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RESEARCH

The Japanese Market for Imported Fruit Juices

Shiferaw T. Feleke and Richard L.Kilmer

Japan deregulated imports of fruit juices in early 1990s. Since then, the import penetration ratio (i.e. the fraction of income spent on imports or the increase in the extent of consumption of imports) of processed fruits into Japan has increased (JETRO). The deregulation of the fruit juice imports in the 1990s combined with rising income level have created an opportunity for the world's largest producers of fruit juice to expand their exports and raise market share. A fundamental understanding of the competition for market share involves market structure analysis (MSA) which explains the nature and extent of competition or the extent to which products are substitutes or complements. The identification of market structure is useful for assessing strategic opportunities, developing marketing programs, and assessing market share to evaluate performance (Vilcassim, 1989). The study was aimed at assessing the competition among major exporters of fruit juices into Japan and simulating the effect of the declining Japanese population growth rate on the demand for fruit juices. To this end, a differential consumer demand approach has been applied. Results indicate that most exporters can't increase market share through price reductions. Consequently, product promotion and product differentiation is a plausible option for most countries to stay competitive in Japan's fruit juice market. The demand for fruit juice in Japan will decrease over the period 2006 through 2020 for 11 of 18 fruit juice/country combinations because of negative population growth. Thus, the competition among countries in the Japanese fruit juice market will increase over time.

Implications of Trade Liberalization and Domestic Reforms on EU Agricultural Markets

Ellen Huan-Niemi , Leena Kerkeläb, Heikki Lehtonenc, and Jyrki Niemi

The objective of this paper is to explore the overall effects of further trade liberalization and the implemented CAP reforms on EU agricultural production, EU imports and EU exports within different EU regions by using the Global Trade Analysis Project (GTAP) model. The GTAP model is used to compare a lower tariff reduction formula (EU Proposal) with a higher reduction formula (US Proposal) in order to show how sensitive the examined agricultural commodity/sector is to the different tariff reduction formulae.

This analysis reveals that EU imports would escalate and EU exports would plummet with declining EU production because of trade liberalization and domestic policy reforms in the EU agricultural markets and sectors. The most striking impact of a steeper tariff reduction formula

(US Proposal) is that the quantity of EU imports doubles compared to a milder tariff reduction formula (EU Proposal). Trade liberalization and domestic policy reforms will cause production declines in the old EU member countries for all the examined agricultural products, whereas the new EU member countries may encounter production growth in some of the examined agricultural products. Bovine meat products, dairy products, and sugar may encounter the most drastic decline in exports. Moreover, the imports of bovine meat products and sugar may grow to extremely high levels due to trade liberalization, especially if the tariffs are reduced under the US Proposal: Finland may be flooded by imports of these products. In order to protect the domestic production of these products, the EU may designate sugar, bovine meat products, and dairy products as sensitive products in the WTO. However, aggregates are deceptive because the GTAP model could not include products at the level of detail at which tariff lines are specified (for example at the 8-digit level). Consequently, the assessment of EU agricultural products that are sensitive to trade liberalization cannot be precise in this study.

Farmer Acceptance of Genetically Modified Seeds in Germany: Results of a Cluster *Amos Gyau, Julian Voss, Achim Spiller, and Ulrich Enneking*

The use of biotechnology in agriculture is of minimal importance in German agriculture compared to other countries like the United States. However, with the eminent introduction of the Genetically Modified (GM) corn in Germany and other European countries, discussion on plant genetic engineering has assumed an increasing momentum recently. The main objective of this paper is to contribute to this discourse by segmenting 370 German farm managers according to their attitudes and expected decisions on the use of the GM seeds.

Cluster analysis based on a technology acceptance model revealed five main farmer groups. The results indicate that the farmers do not differ in terms of their level of farm size and age. However, significant differences were observed in terms of the level of education, with the more educated farmers showing a higher propensity for the use of GM seeds compared to their counterparts who have a lower level of education. Furthermore, the clusters were found to differ in terms of the level of informedness on biotechnology, willingness to take risks, and general attitude towards the use of GM seeds.

We conclude that the use of effective and tailored communication, risk management activities, and education could be an effective strategy that can be used by the biotechnology industry and other interest groups to promote the use of GM seeds in Germany.

Assessing Consumer Preferences for Organically Grown Fresh Fruit and Vegetables in Eastern New Brunswick *Morteza Haghiri, Jill E. Hobbs and Meaghan L. McNamara*

Despite increases in the share of organic produce in North America, very little is known about consumer preferences toward the consumption of organic fresh fruit and vegetables in the Maritimes region of Canada. Previous studies have assessed a number of factors determining consumer preferences toward organic products, often with contradictory results across different regions and different products. Region and product-specific analyses are therefore of great value to agri-food managers. This study examines consumers' willingness-to-pay a premium to purchase organically grown fresh fruit and vegetables in eastern New Brunswick, Canada. Three important points can be highlighted from the results of this research. i) the effects of socio-

economic and demographic variables on consumers' willingness-to-pay suggest that distinct consumer segments for organic fresh produce can be identified within this region, ii) many consumers in eastern New Brunswick appear to have little or no knowledge about various practices of organic farming, such as integrated-pest management, and iii) when making food choices, consumers in eastern New Brunswick tend to prioritize their health over the environment.

Are Traditional Cooperatives an Endangered Species? About Shrinking Satisfaction, Involvement and Trust *Jerker Nilsson, Anna Kihlén, and Lennart Norell*

Several studies indicate that traditionally organized cooperatives have had and are having difficulties in today's markets, which are increasingly characterized by intense international competition. Some researchers who have studied this issue explain the development in terms of members' attitudes and behavior. With the traditional cooperative model's emphasis on unallocated equity, the members may easily feel alienated by increasingly large cooperatives with their more complex structures.

This study empirically tests these member attitude and behavioral hypotheses in a traditionally-based large and complex agricultural cooperative. A survey was conducted among members of a Swedish cooperative in the farm supply and crop marketing industry. The data were analyzed by structural equation modeling, a statistical method that reveals underlying interconnections among answer variables.

The findings indicate that the members perceive the cooperative to be so large and complex that they have difficulties understanding operations. This gives rise to dissatisfaction and low involvement, as well as mistrust of the leadership. Moreover, the members do not believe that the cooperative can be remodeled to strengthen member control. Thus, findings support the behavioral explanations presented in prior studies.

In spring 2009, after the data for this study was collected, the board of the cooperative under study introduced a number of measures, intended to reform the business away from the traditional cooperative model. Two new types of shares were introduced, both of which are freely tradable and appreciable. Mass media in the agricultural sector reported that members have a positive attitude toward the innovations. The experiences from the spring and the summer 2009 are, however, not as positive. The members have shown only little interest in the new shares and only few shares are traded on the market for these shares.

Toward Better Defining the Field of Agribusiness Management
Desmond Ng and John W. Siebert

Despite the growth and interest in the agribusiness profession, what constitutes agribusiness management research continues to be a perennial debate. As the field of agribusiness management has historically operated within the larger profession of agricultural economics, some view that agribusiness management is the application of economic principles to the study of the agribusiness firm. Yet, Harling's (1995) survey found that 70% surveyed viewed economics and management as distinctly different disciplines. In fact, "99% agreed that more than production and cost functions were needed to understand a business" (Harling, 1995, p. 506). Hence, Harling (1995), as well as French et al. (1993), have thus argued that in order to

advance agribusiness management as a discipline, there is a distinct need for managerial explanations of firm behavior.

This study argues that the advancement of a field is predicated on defining a field's set of fundamental questions or issues because resolution of such issues serves to elevate the field to a high level of inquiry. As a result, in order to advance the domain, and thus role of agribusiness management in agricultural economics, this study examines four questions of strategy and outlines the pertinent theories used in resolving such concerns. The relevance and implications of each of these various explanations to the study of the agribusiness firm are also discussed. We conclude with the contributions and implications of this study.

World Soybean Production: Area Harvested, Yield, and Long-Term Projections *Tadayoshi Masuda and Peter D. Goldsmith*

Soybeans *(Glycine max)* serve as one of the most valuable crops in the world, not only as an oil seed crop and feed for livestock and aquaculture, but also as a good source of protein for the human diet and as a biofuel feedstock. World soybean production increased 4.6% annually from 1961 to 2007 and reached average annual production of 218 million tons in 2005-07. Two thirds of the growth was due to land expansion and one third to yield increases. The contribution of yield growth to production growth declined since the 1990s and not kept up with soybean demand growth. This has resulted in a significant increase in the demand for land on which to grow soybeans.

A Box-Jenkins ARIMA type univariate time series model that is exponentially smoothed and includes a damped trend is used to forecast land use, yield, and overall production at the country and continent level. Results present significant expansion of soybean production in Latin America, especially Argentina. Three forecast scenarios highlight the interplay between land use and yield and the challenge of meeting a forecasted world soybean demand of 317 million metric tons on a limited land base in the year 2030. Soybean producers will need an additional 47 million hectares, a 50% increase, at current yield growth levels. Under a high yield growth scenario though, producers actually require less land to meet demand than is currently being used for soybean production. Greater investment germplasm and agronomic research and development to intensify production will raise soybeans yields in both high and low yield soybean countries. Such investment, sensitive to environmental impacts, will reduce conversion pressures on native biomes and limit the expansion of agricultural lands.

Do Private Labels Generate Loyalty? Empirical Evidence for German Frozen Pizza *Nadine Wettstein, Stephan Brosig, Thomas Glauben, Jon H. Hanf, and Jens-Peter Loy*

The increase of private labels in the food market and retailers' high expenditures for establishing them raise a central question: Do consumers really consider private labels as "real" brands and develop loyalty towards them?

A necessary condition of brand loyalty is repurchase behaviour. Thus, in this paper we analyse a four-year panel data set on the frozen pizza purchases of 14,000 households to study differences in consumers' repurchase behaviour between two strong national brands and private labels. Thereby, we include the dynamic aspect of repurchase behaviour, which is an important extension of previous models. Additionally, we consider household characteristics. This

facilitates a classification between specific household segments and the influence of their characteristics on repurchase behaviour. Our results show differences between national brand and private label buyers. Moreover, we find that the effects of several household characteristics on repurchase behaviour differ between national brands and private labels. This provides insights useful for a number of areas in marketing and product management. As defined in the marketing literature, brand loyalty is only one source of repurchase behaviour. Some researchers point out that it is also important to consider underlying attitudes. Thus, the definition of "true" brand loyalty includes both a behavioural and an attitudinal component. Subsequently, this attitudinal component needs to be tested. But it cannot be observed directly by using panel data. We think that analysing cross-buying effects or consumers' tolerance towards price increases could be possibilities for future research.

Trade-offs between Shopping Bags Made of Non-degradable Plastics and Other Materials, Using Latent Class Analysis: The Case of Tianjin, China

Catherine Chan-Halbrendt, Di Fang, and Fang Yang

Tianjin, China's fifth largest city has severe environmental problems. One cause is the high prevalence of plastic bag usage. This is a problem occurring in China's other major cities as well. To curtail plastic bag consumption, a law requiring large retail stores in China to charge for bags was enacted on June 1, 2008. As a result, many plastic bag-manufacturing plants were closed. However, because of the wide spread usage of plastic bags, they are still being manufactured and consumed. The premise of this study is that the current cost of plastic bags, at 0.3 CNY, is too low to change customer's consumption behavior. The purpose of this study is to explore the attitude of people regarding the substitution of plastic bags with bags made from alternative materials, and their willingness to pay for such substitutes. This study used a conjoint choice experiment to measure Tianjin residents' preferences for degradable and non-plastic materials bags. The results show that most people do not like non-degradable plastic bags and would use bags made of other materials if they were sold at a reasonable price. Based on the latent class and socio-demographic segmentation results, there are material and price preference distinctions among age groups. Also, there are niche markets for paper, cloth, and degradable plastic bags where costs are of a lesser concern in consumer decisions. Bag manufacturers should capitalize on the market information provided in this study to maximize their revenues. Specifically, the age factor has a large influence on consumer preferences for the type of shopping bags. As a producer and marketer of bags, it might be a good strategy to discover where the different age groups shop. Large modern shopping malls are often frequented by the younger generations, which clearly prefer biodegradable plastics, according to this study. For a majority of the respondents cost was negatively correlated, as was expected, so it is crucial for bag manufacturers, which produce for large markets to be cost conscious. Although, from the study's results, some consumers are willing to pay more if the bags are made from environmentally friendly material.

CASE

Strategic Decision Making Under Uncertainty: Innovation and New Technology Introduction during Volatile Times

Michael Boehlje and Maud Roucan-Kane

This case study outlines the strategic, marketing, and organizational issues facing the farm machinery and equipment division of Deere and Company as it tries to continue to grow. Deere Ag Division is considering the development of products in the information domain, which encompasses many opportunities of breakthroughs or disruptive innovations to market to new or underserved customers. While these disruptive innovations face uncertainties and challenges (capabilities and capacities that may be beyond Deere's current skill set, a more intimate knowledge of potential new customers, which may not be the focal point of the current sales/marketing initiatives), they can also, if successful, generate more profits. Since these disruptive innovations do not compete with current Deere products (in many cases they are add-ons to existing products), they can also attract new customers and generate new sales.

Instructors can use this case to discuss uncertainties and tools to mitigate risk. Readers must think strategically about innovation and the uncertainties associated with each innovation project. Beyond a listing of uncertainties, readers are also challenged to think about ways to mitigate risk through the use of real options, an options portfolio, and organizational structure.

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The Japanese Market for Imported Fruit Juices

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Abstract

The objectives were to analyze the competitiveness of countries exporting fruit juices into Japan and simulate the effect of the negative Japanese population growth rate on fruit juice demand. The relative price version of the Rotterdam demand model was estimated for orange, grapefruit, other citrus, apple, pineapple and grape juices. Results indicate that most exporters can't increase market share through price reductions. Product promotion and product differentiation is a more plausible option. The growth of fruit juice demand in Japan is expected to decrease over the period 2006 through 2020 for 11 of the 18 fruit juice/country combinations because of negative population growth rate.

Keywords: competitiveness, fruit juice, Japan, Rotterdam model, population decline.

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Introduction

There has been a more rapid expansion of the global fruit market than the trade in other agricultural commodities, especially since the 1980s due to rising incomes, falling transportation costs, improved technology, and evolving international agreements (Huang 2004). As a major player in the global trade, Japan expanded its imports of fruit juices significantly after the mid-1990s when citrus and non-citrus juice import restrictions were liberalized. This has created a better opportunity for the world's largest producers of fruit juice to compete for market share.

A fundamental understanding of the competition for market share involves market structure analysis (MSA) which explains the nature and extent of competition or the extent to which products are substitutes or complements (Allenby 1989). In light of this, several studies have investigated the competition for market share of different products including fresh and processed fruits and vegetables [Lee, Seale, and Jierwiriyapant 1990; Sparks 1992; Lee, Brown, and Seale 1994; Brown 1993; Schmitz and Seale 2002]. Among these, Lee, Seale, and Jierwiriyapant (1990) and Schmitz and Seale (2002) deal with the competition for market share of fruits in the Japanese market. Lee, Seale, and Jierwiriyapant (1990) estimated Japan's import demand for citrus juice and fresh fruits. Results indicated that U.S. fresh grapefruit exports to Japan would have to compete against imports of bananas and pineapples for the Japanese import dollars, and that U.S. citrus juice exports would have to compete against juice imports from Brazil and Israel. Schmitz and Seale (2002) estimated different versions of the system-wide import demand for fresh fruits. Results indicated that exporters of grapefruit would benefit from an increase in expenditure on fresh fruit imports and a decrease in price while exporters of other fresh fruits such as bananas, oranges, lemons, and pineapple would suffer from a decrease in price of fresh fruits. Further, results indicated that oranges are substitutes for both grapefruit and lemons, and bananas and grapefruits are also substitutes.

Unlike most empirical studies including Lee, Seale, and Jierwiriyapant (1990) which have pursued the estimation of demand functions without first identifying the underlying market structure, we tested two plausible scenarios of market structure (i.e. non-uniformly competitive and uniformly competitive) and identified the underlying market structure for the Japanese fruit juice market before estimating the necessary parameters. This is consistent with Seale et al (2005) who assessed the degree of competition (i.e. market structure) among five fresh fruits at an aggregate level and two fresh fruits (banana and grapes) disaggregated by country of origin using the uniform Rotterdam model. Unlike Seale et al (2005), our study focuses on the fruit juice market (both citrus and non-citrus) disaggregated by country of origin and uses monthly data collected after the deregulation of the fruit juice market in the 1990s to avoid the possibility of biased parameter estimates due to structural changes.

