obvious, but the experience one may seem odd until one notes that many of the assisted farmers are newly in tomato production, having been helped to switch to tomatoes from less profitable crops. Moreover, older producers (controlling for education and experience) tend to sell to the traditional channel. It is possible that youthful energy and entrepreneurship is needed to brave the step to the modern channels!

Third, interestingly, selling to supermarket channels is positively correlated with distance to an asphalted road, which indicates that the chains may not just work with

producers with better road access. In other words, those producers located in the hinterland may still be part of the chains preferred supplier lists. Presumably, as one would expect the more the tomatoes are bounced over unpaved roads, the higher the loss rate. However from our qualitative interviews we learned that logistic improvements were introduced to minimize losses, such as a maximum weight per plastic crate and other measures that reduced the contact between plastic crates. On the other hand, the difference in average distance to a paved road for those farmers selling to supermarkets versus the traditional market does not appear to be considerable.

(d) Comparison over Channel Strata of Technology and Efficiency

Here we estimate the production functions for the different channel strata. Subsequently we derive the technical efficiency and allocative efficiency results. Conditional on market channel choice, the producer's production function is represented as:

$$(4) \qquad Y_{ij} = A_{ij} \prod^{h} X_{ijh}^{\alpha_{jh}} \qquad \forall j \in N$$

where Y_{ij} represents the i^{th} farm's total tomato production in kilograms in 2004, j^{th} market channel. In the technological relation A_{ij} represents the technological efficiency level. α_{jh} is a vector of positive parameters. X_{ij} is a vector of h inputs. As endogenous stratification is used, and this is the second stage of the switching regression the first stage of which is the channel choice, we include in the estimation model the farm-specific observation for the producer's conditional probability of being in that channel (represented by the inverse mills ratio (IMR) calculated from the first stage). We use a

logarithmic transformation of the Cobb Douglas function; there was no additional explanatory power from use of the quadratic or translog functions, as judged by a standard F-test. [7] We estimate the production functions using its standard log-linear transformation as follows:

$$(5) \quad \ln Y_{ij} = \ln A_{ij} + \alpha_{j1} \ln X_{ij1} + ...\alpha_{jh} \ln X_{ijh} + \alpha_{j} \lambda_{ij} + \eta_{ij}$$

$$\forall j \in N \;\&\; \forall h \in X$$

Where the vector X_{ij} includes the following variables, all totals for 2004:

(a) LABOR is total labor days used to produce tomatoes; it includes family and hired labor.

(b) FERTILIZERS is the total cost of organic fertilizers.

(c) FOLIARS, INSECTICIDES, FUNGICIDES, HERBICIDES, SEEDS represent the total cost of these items applied.[8]

(d) LAND is total tomato area measured in hectares.

(e) IRRIG is the percentage of tomato land that is irrigated.

(f) AGMACH is a dummy variable equal to one for use of tractor and 0 for animal traction.

(g) REG1 and REG2 are dummy variables for regions, which aim to capture differences in soil and weather conditions between the regions.

(h) λ_{ij} represents the inverse mills ratio (IMR) calculated from the channel choice equation, used to correct for selection bias. Following Heckman (1979)

we use an extension to multiple outcomes further discussed in Vella (1998), Dubin and McFadden (1984) and Bourguignon et al. (2004).

(i) α_j is the vector estimated parameters

(j) η_{ij} is the error term[9].

The regression results are shown in Table 6. We applied the Chow Test to test the null hypothesis of equality of production function parameters of the three supply chains as $\alpha_{j=k} = \alpha_{j\neq k} \forall j$ and the alternative hypothesis of at least one parameter statistically different. At 99% significance level the null hypothesis was rejected in all cases[10]. Hence, the results support that the technology used by the producers in the three supply chains differs.[11]

We use the parameters to examine efficiency. The producers selling to the supermarket chains are substantially more technically efficient than the traditional channel growers. Lau and Youtopoulos (1971) note that technical efficiency is reflected in the intercept term of the Cobb Douglas production function. A comparison of the intercepts of the production functions as measures of technical efficiency indicate that producers selling to La Colonia have the highest technical efficiency, followed by producers selling to CSU, with the traditional growers the lowest. In terms of partial measures, the marginal physical productivity (MPP) of land is three and six times higher for producers selling to the CSU and La Colonia supermarket chains compared to the producers selling to the traditional markets. Moreover, the MPP of organic fertilizers and chemicals of producers selling to the supermarkets is higher than that of the producers

selling to the traditional channel. Producers selling to the traditional channel show a higher MPP of seeds as compared to supermarket chains, which suggests that they might have difficulties in acceding to either good quality or enough quantities of seeds. The MPP of labor of producers selling to La Colonia supermarket chain is highest and it is an indication of less labor available (as noted above). The MPP of labor of producers selling to the CSU supermarket chain and traditional markets is somewhat similar. These results taken together are probably due to the greater education, specialization, and assistance received by the supermarket channel producers.

Using the physical productivity estimates plus product prices and factor prices, we examine allocative efficiency. In neoclassical theory, allocative efficiency occurs at the point at which the marginal value product (MVP) of a factor equals the factor's price. If the MVP exceeds the factor price, more of the factor could be profitably used and this reflects a constraint to access of the factor, and the opposite, an overuse of the factor. For example, Carter and Wiebe (1990) show that smaller farmers in Kenya have a constraint in access to capital (such as fertilizer) but an overuse of labor (indicating a constraint to selling labor in other markets).

Table 7 compares the MVPs with the factor prices. Here, as in the next section, in order to avoid endogeneity, we use average prices (observations for each of the seven municipalities) for factors and output. The main results are as follows.

First, producers selling to CSU-Hortifruti are close to being allocation-efficient in chemical foliars, fungicides, and seeds. The MVP exceeds factor prices for labor, fertilizers, and herbicides, but not by much. However, the MVP of insecticides is below their price, indicating overuse. This practice is common in agroindustry outgrower

schemes, as the buyer is sensitive, as in the present case, to insect damage, so producers overuse pesticide to reduce risk of rejection. The MVP of land is well above the land price; this land constraint may well be due to lack of irrigation area and the low quality of the non-cropped land in their holding (mainly hillsides and rocky areas), as well as land market constraints.[12]

The producers selling to La Colonia and to traditional market channels exhibit excess of MVP of labor over wage, indicating a labor constraint, corroborating points made above. Both sets of these growers also over-use chemical inputs (the MPVs of these factors are well below their prices). They may be compensating for the labor shortages, as well as (over) managing risk from pest infestations, and lack of knowledge from limited technical assistance.

(e) Output Supply and Input demand functions

Here we estimate the output supply and input demand functions, again endogenously stratifying for the three market channels and controlling for selection bias by including the IMR in the equations. The equations are derived from the profit function using Hotellings Lemma (without needing the assumption of profit maximization behavior, see Sadoulet and de Janvry, 1995) and obtain the following three equations:

$$(6) \qquad Y_{ji(marketings)} = \delta_j + \delta_j P_m + \delta_j W_m + \delta_j K_{ij} + \delta_j \lambda_{ij} + \eta_{ij}$$

$$(7) \qquad X_{ji(labor)} = \alpha_j + \alpha_j P_m + \alpha_j W_m + \alpha_j K_{ij} + \alpha_j \lambda_{ij} + \eta_{ij}$$

$$(8) \qquad X_{ji(non-labor)} = \beta_j + \beta_j P_m + \beta_j W_m + \beta_j K_{ij} + \beta_j \lambda_{ij} + \eta_{ij}$$

Where: $Y_{ij(marketings)}$ represent the producer's output supply (no home-consumption is assumed) during the 2004 cropping season, $X_{ij(labor)}$ represents the producer's demand for labor measured in total labor days per farm per year and includes family and hired labor days. $X_{ij(non\text{-}labor)}$ represents the producer's demand for non-labor variable inputs.[13] P is the average price per municipality of tomatoes measured in US$ per kilogram. W is the vector of input prices (per municipality) and it includes the wage rate (US$ per day), and the non-labor variable inputs price per municipality (US$/Kg).K is the vector of fixed factors and it includes:

a) LAND is total tomato area measured in hectares.

b) IRRIG is the percentage of tomato land that is irrigated.

c) AGMACH is a dummy variable equal to one for use of tractor and 0 for animal traction.

d) REG1 and REG2 are dummy variables for regions, which aim to capture differences in soil and weather conditions between the regions.

e) λ_{ij} represents the inverse mills ratio (IMR) calculated from the first stage (market channel choice model).

f) $\delta_j, \alpha_j, \beta_j$ 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.