Fruit juice managers can use the information from this research to assess the appropriateness of their marketing strategy. Their marketing strategy depends on the underlying market structure that describes the relationship among fruit juices within the same juice group and across different juice groups. Further, the identification of market structure is useful for assessing strategic opportunities in the fruit juice industry, for developing fruit juice marketing programs, and for assessing the market share of each fruit juice in order to evaluate performance (Vilcassim 1989).

The objectives of this article are (1) to assess the competitiveness of the world's largest exporters of fruit juice in Japan's market through the analysis of market structure and (2) to simulate the impact of changes in population growth on the growth rate of demand for fruit juices in Japan which has been undergoing a profound change as a result of its aging population. The analysis of market structure in marketing is concerned with identifying closely competing brands of the same product or competing products. To accomplish these objectives, the relative price version of the Rotterdam model was used. This model was chosen for its strong links to the economic theory of the consumer and global separability.

Global Fruit Trade

As a result of trade liberalization and technological advances in fruit transport and storage, the fruit industry is becoming more global in scope. The major players in the global trade of fruits are the European Union (E.U.), the North American Free Trade Agreement (NAFTA) countries, China and Japan.

The international trade in fruits is dominated by processed forms. Exports of fresh citrus fruits represent only 10% of total citrus fruit production (United Nations Conference on Trade and Development (UNCTAD)). Citrus fruits rank first in international fruit trade in terms of value. According to UNCTAD, international trade in citrus juice only started to increase in the 1940s, after World War II, when citrus processing technologies were invented and developed. The advent of frozen concentrated orange juice (FCOJ) after World War II provided a new impetus for the citrus industry (Spreen et al. 2006). Citrus fruit processing accounts for approximately one third of total citrus fruit production. More than 80% of citrus fruit processing is orange juice production. Orange juice is the most important of Japan's citrus juice imports. UNCTAD notes that the major feature of the world market for orange juice is the geographical concentration of production. The State of Florida in the U.S. and the State of Sao Paulo in Brazil are the two major players accounting for approximately 85 percent of the world's orange juice production. The juice is made into one of two product forms: bulk FCOJ or not-from-concentrate (NFCOJ). In order to reduce the volume, International trade in orange juice takes place in the form of FCOJ so that storage and transportation costs are lower. Nearly all of the FCOJ traded in the world is first concentrated to 65 degree or 66 degrees Brix (Spreen, et al. 2006). NFCOJ is single strength orange juice that is de-oiled with a centrifuge, then either pasteurized, chilled, and packaged or stored for future sale. Forms of Japan's imports of orange and other juices are available on http://www.customs.go.jp/english/tariff/2008_4/data/20.htm.

Most of orange juice imports by Japan come from Brazil whose exports account for over 70% of Japan's total imports of orange juice (Table 1). Brazil has a bulk orange juice storage terminal in Japan which allows it to ship juice in bulk rather than in drums and retail containers as used by U.S. producers.

The U.S. is the leading exporter of apple juice, grapefruit juice and grape juice to Japan. Thailand and Israel are the leading exporters of pineapple juice and other citrus, respectively.

Global Fruit Consumption

Higher income, urbanization, demographic shifts, improved transportation, and consumer perceptions regarding quality and safety are changing global food consumption patterns (Huang 2004). Diet diversification and increasing demand for better quality products have increased imports of high-value and processed food products in developed countries. Fruits are mainly consumed in industrialized countries, not only because consumers in these countries have high income levels but also because they have increasing concerns about healthy eating. However, the growth of per capita consumption of fruits in these countries seems to be stagnating. Over the period 1980 to 2003, the per capita consumption of citrus fruits (oranges, grapefruit and lemons and limes) in these countries grew at an average rate of one percent per annum (Food and Agriculture Organisation (FAO)). The average per capita consumption of oranges and Mandarins in industrialized countries over the period 1990 to 2003 is 29 kilograms while that of grapefruit and lemons and limes is 3.0 and 3.6 kilograms, respectively (FAO).

Table 1. Fruit juice imports to Japan by country of origin

Product	Exporter	%
Orange juice	Brazil	72.4
	U.S.	23.7
	ROW	3.9
Apple juice	U.S.	22.4
	China	18.9
	ROW	58.7
Grapefruit juice	U.S.	87.1
	Israel	9.6
	ROW	3.3
Grape juice	U.S.	46.9
	Argentina	11.7
	ROW	41.4
Pineapple juice	Thailand	42.4
	Philippines	27.6
	ROW	30.0
Other citrus juice	Israel	40.5
	Italy	21.8
	ROW	37.7

(Japan External Trade Organization (JETRO))

The average annual per capita consumption of oranges and apples in Japan over the period 1980 to 2003 is about 14 and 12 kilograms, respectively, while those of grapes and grapefruit are 2.8 and 2.5 kilograms, respectively (FAO). Japan's domestic supply of pineapples is heavily dependent on imports. In 2003, 95% of the domestic supply of pineapples came from imports (FAO). Japan is also heavily dependent on imports for its supply of lemons and limes. In terms of apples and grapes, the significance of imports has been increasing since the last decade during which the deregulation was in effect.

Materials and Methods

Theoretical framework

Consumption theory is amenable to the identification of market structure through the analysis of the change in marginal utilities of a certain product due to a change in consumption of a closely related product. The changes in marginal utilities depend on how consumers perceive a specific commodity from one country and the same commodity from another country. The decrease in marginal utility of one product with an increased consumption of another product implies that the products are substitutes and are thus in a competitive market structure. Otherwise, they are not substitutes (i.e., complements or independent) and are thus in a noncompetitive market structure. Substitute products can be uniform (close) or non-uniform (differentiated). Similarly, a competitive market structure can be uniformly competitive or non-uniformly competitive. A group of closely-related products are uniform substitutes when the cross effect of an additional dollar spent on one product on the marginal utility of another dollar spent on another product is the same for all pairs of products in the group (Brown, 1993). If two products imported from two different countries are uniform substitutes, consumers may not be influenced by the country of origin. Consequently, price will be the overriding factor in the decision of purchase. On the contrary, if two products are non-uniform substitutes, consumers may be influenced by the country of origin. They perceive the product from one country and the same product from another country as differentiated. Consequently, price will be just one factor affecting consumers' decision of purchase. Product attributes will be important criteria in consumers' decision of purchase.

In order to identify the type and degree of competition in the Japanese fruit juice market, we consider two plausible market structures.

Non-uniformly Competitive Market

This is a case where competition occurs between products such that the effect of a change in price of a given product on the demand for another product varies from product to product irrespective of their groups. In this market structure, consumers care about the country of origin of the product because the change in marginal utility of a dollar spent on product *i* caused by an extra dollar spent on product *j* is different from the change in the marginal utility of a dollar spent on product *k* caused by an extra dollar spent on product *j*. This means, for example, that the change in marginal utility of a dollar spent on Brazilian orange juice caused by an extra dollar spent on the rest of the world (ROW) orange juice is different from the change in marginal utility of a dollar spent on the U.S. orange juice caused by an extra dollar spent on the ROW orange juice. This implies that consumers may pay a different price for products of the same group since they perceive one product as differentiated from the other.

Uniformly Competitive Market

This is the case where the effect of a change in price of a product in one group on the demand for another product within the same group is the same for all pairs of products within that group. Further, the effect of a change in price of a product in one group on the demand for another

product which belongs to a different group is the same for all pairs of products in the two groups. This implies that consumers don't care about the country of origin of the product. This means, for example, that the change in marginal utility of a dollar spent on Brazilian orange juice caused by an extra dollar spent on the rest of the world (ROW) orange juice is the same as the change in marginal utility of a dollar spent on the U.S. orange juice caused by an extra dollar spent on the ROW orange juice. This suggests that consumers may not pay a different price for products of the same group since they perceive one product as homogenous to the other.

Empirical Model

In the field of demand analysis, the issue of selecting a model among competing functional forms has been addressed in a number of studies (Barten 1993; Eales et al. 1997). Economic theory does not suggest a criterion to choose ex ante between demand models. The choice of a functional form is at the interface of economic theory and the data. In other words, the functional form should satisfy the economic proprieties such as homogeneity and symmetry and fit satisfactorily to empirical data. Parsimony and flexibility are desirable properties considered in the selection of functional forms. The most common and parsimonious demand model, which dominated the import demand literature in the past, was the Armington trade model. However, the Armington trade model came to be increasingly criticized on both conceptual and empirical grounds. The hypothesis of separability and homotheticity may not be supported by import data (Alston et al. 1990). Traditional methods of implementing the Armington trade model result in theoretically and statistically inconsistent parameter estimates (Davis and Kruse 1993).

Consequently, system-wide demand models such as the Rotterdam model and the Almost Ideal Demand Systems (AIDS) have come to be popular in the contemporary import demand literature (Fabiosa and Ukhova 2000; Washington and Kilmer 2002). Barten (1993) demonstrates that the Rotterdam and AIDS models are special cases of a general demand model so that nested tests can be applied to choose either the Rotterdam or AIDS model or the hybrid of these two models (Central Statistical Bureau (CBS) and National Bureau of Research (NBR)). However, separability is an issue in estimating system-wide models (Seale 1996). The AIDS model is not globally separable and only becomes separable locally under stringent conditions (Lee et al. 1994). This will render multi-stage demand estimation difficult. We choose to use the Rotterdam model because of its global separability, its strong links with the economic theory of the consumer and its flexibility to apply it to aggregate data, which is the case in this study. Between the absolute and relative price version of the Rotterdam model, we choose the relative price version of this model because the relative price coefficients accounts for the specific price substitution effects that aid to identify specific market structures. The marginal expenditure shares and price coefficients of the Rotterdam model are assumed to be constant.

The Relative Price Version of the Rotterdam Model

Following Theil (1980), the relative price version of the Rotterdam model can be given as

$$(1) \qquad \overline{w}_{it} dq_{it} = \theta_i dQ_t + \sum_{j=1}^{N} v_{ij} \left(\frac{dp_{jt}}{dP_t} \right) + \varepsilon_{it}.$$

where $\overline{w}_{it} = \left(w_{it} + w_{i,t-12}\right)/2$ is the average expenditure share ; $dq_{it} = \log\left(q_{it}/q_{i,t-12}\right)$ is the finite change in quantity imported of product i; θ_i is the marginal expenditure share of product i; $dQ_t = \overline{w}_{1t}dq_{1t} + ... + \overline{w}_{Nt}dq_{Nt}$ is the finite change version of the Divisia price index (real income) ; v_{ij} is the relative (Frisch-deflated) price coefficients; $dp_{jt} = \log\left(p_{jt}/p_{j,t-12}\right)$ is the finite change in price of product j; $dP_t = \theta_1 dp_{1t} + ... + \theta_{1N}dp_{Nt}$ is the finite change version of the Frisch price index (the lower case p is for prices of individual products and the upper case P is for Divisia price indices); and ε_{it} is the demand disturbance.

The relative price version of the Rotterdam model is used to describe the non-uniformly competitive market structure. This model describes the nature and extent of competition between any two products irrespective of product group. Consumers treat each individual product as different from another.

Now, following Theil (1980) and Seale (2003) we impose a restriction on the relative price coefficients v_{ij} in equation (1) so that the effect of a change in price of a product in one group on the demand for another product in another group is the same for all pairs of products in the two groups. Further, we impose a similar restriction that the effect of a change in price of a product in one group on the demand for another product within the same group is the same for all pairs of products within that group. This implies that consumers will not care about the country of origin of the product when they choose between products within the same group. This model is called *block-wise dependent uniform substitute Rotterdam model* and will describe the uniformly competitive market structure. The block-wise dependent uniform substitute Rotterdam model can be given as

$$(2)\ \overline{w}_{it}dq_{it} = \theta_i dQ_t + \phi\theta_i\left(\frac{1-k_i\theta_i}{1-k_i\Theta_g}\right)\frac{dp_{it}}{dP_t} + \phi\sum_{j\neq i\in S_g}\frac{-k\theta_i\theta_j}{1-k\Theta_g}\frac{dp_{jt}}{dP_t} + \theta_i^{'}\sum_{h\neq g}V_{gh}\frac{dp_{ht}}{dP_t} + \varepsilon_{it},$$

where θ_i is the unconditional marginal expenditure share; $\theta_i^{'}$ is the conditional marginal expenditure share; V_{gh} is the group relative price coefficient defined as $V_{gh} = \sum_{i\in g}\sum_{j\in h} v_{ij}$ where $g \neq h$; Θ_g is the group marginal expenditure shares of group g defined as $\Theta_g = \sum_{i\in S_g}\theta_i$; ϕ is expenditure flexibility; k is a constant; and ε_i is the demand disturbance.

Data Sources

The sources of data for this study are the Statistics Bureau of Japan and Japan's Ministry of Finance. Monthly population data from January 1999 to December 2005 came from the web page (http://www.stat.go.jp/english/data/jinsui/2-2.htm) maintained by the Statistics Bureau of Japan's Ministry of Internal Affairs and Communications. The period 1999 through 2005 was chosen because we were interested in the effects of price and expenditure changes in the new deregulated/liberalized Japanese fruit juice market. We wanted to model the deregulated period which followed deregulation in the early 1990s. Import data came from the Trade Statistics of Japan that are published by the Ministry of Finance and the Customs under the provision of the Customs Law and the relevant international conventions. It is available on the web page

http://www.customs.go.jp. The monthly imports and expenditures on imports of orange, grapefruit, other citrus, apple, pineapple and grape juices were obtained for the period January, 1999 to December, 2005. The values of imports are on a cost, insurance and freight (CIF) basis, which include costs of the product, insurance and transportation. Unit import values, which proxy commodity prices, were obtained by dividing import values by import quantities. Fruit juices are imported into Japan in different levels of concentration and varying units of measure. In order to have a common unit, the different kinds of fruit juices were converted into single strength equivalent gallons (SSE).

Results and Discussion

Descriptive Results

Since Japan's deregulation of imports in the early 1990s, imports of fruit juices on average have increased with the exception of U.S. orange, grapefruit, apple, and grape juices (Table 2). Over the period January, 1999 to December, 2005, the imports of U.S. orange, grapefruit, apple, and grape juices has decreased on average by 22.1%, 2.4%, 21.0%, and 6.2% annually (i.e., from one month in year *t*-12 to the same month in year *t*). The highest average increase was attained by the ROW grapefruit juice (35.8%) followed by Israel grapefruit juice (26.1%), Chinese apple juice (23.6%), and ROW other juice (22.1%). The analysis of import stability as measured by the coefficient of variation shows that the import of fruit juices into Japan over the given period exhibited significant fluctuations. The fluctuation of imports varies from country to country. Imports of U.S. grapefruit juice and U.S. grape juice have experienced the highest fluctuations among U.S. fruit juices.

Table 2. Fruit juice quantity and price average log-changes, and expenditure shares, Japan, January 1999 to December 2005

Imports	**Quantity log-changes** $dq_i = \log(q_{it} / q_{i,t-12})$		**Price log-changes** $dp_i = \log(p_{it} / p_{i,t-12})$		**Expenditure shares** $(\overline{w}_i)$	
	Mean	SD	Mean	SD	Mean	SD
U.S. orange	-0.2206	0.6136	-0.0289	0.1851	0.0589	0.0318
Brazil orange	0.0667	0.8982	-0.0504	0.2038	0.2556	0.0888
ROW orange	0.1733	0.7871	0.0437	0.3829	0.0397	0.0209
U.S. grapefruit	-0.0240	0.5504	0.0548	0.3167	0.0880	0.0315
Israel grapefruit	0.2608	0.8909	0.0818	0.4276	0.0343	0.0166
ROW grapefruit	0.3579	1.1932	0.0481	0.7038	0.0169	0.0118
U.S. apple	-0.2102	1.0034	-0.0258	0.2131	0.0359	0.0274
China apple	0.2355	0.4799	-0.0730	0.2728	0.0881	0.0344
ROW apple	0.0225	0.2977	-0.0323	0.1687	0.1404	0.0275
Thailand pineapple	0.1925	0.8945	-0.0784	0.3494	0.0108	0.0066
Philippine pineapple	0.0958	1.7272	-0.0605	0.3560	0.0081	0.0041
ROW pineapple	0.1298	1.5415	-0.0546	0.5133	0.0090	0.0063
U.S. grape	-0.0615	0.4980	-0.0462	0.1842	0.0586	0.0260
Argentina grape	0.1897	1.0392	-0.0353	0.2356	0.0110	0.0075
ROW grape	0.0930	0.3860	-0.0427	0.1638	0.0755	0.0192
Israel other citrus	0.0167	0.4673	-0.0690	0.2435	0.0204	0.0055
Italy other citrus	0.1684	0.7460	-0.0687	0.2059	0.0189	0.0067
ROW other citrus	0.2206	0.5940	-0.0840	0.4184	0.0289	0.0133

Source: Study data

Over the same period, Japan's import price of all fruit juices has decreased for all juices except ROW orange juice, U.S. grapefruit juice, Israel grapefruit juice, and ROW grapefruit juice (Table 2). On average, Japan's import price of U.S. orange, apple and grape juices has decreased by 2.9%, 2.6%, and 4.6% per year (i.e., from one month in year *t*-12 to the same month in year *t*) over the period January, 1999 to December, 2005 and U.S. grapefruit juice increased 5.5%. Over the same period, other juice imported from ROW has witnessed the largest average annual price decrease (8.4%). Among U.S. products, prices of orange, grapefruit, and grape juices are the second most stable of the respective competitors' products. The price of U.S. apple juice is less stable compared to their respective rival products.

Except for Brazilian orange juice (25.6%) and the ROW apple juice (14.0%), the average expenditure share of fruit juices in Japan is below 10% (Table 2). Expenditure share of U.S. juices, expressed as a percentage of total fruit juice expenditure, ranges from 3.6% for apple juice to 8.8% for grapefruit juice.

Test for First-order Autocorrelation

A test for first order autocorrelation was carried out for equation (1) and equation (2), considering each model with and without autocorrelation as the unrestricted and restricted model, respectively. The result of the test indicates that the null hypothesis of no autocorrelation was rejected in both models, implying that the data is serially correlated. The value of ρ, which is common across equations in each system, is 0.24 for equation (1) and 0.29 for equation (2). Both are significantly different from zero at the 0.001 level.

Selection of the Model that Best Identifies the Market Structure

Having corrected for first-order autocorrelation, we conducted a likelihood ratio test to select the model that best identifies the market structure of the Japanese fruit juice market. The identification of the market structure involves a comparison between the relative price version of the Rotterdam model (equation (1)) and the block-wise uniform substitute-Rotterdam model (equation (2)). The block wise dependent uniform substitute model is a restricted model and represents the uniformly competitive market structure while the relative price version of the Rotterdam model is an unrestricted model and represents the non-uniformly competitive market structure. The log likelihood value of the unrestricted equation (equation 1) is 3744.5 while that of the restricted equation (equation 2) is 3614.8. The value of the model chi-square is 259.4 with 132 degrees of freedom which is greater than the critical chi-square value at 1% probability level.

Therefore, we reject the restricted equation (2). The competition between any two products in two different product groups or within the same product group is not the same for all pairs of products in the two groups or within the same group. This means that the change in marginal utility of a dollar spent on a product in one product group caused by an extra dollar spent on another product in another product group is not the same for all pairs of products in the two groups. Furthermore, the change in marginal utility of a dollar spent on a product caused by an extra dollar spent on another product is not the same for all pairs of products within the same group. This implies that consumers are influenced by the country of origin and thus decide to

Table 3. Parameter estimates (v_{ij}) of cross prices of fruit juices in Japan

	Estimates	SE
U.S. orange/Thailand pineapple	0.0209***	0.0056
U.S. orange/Philippine pineapple	0.0205***	0.0050
U.S. orange/Argentine grape	-0.0149***	0.0060
U.S. orange/Israel other citrus	-0.0146***	0.0056
Brazil orange/ROW orange	-0.0447*	0.0236
Brazil orange/U.S. grapefruit	-0.1147***	0.0354
Brazil orange/ROW grapefruit	-0.0473**	0.0197
Brazil orange/China apple	-0.1200***	0.0378
Brazil orange/ROW apple	-0.1074***	0.0413
Brazil orange/Thailand pineapple	-0.0225**	0.0111
Brazil orange/ROW pineapple	0.0429***	0.0159
Brazil orange/ROW grape	-0.0513*	0.0275
Brazil orange/Israel other citrus	-0.0192**	0.0095
ROW orange/ROW grapefruit	0.0097***	0.0032
ROW orange/ROW apple	0.0195**	0.0094
ROW orange/U.S. grape	0.0128*	0.0069
ROW orange/Israel other citrus	0.0049*	0.0026
ROW orange/Italy other citrus	0.0074**	0.0034
ROW orange/ROW other citrus	0.0069**	0.0034
U.S. grapefruit/ROW grapefruit	0.0124***	0.0047
U.S. grapefruit /U.S. apple	0.0217*	0.0119
U.S. grapefruit /Thailand pineapple	-0.0160***	0.0037
U.S. grapefruit /Philippine pineapple	-0.0144***	0.0033
U.S. grapefruit /Argentina grape	0.0092**	0.0039
U.S. grapefruit/ROW grape	0.0215***	0.0087
Israel grapefruit/China apple	0.0164**	0.0079
Israel grapefruit /Argentina grape	0.0070**	0.0030
Israel grapefruit /Israel other citrus	-0.0082***	0.0025
ROW grapefruit/Italy other citrus	-0.0056***	0.0020
U.S. apple/ROW pineapple	-0.0104*	0.0057
U.S. apple /Argentina grape	-0.0216***	0.0049
U.S. apple/Italy other citrus	0.0104*	0.0058
U.S. apple/ROW other citrus	0.0127**	0.0061
China apple/U.S. grape	0.0182*	0.0095
ROW apple/Thailand pineapple	-0.0181***	0.0060
ROW apple/Argentina grape	0.0201***	0.0065
Thailand pineapple/ROW grape	0.0163***	0.0051
Thailand pineapple/Israel other citrus	0.0055**	0.0024
Philippine pineapple/Argentina grape	0.0061***	0.0021
Philippine pineapple/ROW grape	0.0072*	0.0043
Philippine pineapple/ROW other citrus	0.0037**	0.0019
ROW pineapple/Argentina grape	0.0060***	0.0020
U.S. grape/Israel other citrus	0.0122***	0.0047
Argentina grape/Italy other citrus	-0.0061*	0.0034
Argentina grape/ROW other citrus	-0.0068***	0.0022
Rho	0.2443***	0.0276

Note: *** (**)* significance at 1%, 5% and 10% (*t* statistic). Only statistically significant parameter estimates presented. Number of Observations = 83; Log Likelihood = 3744.50; Schwartz B.I.C. = -3124.45.

buy a given fruit juice based on the country of origin. In other words, product attributes are factored into the decision of purchase. Therefore, based on results of the likelihood ratio test we select the relative price version of the Rotterdam model (equation (1)) (Table 3) and hence the *non-uniformly competitive* market structure as the underlying market structure of the Japanese fruit juice market. This is consistent with Seale et al (2005) who showed that the fresh market for grapefruit, oranges, lemons, pineapples, and berries are not uniform substitutes. However, in contrast to our results, Seale et al. (2005) found that bananas and grapes disaggregated by country of origin are uniform substitutes.

Expenditure Elasticities

The expenditure elasticities are calculated at the sample means of expenditure shares of the respective imported fruit juices. The estimates of the expenditure elasticities are all positive except for ROW pineapple juice and U.S. grape juice which are both negative and insignificant (Table 4). Among the 18 fruit juices, only the demand for Brazilian orange juice is expenditure elastic (3.0997). This is due to the higher expenditure share of Brazilian exports (25.6%) (Table 2). Given that Brazilian orange juice makes up the larger proportion of the total imports of fruit juices into Japan, a one percent increase in expenditure on imported fruit juices results in a far greater increase in actual imports of Brazilian orange juice. Furthermore, Brazil's orange juice market share would increase further upon the expansion of the Japanese market of imported fruit juices over time. However, under conditions in which the economy slows down (expenditure growth slows down) Brazil will be worse off because a given percentage decrease in expenditures on imported fruit juices results in a far greater decrease in actual imports. Brazil's orange juice market share would decrease further upon the contraction of the market of imported fruit juices over time because of its larger expenditure elasticity. Since recession has been more frequent in Japan over the past few years, Brazil needs to devise an effective export strategy

Table 4. Expenditure elasticity estimates of fruit juices in Japan

Product	Estimate	SE
U.S. orange	0.2939	0.2074
Brazil orange	3.0997***	0.1686
ROW orange	0.1096	0.1895
U.S. grapefruit	0.5301***	0.1358
Israel grapefruit	0.0579	0.3008
ROW grapefruit	0.7593**	0.3881
U.S. apple	0.6132	0.4104
China apple	0.4265***	0.1437
ROW apple	0.1851**	0.0939
Thailand pineapple	0.5132*	0.3176
Philippine pineapple	0.2085	0.3848
ROW pineapple	-0.6668	0.5479
U.S. grape	-0.0003	0.1716
Argentina grape	0.0737	0.3239
ROW grape	0.2553**	0.1161
Israel other citrus	0.4891***	0.1446
Italy other citrus	0.0219	0.2187
ROW other citrus	0.24589	0.1847

*** (**)* significance at 1%, 5% and 10%

which takes account of the performance of the economy. The fact that the demand for U.S. major fruit juice exports (orange, grapefruit, apple and grape juices) is expenditure inelastic or perfectly inelastic implies that a reduction in Japanese expenditures on fruit juices has a smaller effect on U.S. juice exports to Japan than on Brazilian orange juice exports to Japan.

Because of the lack of similar studies on demand for fruit juices, it is difficult to make direct comparison and contrast with our estimates which were made under different circumstances involving use of a large sample of monthly data disaggregated by country of origin while others have used aggregate data that has not taken account of the country of origin. Further, there are differences in the underlying market structure, the assumption of separability as well as the number of possible substitutes, which are all important determinants of elasticity. Given these caveats, Schmitz and Seale (2002) estimated that the expenditure elasticity of the Japanese import demand for fresh grapefruits is 2.29 and that of fresh pineapple is 1.16 while the expenditure elasticity of the Japanese import demand for fresh bananas, fresh oranges and fresh lemons is 0.58, 0.91 and 0.87, respectively. Similarly, Lee, Brown and Seale (1992) estimated that the expenditure elasticity for the Canadian import demand for fresh oranges, fresh apples, orange juice and apple juices estimated under the assumption of strong separability are 1.37, 1.11, 1.30 and 1.80, respectively. The estimates of the expenditure elasticity of the Canadian import demand for fresh grapefruit, bananas and tomato juice is perfectly expenditure inelastic.

Population Growth

The growth of population is another major factor anticipated to affect the demand for imported fruit juices in Japan as a result of its aging population. The population growth of Japan turned negative in 2006 (Statistics Bureau of Japan). With per capita income growing at 2% per annum and assuming that the growth will remain at 2% until 2020, the growth of demand for fruit juices imported into Japan is projected in Table 5 (See Appendix 1). The growth of demand for fruit juice in Japan is positive for all juices that have expenditure elasticity significantly different from zero (Table 4) except ROW apple juice which switches from a positive growth rate to a negative growth rate in 2017 because the decrease in population outweighs the positive expenditure elasticity (Table 4). Products which have statistically significant positive expenditure elasticities will continue to grow at a declining growth rate through 2020 regardless of the negative growth of population except for ROW apple juice as previously explained. Brazilian orange juice is the least affected of all the juices because its growth rate starts out at a relative high rate in 2006 (6.20%) and declines to 5.71% by 2020 despite the negative population growth. The remaining juices that have a statistically significant positive expenditure elasticity (Table 4) will decline to a 1.03% growth rate or lower by 2020. Juices with zero expenditure elasticity (i.e., statistically insignificant expenditure elasticity) have a declining negative growth rate that is identical to the declining negative growth rate of Japan's population.

These simulations were made under the assumption that the growth of per capita income will remain constant at 2% per annum over the period 2006 through 2020. The prospect of the growth of demand for fruit juices will depend on the growth of per capita income relative to the decline in growth of the population. The 2% growth of per capita income along with a statistically significant positive expenditure elasticity will offset the decrease in population growth so that the decline in the growth of demand may be slowed. If income grows at more than 2%, the decline in the growth of juice demand will be further slowed even though population growth is negative.

Own-price Elasticities

In order to assess the responsiveness of Japan's imports to changes in price, uncompensated and compensated own-price elasticities were calculated. Results indicate that uncompensated own price elasticities of demand for fruit juices in Japan are all negative and statistically different from zero (Table 6). Among the 18 fruit juices, only U.S. orange juice, ROW orange juice, Philippine pineapple juice, and Italian other citrus juice are uncompensated price elastic. Of these, the demand for Philippine pineapple juice is the most price elastic (-2.9525) followed by ROW orange juice (-1.7702), U.S. orange juice (-1.5591), and Italian other citrus juice (-1.4134). The demand for ROW grape juice (-0.9881) and ROW other citrus juice (-0.9745) can be rounded to unitary price elastic.

Table 6. Own price elasticities of fruit juices in Japan

Product	**Uncompensated own price elasticities**		**Compensated own price elasticities**	
	Estimate	SE	Estimate	SE
U.S. orange	-1.5591***	0.0122	-1.5417***	0.0244
Brazil orange	-0.7619***	0.0431	0.0303	0.9073
ROW orange	-1.7702***	0.0075	-1.7658***	0.0056
U.S. grapefruit	-0.7912***	0.0119	-0.7445***	0.0430
Israel grapefruit	-0.4533***	0.0103	-0.4513***	0.0040
ROW grapefruit	-0.8995***	0.0065	-0.8867***	0.0338
U.S. apple	-0.7941***	0.0147	-0.7721***	0.0614
China apple	-0.4717***	0.0126	-0.4341***	0.0366
ROW apple	-0.3531***	0.0132	-0.3270***	0.0165
Thailand pineapple	-0.8989***	0.0034	-0.8933***	0.0119
Philippine Pineapple	-2.9525***	0.0031	-2.9509***	0.0044
ROW pineapple	-0.6133***	0.0049	-0.6193***	0.0225
U.S. grape	-0.9010***	0.0100	-0.9010***	0.0000
Argentina grape	-0.3225***	0.0035	-0.3217***	0.0018
ROW grape	-0.9881***	0.0087	-0.9688***	0.0152
Israel other citrus	-0.4310***	0.0029	-0.4210***	0.0098
Italy other citrus	-1.4134***	0.0041	-1.4130***	0.0006
ROW other citrus	-0.9745***	0.0053	-0.9674***	0.0089

*** significance at 1%

These results indicate that exporters of U.S. orange juice, ROW orange juice, Philippine pineapple juice, and Italian other citrus juice can increase market share and increase total revenue by decreasing market prices. On the other hand, the remaining juices with inelastic price elasticity will increase market share and reduce total revenue if they increase price. Thus, different marketing strategies should be employed depending on the price elasticity of demand for a firm's juice.

Results indicate that the absolute value of the uncompensated price elasticities of most of the fruit juices is higher than those of the respective compensated price elasticities. However, the magnitude of the difference between the two elasticities is very small. An exception is the uncompensated price elasticity of Brazilian orange juice which is -0.7619 while that of compensated price elasticity is zero. This large difference is due to a large income effect. This is apparent in the large expenditure elasticity for Brazilian orange juice (3.0997).

These estimates are not directly comparable with any published studies; however, Lee, Seale, and Jierwiriyapant (1990) and Lee, Brown and Seale (1992) did look at fruit juices. Lee, Seale, and Jierwiriyapant (1990) citrus juice imports into Japan were an aggregation of orange juice, grapefruit juice and all other citrus juices. Using annual data, they found that the compensated own price elasticity for Brazil was -1.822 compared to zero for this study which used monthly data. The elasticity for the U.S. was not statistically different from zero compared to -1.5417 for this study. Lee, Brown and Seale (1992) showed that the compensated price elasticity of demand for orange juice and apple juice imported into Canada are perfectly price inelastic (i.e., not different from zero). The variation in estimates of the elasticities is due to the difference in the number of available substitutes, market structure and proportion of income spent on a good. Since we have several substitutes and imports of the same product and competing product from different countries are close substitutes, we expect our estimates to be higher than those estimated under other circumstances such as when products are assumed to be strongly separable, not disaggregated by country and only few substitutes are available.