The marketing function and labor and non-labor input demand function results are presented in Table 8. The regression results combined with average sample variable values are used to calculate the elasticities and absolute marginal responses of price and non-price factors of producers selling to the three market channels. Several salient points emerge.

First, the output supply price elasticities and intermediate input price elasticities (labor and non-labor variable inputs) are higher for producers selling to supermarket chains than those of producers selling to the traditional channel. For example, an increase of 10% in the price of tomatoes will increase the supply of tomatoes of CSU producers by 777Kg, which is 95% higher than the expected increase in supply of traditional producers. La Colonia producers will increase two times and a half that of CSU producers. While this measures a cross-section response, it is typical in the literature to interpret this as what would be the medium-long term response to price increases, and this suggests that the modern channel producers are more sensitive and responsive to price changes than the traditional channel farmers, perhaps because of their commercial orientation and greater access to assistance and credit.

Second, the own-price elasticity of labor demand is substantially higher for the traditional market than for the supermarket channel growers; moreover, the own-price elasticity of capital (non-labor inputs) is much higher for the supermarket channel growers (with the expected differences between the chains, with a lower elasticity among the CSU growers due to the presence of the smaller NGO-assisted farms). If one thinks of that elasticity as correlated with the slope of the isoquant (labor-capital) where the factor price ratio is tangent, this corroborates the point above that the traditional

farmers' technology is more labor-intensive, while the supermarket-channel growers (on average) is more capital-intensive.

Third, producers' non-price elasticities are somewhat similar for producers selling to the three market channels, but the elasticities are relatively low. By contrast, the elasticity of output supply with respect to land is higher for supermarket-channel producers, expected from our findings above of higher yields of that group.

4. CONCLUSIONS AND IMPLICATIONS

At a very early stage of development of the supermarket sector in Nicaragua, results indicate that the main two supermarket chains have already introduced vertical coordination strategies going beyond the spot market relations still used in the traditional market. The supermarket chains have sought to win middle-class consumers with higher quality while extending their sales to the lower middle and upper-lower income segments with lower prices for foods, and recently have started on this path with fresh produce. The chains shifted to greater control of quality and lower transaction costs, hence overall costs, with the very recently new coordination strategies, involving new-generation wholesalers rather than traditional brokers, de facto contracts with farmers on preferred supplier lists, and arranging (through their own agronomists, or NGOs, or input suppliers) technical assistance and credit that are apparently difficult for those merely in traditional markets to access.

The regression and descriptive statistic results show that while farmers in the "small" category can access the supermarket channels, the farmers who do so unassisted by NGOs tend to be the larger and more capitalized tier (in education, experience, and physical capital) of small farmers, and those assisted by NGOs, while less capitalized and smaller, are helped by NGOs with technical assistance and organizational assistance to form groups that overcome their asset poverty to meet the modern channel's requirements. The results also show that once accessed, the modern channel allows substantially higher profits (from slightly higher prices and substantially greater efficiency, using more capital-intensive technology) to farmers compared to the traditional market.

Several implications are pertinent. It is clear that for farmers to enter the modern channels, they need a spectrum of forms of capital that most traditional farmers, even commercial ones, do not have in abundance: experience, education, organization, irrigation, access to technical assistance and finance, even some greenhouses. That of course means that, unassisted, most farmers cannot access these market channels. While the "elite" of small farmers enter unassisted, the smallest (non elite in land and capital) enter the modern supply channel with help from NGOs – NGOs who employ agronomists and business management specialists usually well beyond the reach, too expensive for access, of the traditional government agencies charged with rural development. It is instructive to note that a representative project of the NGOs spends, by our calculations, about 8 times more per farmer in these programs, than do the agricultural agencies of the Nicaraguan government. It is safe to say that the Nicaraguan government either cannot or will not be able to afford mass-scale upgrading of farmers to enter modern channels. At present this is not a problem, as the supermarket-market is still small. But the growth of the latter means that some day, perhaps in the next decade, supermarkets will control half or more of the produce market, as they do already in Brazil. The development program and policy issue of how to upgrade large numbers of farmers to prepare for the market transformation thus emerges as a critical issue for debate today, to prepare for tomorrow.

Table 13: Producers' supplies by market channel (Continuation)

Parameter Estimates	Supermarket		Processor		Traditional	
	Male Cattle supplies	Female Cattle supplies	Male Cattle supplies	Female Cattle supplies	Male Cattle supplies	Female Cattle supplies
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%. A Chow test of equality of equality of the parameters of the structural equations between the supply chains was performed and rejected the null hypothesis of equality.

Table 13: 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)

Table 11: Producers' sales and purchases of cattle by channel (Continuation)

	Nicaragua			Costa Rica			Sig	Sig
	Superm arket	Processor	Auction	Supermark et	Processor	Auction	Nica	CR
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 11: Producers' sales and purchases of cattle by channel

	Nicaragua			Costa Rica			Sig	Sig
	Superm arket	Processor	Auction	Supermark et	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		

Table 10: Farm and Producer Characteristics (Continuation)

	Nicaragua			Costa Rica			Sig	Sig
	Supermarket	**Processor**	**Auction**	**Supermarket**	**Processor**	**Auction**	**Nica**	**CR**
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 10: 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		

Table 9: Vertical Coordination Strategies in the Beef Supply Chains (Continuation)

Supply chain transactions	Vertical Coordination Strategy				
	Spot Market	Specifications Contract	Relation - based Alliance	Equity - based alliance	Vertical Integration
In COSTA RICA					
Large-scale Export-Oriented Processors procurement systems:					
1) Between Export Markets, Supermarket chain, and Processor owned stores & Large-scale processors*			X		
2) Between Large-scale processors & Producers	X				
Supermarket chains procurement systems:					
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 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 5: Marketing Channel Selection Estimation Results (WESML)

	Number of obs =	145
Wald chi2 (28) = 7724.76	Prob > chi2 =	0.0000
Log pseudo-likelihood = -51.928071	Pseudo R2 =	0.6061
Covariate	**CSU-Hortifruti**	**La Colonia**
Producer is female	-0.155	1.662
	(0.88)	(1.59)
Age of farmer (years)	0.037	-0.078*
	(0.03)	(0.06)
Experience in tomato production (years)	-0.093**	0.097
	(0.04)	(0.06)
Producer education (years of schooling)	0.155*	-0.027
	(0.09)	(0.15)
Household size (members)	0.183	0.057
	(0.24)	(0.18)
Dependency ratio	0.362	0.758
	(1.26)	(1.93)
Producers has means of transport (dummy)	0.626	-1.069
	(0.71)	(1.13)
Livestock (head)	0.009	0.035
	(0.10)	(0.04)
Producer has electricity (dummy)	-0.67	1.929
	(0.99)	(1.91)
Distance to asphalted road (kms)	0.129***	0.080*
	(0.04)	(0.04)
Overall farm size (ha)	-0.064	0.044
	(0.05)	(0.04)

Notes: 1. Robust standard errors in parentheses. 2. Parameter * significant at 10%; ** significant at 5%; *** significant at 1%. 3. Base Category is traditional marketing chain.