Cross-price Elasticities

Like the case with own price elasticities, two types of cross-price elasticities, uncompensated and compensated, were calculated at the mean values of expenditure shares over the period January 1999 to December, 2005 in Tables 7 and 8 (See Appendix 2 and 3). Results indicate that more uncompensated cross price elasticities are statistically significant than compensated price elasticities for substitutes and complements which indicates that the expenditure effect on consumption is greater than zero. Also, most substitutes and complements are price inelastic. Furthermore, there are more uncompensated substitutes (54.2%) (Table 7) than uncompensated complements (40.2%) (Table 8) and 5.6% are independent.

This indicates that the fruit juice market is competitive with 54.2% or 166 of the product combinations being substitutes (Table 7). Of the uncompensated substitutes, juices within the same product group (e.g., U.S. orange juice and Brazilian orange juice) and among product groups (U.S. orange juice and Israel grapefruit juice) are substitutes for one another. This is consistent with the market structure hypothesis when the non-uniformly competitive market structure was statistically found to be the underlying market structure of the Japanese fruit juice market. Given the 166 (123) uncompensated substitute (complement) combinations, five (six) are greater than 1.0. This indicates that price changes do not make large percentage changes in the quantity or market share of substitutes or complements because most are inelastic. Furthermore, of the uncompensated substitutes (complements) that are inelastic, only 16 (11) are between the absolute value of 0.5 and unitary elasticity. This indicates that 87.3% (86.2%) of the substitutes (complements) are less than the absolute value of 0.5, very inelastic.

Substitutes

The substitutes that are elastic include Thailand pineapple (*i*)/U.S. orange juice (*j*) ($\varepsilon_{ij} = 1.9386$) ($\varepsilon_{ji} = 0.3583$), Thailand pineapple/ROW grape juice (1.5037) (0.2182), Philippine pineapple/U.S. orange juice (2.5281) (0.3484), ROW pineapple/Brazil orange juice (3.0933) (0.0758), and Argentina grape/ROW apple juice (1.8113) (0.1416). However, when the reverse is true (e.g., U.S. orange/Thailand pineapple juice), the price change brings about a smaller

percentage change in quantity which is inelastic. This indicates that the juices are not perfect substitutes and consumers prefer the inelastic product more than the elastic product. Consumers are less willing to reduce consumption of the inelastic product even though the price of the substitute product has decreased. For example, consumers decrease their consumption of U.S. orange juice (Thailand pineapple juice) by 0.3583% (1.9386%) when the price of Thailand pineapple juice (U.S. orange juice) is decreased by 1% (1%). Finally, the most volatile product is pineapple juice where four of the five elastic substitutes are pineapple juice from different countries.

Of the 16 substitutes with an elasticity between 0.5 and 1.0, five are pineapple juice, 4 are grape juice, three are other citrus juice, two are grapefruit juice, one is orange juice and one is apple juice. When this is combined with the five substitutes greater than 1.0 for a total of 21 substitutes with an elasticity greater than 0.5, nine are pineapple juice and 5 are grape juice for a total of 14 or two-thirds of the elastitites greater than 0.5. This is further evidence that pineapple juice is the most volatile product (the largest percentage quantity changes) and grape juice is next. The remaining substitutes (145 country product combinations) are inelastic and have country product *i*/country product *j* combinations similar to those already discussed plus some ε_{ij} and ε_{ji} combinations that are approximately equal.

Each country product (i.e., U.S. orange juice, U.S. grapefruit juice, etc.) has between 7 and 11 substitutes except Brazil orange juice (3) and ROW orange juice (14). Brazil orange juice (ROW orange juice) has the fewest (most) substitutes of any country juice combination. The substitutes for Brazil orange juice are Brazil orange (*i*)/U.S. orange juice (*j*) ($\varepsilon_{ij} = 0.0490$) ($\varepsilon_{ji} = 0.9300$), Brazil orange/ROW pineapple juice (0.0758) (3.0933), and Brazil orange/Italy other citrus (0.0123) (0.9531). When the substitutes change their price, the quantity of Brazil orange juice changes between 0.0123% and 0.0758%; however, when the reverse is true (e.g., U.S. orange/Brazil orange juice), a Brazil price change brings about a quantity change in the substitutes between 0.9300% and 3.0933%. This indicates that Brazil orange juice is the preferred juice among the four juices. A price decrease by substitutes decrease Brazil orange juice (the substitute's) consumption by a smaller (larger) quantity percentage.

ROW orange juice has the most substitutes (14) (Table 7). This makes the competition between ROW orange juice and 14 out of 17 other country juices the most competitive (in terms of the number of juices) in the juice market; however, the cross-price elasticities (ε_{ij} and ε_{ji}) range from 0.5562 to almost zero. Thus the quantity impacts from price changes are relatively small.

Complements

Country product combinations that are complements (123) have six complements which have cross-price elasticities that are less than -1.0 (elastic). These include Thailand pineapple (*i*)/U.S. grapefruit juice (*j*) ($\varepsilon_{ij} = -1.4462$)($\varepsilon_{ji} = -0.1779$), Thailand pineapple/ROW apple juice (-1.7002)(-0.1274), Philippine pineapple/U.S. grapefruit juice (-1.7631)(-0.1656), ROW pineapple/U.S. apple juice (-1.1774)(-0.3096), Argentina grape/U.S. orange juice (-1.3483)(-0.2558), and Argentina grape/U.S. apple juice (-1.9527)(-0.6081)(Table 8). However, when the reverse is true (e.g., U.S. grapefruit/Thailand pineapple juice), the price change brings about a smaller percentage change in quantity which is inelastic. This indicates that the juices are not

perfect complements and consumers prefer the inelastic product more than the elastic product (i.e., U.S. grapefruit juice quantity changes by a smaller percentage (0.1770) than Thailand pineapple juice quantity which changes by a larger percentage (1.4462)). Consumers want more stability in U. S. grapefruit consumption than Thailand pineapple juice consumption. Finally, the most volatile product is pineapple juice where four of the six elastic complements are pineapple juice. Grape juice is the remaining two elastic complements.

Of the 11 complements with an elasticity between -0.5 and -1.0, orange juice, grapefruit juice, apple juice, pineapple juice, and grape juice have two complements each and other citrus juice has one. When this is combined with the six elastic complements for a total of 17 complements with an elasticity less than -0.5, six are pineapple juice and four are grape juice for a total of 10 or 58.8% of the elasticites less than -0.5. This is further evidence that pineapple juice is the most volatile product (the largest percentage quantity changes) and grape juice is next. The remaining complements (106 country product combinations) are inelastic and have country product *i*/country product *j* combinations similar to those already discussed plus some ε_{ij} and ε_{ji} combinations that are approximately equal.

Each country product (i.e., U.S. orange juice, U.S. grapefruit juice, etc.) has between 4 and 8 complements except ROW orange juice (3) and Brazil orange juice (14). This is the opposite of what was found in juice substitutes as Brazil orange juice (ROW orange juice) had the fewest (most) substitutes of any country juice combination. The complements for ROW orange juice are ROW orange (*i*)/Brazil orange juice (*j*) (ε_{ij} = -0.8570) (ε_{ji} = -0.2522), ROW orange/Thailand pineapple juice (-0.0222) (-0.0976), and ROW orange/Philippine pineapple juice (-0.0698) (-0.3453). When the complements change their price, the quantity of ROW orange juice changes between 0.0222% and 0.8570%; however, when the reverse is true (e.g., U.S. orange/Brazil orange juice), a ROW price change brings about a quantity change in the complements between 0.0976% and 0.3453%. This indicates that ROW orange juice is the preferred to Philippine pineapple juice, not preferred to Brazil orange juice, and about equal with Thailand pine apple juice.

Brazil orange juice has the most complements (14) (Table 8). This makes the relationship between Brazil orange juice and 14 out of 17 other country juices a complementary relationship in the juice market. When the Brazil orange price is changed and the 14 juice prices remain constant, nine of the complements remain complements, one complement becomes an independent, and four complements become substitutes. This indicates that when the 14 juices individually change their price, consumers increase or decrease their consumption of Brazil orange juice along with the increase or decrease in the quantity of the other 14 juices. When the price of Brazil orange juice is changed however, consumers treat nine of the complements as complements, one complement becomes an independent, and four complements become substitutes. Consumers view Brazil orange juice in different ways when the price of Brazil orange juice is changed. Brazil orange juice is a preferred juice product in Japan.

Conclusions and Implications

The purpose of this study was to assess the competitiveness of the world's largest exporters of fruit juice into Japan through the analysis of market structure. The analysis of market structure in

marketing is concerned with identifying closely competing brands of the same product. To this end, we tested two plausible scenarios of market structures (i.e. non-uniformly competitive and uniformly competitive) within the context of consumer demand theory and selected the non-uniformly competitive market structure as the underlying Japanese fruit juice market structure. The identification of fruit juice market structure is useful for assessing strategic opportunities, developing marketing programs, and assessing market share to evaluate performance (Vilcassim, 1989). Further, the appropriateness of marketing strategy depends on the relationship between products within the same product group and across different product groups.

Results of the study have important implications to countries exporting fruit juices to Japan for making marketing strategies such as price reduction, product differentiation as well as an export supply plan in light of the expansion and contraction of the Japanese market for imported fruit juices because of the change in income and declining population. Given that the effectiveness of a supply plan in raising market share through export expansion depends on the estimates of expenditure and price elasticities, the country which benefits the most from the growth of income in Japan is Brazil. Brazilian orange juice has the highest expenditure elasticity and expenditure share in Japan's market. An increase in Japan's expenditure on imported fruit juices results in a far greater increase in actual imports of Brazilian orange juice than any other country.

Consequently, Brazilian expenditure share will increase upon the expansion of the Japanese market of imported fruit juices over time. However, under conditions in which expenditure growth slows, Brazil will be worse off because a decrease in expenditure on imported fruit juices results in a far greater decrease in actual imports and its market share will decrease upon the contraction of the market of imported fruit juices over time. Hence, Brazil needs to have an export strategy which takes account of the performance of Japan's economy.

In addition to expenditures, the growth of population is another major factor anticipated to affect the demand for imported fruit juices in Japan. The Japanese population growth peaked in 2005 and turned negative in 2006. The growth of fruit juice demand in Japan is expected to decrease over the period 2006 through 2020 for 11 of the 18 fruit juice/country combinations because of negative population growth rate.

Given that the demand for the U.S. orange juice, ROW orange juice, Philippines pineapple juice and Italy other citrus juice is price elastic, price discounting can be an effective tool for the U.S., ROW, Philippines, and Italy fruit juice industry in expanding their exports to Japan. Since the demand for other country juice combinations are price inelastic, export supply expansion through price-oriented marketing strategies, trade negotiations or other marketing activities that involve reduction of prices will negatively impact the other exporting countries. These other countries should reduce their cost of production, processing, and marketing so that they can stay more competitive in Japan's import market.

The degree of competition depends on the magnitude of cross price elasticities. Given that the cross price elasticities of most of the juices imported into Japan are below one, an exporter can't take market share from another exporter quickly through price reductions. A notable exception is the U.S/Brazilian orange juice. A decrease in the price of Brazilian orange juice has a significant negative impact on the demand for U.S. orange juice but not vice versa. However,

since the demand for Brazilian orange juice is price inelastic, Brazil does not have a reason to decrease price under the current market structure. Therefore, the U.S. citrus industry should pay close attention to the development of the Brazilian citrus industry. Assume, for example, that Brazil becomes more competitive through non-price competition such as product promotion. Unless there is a similar response by the U.S. citrus industry, there may be adverse effects on the demand for U.S. orange juice. Generally, because of the low cross price elasticities of fruit juices in Japan, product promotion and further product differentiation is a more plausible option for most countries to stay competitive in Japan's fruit juice market.

Fruit juice managers can use the information in this article to assess strategic opportunities in the fruit juice industry such as identifying which fruit juice/country combinations their company is competitive with and which countries they complement and are not competitive with. These results will help managers decide whether a price competitive strategy or a non-price competitive strategy is the most appropriate fruit juice marketing program. Furthermore, the results will help managers identify who their competitors are in a market in order to assess the market share of each fruit juice competitor in order to evaluate performance.

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Appendix 1.

Table 5. Projected growth estimates (%) of the demand for fruit juices in Japan.

Year	Population growth rate[a]	Orange Juice			Grapefruit juice			Apple			Pineapple juice			Grape juice			Other juice		
	Percent	U.S.	Brazil	ROW	U.S.	Israel	ROW	U.S.	China	ROW	Thailand	Philippine	ROW	U.S.	Argentina	ROW	Israel	Italy	ROW
2006	-0.01	-0.01	6.20	-0.01	1.06	-0.01	1.52	-0.01	0.85	0.37	1.03	-0.01	-0.01	-0.01	-0.01	0.51	0.98	-0.01	-0.01
2007	-0.05	-0.05	6.15	-0.05	1.01	-0.05	1.47	-0.05	0.80	0.32	0.98	-0.05	-0.05	-0.05	-0.05	0.46	0.93	-0.05	-0.05
2008	-0.10	-0.10	6.10	-0.10	0.96	-0.10	1.42	-0.10	0.75	0.27	0.93	-0.10	-0.10	-0.10	-0.10	0.41	0.88	-0.10	-0.10
2009	-0.14	-0.14	6.06	-0.14	0.92	-0.14	1.38	-0.14	0.71	0.23	0.89	-0.14	-0.14	-0.14	-0.14	0.37	0.84	-0.14	-0.14
2010	-0.17	-0.17	6.03	-0.17	0.89	-0.17	1.35	-0.17	0.68	0.20	0.86	-0.17	-0.17	-0.17	-0.17	0.34	0.81	-0.17	-0.17
2011	-0.21	-0.21	5.99	-0.21	0.85	-0.21	1.31	-0.21	0.64	0.16	0.82	-0.21	-0.21	-0.21	-0.21	0.30	0.77	-0.21	-0.21
2012	-0.24	-0.24	5.96	-0.24	0.82	-0.24	1.28	-0.24	0.61	0.13	0.79	-0.24	-0.24	-0.24	-0.24	0.27	0.74	-0.24	-0.24
2013	-0.28	-0.28	5.92	-0.28	0.78	-0.28	1.24	-0.28	0.57	0.09	0.75	-0.28	-0.28	-0.28	-0.28	0.23	0.70	-0.28	-0.28
2014	-0.31	-0.31	5.89	-0.31	0.75	-0.31	1.21	-0.31	0.54	0.06	0.72	-0.31	-0.31	-0.31	-0.31	0.20	0.67	-0.31	-0.31
2015	-0.34	-0.31	5.89	-0.31	0.75	-0.31	1.21	-0.31	0.54	0.06	0.72	-0.31	-0.31	-0.31	-0.31	0.20	0.67	-0.31	-0.31
2016	-0.37	-0.34	5.86	-0.34	0.72	-0.34	1.18	-0.34	0.51	0.03	0.69	-0.34	-0.34	-0.34	-0.34	0.17	0.64	-0.34	-0.34
2017	-0.40	-0.40	5.80	-0.40	0.66	-0.40	1.12	-0.40	0.45	-0.03	0.63	-0.40	-0.40	-0.40	-0.40	0.11	0.58	-0.40	-0.40
2018	-0.43	-0.43	5.77	-0.43	0.63	-0.43	1.09	-0.43	0.42	-0.06	0.60	-0.43	-0.43	-0.43	-0.43	0.08	0.55	-0.43	-0.43
2019	-0.46	-0.46	5.74	-0.46	0.60	-0.46	1.06	-0.46	0.39	-0.09	0.57	-0.46	-0.46	-0.46	-0.46	0.05	0.52	-0.46	-0.46
2020	-0.49	-0.49	5.71	-0.49	0.57	-0.49	1.03	-0.49	0.36	-0.12	0.54	-0.49	-0.49	-0.49	-0.49	0.02	0.49	-0.49	-0.49

[a] Source: National Institute of Population and Social Security Research, Japan Ministry of Health, Labour and Welfare, *Population Projections for Japan: 2006-2055*, January 2006 (http://www.ipss.go.jp/index-e.html). Note: The growth of demand for fruit juices for each country was calculated using the following formula: Growth of demand (%) = % growth rate of population from Table 5 + (per capita income growth rate of 2% times the expenditure elasticity from Table 4 (if significant from zero)).