Table 6: Second stage: Production Function Estimation Results

Covariate	CSU-Hortifruti	La Colonia	Traditional
Labor (family and hired days)	0.621**	2.084***	0.609***
	(0.33)	(0.85)	(0.26)
Fertilizers (US$/farm)	0.203*	0.423***	0.034*
	(0.12)	(0.18)	(0.21)
Foliars (US$/farm)	0.124	0.157	-0.072
	(0.26)	(0.27)	(0.12)
Insecticides (US$/farm)	0.699*	0.31	0.115
	(0.38)	(0.25)	(0.15)
Herbicides (US$/farm)	0.135	0.018	0.044
	(0.07)	(0.05)	(0.04)
Fungicides (US$/farm)	0.426*	0.322	0.04
	(0.20)	(0.15)	(0.06)
Seeds (US$/farm)	0.095*	0.084	0.062
	(0.02)	(0.10)	(0.10)
Total tomato area (ha)	0.134*	1.189*	0.442***
	(0.05)	(0.69)	(0.12)
Irrigation (% of tomato area irrigated)	0.126	0.092***	0.126***
	(0.25)	(0.08)	(0.06)
Tractor use (1=yes)	0.243*	0.016	0.054
	(0.09)	(0.57)	(0.10)
Mills1	0.056	0.03	-0.012
	(0.04)	(0.02)	(0.02)
Mills2	0.018	-0.005	0.001
	(0.02)	(0.02)	(0.02)
Constant	1.686**	1.851***	1.052*
	(0.73)	(0.34)	(0.62)
Observations	43	26	76
R-squared	0.73	0.72	0.63

Notes: 1. Robust standard errors in parentheses. 2. Parameter * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 9: 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					
Large-scale Export-Oriented Processors procurement systems:					
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				
Supermarket chains procurement systems:					
1) Between CSU (leading supermarket chain) & ICI (Specialized wholesaler)				X	
2) Between ICI (Specialized wholesaler) & Processor.			X		
3) Between ICI & 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				

Table 8: Output Supply and Intermediate Input demand Function Estimation Results (Continuation)

Parameter Estimates	Hortifruti			La Colonia			Traditional		
	Tomato Output Supply	Labor Demand	Non-labor input demand	Tomato Output Supply	Labor Demand	Non-labor input demand	Tomato Output Supply	Labor Demand	Non-labor input demand
Price elasticities									
Price tomato	0.42	0.18	0.55	0.16	0.17	0.29	0.11	0.11	0.37
Wage	-0.88	-0.80	0.08	-0.69	-0.54	1.48	-0.05	-0.26	0.60
Non-labor inputs	-0.51	0.41	-0.32	-0.04	0.20	-1.49	-0.10	0.22	0.52
Non-price elasticities									
Tomato area	0.99	1.22	0.69	1.01	0.88	0.62	1.10	0.94	1.30
Tomato irrigated area	0.11	-0.01	0.10	0.09	0.00	-0.06	0.10	0.04	0.03
AGMACH	0.09	-0.05	-0.21	0.03	0.19	0.03	0.03	0.08	0.08

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

Table 8: Output Supply and Intermediate Input demand Function Estimation Results (Zellners)

Parameter Estimates	Hortifruti			La Colonia			Traditional		
	Tomato Output Supply	Labor Demand	Non-labor input demand	Tomato Output Supply	Labor Demand	Non-labor input demand	Tomato Output Supply	Labor Demand	Non-labor input demand
Price tomato (US$/Kg)	33810*	185	1109	77892*	644	3341	18207	199	1296
	(14639)	(220)	(739)	(19910)	(1076)	(5079)	(30562)	(213)	(989)
Wage (US$/day)	-8687***	-101*	21	-34847	-204	1728	-757	-44*	202
	(4262)	(64)	(215)	(65966)	(356)	(1683)	(6622)	(26)	(206)
Non-labor inputs (US$/Kg)	-5093**	52**	-82**	-3394	114	-2647***	-2541	58**	273
	(1493)	(22)	(35)	(2578)	(138)	(652)	(1924)	(27)	(122)
Tomato area (ha)	32294*	502	562***	38194**	247***	547***	29393***	256***	706***
	(1534)	(23)	(77)	(4071)	(22)	(104)	(1993)	(14)	(62)
Tomato irrigated area %	7458**	-11	177	21589**	2	-333	9631	34	65
	(3178)	(48)	(160)	(9069)	(103)	(486)	(6941)	(48)	(216)
AGMACH	4500**	-32	-266**	5198***	227	122	1676	45	91
	(2195)	(33)	(111)	(1536)	(191)	(902)	(5083)	(35)	(128)
millsp1	-214	-17*	3	-634	-15	-134	-2144	16*	-66*
	(595)	(8)	(30)	(4083)	(22)	(104)	(2288)	(9)	(40)
millsp2	206	4	-32	2272	-31	69	469	-9	8
	(273)	(4)	(35)	(4290)	(23)	(109)	(742)	(5)	(23)
Constant	11819*	173	-394	-73789	130	-8464	-8002	-229	-729
	(4057)	(121)	(407)	(183262)	(990)	(4675)	(20939)	(146)	(650)
R2	0.85	0.84	0.65	0.81	0.82	0.78	0.74	0.78	0.66
Observations		43			26			76	

CHAPTER 3: ESSAY ON CATTLE PRODUCERS' PARTICIPATION IN MARKET CHANNELS IN CENTRAL AMERICA: SUPERMARKETS, PROCESSORS, AND AUCTIONS

Abstract

This paper focuses on the determinants of the participation of cattle producers in the supermarket channel, export processor channel, and traditional auction channel. It begins with an 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 300 farms in the two countries.

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

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. Access to such markets can open opportunities in dynamic urban markets and diversify production away from basic grains. Research in the past several decades on farmers' participation in markets, including livestock markets, has followed several paths.

First, 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 contributes 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 transition from subsistence to commercial production systems.

Second, given 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), who analyzed the determinants of auction market channel versus processor market channel using a sample choice of cattle producers in the UK.

The need for additional research, in particular in developing countries where markets are 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). The geographical context for this paper provides an illustration. Since market liberalization, and especially foreign direct investment (FDI) liberalization, occurred 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 modern 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 desire to differentiate themselves from their competitors in traditional markets, and from each other, 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 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, organizational, and financial capital resources, 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 producers' 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 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, and presents the descriptive and 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 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. There are three supply chains : 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 (the terms "supply chains" and "market channels" are used interchangeably) 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 use the Peterson, Wysocki and Harsh (PWH) model as the 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 understanding of how and why the agents along the supply chains (supermarkets, wholesalers, producers), choose certain strategies from a vertical coordination continuum. Several points should be emphasized.

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 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 could 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 penalties for 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). There are many potential ways to vertically coordinate the procurement of cattle (or processed beef) so 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. As firms move from spot markets towards vertical integration they increase the level of control of the supply chain, 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 its 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 happen, according to Williamson (1973), because of intentional opportunism of economic actors or unintentionally due to bounded rationality of estimating production plans (under or overestimation).

Fourth, as one moves 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, the coordination mechanism is based mainly on price discovery, and the decision is whether or not to engage in the transaction. There is no establishment of coordination mechanisms beyond the transaction itself. This type of coordination mechanism is equivalent to auction markets. The next level of control is represented by the specification contract, which is a coordination mechanism in which the agents engage in a transaction by specifying 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 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 is executed. 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 are 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. Importantly, the former strategy of an alliance is *shared*, while the latter is not but is the result of separate and unrelated decisions. Strategies might differ because of the likelihood and costliness of coordination errors of each relation.