Appendix 2.

Table 7. Cross-price elasticity estimates of substitutes

Products	Uncompensated cross price elasticity		Compensated cross price elasticity	
	Estimates	SE	Estimates	SE
U.S. orange/Brazil orange	0.9300***	0.0530	1.0051**	0.4144
U.S. orange/ROW orange	0.1446***	0.0082	0.1563	0.1481
U.S. orange/Israel grapefruit	0.2205***	0.0071	0.2305	0.1557
U.S. orange/ROW grapefruit	0.0287***	0.0035	0.0336	0.0924
U.S. orange/ROW apple	0.4228***	0.0291	0.4641	0.2912
U.S. orange/Thailand pineapple	0.3583***	0.0022	0.3614***	0.0965
U.S. orange/Philippine pineapple	0.3484***	0.0016	0.3508***	0.0854
U.S. orange/ROW pineapple	0.0066***	0.0018	0.0093	0.0990
U.S. orange/U.S. grape	0.1366***	0.0121	0.1539	0.2254
Brazil orange/U.S. orange	0.0490***	0.0099	0.2318**	0.0955
Brazil orange/ROW pineapple	0.0758***	0.0015	0.1040***	0.0358
Brazil orange/Italy other citrus	0.0123***	0.0032	0.0712**	0.0328
ROW orange/U.S. orange	0.2253***	0.0111	0.2317	0.2195
ROW orange/U.S. grapefruit	0.0884***	0.0166	0.0981	0.1604
ROW orange/Israel grapefruit	0.1449***	0.0065	0.1487	0.1334
ROW orange/ROW grapefruit	0.2474***	0.0032	0.2492***	0.0810
ROW orange/U.S. apple	0.2130***	0.0068	0.2170	0.2173
ROW orange/China apple	0.1789***	0.0167	0.1886	0.1662
ROW orange/ROW apple	0.4866***	0.0266	0.5021**	0.2358
ROW orange/ROW pineapple	0.0131***	0.0017	0.0141	0.0807
ROW orange/U.S. grape	0.3164***	0.0111	0.3228*	0.1758
ROW orange/Argentina grape	0.0199***	0.0021	0.0211	0.0755
ROW orange/ROW grape	0.1885***	0.0143	0.1968	0.1629
ROW orange/Israel other citrus	0.1268***	0.0038	0.1290*	0.0660
ROW orange/Italy other citrus	0.1863***	0.0036	0.1884**	0.0877
ROW orange/ROW other citrus	0.1734***	0.0054	0.1766**	0.0862
U.S. grapefruit/ROW orange	0.0232***	0.0054	0.0443	0.0724
U.S. grapefruit/Israel grapefruit	0.0201***	0.0046	0.0384	0.0838
U.S. grapefruit/ROW grapefruit	0.1550***	0.0023	0.1640***	0.0512
U.S. grapefruit/U.S. apple	0.2674***	0.0048	0.2865**	0.1304
U.S. grapefruit/China apple	0.0623***	0.0119	0.1090	0.1035
U.S. grapefruit/Argentina grape	0.1006***	0.0015	0.1065**	0.0434
U.S. grapefruit/ROW grape	0.2389***	0.0102	0.2789***	0.0950
U.S. grapefruit/Israel other citrus	0.0124***	0.0027	0.0232	0.0366
Israel grapefruit/U.S. orange	0.3923***	0.0177	0.3957	0.2672
Israel grapefruit/ROW orange	0.1698***	0.0119	0.1721	0.1545
Israel grapefruit/U.S. grapefruit	0.0933***	0.0264	0.0984	0.2150
Israel grapefruit/China apple	0.4823***	0.0265	0.4874**	0.2245
Israel grapefruit/ROW apple	0.1660***	0.0422	0.1742	0.2867
Israel grapefruit/Philippine pineapple	0.0103***	0.0024	0.0108	0.0750
Israel grapefruit/ROW pineapple	0.0894***	0.0027	0.0900	0.1053
Israel grapefruit/Argentina grape	0.2059***	0.0033	0.2065**	0.0870
Israel grapefruit/ROW grape	0.1359***	0.0227	0.1403	0.1953
Israel grapefruit/Italy other citrus	0.0870***	0.0057	0.0881	0.0995

Table 7. Cross-price elasticity estimates of substitutes-*continued*

Products	**Uncompensated cross price elasticity**		**Compensated cross price elasticity**	
	Estimates	SE	Estimates	SE
ROW grapefruit/U.S. orange	0.0726***	0.0228	0.1174	0.3225
ROW grapefruit/ROW orange	0.5562***	0.0154	0.5864***	0.1906
ROW grapefruit/U.S. grapefruit	0.7875***	0.0341	0.8544***	0.2669
ROW grapefruit/ROW apple	0.4108***	0.0545	0.5175	0.3597
ROW grapefruit/Thailand pineapple	0.0210***	0.0042	0.0292	0.0983
ROW grapefruit/Philippine pineapple	0.0375***	0.0031	0.0437	0.0911
ROW grapefruit/ROW pineapple	0.0287***	0.0035	0.0356	0.1302
ROW grapefruit/ROW grape	0.1915***	0.0293	0.2489	0.2333
U.S. apple/Brazil orange	0.3350***	0.1049	0.4918	0.7350
U.S. apple/ROW orange	0.2158***	0.0163	0.2401	0.2405
U.S. apple/U.S. grapefruit	0.6481***	0.0361	0.7021**	0.3197
U.S. apple/Thailand pineapple	0.0493***	0.0044	0.0559	0.1315
U.S. apple/Philippine pineapple	0.1294***	0.0033	0.1344	0.1197
U.S. apple/U.S. grape	0.4240***	0.0240	0.4600	0.3464
U.S. apple/ROW grape	0.1562***	0.0310	0.2025	0.3089
U.S. apple/Italy other citrus	0.2802***	0.0077	0.2919*	0.1631
U.S. apple/ROW other citrus	0.3513***	0.0118	0.3690**	0.1705
China apple/ROW orange	0.0681***	0.0057	0.0851	0.0750
China apple/U.S. grapefruit	0.0714***	0.0126	0.1089	0.1034
China apple/Israel grapefruit	0.1753***	0.0049	0.1900**	0.0875
China apple/ROW grapefruit	0.0143***	0.0024	0.0215	0.0538
China apple/Thailand pineapple	0.0508***	0.0015	0.0554	0.0410
China apple/U.S. grape	0.1816***	0.0084	0.2066*	0.1068
China apple/ROW grape	0.0381***	0.0108	0.0703	0.0966
China apple/Israel other citrus	0.0177***	0.0029	0.0264	0.0363
China apple/ROW other citrus	0.0292***	0.0041	0.0416	0.0541
ROW apple/U.S. orange	0.1838***	0.0055	0.1947	0.1222
ROW apple/ROW orange	0.1347***	0.0037	0.1421**	0.0667
ROW apple/U.S. grapefruit	0.0270***	0.0082	0.0433	0.0864
ROW apple/Israel grapefruit	0.0362***	0.0032	0.0426	0.0701
ROW apple/ROW grapefruit	0.0591***	0.0015	0.0622	0.0432
ROW apple/Philippine pineapple	0.0196***	0.0007	0.0211	0.0386
ROW apple/U.S. grape	0.1024***	0.0055	0.1133	0.1015
ROW apple/Argentina grape	0.1416***	0.0010	0.1437***	0.0463
ROW apple/ROW grape	0.0575***	0.0071	0.0715	0.0993
ROW apple/Italy other citrus	0.0450***	0.0017	0.0485	0.0538
Thailand pineapple/U.S. orange	1.9386***	0.0187	1.9689***	0.5256
Thailand pineapple/ROW grapefruit	0.0369***	0.0053	0.0456	0.1535
Thailand pineapple/U.S. apple	0.1672***	0.0114	0.1857	0.4366
Thailand pineapple/China apple	0.4061***	0.0279	0.4513	0.3346
Thailand pineapple/Argentina apple	0.3359***	0.0035	0.3416	0.2387
Thailand pineapple/ROW grape	1.5037***	0.0239	1.5425***	0.4701
Thailand pineapple/Israel other citrus	0.5214***	0.0064	0.5319**	0.2298
Thailand pineapple/Italy other citrus	0.2082***	0.0060	0.2180	0.2752
Thailand pineapple/ROW other citrus	0.0917***	0.0092	0.1065	0.1994
Philippine pineapple/U.S. orange	2.5281***	0.0226	2.5404***	0.6187
Philippine pineapple/Israel grapefruit	0.0386***	0.0132	0.0457	0.3168

Table 7. Cross-price elasticity estimates of substitutes-*continued*

Products	**Uncompensated cross price elasticity**		**Compensated cross price elasticity**	
	Estimates	SE	Estimates	SE
Philippine pineapple/ROW grapefruit	0.0873***	0.0065	0.0908	0.1893
Philippine pineapple/U.S. apple	0.5858***	0.0138	0.5933	0.5285
Philippine pineapple/ROW apple	0.3352***	0.0540	0.3645	0.6670
Philippine pineapple/U.S. grape	0.1515***	0.0225	0.1637	0.5259
Philippine pineapple/Argentina grape	0.7488***	0.0042	0.7511***	0.2673
Philippine pineapple/ROW grape	0.8922***	0.0290	0.9080*	0.5334
Philippine pineapple/Israel other citrus	0.1597***	0.0078	0.1639	0.2497
Philippine pineapple/Italy other citrus	0.1959***	0.0073	0.1998	0.3102
Philippine pineapple/ROW other citrus	0.4559***	0.0111	0.4620**	0.2351
ROW pineapple/U.S. orange	0.0996***	0.0323	0.0603	0.6422
ROW pineapple/Brazil orange	3.0933***	0.1400	2.9229***	1.0082
ROW pineapple/ROW orange	0.0885***	0.0217	0.0620	0.3532
ROW pineapple/Israel grapefruit	0.3628***	0.0188	0.3399	0.3979
ROW pineapple/ROW grapefruit	0.0775***	0.0092	0.0662	0.2421
ROW pineapple/Argentina grape	0.6693***	0.0060	0.6620***	0.2258
ROW pineapple/Israel other citrus	0.1860***	0.0111	0.1723	0.1889
U.S. grape/U.S. orange	0.1546***	0.0101	0.1546	0.2265
U.S. grape/ROW orange	0.2188***	0.0068	0.2188*	0.1192
U.S. grape/U.S. apple	0.2817***	0.0061	0.2817	0.2122
U.S. grape/China apple	0.3105***	0.0151	0.3104*	0.1605
U.S. grape/ROW apple	0.2714***	0.0241	0.2713	0.2430
U.S. grape/Philippine pineapple	0.0227***	0.0014	0.0227	0.0729
U.S. grape/Argentina grape	0.0254***	0.0019	0.0254	0.0891
U.S. grape/ROW grape	0.1891***	0.0129	0.1890	0.1877
U.S. grape/Israel other citrus	0.2093***	0.0035	0.2093***	0.0808
U.S. grape/Italy other citrus	0.0691***	0.0032	0.0691	0.1031
U.S. grape/ROW other citrus	0.0942***	0.0049	0.0942	0.0907
Argentina grape/Brazil orange	0.4364***	0.0828	0.4552	0.6331
Argentina grape/ROW orange	0.0731***	0.0128	0.0760	0.2710
Argentina grape/U.S. grapefruit	0.8403***	0.0285	0.8468**	0.3453
Argentina grape/Israel grapefruit	0.6378***	0.0111	0.6403**	0.2697
Argentina grape/ROW apple	1.8113***	0.0455	1.8217***	0.5873
Argentina grape/Thailand pineapple	0.3328***	0.0035	0.3336	0.2331
Argentina grape/Philippine pineapple	0.5512***	0.0026	0.5518***	0.1964
Argentina grape/ROW pineapple	0.5427***	0.0029	0.5434***	0.1853
Argentina grape/U.S. grape	0.1303***	0.0190	0.1347	0.4721
ROW grape/ROW orange	0.0934***	0.0046	0.1036	0.0858
ROW grape/U.S. grapefruit	0.3027***	0.0102	0.3251***	0.1107
ROW grape/Israel grapefruit	0.0550***	0.0039	0.0638	0.0888
ROW grape/ROW grapefruit	0.0513***	0.0019	0.0557	0.0522
ROW grape/U.S. apple	0.0871***	0.0041	0.0963	0.1469
ROW grape/China apple	0.0596***	0.0102	0.0821	0.1127
ROW grape/ROW apple	0.0971***	0.0163	0.1330	0.1848
ROW grape/Thailand pineapple	0.2182***	0.0012	0.2210***	0.0673
ROW grape/Philippine pineapple	0.0957***	0.0009	0.0978*	0.0574
ROW grape/U.S. grape	0.1318***	0.0068	0.1468	0.1458
ROW grape/Italy other citrus	0.0041***	0.0022	0.0089	0.0860

Table 7. Cross-price elasticity estimates of substitutes-*continued*

Products	Uncompensated cross price elasticity		Compensated cross price elasticity	
	Estimates	SE	Estimates	SE
Israel other citrus/Brazil orange	0.2479***	0.0369	0.3730	0.2839
Israel other citrus/ROW orange	0.2317***	0.0057	0.2511*	0.1286
Israel other citrus/U.S. grapefruit	0.0572***	0.0127	0.1003	0.1577
Israel other citrus/China apple	0.0709***	0.0127	0.1140	0.1567
Israel other citrus/Thailand pineapple	0.2764***	0.0015	0.2817**	0.1217
Israel other citrus/Philippine pineapple	0.0613***	0.0011	0.0653	0.0994
Israel other citrus/ROW pineapple	0.0722***	0.0013	0.0767	0.0841
Israel other citrus/U.S. grape	0.5724***	0.0084	0.6011***	0.2320
Israel other citrus/ROW other citrus	0.0334***	0.0041	0.0475	0.0993
Italy other citrus/Brazil orange	0.9531***	0.0559	0.9587**	0.4422
Italy other citrus/ROW orange	0.3938***	0.0087	0.3947**	0.1837
Italy other citrus/Israel grapefruit	0.1587***	0.0075	0.1594	0.1801
Italy other citrus/U.S. apple	0.5517***	0.0078	0.5525*	0.3088
Italy other citrus/ROW apple	0.3561***	0.0307	0.3591	0.3983
Italy other citrus/Thailand pineapple	0.1240***	0.0023	0.1243	0.1569
Italy other citrus/Philippine pineapple	0.0855***	0.0017	0.0857	0.1330
Italy other citrus/U.S. grape	0.2123***	0.0128	0.2135	0.3188
Italy other citrus/ROW grape	0.0339***	0.0165	0.0356	0.3423
Italy other citrus/ROW other citrus	0.0318***	0.0063	0.0324	0.1409
ROW other citrus/Brazil orange	0.2643***	0.0472	0.3271	0.3413
ROW other citrus/ROW orange	0.2326***	0.0073	0.2423**	0.1184
ROW other citrus/U.S. apple	0.4488***	0.0066	0.4577**	0.2114
ROW other citrus/China apple	0.1048***	0.0162	0.1265	0.1647
ROW other citrus/Thailand pineapple	0.0371***	0.0020	0.0398	0.0744
ROW other citrus/Philippine pineapple	0.1278***	0.0015	0.1298**	0.0660
ROW other citrus/U.S. grape	0.1763***	0.0108	0.1907	0.1837
ROW other citrus/Israel other citrus	0.0285***	0.0037	0.0335	0.0700
ROW other citrus/Italy other citrus	0.0165***	0.0035	0.0212	0.0923

*** (**) * significant coefficients only at 1%, 5% and 10%

Appendix 3.