Fifth, agents in 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 error 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.[14] 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 their cattle volume substantially 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 sex, 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 in times of shortfalls, San Martín uses 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), a chain with about 65% of the market (CSU is headquartered in Costa Rica, hence it is a regional multinational also present in Honduras). In second-place (with 20% of the market) is the supermarket chain *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 achieves 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 a 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 of 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.[15] 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, the leading chain CSU buys all its cattle from "Industrias Carnicas Integradas" ("Integrated Meat Industries") (ICI). CSU and ICI are based in Costa Rica and are part of the same holding company. CSU started to work with ICI because it could monitor easily and get consistent supplies of beef, 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 of the three large-scale export oriented processors (San Martin), 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 a 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 1200 per month to its Nicaraguan CSU stores.

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. 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, it must be that the reasons why the large-scale processors and ICI do not buy from the auction market do not stop the buyers in the auction market sourcing 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 at least 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, which in turn might be associated with negative future expectations 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 into 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 consumers, as well as enforcement of safety standards by the 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 transactions 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 for cattle is high. 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 cut 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 on 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 in 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 9 a summary of different coordination mechanisms strategies a producer faces when selling to large-scale export-oriented processors, to supermarket chains or to auction markets. 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. Consider first that the large-scale export-oriented processor supply chain serves a demanding customer, one based on international (or domestic) safety and taste requirements, and thus increasing complementary across the supply chain. It also has greater asset specificity as large plants must have proper supply of cattle or their efficiencies are not realized. Thus costliness of coordination error is high and well managed/higher-intensity-of-control coordination strategies are needed. The regional buyer becomes an acceptable coordination strategy because the buyer understands the processor's needs both in terms of asset specificity quantity wise and complementarity's quality wise, and can more efficiently sort through local supply availability than the processor can on its own. More intense control strategies would involve significantly more cost (and capital)

while not likely yielding much additional reduction in costliness of error. As second-tier channels, the firms involved likely have less control competence and capital availability than the leading channel but more than the traditional channel. Thus, some movement away from spot markets to more managed coordination including a relation-based alliance. No formal contract exists between the regional buyer and processor transaction, which is on the border between spot market and specification contract and not a pure spot market relationship. The buyer will only be successful if he brings the processor cattle that meet specification needs. In the case of Nicaragua, the processor uses regional buyers (that previously worked internally but now externally) on a regular basis rather than transaction by transaction basis. Once a good buyer is found the processor will continue to use him across many transactions. In the case of Costa Rica, competition for cattle (because of declining cattle stocks) have become more intense, hence they are devoting additional resources and avoiding the regional buyer intermediation.

Second, the leading supermarket supply chain probably serves the most demanding customers (domestically and based on quality sensitivity) and needs to support its brand reputation/differentiation most intensively--both of these lead to even higher levels of complimentary than that needed by the second-tier channel or merely export-oriented channel. Asset specificity (plant scale and reputation) also raise the costliness of coordination error. Therefore, this supply chain has the highest costliness of error. As the leading supply chain market share wise, it is likely controlled by the most managerially sophisticated and capital-rich firms. The strategy selected can thus be the most intense from a coordination control perspective. In total then, this supply chain

results in the most intense form of coordination in its operation-specification contracts and an equity alliance.

Third, the auction market supply chain serves the least demanding ultimate consumer of beef (likely the most price sensitive consumer willing to trade off quality concerns) therefore complimentary is lowest for this channel across it vertical levels. Also, being smaller scale at each level likely leads to less asset specificity for each level. Together then, the costliness of coordination error is least for this supply chain and thus spot markets are adequate coordination strategies. In addition, these small players likely have the least capital and control competence (management sophistication in general) meaning that more intense control strategies to the right on the continuum are less feasible for them to implement even if some concern about costliness of coordination error were present.

Lastly, given the differences among the supply chains, our general hypothesis is that producers' capacities affect their ability to sell to each of them 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 to ensure the sample would contain producers selling to the supermarket chains. We conducted an 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.[16] 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, and that has a sampling error of 10% with a probability of 90%. We collected our data during June and July of 2004.

We start this section by focusing on salient results presented in Table 10. First, note that the farms which sell directly to supermarkets and large-scale plants tend to be animal-finishers that have 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 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 why larger farmers tend to be on the preferred supplier lists of the supermarkets and big processors. The small livestock producers do not have 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 the 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 because the supermarket procurement system 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 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 because 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 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" for 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 11, 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 have 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 producers. 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 producers to find 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 (cattle sales over cattle stock) 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 11 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 in quality over the producer groups in quality. Table 11 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.[17] This has led to older steers at slaughter (four years and above) which results 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. Data in both countries support the fact that producers selling to the supermarket channel buy heavier animals from other producers for their finishing operations 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, or whether to be part of a large processor supply chain or not. The model is estimated as a multinomial logit with two equations, one for producers selling to the supermarket chain and one for producers selling to the large-scale processor. The traditional supply chain is used as the base. After briefly discussing the main results of the multinomial logit we estimate 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 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 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 each alternative with some characteristics in a choice set. A producer i can choose among N market channels. 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, that of the leading large-scale processor, or the auction market. A producer can only be part of one of the three supply chains.[18] The producer's utility from participating in market channel j is represented by U_{ij}. The producer makes a marginal benefit-cost calculation based on the utilities achieved by selling to any channel. The utilities are given by

$$(1) \quad U_{ij} = \beta_j X_{ij} + \varepsilon_{ij} \qquad \forall j \in N$$

We can't observe the utilities directly but the choice made by the producer reveals which one provides the greater utility (Greene, 2000). We don't directly observe the costs and benefits arising from meeting the standards. The RUM model captures that indirectly from observing the market choice a producer has selected. Also, as the market channels have specific standards or range of standards (from qualitative interviews), in practice

only a few of them are directly observable by the producer such as: weight, age, gender but some like fat content are not observable. The survey of farms measured two of them and shown in table 11 (age and weight). We have not included this in the model because the channel choice affects clearly influence these variables and endogenous problems arise. The RUM model reflects the choice made with greatest utility given market channel alternatives (incorporating indirectly their standards compliance costs and benefits) given the vector of constraint X (producer, farm characteristics, transaction). A producer selects market channel k if

(2) $U_{ik} > U_{ij} \forall j \neq k$

Here U_{ij} denotes random utility associated with the market channel j, and $\beta_j X_{ij}$ be an index function denoting producer i's average utility associated with this alternative. The term ε_{ij} denotes a random error which is specific to a producer's utility preference (McFadden, 1976).[19]

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

(3). $Y_{ij} = \beta_j X_{ij} + \varepsilon_{ij}$

Where in the first equation $Y_{i1}=1$ if producer chooses the CSU-ICI market channel (Leading supermarket chain), 0 otherwise (which is equivalent to $Y_{i1} = 1$ if $U_{i1} > U_{ij} \forall j \neq 1$). In the second equation $Y_{i2}=1$ if producer chooses to sell to the large-

scale processor market channel (Arreo or San Martin), 0 otherwise. X_{ij} is a vector of producer characteristics influencing the producer's indirect utility.

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: 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 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 (can use without paying), 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 not only affects the farmer capacity to enter the supermarket market chain but also its capacity to remain in 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 higher valued 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 Boss Indicuss and not crossbred with other Boss Taurus breeds (similar as in Holloway et al., 2004). Angus, Holstein, and Jersey crosses 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 and be able to select (meet the buyer's quality requirements) the supermarket channel. This is because the tropical breeds are less efficient and take longer to reach slaughter age, in particular when feeding practices are poor. Hence quality may not conform to buyers' specifications. Note that farmers make adjustments "in the long run" to their cattle level stocks and to cattle stock characteristics such as how much of it are female or its breed mix. In the short run (our data) those characteristics are predetermined and so they affect (or limit) 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. These three variables capture farm's access to infrastructure and the larger the distance to roads (it is hypothesized) the less likely is a cattle producer to sell to supermarket channels reflecting difficulties in trading important quantities of cattle consistently. The availability of ELECTRICITY and technical assistance are hypothesized to affect positively the odds that the producer can implement correctly some technologies that will produce cattle with quality levels desired in order to sell to the supermarket channel. COSTARICA is a dummy equal to one if the cattle producer is in Costa Rica and zero if located in Nicaragua and it expected to capture differences in the industry and retail sector between the two countries.