Table 8. Cross-price elasticity estimates of complements

Products	Uncompensated cross price elasticity		Compensated cross price elasticity	
	Estimate	SE	Estimate	SE
U.S. orange/U.S. apple	-0.3456***	0.0074	-0.3350	0.2526
U.S. orange/China apple	-0.0715***	0.0182	-0.0456	0.1980
U.S. orange/Argentina grape	-0.2558***	0.0023	-0.2526**	0.1024
U.S. orange/ROW grape	-0.3345***	0.0156	-0.3123	0.2177
U.S. orange/Israel other citrus	-0.2437***	0.0042	-0.2377**	0.0957
U.S. orange/Italy other citrus	-0.1099***	0.0039	-0.1043	0.1195
Brazil orange/ROW orange	-0.2522***	0.0067	-0.1289**	0.0531
Brazil orange/U.S. grapefruit	-0.2305***	0.0148	0.0423	0.0817

Table 8. Cross-price elasticity estimates of complements-*continued*

Products	**Uncompensated cross price elasticity**		**Compensated cross price elasticity**	
	Estimate	SE	Estimate	SE
Brazil orange/Israel grapefruit	-0.1849***	0.0058	-0.0784	0.0686
Brazil orange/ROW grapefruit	-0.1024***	0.0028	-0.0500	0.0438
Brazil orange/U.S. apple	-0.0422***	0.0060	0.0691	0.1033
Brazil orange/China apple	-0.3473***	0.0148	-0.0741	0.0847
Brazil orange/ROW apple	-0.5820***	0.0237	-0.1465	0.0969
Brazil orange/Thailand pineapple	-0.0633***	0.0018	-0.0297	0.0265
Brazil orange/Philippine pineapple	-0.0540***	0.0013	-0.0288	0.0238
Brazil orange/U.S. grape	-0.2827***	0.0099	-0.1009	0.0747
Brazil orange/Argentina grape	-0.0146***	0.0018	0.0197	0.0274
Brazil orange/ROW grape	-0.2322***	0.0127	0.0019	0.0677
Brazil orange/Israel other citrus	-0.0335***	0.0034	0.0298	0.0227
Brazil orange/ROW other citrus	-0.0527***	0.0048	0.0370	0.0387
ROW orange/Brazil orange	-0.8570***	0.0484	-0.8289**	0.3414
ROW orange/Thailand pineapple	-0.0222***	0.0020	-0.0210	0.0703
ROW orange/Philippine pineapple	-0.0698***	0.0015	-0.0689	0.0632
U.S. grapefruit/Thailand pineapple	-0.1779***	0.0014	-0.1721***	0.0416
U.S. grapefruit/Philippine pineapple	-0.1656***	0.0011	-0.1613***	0.0372
U.S. grapefruit/ROW pineapple	-0.0066***	0.0012	-0.0018	0.0491
U.S. grapefruit/U.S. grape	-0.1730***	0.0079	-0.1419	0.1048
U.S. grapefruit/Italy other citrus	-0.0723***	0.0025	-0.0622	0.0505
U.S. grapefruit/ROW other citrus	-0.0087**	0.0039	0.0065	0.0527
Israel grapefruit/Brazil orange	-0.5981***	0.0769	-0.5833	0.5104
Israel grapefruit/ROW grapefruit	-0.0440***	0.0050	-0.0431	0.1149
Israel grapefruit/U.S. apple	-0.1360***	0.0108	-0.1339	0.2973
Israel grapefruit/Thailand pineapple	-0.0751***	0.0032	-0.0745	0.0821
Israel grapefruit/U.S. grape	-0.2423***	0.0176	-0.2389	0.2230
Israel grapefruit/Israel other citrus	-0.2392***	0.0061	-0.2380***	0.0730
Israel grapefruit/ROW other citrus	-0.1023***	0.0087	-0.1006	0.1098
ROW grapefruit/Brazil orange	-0.9501***	0.0992	-0.7560	0.6624
ROW grapefruit/Israel grapefruit	-0.1136***	0.0133	-0.0875	0.2334
ROW grapefruit/U.S. apple	-0.2623***	0.0139	-0.2350	0.3456
ROW grapefruit/U.S. grape	-0.1040***	0.0227	-0.0594	0.2629
ROW grapefruit/Argentina grape	-0.1378***	0.0043	-0.1294	0.1045
ROW grapefruit/Israel other citrus	-0.0747***	0.0079	-0.0592	0.0861
ROW grapefruit/Italy other citrus	-0.3479***	0.0073	-0.3335***	0.1198
ROW grapefruit/ROW other citrus	-0.0207*	0.0112	0.0012	0.1352
U.S. apple/U.S. orange	-0.5858***	0.0241	-0.5497	0.4145
U.S. apple/Israel grapefruit	-0.1491***	0.0141	-0.1280	0.2842
U.S. apple/ROW grapefruit	-0.1209***	0.0069	-0.1105	0.1626
U.S. apple/China apple	-0.1228***	0.0361	-0.0687	0.3372
U.S. apple/ROW apple	-0.4543***	0.0576	-0.3681	0.4504
U.S. apple/ROW pineapple	-0.3096***	0.0037	-0.3041*	0.1589
U.S. apple/Argentina grape	-0.6081***	0.0045	-0.6013***	0.1390
U.S. apple/Israel other citrus	-0.0578***	0.0083	-0.0452	0.1183
China apple/U.S. orange	-0.0556***	0.0084	-0.0305	0.1324
China apple/Brazil orange	-0.3241***	0.0367	-0.2151	0.2458
China apple/U.S. apple	-0.0433***	0.0051	-0.0280	0.1375

Table 8. Cross-price elasticity estimates of complements-*continued*

Products	**Uncompensated cross price elasticity**		**Compensated cross price elasticity**	
	Estimate	SE	Estimate	SE
China apple/ROW apple	-0.1019***	0.0201	-0.0419	0.1442
China apple/Philippine pineapple	-0.0068***	0.0011	-0.0034	0.0372
China apple/ROW pineapple	-0.0555***	0.0013	-0.0516	0.0508
China apple/Argentina grape	-0.0039**	0.0015	0.0007	0.0432
China apple/Italy other citrus	-0.0101***	0.0027	-0.0020	0.0499
ROW apple/Brazil orange	-0.3139***	0.0240	-0.2665	0.1763
ROW apple/U.S. apple	-0.1008***	0.0033	-0.0941	0.1152
ROW apple/China apple	-0.0426***	0.0082	-0.0263	0.0905
ROW apple/Thailand pineapple	-0.1274***	0.0010	-0.1254***	0.0429
ROW apple/ROW pineapple	-0.0023***	0.0008	-0.0006	0.0453
ROW apple/ROW other citrus	-0.0496***	0.0027	-0.0442	0.0495
Thailand pineapple/Brazil orange	-0.8346***	0.0811	-0.7034	0.6271
Thailand pineapple/ROW orange	-0.0976***	0.0126	-0.0772	0.2583
Thailand pineapple/U.S. grapefruit	-1.4462***	0.0279	-1.4010***	0.3384
Thailand pineapple/Israel grapefruit	-0.2541***	0.0109	-0.2365	0.2607
Thailand pineapple/ROW apple	-1.7002***	0.0446	-1.6281***	0.5575
Thailand pineapple/Philippine pineapple	-0.0207***	0.0025	-0.0165	0.1820
Thailand pineapple/ROW pineapple	-0.1465***	0.0028	-0.1418	0.1767
Thailand pineapple/U.S. grape	-0.3244***	0.0186	-0.2943	0.4502
Philippine pineapple/Brazil orange	-0.9578***	0.0983	-0.9044	0.7483
Philippine pineapple/ROW orange	-0.3453***	0.0153	-0.3370	0.3088
Philippine pineapple/U.S. grapefruit	-1.7631***	0.0338	-1.7447***	0.4032
Philippine pineapple/Thailand pineapple	-0.0243***	0.0041	-0.0220	0.2420
Philippine pineapple/ROW pineapple	-0.2894***	0.0035	-0.2875	0.2100
ROW pineapple/U.S. apple	-1.1774***	0.0196	-1.2014*	0.6278
ROW pineapple/China apple	-0.4415***	0.0482	-0.5003	0.4923
ROW pineapple/Thailand pineapple	-0.1615***	0.0059	-0.1687	0.2103
ROW pineapple/Philippine pineapple	-0.2519***	0.0044	-0.2573	0.1879
ROW pineapple/U.S. grape	-0.4901***	0.0321	-0.5292	0.5223
ROW pineapple/ROW grape	-0.4294***	0.0413	-0.4798	0.4814
ROW pineapple/Italy other citrus	-0.1612***	0.0104	-0.1739	0.2561
ROW pineapple/ROW other citrus	-0.3080***	0.0158	-0.3274	0.2601
U.S. grape/Brazil orange	-0.4395***	0.0438	-0.4396	0.3256
U.S. grape/U.S. grapefruit	-0.2129***	0.0151	-0.2129	0.1573
U.S. grape/Israel grapefruit	-0.1399***	0.0059	-0.1399	0.1305
U.S. grape/ROW grapefruit	-0.0171***	0.0029	-0.0171	0.0757
U.S. grape/Thailand pineapple	-0.0542***	0.0018	-0.0543	0.0830
U.S. grape/ROW pineapple	-0.0820***	0.0015	-0.0820	0.0809
Argentina grape/U.S. orange	-1.3483***	0.0190	-1.3439**	0.5450
Argentina grape/ROW grapefruit	-0.1987***	0.0054	-0.1975	0.1595
Argentina grape/U.S. apple	-1.9527***	0.0116	-1.9501***	0.4508
Argentina grape/ROW grape	-0.3808***	0.0244	-0.3752	0.5049
Argentina grape/Israel other citrus	-0.0501***	0.0066	-0.0486	0.2649
Argentina grape/Italy other citrus	-0.5552***	0.0061	-0.5538*	0.3068
Argentina grape/ROW other citrus	-0.6208***	0.0093	-0.6187***	0.2047
ROW grape/U.S. orange	-0.2587***	0.0068	-0.2437	0.1699
ROW grape/Brazil orange	-0.0587**	0.0296	0.0065	0.2291

Table 8. Cross-price elasticity estimates of complements-*continued*

Products	**Uncompensated cross price elasticity**		**Compensated cross price elasticity**	
	Estimate	SE	Estimate	SE
ROW grape/ROW pineapple	-0.0601***	0.0010	-0.0577	0.0579
ROW grape/Argentina grape	-0.0578***	0.0012	-0.0550	0.0747
ROW grape/Israel other citrus	-0.0303***	0.0023	-0.0250	0.0685
Israel other citrus/U.S. orange	-0.7145***	0.0085	-0.6857**	0.2761
Israel other citrus/Israel grapefruit	-0.4169***	0.0049	-0.4001***	0.1227
Israel other citrus/ROW grapefruit	-0.0572***	0.0024	-0.0489	0.0712
Israel other citrus/U.S. apple	-0.0972***	0.0052	-0.0796	0.2080
Israel other citrus/ROW apple	-0.0605***	0.0203	0.0082	0.2868
Israel other citrus/Argentina grape	-0.0318***	0.0016	-0.0264	0.1436
Israel other citrus/ROW grape	-0.1296***	0.0109	-0.0927	0.2532
Israel other citrus/Italy other citrus	-0.1739***	0.0027	-0.1646	0.1611
Italy other citrus/U.S. orange	-0.3252***	0.0128	-0.3239	0.3712
Italy other citrus/U.S. grapefruit	-0.2907***	0.0192	-0.2887	0.2343
Italy other citrus/ROW grapefruit	-0.2974***	0.0037	-0.2970***	0.1067
Italy other citrus/ROW pineapple	-0.0835***	0.0019	-0.0833	0.1227
Italy other citrus/Argentina grape	-0.3235***	0.0024	-0.3232*	0.1791
Italy other citrus/Israel other citrus	-0.1777***	0.0044	-0.1772	0.1735
ROW other citrus/Israel grapefruit	-0.1277***	0.0063	-0.1192	0.1302
ROW other citrus/ROW apple	-0.2492***	0.0259	-0.2147	0.2400
ROW other citrus/ROW pineapple	-0.1050***	0.0016	-0.1027	0.0816
ROW other citrus/Argentina grape	-0.2393***	0.0020	-0.2366***	0.0783

*** (**) * significant coefficients only at 1%, 5% and 10%.

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Implications of Trade Liberalization and Domestic Reforms on EU Agricultural Markets

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Abstract

The objective of this paper is to explore the overall effects of further trade liberalization and the implemented CAP reforms on EU agricultural production, imports and exports within different EU regions by using the Global Trade Analysis Project (GTAP) model. The GTAP model is used to compare a lower tariff reduction formula (EU Proposal) with a higher reduction formula (US Proposal) in order to show how sensitive the examined agricultural commodity/sector is to the different tariff reduction formulae. This analysis reveals that EU imports would escalate and EU exports would plummet with declining EU production because of trade liberalization and domestic policy reforms in the EU agricultural markets and sectors.

Keywords: EU, WTO, CAP reforms, tariff reductions, export subsidies.

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Introduction

The agricultural sector has been one of the most contentious issues in the multilateral trade negotiations under the World Trade Organization (WTO). New rules are being negotiated for the three pillars of agricultural trade: export competition, domestic support and market access. Trade distorting policies in these pillars are being scrutinized and new rules created in the WTO to reduce distortion in world agricultural trade.

In the area of export competition, WTO members agreed in December 2005 at the WTO Ministerial Conference in Hong Kong to eliminate all forms of agricultural export subsidies by 2013 if there is a new multilateral trade round. However, it should be noted that no new rules on export competition will be implemented until the issue of state trading enterprises, export credits, and food aid are dealt with. These issues are deemed to be trade distorting policies for export competition.

The key distinction in the negotiations on domestic support is between trade distorting and non-trade distorting farm subsidies. This distinction arose from attempts to reduce distortion in world agricultural markets caused by domestic farm programs, while preserving the ability of policymakers to support farmers and rural areas at the level they consider appropriate. In principle, it has already been conceded that current ceilings will be substantially reduced, and WTO members with the highest domestic support levels, such as the EU, should make the biggest reductions.

The market access pillar of the negotiations has proved to be the trickiest to negotiate, because all countries have market access barriers, whereas only some have export subsidies or domestic support. Hence, the range of interests involved in the market access side of the negotiations is more complex. Most WTO members are under pressure to protect their farmers, but many also want to open up others' markets. Among the developing countries, some are dubious about opening up agricultural trade and take a defensive position, while others want to see increased exports from developing countries to developed countries as well as more trade between developing countries. The key points that have emerged concerning market access are the type of tariff reduction formula that would produce the agreed result, how developing countries might be given further flexibility for their "special products" and might be able to use "special safeguard" actions to deal with surges in imports or falls in prices, and how the sensitive products of all member countries might be treated.

Trade liberalization through the Doha Round is expected to have an impact on EU agriculture. An important question for the EU is whether the reforms of the Common Agricultural Policy (CAP) have improved the ability of the EU to adjust to a more liberal trade environment. Although the domestic reforms did not overtly deal with external trade and import protection, benefits from the CAP reforms in terms of a reduced need for export subsidies and tariff protection are automatically the results of lower support prices for EU agricultural products. Furthermore, the decision of the EU to combine all of its domestic support payments for agriculture into one decoupled Single Farm Payment (SFP) is expected to improve the ability of the EU to adjust to the gradual liberalization of agricultural markets that lies ahead.

The objective of this paper is to explore the implications of tariff reductions, the elimination of export subsidies and the implemented CAP reforms on EU agricultural production, imports and exports within different EU regions by using the multi-region and multi-sector computable general equilibrium model known as the Global Trade Analysis Project (GTAP) model. Decomposition of the different policy effects on EU agricultural production is also examined, and the model is used to compare a lower reduction formula from the EU and a higher reduction formula from the US to show how sensitive the examined agricultural commodity/sector is to the different tariff reduction formulae. This will indicate which agricultural commodities/sectors are vulnerable to further market opening and an extreme reduction in tariffs.

The WTO Negotiations and CAP Reforms: Price Spikes and Volatility in the Global Agricultural Markets

Traditionally in the WTO, many aspects of the agricultural negotiations have been driven by an assumption of excess supply, low prices and protectionism. Subsidies to farmers and tariffs on imports have been at the heart of the stalemate in the long-struggling Doha Round of WTO trade talks. Agricultural policy in the developed countries has been driven by the need to deal with excess production. This has been particularly true of the EU and the US. For decades, both supported their farmers with excessively high levels of public support that generated chronic surpluses over domestic consumption. These surpluses produced the notorious butter, cereal and beef mountains in the EU. The excess stocks were disposed of on the world market with export subsidies. This had the effect of subduing world prices and creating a gap between EU internal prices and world prices. Essentially, the agenda agreed at the WTO is an effort to even out the distortions between countries that are exporting to the world market without subsidies and those that are relying on subsidies due to the price gap between domestic and world prices. The existence of this gap has inevitably led to the CAP reforms, which seek to lower EU internal prices closer to world prices. Ironically, the Doha Round was used as leverage by the European Commission to get the process of the CAP reforms underway (Cunha and Swinbank 2009).

The Doha Round was launched in 2001 with the goal of adding billions of dollars to global commerce and lifting millions of people worldwide out of poverty due to trade liberalization. However, the surge in prices for all agricultural commodities from 2006 to 2008 brought this assumption into question, because trade liberalization and the removal of protection and support policies in agriculture will raise world food prices (OECD 2000, Diao et al. 2001, FAPRI 2005, Abler and Blandford 2007, World Bank 2008a). The Food and Agriculture Organization of the United Nations (FAO 2008a) estimated that, mainly as a result of high food prices, the number of chronically hungry people in the world rose by 75 million in 2007 to reach 923 million. Moreover, in 2008 the FAO (2009) estimated that up to 37 countries in the world were facing food crises, and the World Bank (2008b) estimated that 33 countries would face potential social unrest because of rising food and energy prices. Food riots were reported in Egypt, Cameroon, Cote d'Ivoire, Senegal, Burkina Faso, Indonesia, Madagascar, Mauritania, Mozambique, and Haiti in early 2008. Price increases in the world market will benefit large exporters of agricultural and food products. Conversely, net food importers will lose and face a much higher food bill (FAO 2008b). Increases in food prices would be most distressing for poor developing countries with limited resources to help their poor consumers, making it more difficult to achieve the Millennium Development Goal to halve, between 1990 and 2015, the proportion of people who suffer from hunger.

According to the FAO (2008a, 2008b), high food prices have a particularly devastating effect on the poorest in both urban and rural areas, the landless, and female-headed households. Hence, high food prices hamper poverty reduction measures. Food price inflation hits the poor hardest because food accounts for a much higher share of their total expenditures than in wealthier populations. Food represents only about ten to twenty percent of consumer spending in developed countries, but expenditure on food represents as much as forty to eighty percent of consumer spending in developing countries, many of which are net food importers.

The high world commodity prices between 2006 and 2008 have spurred countries including Brazil, China, Indonesia, Vietnam, India, Egypt, Cambodia, Pakistan, Russia, Kazakhstan, Ukraine, Argentina, and Malawi to impose curbs on food exports in order to ensure their domestic supplies remain plentiful and insulate their domestic markets from price increases. Such moves lie counter to the spirit of the intended Doha Round deal, which is meant to make it easier to export and sell agricultural and other goods in overseas markets. Export restrictions are not prohibited by the WTO, and this issue has emerged as a theme in the WTO negotiations. In fact, export curbs such as quotas, taxes and export bans have exacerbated the food crisis. During the rise in food prices, many developing countries such as India, Indonesia, Saudi Arabia, Peru, Turkey, and Burkina Faso have slashed import tariffs in a desperate effort to reduce the cost of imported food in order to stave off food riots. However, developing countries such as India and Indonesia have sought in the Doha Round to maintain the possibility of keeping higher tariffs for agricultural products or obtaining concessions that would allow them to protect particular agricultural products by increasing tariffs. This position is built around the assumption of low world food prices and high world stockpiles of food. In past decades, farm subsidies and support programs have allowed major grain exporting countries to maintain large surpluses, which could be tapped during food shortages to keep prices down. However, new trade and agricultural policies have made agricultural production much more responsive to market demands, putting global food reserves at their lowest level in a quarter of a century. Without reserves, bad weather and poor harvests have a bigger impact on prices. According to the World Bank (2008b), the prices of staples jumped 80 percent in 2008 compared to 2005, whereby the real price of rice hit a 19-year high and the real price of wheat rose to a 28-year high in early 2008.

No single factor was responsible for the 2006-2008 rapid escalation of food commodity prices (USDA 2008, USDA 2009), but rather a set of interrelated factors that included both short-term and long-term supply and demand trends. Among these were the burgeoning food and feed demand in developing countries due to population growth and the increasing demand for meat and dairy products in China and India, as well as the increased demand for agricultural raw materials (grains, oilseeds, etc) to make biofuels, government policies worldwide (export bans, restrictions and taxes, aggressive importing of food supplies, etc.) to ensure domestic supplies and insulate domestic markets from food price inflation, declining yields in agriculture due to reduced investments, and production shortfalls due to weather and disasters. Additionally, macroeconomic factors contributed to the price escalation, such as sharply higher crude oil and energy prices that boosted the production costs of agricultural products from fertilizers to transport to food processing, the depreciation of the US dollar, the accumulation of foreign reserves or petrodollars that increased purchases of food worldwide, lower food stockpiles worldwide, and global investment funds that speculated in the commodities markets (Table 1).

Table 1. Factors contributing to the price spikes and volatility of food commodity prices

Contributing factors during the years	1971-74	1994-96	2006-08
Long-term			
Demand side			
Export demand growth	X	X	X
Due to food demand growth		X	X
Due to population growth			X
New use/innovation: biofuels			X
Supply side			
Slow production growth	X	X	X
Declining R&D investment		X	X
Land retirement	X	X	
Short-term			
Demand side			
Government food policies	X	X	X
Supply side			
Government food policies	X	X	X
Weather-induced crop losses/failures	X	X	X
Macroeconomic			
Economic growth		X	X
Depreciation of the US dollar	X	X	X
Rising crude oil and energy prices	X		X
Accumulation of petrodollars/foreign reserve	X		X
Future market/speculation	X		X
Inflation	X		X
Financial crisis		X	X
Reduced global stockpiles of food	X	X	X

Source: FAO 2008b, USDA 2008, USDA 2009.

The rapid rise in food prices between 2006 and 2008 was exceptional in magnitude, but not unique. Two other major periods with a rapid surge in prices occurred in 1971-1974 and 1994-1996, with similar sets of interrelated factors that caused the price spikes and volatility in prices (Table 1). In these past periods of price spikes, market adjustments eventually brought prices back down (USDA 2009). Similarly, the high prices seen in 2006-2008 have dropped, but market adjustments are occurring in a more volatile environment. The global financial and economic crisis that started at the end of 2008 has clearly contributed in reversing the 2006-2008 price spikes. The situation is similar to the 1994-1996 surges in food prices that ended with the 1997-1999 financial crisis in Asia, Russia, and Latin America that caused global demand to fall. While history provides some insights into current and future economic phenomena, the past does not

necessarily predict the future, nor does it fully explain events occurring in today's markets. The current financial and economic structure in the agricultural sector is different from that in the past, and policy options and actions have changed as well. Nonetheless, future global population and income growth, policy developments and climate change will have a substantial impact on the demand for and supply of agricultural commodities. The volatility in commodity prices will continue, but the impacts cannot be shown with the use of a general equilibrium model such as the Global Trade Analysis Project (GTAP) model. According to the model, the economy will adjust in the long term, and prices will thus return to equilibrium levels due to substitutions and structural adjustments in the economy.

Methodological Framework of the Study

The quantitative results of the assumed policy changes of this study are derived by using a multi-region and multi-sector computable general equilibrium model (Hertel 1997) known as the Global Trade Analysis Project (GTAP) model. The GTAP model and database are standard tools for analysis in the changing global markets for commodities (Hertel 1997, Dimaranan and McDougall 2005). The standard model assumes a competitive environment where consumers and firms take the prices of goods and factors of production as given. It is assumed that the outcome of the model is one of optimizing behavior by firms and consumers restricted by their resources (land, labor, capital, and natural resources), restraints (taxes etc.), and their objective functions. The computable general equilibrium (CGE) models are thus highly suited to analyzing overall trade and welfare effects, as they offer a comprehensive assessment of cross- and inter-industry linkages, including upstream and downstream effects. The GTAP version 6 database represents global production and trade for 87 countries/regions, 57 commodities/sectors, and 5 primary factors. The data characterize intermediate demand and bilateral trade in 2001, including tax rates on imports and exports, and other indirect taxes. The main data file represents the world economy in 2001 as a system of flows of goods and services, measured as money values, in millions of US dollars. In this analysis, the database is aggregated into 16 countries/regions (Table 2) and 15 commodities/sectors (Table 3), whereby 12 commodities/sectors deal with the agriculture and food sectors. This model is unable to measure or show the impact of price volatility in these commodities because of the optimizing behavior by firms and consumers that will lead prices back to new equilibrium levels in the long term. Different trade policies as well as domestic policies are implemented in the model and database as price wedges between different prices, e.g. the domestic and world market price. Exogenous changes such as trade liberalization will affect the relative prices between regions and commodities, as well as the behavior of consumers and producers within the economies, to produce a new equilibrium. The multilateral trade liberalizations assumed in this study are the abolition of export subsidies (export competition pillar) and a reduction in tariffs (market access pillar). The 2001 database is used to examine the unilateral reform in domestic support by the EU and to reflect the policy implications of the CAP reforms implemented in 2003. Thus, the GTAP model is utilized to demonstrate the impacts of policy changes on the three pillars of agricultural trade: 1) the domestic support pillar, with shocks to represent the reforms implemented in the EU Common Agricultural Policy; 2) the export competition pillar, with shocks to represent the abolition of export subsidies; and 3) the market access pillar, with shocks to represent the multilateral reduction in agricultural tariffs under two different assumptions, namely a lower reduction under the EU Proposal and higher reduction under the US Proposal.

Table 2. The country coverage comprises 16 countries/regions in the GTAP version 6 database

Regions within the EU	
FIN	Finland
FRA	France
GERA	Germany and Austria
NEU	Belgium, Netherlands, UK, Ireland, Denmark, Luxembourg, Sweden
SEU	Spain, Italy, Portugal, Greece
POL	Poland
REU	Cyprus, Czech Republic, Estonia, Hungary, Latvia, Slovakia, Slovenia, Bulgaria, Romania
Other Regions	
EFTA	Switzerland, Norway, Iceland
USA	United States
MERCOSUR	Brazil, Argentina, Uruguay
AUSNZ	Australia and New Zealand
RUSSIA	Russia
CHINA	China and Hong Kong
INDIA	India
LDCs	Least developed countries in Africa
ROW	Rest of the world

Table 3. The commodity coverage comprises 15 commodities/sectors in the GTAP version 6 database

WHEAT	Wheat
GRO	Other grains
V_F	Vegetables, fruits, nuts
OCR	Other crops
MILK	Raw milk
CATTLE	Bovine animals
OTAG	Animal products n.e.c.
CATTMEAT	Bovine meat products
OTMEAT	Other meat products
DAIRY	Dairy products
SUGAR	Sugar
OTFOOD	Other food products
RESOUR	Resources
MANUFAC	Manufacturing
SVCES	Services

Domestic Support: Reform of the EU Common Agricultural Policy

The GTAP model is calibrated to include the impacts of the implemented reforms in the EU Common Agricultural Policy (CAP). The CAP reforms approved at the EU Agricultural Council

in Luxembourg in September 2003 are important modeling issues. Under these reforms, most of the CAP support payments for arable crops and livestock have been decoupled from production and a new Single Farm Payment Scheme (SFP) has been set up in the EU member states. More than 90% of all direct support payments to farmers in the EU-25 member states became decoupled from production in 2005 to 2006. Nonetheless, the EU Commission has given the members states a number of options for implementing the reform, whereby part of the support payments may still be linked to production. There is a great deal of flexibility, especially for the decoupling of beef support payments, and also for cereal and milk support payments.

In the GTAP version 6 database, the OECD Producer Support Estimates (PSE) in 2001 are used as the domestic support estimates, which have been further disaggregated in the EU for 15 member states and 12 agricultural and food commodities/sectors (Jensen 2006, Huang 2006). The support payments are then grouped into four categories: output subsidies, intermediate input subsidies, land-based subsidies, and capital-based subsidies.

The policy specification for domestic support adopted in this study refers to earlier contributions. Several papers (Frandsen et al. 2002, Bach et al. 2000, Brockmeier et al. 2006) have introduced changes to the GTAP model aimed at improving policy representation, with special reference to the CAP. Gohin (2006) emphasized the correct representation of agricultural policy instruments when assessing a policy. In CGE models such as the GTAP, production costs and production technologies are represented by more or less flexible functional forms, mainly depending on the distinction between products (inputs and outputs) and factors. It is important to define which policy instruments can be reasonably classified as output subsidies and which instruments accrue to the production inputs such as land, labor and capital. Substitution possibilities between the inputs influence the production effects of changing farm subsidies. For example, the production effects of the coupled CAP support payments for beef are likely to be different if the bull premium is classified as an output subsidy rather than a capital subsidy.

Following the arguments of Gohin (2006) as well as Jensen and Yu (2005), it is reasonable to classify the Agenda 2000[1] bull premium as an output subsidy, since bulls can usually be grown relatively intensively to an appropriate carcass weight in order to meet the market demand for meat. Meanwhile, the slaughter premium and suckler cow premium are classified as capital subsidies, because the slaughter premium (paid per head of all slaughtered bovine animals) and suckler cow premium contribute to the maintenance of the existing animal stock rather than the quantity of beef produced. Since part of the decoupled Agenda 2000 beef support payments accrue explicitly to farmland after the CAP reforms, the payments should increase farmland values.

With regard to milk production, the most important point about the CAP reforms is that the intervention prices for skim milk powder (SMP) and butter were gradually reduced by 15% and 25%, respectively. EU farmers were initially compensated for income losses with the dairy cow premium, which was based on milk quotas. Later, the dairy cow premium (milk support payment) was combined with the decoupled Single Farm Payment in 2007. The decrease in the intervention prices for butter and skim milk powder have been implemented as a decrease in the market price of milk (by 15%).

[1] The EU Common Agricultural Policy reforms implemented in 2000.

The shocks applied in the GTAP model due to the CAP reforms are based on the support payments accrued to land subsidies, output subsidies, and capital subsidies by different regions of the EU (Table 4). The implementation of the CAP reforms in each EU member state is taken into account in the model by using information from the European Commission (2005b, 2004a, 2004b). In the case of the EU-15 member states, the decoupled and coupled parts of the CAP support payments are based on statistics from the European Commission. In the case of the EU-10 new member states, the total sum of the CAP payments to the new member states is taken into account and gradually increased until 2011. All the CAP support payments for the EU-10 new member states are accrued to farmland.

Table 4. CAP support. Subsidy category and region in the EU until 2011

	Total CAP subsidies EUR million	**Land subsidies* EUR million**	**Output subsidies** EUR million**	**Capital subsidies*** EUR million**
Finland	522	518	26	8
France	8055	7075	0	980
Germany & Austria	6179	5963	0	216
Northern EU	8259	7920	89	250
Southern EU	7694	7222	13	459
Poland	994	997	-	-
Rest of EU	1159	1159	-	-

Source: European Commission 2004a, 2004b, 2005b, own calculations

***** Land subsidies are the historical CAP area payment, the decoupled bull premium, decoupled slaughter premium, decoupled suckler cow premium and decoupled milk premium

****** Output subsidies are the coupled bull premium

******* Capital subsidies are the coupled slaughter premium and coupled suckler cow premium

In this study, modeling of the CAP policies by using the GTAP model is simplified in many ways, given the intricacies of the CAP. However, there are limitations to this approach that are worth highlighting. The approximation of the measures included in the CAP reform does not take into account several important parts of the reforms: the modulation of direct payments, the introduced environmental cross-compliance elements, and the provision for rural development. Modeling of such measures is incompatible with the representative assumptions used in the GTAP model, as the measures require some differentiation between the different types of farmers.

Export Competition: Abolition of Export Subsidies

Export subsidies occur when the government gives an exporter a direct per-unit payment based on the volume of goods cleared for foreign destinations. Such a payment enables an export firm to purchase the product internally at a higher price and sell it externally at a lower price. The EU is by far the largest user of per-unit export subsidies. Other significant users of export subsidies include Switzerland, Norway, and the US. The reliance of the EU on subsidies for agriculture stems from the Common Agricultural Policy (CAP). The CAP supports producer prices at levels above world market prices, stimulating production in the EU and resulting in exportable surpluses of many commodities. The EU has been actively subsidizing the disposal of surpluses in many commodities on the world market, and thus distorting trade flows.