Table 12 contains the market channel choice estimation results. Overall farm size is a highly significant determinant of market channel participation in the supermarket and in the processor market channels. We know that larger farms are more likely to sell to these channels than are smaller ones. Although we would need additional data before concluding (complete data for several years, which unfortunately unavailable), this might indicate that 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 or that farms selling to supermarkets have better growth prospects. Although in the short term, overall farm size can be considered fixed, in the long run endogeneity problems can arise from the fact that farms that participate in the supermarket channel can grow larger. The later is more evident from the qualitative analysis data that supports that supermarket's increasing cattle quantity requirements are not to be met by exclusively adding new farmers but rather as a combination of new farmers in their preferred lists and more important "higher quantities" from the current producers in their lists.

Also, 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 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.

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. Perhaps improved prairies and cattle stock breed variables will become a significant factor in the future once marginal quality gains from other factors are fully exploited (such as carcass weight and age).

Fourth, human capital and labor availability do not have significant effects. The only two variables significant for the processor channel are education and dependency ratio. Results indicate that more education reduces the probabilities of selling to the processor market channel. Note that the negative correlation between education and the processing channel was unexpected. See that there are greater differences in producer's education among the channels in Costa Rica as compared to those in Nicaragua. As in the case of Costa Rica where we observe greater difference in producer's average education levels among channels, the processing channels has the lowest level and those selling to the supermarket and auction channels have greater. The processing channel has been operating since the 60s and 70s and the auction and supermarket sector started in the mid 80s and 90s, which perhaps explains greater differences in educations between the channels in the two countries. It is possible that those more educated are able to understand and compare the requirements arising from new and multiple market channels and capture the benefits of selling to them. This may indicate that those more educated are shifting away from selling to the consolidated processing sector and moving towards alternative market channels. 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. 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 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.[20]

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:

$$(4) \qquad Y_{ij(males)} = \delta_j + \delta_j P_m + \delta_j W_m + \delta_j K_{ij} + \delta_j \lambda_{ij} + \eta_{ij}$$

$$(5) \qquad Y_{ij(female)} = \alpha_j + \alpha_j P_m + \alpha_j W_m + \alpha_j K_{ij} + \alpha_j \lambda_{ij} + \eta_{ij}$$

Note that before, $Y_{ij} = (0,1)$ represented market channels and now, Y_{ij} = Number of cattle.

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 or 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. [21] 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 because of 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.[22] δ_j, α_j are the estimation parameters and η_{ij} is the error term. We estimate the system for each market channel using a Zellner's seemingly unrelated regression (SUR) model to exploit potential correlation across the errors in the three equations in order to gain efficiency in the estimation.

Table 13 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 (as oppose to long run where fixed factors can be adjusted and elasticities increase) and previous aggregate model results, which has shown even negative elasticities in the short run (Aadland and Bailey, 2001). There are four significant results that appear most relevant.

First, supply elasticity of males with respect to the 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 because cattle stock 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. The model suggest that supplies marketed might not increase substantially as cattle stocks and overall farm size increase, which reflect the limited adjustments farms can make to their cattle stock and overall farm size in the short run. As expected female cattle stock has a much less important impact effect on supplies given the time period it requires to produce calves rather than liquidating productive

stock. Producers may not sell 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 indirectly this result because producers selling to the supermarket chain are required to meet rapidly the quantities demanded, which is a requirement (keep up with demand) 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 innovate 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 skyrocketed in Costa Rica at the same time supermarkets skyrocketed.

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 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. CONCLUSIONS AND IMPLICATIONS

We first present the conclusions and implications that arise from the quantitative analysis and second from the supply chains qualitative analysis. Note that we used cross sectional data, hence our results should be taken with some caution, in particularly in terms of supermarket causality effects. They are useful to generate hypothesis to be tested and validated by additional research.

Implications from 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. Although we acknowledge that more research is needed to verify our findings, they seem to indicate that bigger, specialized and more responsive cattle producers are likely to become the market gatekeepers in the arising preferred supplier list of the more integrate supermarket supply chains.

Smaller producers, supermarket chains and auction markets. From the interviews we found that 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 later shift suggests that as the supermarket sector grows and displace the traditional retailers, auction markets will see their demands shrinking overtime. However, auction markets in Costa Rica have increased substantially in the same period the supermarket sector grew. Our data shows that more producers selling to the supermarket chain "buy cattle" (as oppose to raise their own cattle) and their main source are the auction markets. That said, as supermarket grow auction markets might become important sellers of cattle to producers that sell to supermarket chains rather than selling directly to the chains. Our data shows that smaller producers sell to auction markets as compared to supermarket chains and processors. 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 or incipient development of auction markets. From the Costa Rican experience, we might not

necessarily conclude that as supermarket develop in Nicaragua auction markets development might be impeded (because the chains do not source from them). What happens to the auction markets is an important question because our data supports that smaller producers sell to them. Moreover, 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.

Effects on the beef processing industry. As supermarkets buy only cattle carcasses or process their animals in large-scale HACCP certified processors and do not buy from the smaller processors with insufficient food safety processing capabilities (both in Costa Rica and Nicaragua), the effects on the beef processing industry indirectly accelerate the disappearance of smaller processors. Even when we don't have data that characterizes the producers selling to the smaller processors; it is somewhat obvious that the low volumes processed by hundreds of small processors mostly in rural areas are sourced from smaller producers, which is yet to test and validate by additional research. Moreover, 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. The general implication is that consumers are benefiting from higher hygienic and safety standards by shopping at

the supermarkets but the smaller processors and producers that mainly sell to them will face a declining/shrinking demand for their cattle.

Changes in the beef supply chains coordination mechanisms. 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. On one hand, the more integrate supermarket supply chain benefits the consumers as it enforces its quality standards, thus ensuring its reputation in the mind of consumers. On the other hand, higher levels of control over the supply chains are likely to set stricter rules in which those producers that don't live up to the standards will be excluded.

Table 7: Marginal Product Value (MPV) and Average Product Value (APV) by Marketing Chain (calculated from second stage Cobb Douglas production function).

Input variable	CSU-Hortifruti			La Colonia			Traditional		
	MPV	APV	Factor Price	MPV	APV	Factor Price	MPV	APV	Factor Price
Labor: family & hired (labor day)	10	18	1.9	70	33	2.5	13	22	2.3
Organic non labor variable inputs									
Fertilizers (Kg)	6	30	0.3	14	32	0.3	1	26	0.3
Inorganic non-labor variable inputs									
Foliars (Kg)	11	85	13	8	53	6	-3	38	8
Insecticides (Kg)	15	22	73	7	22	37	3	25	35
Herbicides (Kg)	41	307	15	2	127	18	7	161	13
Fungicides (Kg)	17	39	18	6	18	14	1	27	14
Seeds (Cost in US$)	1.1	12	1	18	220	1	6	89	1
Land (ha)	6,012	7,549	1,489	11,198	9,418	1,325	2,616	5,918	1,658

Notes: (1) The input's marketing chain average marginal physical productivity (MP) is equal to the input's marketing chain production function Cobb-Douglas regression parameter estimate times the marketing chain sample average output (tomato production) divided by the marketing chain input value sample average; (2) Input's marginal product value (MPV) equals the marketing chain input's average marginal physical productivity (MP) times the marketing chain sample average tomato price; (3) Input's average product value (APV) is tomato production times tomato price divided by input; and (4) Factor price is the sample average by channel: Labor is wage per day (US$/labor day); Organic & inorganic variable inputs is US$/Kg; Seeds: its price is measured as the cost of 1 additional US$ spent in seeds; and Land is the value (US$) of acquiring one hectare

Table 4: Tomato Production Characteristics (Continuation)

	CSU-Hortifruti			La Colonia			Traditional			Significance	
	NGO	Non-NGO	Total	NGO	Non-NGO	Total	NGO	Non-NGO	Total	(8)	(9)
Has greenhouse (%)	11	-	9	60	-	12	3	-	1	b,f	b
Use tractor (%)	25	100	37	60	81	77	56	73	64	a,e,g,h	a,b
Use animal traction (%)	72	-	60	20	62	54	67	48	57	a,c,d,f,g,h	
Use manual traction (%)	-	-	-	60	-	12	3	-	1	b,d,f	a
Irrigation											
Number of producers with irrigation system (%)	100	100	100	100	90	92	100	88	94		
Share of area of tomato with irrigation (%)	71	98	76	93	60	66	87	81	84	a,b,d,e,g,i	c
Labor cost (US$/ha) (6)	815	671	792	702	706	705	793	626	705	i	a,b
Family labor cost (US$/ha)	378	107	334	200	48	77	192	138	164	a,e,i	a,b,c
Hired labor cost (US$/ha)	437	563	458	502	658	628	600	488	541	i	a
Total Cost (US$/ha)	3,525	2,379	3,346	2,652	3,488	3,352	2,574	2,601	2,590	a,e,g,i	b,c
Net Income (US$/ha) (7)	3,036	5,492	3,620	2,970	6,158	5,641	2,369	2,858	2,654	a,b,g	a,b,c
Net Income and family labor income (US$/ha)	3,414	5,599	3,954	3,170	6,206	5,718	2,561	2,996	2,818	a,b,g	a,b,c

Notes: For significance test label interpretation see Table 2

Table 4: Tomato Production Characteristics

	CSU-Hortifruti			La Colonia			Traditional			Significance	
	NGO	Non-NGO	Total	NGO	Non-NGO	Total	NGO	Non-NGO	Total	(8)	(9)
Number of Producers (counts)	36	7	43	5	21	26	36	40	76		
Gross Income-sales of tomato (US$/ha)	6,561	7,871	6,967	5,622	9,646	8,993	4,943	5,459	5,243	e	a,b
Price of tomato (US$/Kg) **(2)**	0.23	0.2	0.23	0.18	0.26	0.25	0.23	0.21	0.22	b,d,g,i	c
Yield (Kg/ha)	28,527	39,355	30,290	31,236	37,100	35,972	21,491	25,997	23,834	a,e	a,b
Transport cost (US$/ha) (3)	142	54	129	312	484	445	296	213	253	e,g,h,i	a,b,c
Non-labor variable inputs expenditures (4)	2,285	1,579	2,175	1,371	2,139	1,972	1,233	1,591	1,423	c,d,e	a,b,c
Cost of Fertilizers (US$/Ha)	357	196	332	211	289	271	219	303	262		
Cost of Foliars (US$/Ha)	173	116	164	156	178	179	129	208	171		
Cost of Insecticides(US$/Ha)	660	331	607	287	752	648	334	380	359		
Cost of Herbicides(US$/Ha)	39	11	35	49	92	82	27	44	38		
Cost of Fungicides(US$/Ha)	184	261	195	308	469	432	141	281	214		
Cost of Stakes and string materials (US$/Ha)	240	219	237	291	317	311	251	233	241		
Cost of seeds, others (US$/Ha)	633	444	605	69	43	49	133	142	137		
Tilling cost (US$/ha) (5)	25	23	25	53	52	52	29	22	25		
Irrigation energy costs (US$/ha)	156	81	144	121	119	119	154	100	125		

Table 3: Tomato Production Characteristics (Continuation)

	CSU-Hortifruti			La Colonia			Traditional			Significance	
	NGO	Non-NGO	Total	NGO	Non-NGO	Total	NGO	Non-NGO	Total	(8)	(9)
Tomato production (average per farm, Kg)	12,278	52,419	18,813	72,096	137,068	124,574	25,096	50,138	38,118	a,c,e,g,i	a,b,c
Cycles of tomato production	2.5	1.9	2.4	1.6	2.1	2.0	1.4	1.5	1.4	a,d,e,g,h,i	a,b,c
Total area of tomato (ha)	0.4	1.3	0.6	1.6	3.7	3.3	1.0	1.8	1.4	a,b,c,e,g,i	a,b,c
Labor (days/ha)	426	351	414	281	286	285	333	289	310	a,d,e,g	a,b,c
Family labor (days/ha)	204	59	180	80	19	31	99	67	82	a,e,i	a,b,c
Hired labor (days/ha)	223	292	234	201	267	254	234	222	228	i	
Wage (US$/labor day)	1.96	1.92	1.95	2.49	2.46	2.47	2.56	2.19	2.35		
Input-Labor ratio (Kg/labor days)	3.13	2.20	3.02	3.74	3.68	3.70	2.85	3.60	3.22	c,g,h	a,b,c

Notes: (1) Share of sub-channel by number of producers % is the total number of producers in a given marketing chain assisted or not assisted by NGOs over the total number of producers in that marketing channel times 100; Share of sub-channel by tomato production is the share measured by the total tomato production of all producers in a given marketing chain either assisted or not by NGOs over the total production of all producers in that marketing chain times 100; (2) Price is the average price for all markets, all seasons weighted by volume; Gross income is quantity of tomato sold times price (for all markets, all seasons) divided by total tomato land cropped (US$/ha); (3) Transport cost is the summation of all transport costs per ha incurred in delivering the tomatoes to the buyer.; (4) Non-labor variable input is the summation of all quantities*prices of fertilizers, foliars, insecticides, herbicides, fungicides, tutoring materials and others (seeds) per ha; (5) Tilling cost is the price of renting a tractor and/or animal plus tilling equipment to till an ha plus any additional cost paid for labor need to operate the equipment.; (6) Labor costs is the summation of all hired and family labor days times hired wage (imputing this cost to family labor). Labor days spent in production activities such as land cleaning, planting, fertilization, irrigation, fumigation, weed control, tutoring, harvesting, classification, marketing; (7) Net income is the proxy for restricted profit, that is, the gross income less the summation of transport costs, tilling costs, non-labor input costs and total labor costs (per ha).; (8) Share of total area of tomato with irrigation is total area of tomato with irrigation over the total area of tomato cropped times 100; (9) & (10) See table 2.

Table 3: Tomato Production Characteristics

	CSU-Hortifruti			La Colonia			Traditional			Significance	
	NGO	Non-NGO	Total	NGO	Non-NGO	Total	NGO	Non-NGO	Total	(8)	(9)
Number of Producers (counts)	36	7	43	5	21	26	36	40	76		
Total Cost (US$/ha)	3,525	2,379	3,346	2,652	3,488	3,352	2,574	2,601	2,590	a,e,g,i	b,c
Average Price of non-labor inputs (US$/Kg)											
Price of Fertilizers (US$/Kg)	0.28	0.27	0.28	0.22	0.30	0.28	0.29	0.31	0.30		
Price of Foliars (US$/Kg)	14	10	13	4	6	6	8	7	8		
Price of Insecticides(US$/Kg)	45	39	44	16	43	37	34	31	32		
Price of Herbicides(US$/Kg)	15	13	15	19	18	18	9	16	13		
Price of Fungicide (US$/Kg)	13	20	14	11	13	13	9	11	11		
Average physical quantity of non-labor inputs											
Fertilizers (Kg/Ha)	1288	740	1208	967	968	968	754	963	863		
Foliars (Kg/Ha)	13	11	12	37	28	30	17	28	23		
Insecticides (Kg/Ha)	15	8	14	18	18	18	10	12	11		
Herbicides (Kg/Ha)	3	1	2	3	5	5	3	3	3		
Fungicides (Kg/Ha)	14	13	14	27	35	33	15	25	20		

Table 2: Farm Characteristics (Continuation)

	CSU-Hortifruti			La Colonia			Traditional			Significance	
	NGO	Non-NGO	Total	NGO	Non-NGO	Total	NGO	Non-NGO	Total	sub-channels (6)	Totals (7)
Distance to asphalted road (kms)	11	1	10	3	18	15	6	5	5	a,b,d,e,f,g,h,i	a,b,c
Has electricity (%)	83	100	86	100	95	96	83	95	89		
Receives credit (%)	97	14	84	80	81	81	89	50	68	a,b,c,e,h,i	b
Receives technical assistance (%)	100	29	88	80	33	42	69	30	49	a,c,g,i	a,b

Notes: (1) Overall farm size is the addition of land owned plus land obtained for usufruct plus rented in plus sharecropped in less the summation of land rented out and land sharecropped out (year cropping season 2004); (2) Household size is the total number of family members living in the producer's household (during the last 6 months).; (3) Adults is the number of household members with 15 or more years.; (4) Dependency ratio is the number of members in the household with less than 15 years or older than 65 years over total household size times 100.; (5) Household has off farm income has been defined as any member (or the number of members) with employment outside the farm.; (6) T-test at 10% significance between NGO Vs Non-NGO sub-channels: a = between CSU-Hortifruti NGO & CSU-Hortifruti Non-NGO, b = between La Colonia NGO & La Colonia Non-NGO, c = between Traditional NGO & Traditional Non-NGO, d = between CSU-Hortifruti NGO & La Colonia NGO, e = between CSU-Hortifruti NGO & Traditional NGO, f = between La Colonia NGO & Traditional NGO, g = between CSU-Hortifruti Non-NGO & La Colonia Non-NGO, h = between CSU-Hortifruti Non-NGO & Traditional Non-NGO; and i = between La Colonia Non-NGO & Traditional Non-NGO. (7) T-test at 10% significance between marketing chains totals: a = between CSU-Hortifruti & La Colonia, b = between CSU-Hortifruti & Traditional, and c = between La Colonia & Traditional.

Table 12: 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 2: Farm Characteristics

	CSU-Hortifruti			La Colonia			Traditional			Significance	
	NGO	Non-NGO	Total	NGO	Non-NGO	Total	NGO	Non-NGO	Total	sub-channels (6)	Totals (7)
Number of Producers (counts) (1)	36	7	43	5	21	26	36	40	76		
Share of sub-channel by number of producers (%)	84	16	100	19	81	100	47	53	100		
Share of sub-channel by tomato production (%)	55	45	100	11	89	100	28	72	100		
Overall farm size (ha) (1)	6.3	5.5	6.2	5.0	11.3	10.1	15.9	4.4	9.8	c,e	
Total area cropped in 2004 (ha)	2.3	2.1	2.3	3.9	6.0	5.6	2.7	4.2	3.5		
Area total of tomato (ha)	0.4	1.3	0.6	1.6	3.7	3.3	1.0	1.8	1.4		
Area total of other vegetables (ha)	0.4	0.3	0.4	1.5	1.0	1.1	0.5	0.9	0.7		
Area total of grains (ha)	1.5	0.4	1.3	0.8	1.3	1.2	1.2	1.5	1.4		
Household size (Members)	5.1	2.7	4.7	6.8	4.1	4.6	4.7	4.8	4.7	a,b,f,g,h	
Adults	3.6	2.1	3.4	4.6	2.6	3.0	3.7	3.1	3.4	a,b	
Land-Labor ratio (Overall farm size/Adults)	1.75	2.55	1.84	1.09	4.33	3.38	4.34	1.40	2.91		a,c
Age of producer (years)	47	52	47	44	37	39	46	44	45	b,g,h,i	a,c
Experience with tomatoes (years)	9	2	8	18	13	14	10	13	12	a,d,f,g,h	a,b
Producer education (years of schooling)	6	12	7	4	6	5	5	6	5	a,g,h	
Female producer (%)	8	14	9	0	5	4	22	0	11	c,e,f	
Dependency ratio (%)	29	23	28	31	33	32	24	33	29	c	
House made with construction material (%)	97	100	98	80	76	77	58	90	75	c,e,h	a,b
Household has off farm income (%)	14	0	12	20	29	27	28	23	25	a,g,h	b
Household members with off farm income	0.14	0.00	0.12	0.20	0.52	0.46	0.33	0.30	0.32	a,g,h	a,b
Has means of transport (%)	14	71	23	20	29	27	22	18	20	a,f,g	
Cattle Stock (Heads)	4	0	4	1	6	5	6	2	4	c,g,h	

Table 1: Vertical Coordination Strategies in the Three Tomato Supply Chains

Supply chain transactions	Vertical Coordination Strategy				
	Spot Market	**Specifications Contract**	**Relation - based Alliance**	**Equity - based alliance**	**Vertical Integration**
Leading Supermarket Chain's (CSU) tomato Supply Chain:					
1) Between CSU (leading supermarket chain) & Hortifruti (Specialized wholesaler)				X	
2) Between Hortifruti (Specialized wholesaler) & Producers		X			
Second-Tier Supermarket Chain's (La Colonia) tomato Supply Chain:					
1) Between La Colonia (Second supermarket chain) & Two Specialized wholesalers			X		
2) Between Two Specialized wholesalers & Producers		X			
The Traditional Retailers' tomato Supply Chain.					
1) Between Traditional retailers & Public wholesale market	X				
2) Between Public wholesale market & Intermediaries	X				
3) Between Intermediaries & Producers	X				

CHAPTER 4: CONCLUSIONS

The development of supermarket procurement systems mean for producers market channels that have implemented more integrated coordination mechanisms and institutional arrangements with higher levels of control over the supply chains. Some supermarket chains rely on a dedicated/specialized wholesaler to handle either all produce or all cattle/beef operations. In the more integrated systems, enforcement of minimum levels of quality attributes and food safety standards are implemented and consistency of supplies are both coordinated and transposed to wholesalers and producers. Investments such as distribution and logistical systems are shifted upstream. As producers sell to supermarkets, they become part of a preferred supplier system where producers enter and coordinate a continuous supply of "the group" as oppose to their independent individual supply to spot markets.

Changes in the retail markets as reflected by the increase in market share of supermarkets do not necessarily mean that alternatives markets may not develop. In Costa Rica, and specific to the cattle supply chains, even when the supermarket sector increased substantially its share in overall food retail and the supermarket chains procurement systems shifted away from cattle auction markets (to avoid the additional brokering cost animal's stress), auction markets skyrocketed during the same period.

Although there are substantial requirements and significant payoffs to entering the supermarket channel as compared to the traditional market channel, it varies by product. In the case of cattle, scale and size do matter and there are only few producers in the supermarkets' preferred supplier list. This raises the question of what is going to happen

to the several hundreds of producers selling to traditional markets as supermarkets gain market share. Results show that when producers sell to the supermarket channel they face similar determinants as when selling to major export-oriented processors.

In the case of tomatoes, growers that sell to supermarket market channels face higher costs, stricter conditions and control, slightly higher prices, and technology with higher yields. The growers selling to supermarkets generate higher net incomes per hectare as compared to traditional market channels. There is no conclusive finding in terms of their technology type as while the leading chain is labor bias, the second tier is capital bias as compared to traditional channel.

Small farmers can access the supermarket channel if public/private support is available to them as well as organizational capital. However, there are substantial subsidies in the form of technical assistance, soft credit access, access to fixed assets in production and marketing. The challenge is to design or provide technical assistance in a way that the "producers access become sustainable overtime". Even when the volume of produce sold by supermarkets in Nicaragua is still small, these findings indicate the challenge to development programs to upgrade small farmers to have the capacity to participate in restructuring market channels, and to find alternatives for the majority who are unable to make the grade to participate in the new markets. Although this topic is beyond the scope of this dissertation, a sustainable market oriented model for poor small farmers is needed.

NOTES

[1] Note that in September 2005 Ahold sold its stake to Wal-mart.

[2] See Bardhan (1981) and Eswaran and Kotwal (1985) for theoretical treatment of these phenomena, and Swinnen (2004) for comparative illustrations of similar inter-linkages in Central and Eastern Europe.

[3] Such as in the case of Tate & Lyle global sugar company providing similar assistance to its farmers in Slovakia to resolve "idiosyncratically" (for its specific group of suppliers) the market failures those farmers faced in the technical assistance and credit and input markets; see Gow and Swinnen (2001)

[4] There are three possible reasons why La Colonia wholesalers do not require the producers in their preferred supplier lists to sort the tomatoes and only buy the top quality as Hortifruti does. The first is that those producers are located in more distant regions and so their availability of alternative markets for second quality tomatoes might generate important disincentives for producers, which indeed can generate moral hazard problems (selling the whole production to other markets). Second, some of the wholesalers' clients do not require only first quality tomatoes, which do not generate costly rejections downstream but additional gains. Third, by buying all the production they increase their capacities to arrange collateral payment for the potential risk generated of credit defaults of the producers in their preferred supplier lists. In some way, they make arrangements to maintain long term relations with the inputs supplier companies that provide credit to their farmers.

[5] We acknowledge that the traditional wholesale market existed long before either the term supply chain or the actions usually taken to be supply chain management existed, however we have used the name "supply chain" to reflect that it represents the center of traditional flow of tomatoes from producers to consumers.

[6] Note that the weights only take three values: $w_{j=1}= (q_1/p_1)$; $w_{j=2}=(q_2/p_2)$; $w_{j=3}=(q_3/p_3)$. The estimator requires the true population proportions be known: (1) q_1= population number of producers selling to CSU supply chain over total population targeted (43/369); (2) q_2= population of producers selling to La Colonia supply chain over total population (26/369); and (3) q_3= population of producers selling to traditional markets over total population target (76/369). Sample proportions to be known (1) p_1 = sample of producers selling to CSU supply chain over total sample (43/145); (2) p_2 = sample of producers selling to La Colonia supply chain over total sample (26/145); and (3) p_3 = sample of producers selling to traditional markets over total sample (76/145).

[7] In order to test explanatory differences between production functional forms two F tests were performed for the whole sample (as unfortunately our small sample does not let us performing this test by market channels). In the first test, the restricted form is represented by the Cobb Douglas production function and the unrestricted form is the quadratic production function. The F statistic gave a value of 2.06. In the second test, the restricted form is represented by the Cobb Douglas production function and the unrestricted form is the translog production function. The F statistic equals 1.67. The F value of 99% significance level is equal to 2.0938, hence we fail to reject in both cases the null hypothesis of the join equality of all parameters between the production functional forms, which means that there are no explanatory differences between the Cobb Douglas and quadratic and translog production functions.

[8] The non-labor variable inputs were calculated by multiplying the quantities (standardized to Kilograms) of each specific type of inputs times its price (standardized to Kilograms) and then aggregated by variable category.

[9] The three production functions are estimated using an OLS procedure. We found no evidence of heteroskedasticity after performing the Breusch-Pagan test.

[10] The F statistic for the Chow Test between Producers selling to CSU and La Colonia is 14.65. It is equal to 6.48 for the Chow Test between the producers that sell to the CSU and Traditional channels and equal to 3.92 between producers selling to La Colonia and traditional market channels. The F value of 99%

significance level is equal to 3.67, hence we reject in all cases the null hypothesis of the join equality of all parameters between the production functions.

[11] As economic efficiency is the result of both technical efficiency and allocative efficiency we look at both. Note that marginal physical productivity (MPP) is calculated by multiplying the input's market channel production function parameter times the market channel sample average output (tomato production) divided by the market channel input value sample average.

Subsequently, we calculated the input's marginal product value (MPV) by multiplying the MPP times the sample average tomato price.

[12] Land is the value in US$ of acquiring one hectare calculated from the full sample and presented as average for each supply chain in Table 7.

[13] Variable non-labor inputs include: fertilizers, chemicals foliars, insecticides, fungicides, herbicides aggregated by costs of all types.

[14] We are assuming that spot markets are unregulated, which is perhaps not always the case.

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

[16] A farmer selling to ICI is part of the supermarket supply chain, and those selling to the auction market are part of the traditional markets. Farmers in the large-scale processor supply chain are those that don't sell to ICI or to auction markets.

[17] Compensatory growth is defined as a phase of rapid growth following food restriction

[18] See above how the supply chains are defined.

[19] 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).

[20] 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.

[21] The price includes all cattle sales by category (female and male) over the last 2004 production season. Producers were asked to recall the average price at which they sold their cattle. Variation in price might be due to time variations within 2004.

[22] 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).

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.

Bardhan, P.K. (1991). A Note on Interlinked Rural Economic Arrangements. In Bardhan, P. (ed.) *The Economic Theory of Agrarian Institutions,* Oxford: Oxford University Press.

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.

Berdegué, J. A., Ramírez, E., and Faiguenbaum, S. (2005). *Fomento de la pequeña agricultura en Chile: Ideas para el debate público.* Serie Debates y Temas Agrarios 5. Rimisp: Santiago, Chile.

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.

Carter, M.R. and K.D. Wiebe. (1990). Access to Capital and Its Impact on the Agrarian Structure and Productivity in Kenya. *American Journal of Agricultural Economics,* 72(5):1146-1150.

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.

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.

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

Cosslett, S. R. (1981). Maximum Likelihood Estimator for Choice Based Samples. *Econometrica, 49* (5): 1289-1316.

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

Eswaran, M. and A. Kotwal (1985). A Theory of Contractual Structure in Agriculture. *American Economic Review* 75: 353-367.

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.

Heckman, J. (1979). Sample Selection Bias as a Specification Error. *Econometrica*, 47(1):153-162.

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..*

Hueth, B.M., Ligon, E., Wolf. S. and W. Wu. (1999). "Incentive Instruments in Agricultural Contracts: Input Control, Monitoring, Quality Measurement, and Price Risk," *Review of Agricultural Economics, 21* (2): 374-389.

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. and D. Runsten. 1999. "Contract Farming, Smallholders, and Rural Development in Latin America: The Organization of Agroprocessing Firms and the Scale of Outgrower Production." *World Development* 27 (February): 381–401.

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.

Lau, L.J. and P. Yotopoulos. (1971). A Test for Relative Efficiency and Application to Indian Agriculture," *American Economic Review*, 61(1), March: 94-109.

Leiva, E. F. (2004). *Nicaragua Retail Food Sector Nicaraguan Retail Food Sector 2004.* Global Agricultural Information Network Report # NU4001. USDA Foreign Agricultural Service. Washington DC: USDA.

Manski, F. C. and 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.

Sadoulet, E. and A. De Janvry (1995), *Quantitative Development Policy Analysis*, The John Hopkins University Press, Baltimore and London.

Schejtman, A. (1996) "Agroindustry and small-scale agriculture: conceptual guidelines for a policy to encourage linkage between them." Report LC/R.1660, Economic Commission for Latin America and the Caribbean, Santiago, Chile.

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.

Swinnen, J. (2004). Vertical Integration, Interlinking Markets, and Growth in Transition Agriculture. Paper presented at the European Association of Agricultural Economics Congress in Ghent on "Role of Institutions in Rural Policies and Agricultural Markets." September.

Thrupp, L.A. (1995). *Bittersweet Harvest for Global Supermarkets: Challenges in Latin America's Agricultural Export Boom,* Washington: World Resources Institute.

Vella, F. (1998). Estimating Models with Sample Selection Bias: A Survey. *Journal of Human Resources 33* (1), 127-169.

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