Under the Uruguay Round Agreement on Agriculture (URAA), the WTO members committed to reducing their exports subsidies, and no new export subsidies were permitted. During the Uruguay Round implementation period of six years from 1995 to 2001, export subsidy expenditures were reduced by 36 percent and the volumes of subsidized exports were reduced by 21 percent. The URAA has made it more difficult for countries to resort to direct export subsidies to shore up domestic prices or manage excess supplies. Therefore, the Doha Round has the intention to make it impossible to use export subsidies to boost domestic prices by eliminating such subsidies entirely. This assumption is simulated in this study by using the GTAP model and database.

Export subsidies are part of the GTAP database implemented as a price wedge between the value of exports (free on board basis) and the world market price. The data for export subsidies are directly derived from WTO member countries' notifications to the WTO in the marketing year 2000/2001 and compared to the value of exports for 2000/2001 by using trade data from the United Nations Conference on Trade and Development. A few assumptions on dividing the export subsidies among the EU member states have been made. First, trade within the EU has been neglected in evaluating the export subsidy rates. It has also been assumed that the export subsidy is not dependent on the destination country. The export subsidy rates and global market shares of the aggregated commodities/sectors are estimated in the database (Table 5). Nullification of the export subsidy rates will simulate the entire removal of export subsidies in the model. The model structure assumes that the outcome is driven by the demand conditions and that supply only reacts to these changes. Incidentally, this is contrary to most partial equilibrium model results, which assume the supply capacity to be fixed and price reactions to be much larger. Results of the general equilibrium model may therefore be regarded as long-term impacts.

Table 5. Export subsidy rates and global market shares in the GTAP version 6 database. Region and commodity/sector, marketing year 2000/2001

	EU		**REU**		**EFTA**		**USA**	
	Export Subsidy rate	*Trade share*	*Export subsidy rate*	*Trade share*	*Export subsidy rate*	*Trade share*	*Export subsidy rate*	*Trade share*
Wheat	8.63	24		1.9		0.1		23.6
Other grains	33.39	20.2	0.01	1.7		0.3		41.3
Veges, fruits, nuts	2.31	34		1.2	125.52	0		10.8
Other crops		17.9		1.1		0.4		17.3
Raw milk & bovine animals		33.5	0.02	4.8	94.28	0.3		11.1
Animal products n.e.c.	.067	29.3		2.7		0.8		17.1
Bovine meat products	84.62	31.6		0.9	3.9	0.5		18.4
Other meat products	5.68	52.6	0.17	3.8	11.27	0.2		13.7
Dairy products	30.78	67.2	2.09	4.1	30.99	1.5	7.83	2.8
Sugar	60.22	14.2	6.73	1.2		0.1		4.1
Other food products	2.31	41.7	0.13	2.1	0.58	2.4		9.4
Resources		6.4		0.6	0.24	6.8		1.6
Manufacturing		37.3		2.6	0.13	3.1		12.5
Services		40.9		2.7		3		17.6

Market Access: EU and US Proposals -Two Different Tariff Reduction Formulas

The GTAP model is calibrated to demonstrate the impacts of tariff reductions on production, exports and imports. After calibrating the tariffs in the GTAP database, the model is used to compare two alternative proposals for tariff reductions in the Doha Round: a lower reduction formula from the EU and higher reduction formula from the US (Table 6). This simulation will illustrate how sensitive agricultural products are to the different tariff reduction formulae. This sensitivity analysis will indicate the agricultural products that are vulnerable to further market opening (EU Proposal) and an acute reduction in tariffs (US Proposal).

Table 6. The EU Proposal and US Proposal for tariff reduction

EU Formula		**US Formula**	
Tariff band thresholds	*Linear cuts*	*Tariff band thresholds*	*Linear cuts*
0 - 30%	35%	0 – 20%	55 – 65%
30 - 60%	45%	20 – 40%	65 – 75%
60 - 90%	50%	40 – 60%	75 – 85%
> 90%	60%	> 60%	85 – 90%
Tariff cap	100%	Tariff cap	75%

Source: European Commission 2005a, US Department of State 2005

Approaches to trade liberalization through the reduction of tariffs confront some key methodological challenges (see Bouët et al. 2008). One of these is the frequent, wide divergence between bound tariffs and the tariff rates actually applied. Negotiations in the WTO are conducted on the basis of bound tariffs notified to the WTO. However, these bound tariffs may differ from actual applied tariffs. If so, reductions in bound tariffs as agreed upon in the WTO may not reduce the actual tariffs ('binding overhang'). Large differences between bound and applied tariffs are widespread in developing countries, but generally less so for high-income developed countries. The EU bound rates for tariffs are equal to the actual applied rates. Therefore, in the EU, any cut in bound tariffs immediately results in lower applied tariffs.

Another key issue that needs to be addressed is the weighting scheme used to aggregate the applied tariff rates. In the standard GTAP database, the applied rates in the EU are aggregated using import trade weights. This is done with the help of world import values from the United Nation's COMTRADE database of 2001, excluding intra-EU trade. Trade weights only take the relative importance of trade flows into account, and lead to an endogenous bias, as the weight for each individual tariff decreases with an increase in the tariff. Accordingly, prohibitive tariffs impede market access, and thereby reduce the trade volumes to zero. This issue is not taken into account by the import weighting approach. Trade barriers are therefore underestimated with this method.

This study draws on the detailed data on applied tariffs notified by the EU to the WTO for computation of the so-called ad valorem equivalents (AVE data). These ad valorem equivalents are calculated by working out the "unit value'" of imports over the period of 1999-2001. Import values are taken from the data submitted to the Integrated Database (IDB) of the WTO. The value of imports is divided by the volume of imports over the same period, and this is then compared with the import duty to give an ad valorem equivalent. Variants of this basic formula exist to deal with cases where the "unit value" of any product is substantially affected by factors

such as the existence of tariff quotas as well as other non-tariff barriers. The data are available at the 8-digit level of the Harmonized System (HS) of classification. In this study, these detailed tariffs are aggregated through simple averages up to the product aggregates of the GTAP database. It is, however, worth recalling that although all the ad valorem tariffs of the EU are calculated to the 8-digit level, their modeling within a framework such as the GTAP model would still create conceptual problems due to the need to aggregate these tariffs again for the 12 specific commodities/sectors aggregated in the GTAP database for agriculture. The GTAP model could not include products at the level of detail at which tariff lines are specified (for example at the 8-digit level). The EU tariff schedule includes 2200 tariff lines; thus, the assessment of the impact of trade liberalization on the EU cannot be precise.

Implications of Agricultural Trade Liberalization and CAP Reforms for the EU

The potential consequences of a multilateral agreement in the Doha Round have been assessed in numerous studies (Bouët et al. 2007, Hertel et al. 2007, Anderson and Martin 2006, Decreux and Fontagné 2006, Polasky 2006, Francois et al. 2005). Among these studies, the conclusions are divergent or convergent depending on the methodological choices and designs of the trade reforms implemented in the studies. The present study utilizes a CGE methodology to show the impact of agricultural trade liberalization in the Doha Round and domestic reforms on production, exports, and imports within separate regions of the EU. The results provide only rough indications and not precise projections of the future due to the limitations of the CGE methodology, which include its complexity, data requirements, aggregation issues, and model sensitivity to the selection of key parameters. In particular, CGE models sacrifice commodity and policy details important in examining agricultural trade agreements and lag on policy and market information (Westhoff et al. 2004). Partial equilibrium models are able to capture the policy details, and the commodities are disaggregated compared to CGE models. For example, in the GTAP model, the pigmeat and poultry meat sectors are combined as other meat products, and the bovine sector includes cattle, sheep, goats, and horses. On the other hand, proper analysis of trade agreements would seem to require large-scale general equilibrium models, which simultaneously take into account changing trade flows between countries, supply and demand adjustments, and resource re-allocation between different sectors in the economy. CGE models force conceptual consistency on a problem and provide useful information on spatial trade flows and factor prices important to agriculture (Goldin and van der Mensbrugghe 1996, Hertel 1997). CGE models also capture feedback effects between processing sectors and primary agriculture that can at best be mimicked in partial equilibrium models.

The results from the GTAP model provide estimates of the changing production and trade flows in the EU and within its regions. The different structures of agricultural production and implementation of the CAP reforms are the main reasons for dividing the EU into seven countries/regions (Table 1): Finland, France, Germany & Austria, Northern EU, Southern EU, Poland, and the Rest of the EU. The economies of Denmark, Sweden, the Netherlands, Belgium, Ireland, the United Kingdom (UK), and Luxembourg are grouped as Northern EU, because these countries have relatively high wage rates and an agricultural production structure that is specialized and capital intensive. Finland's economy is similar to Northern EU, but its agricultural production structure is not yet as efficient or capital intensive as Northern EU. In addition, Finland suffers from natural handicaps due to the unfavorable climate, being the

world's northernmost country with a viable agriculture, and hence requiring excessive agricultural subsidies. In fact, this study was established for policy makers in Finland, and Finland is therefore considered as one region. France and Germany (in the GTAP database, Austria is combined with Germany) are singled out because of their sheer size and production capacity in agriculture. Spain, Italy, Portugal, and Greece are grouped as Southern EU because agriculture in these Mediterranean countries has somewhat similar characteristics that are relatively divergent from the other regions. The countries from Central and Eastern Europe and the Mediterranean included in the 2004/2007 EU enlargement are grouped as the Rest of the EU because their national agricultural policies are quite similar and these countries have lower agricultural subsidies compared to the old EU-15 member countries. Poland is singled out as one region from the Rest of the EU due to its huge agricultural production capacity (potentially a relatively large agricultural producer).

Production According to EU Region

The production of bovine meat products in the EU is the most vulnerable to domestic policy reforms and trade liberalization (Appendix 1 and 2). The total EU production of bovine meat products is estimated to decrease by 15% with a value of USD 10.6 billion under the EU tariff reduction formula (Appendix 1) and by 23% with a value of USD 15.9 billion under the US tariff reduction formula (Appendix 2). Northern EU will be the hardest hit region, facing a 26% (Figure 1) decline in production with a value of USD 5.2 billion (Figure 2) under the EU formula and a decline of 38% with a value of USD 7.5 billion under the US formula. The production of bovine meat products in Northern EU represents the largest drop in value (Figure 2) among the commodities/sectors that register a decrease in production, and one of the largest percentage drops (Figure 1) for production. Beef production clearly decreases in countries such as the UK and Ireland (Northern EU), which have decoupled all beef support payments from production. Another cause of the decreasing beef production in these countries is that labor released from agriculture is easily absorbed by strong non-agricultural sectors. The production of beef decreases to a lesser extent in countries that retained a significant proportion of the beef support payments coupled or linked to production, such as Finland. In contrast, there is no decline in the production of bovine meat products in the EU-12 new member states (in fact a slight increase) under the EU tariff reduction formula, but there is a slight decline in production under the US tariff reduction formula. Hence, the EU tariff reduction formula will only have a production decreasing impact in the old EU-15 member states, but the US tariff reduction formula is drastic enough to cause a production decrease in all the EU member states.

In terms of value (Figure 2), the production of dairy products in the EU is the second most vulnerable to domestic policy reforms and trade liberalization. The total EU production of dairy products is estimated to decrease by 7% with a value of USD 8.7 billion under the EU tariff reduction formula (Appendix 1), and by 12% with a value of USD 14.1 billion under the US tariff reduction formula (Appendix 2). Northern EU will again be the hardest hit region, with an 11% (Figure 1) decline in production with a value of USD 4.5 billion (Figure 2) under the EU formula and a decline of 18% with a value of USD 7.1 billion under the US formula. Similar to the case of bovine meat products, the full decoupling of milk support payments due to the CAP reforms and the high opportunity cost of labor in these countries are the main causes for the

decreasing production of dairy products. By contrast, there is no decline in the production of dairy products in the EU-12 new member states, but in fact there is an increase in production.

In percentage terms (Figure 1), the production of wheat and sugar are very vulnerable to domestic policy reforms and trade liberalization. Among the EU regions, the largest percentage drop in production for wheat will occur in Southern EU, and that for sugar will occur in Northern EU. The percentage decreases in production for other meat products and other food products are small compared to the examined commodities/sectors. On the other hand, the production decrease in value (Figure 2) for other food products is quite large, even though the decrease in the percentage is small. In comparison, the percentage decrease in production for sugar is many times greater than for other food products, but the value decrease in production for sugar is much smaller than for other food products.

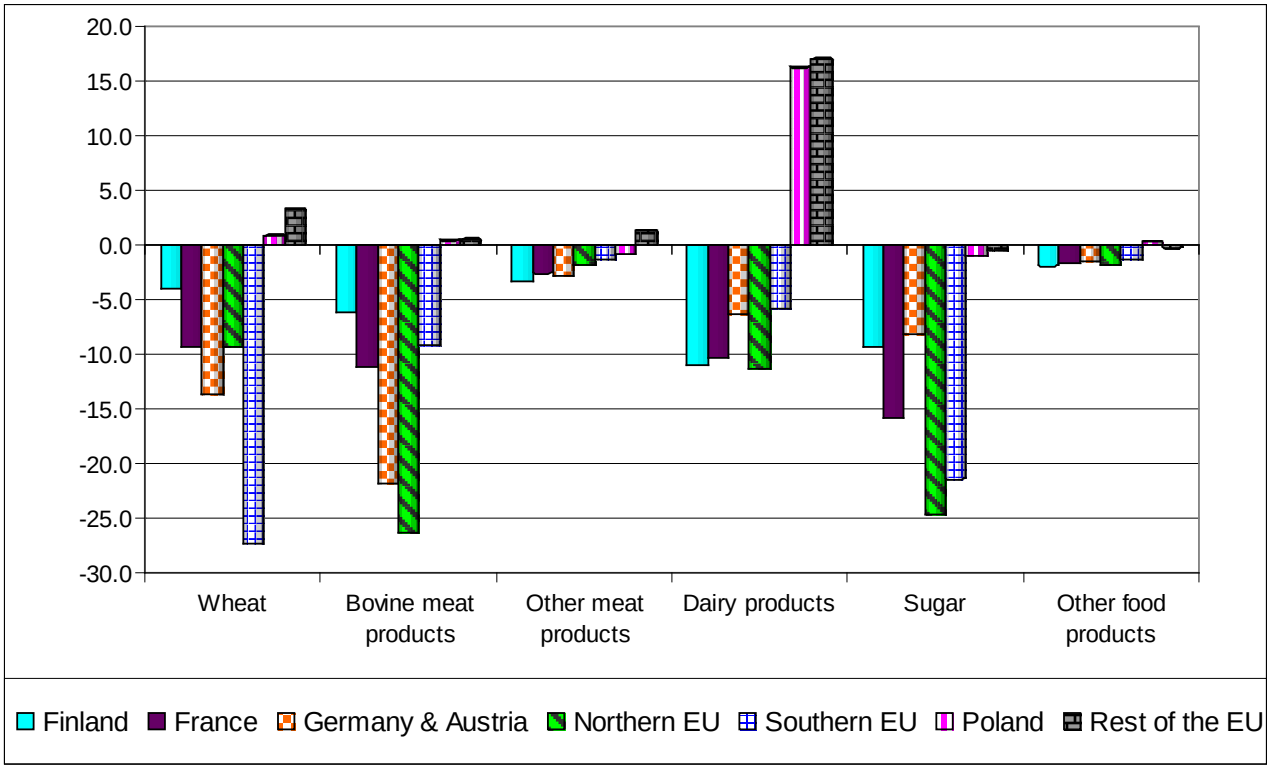

Figure1. Changes in agrifood production (in percentage - %) according to EU region under the EU Proposal for tariff reductions (Reference year 2001 using GTAP version 6 database)**.**

The total impact of CAP reforms, export subsidy abolition, and tariff reduction on production can be decomposed into individual impacts on production (Appendix 7). The charts (Figure 3 and 4) illustrating the decomposition of the different policy effects on EU production demonstrate that tariff reduction has the most powerful impact on the production of sugar, bovine meat products, bovine animals, and other crops, whereas export subsidy abolition has a considerable impact on wheat, other grains, and dairy products. The steeper tariff reduction under the US Proposal would cause a substantial further decrease in the production of other crops, sugar, bovine meat products, bovine animals, and dairy products. CAP reforms are

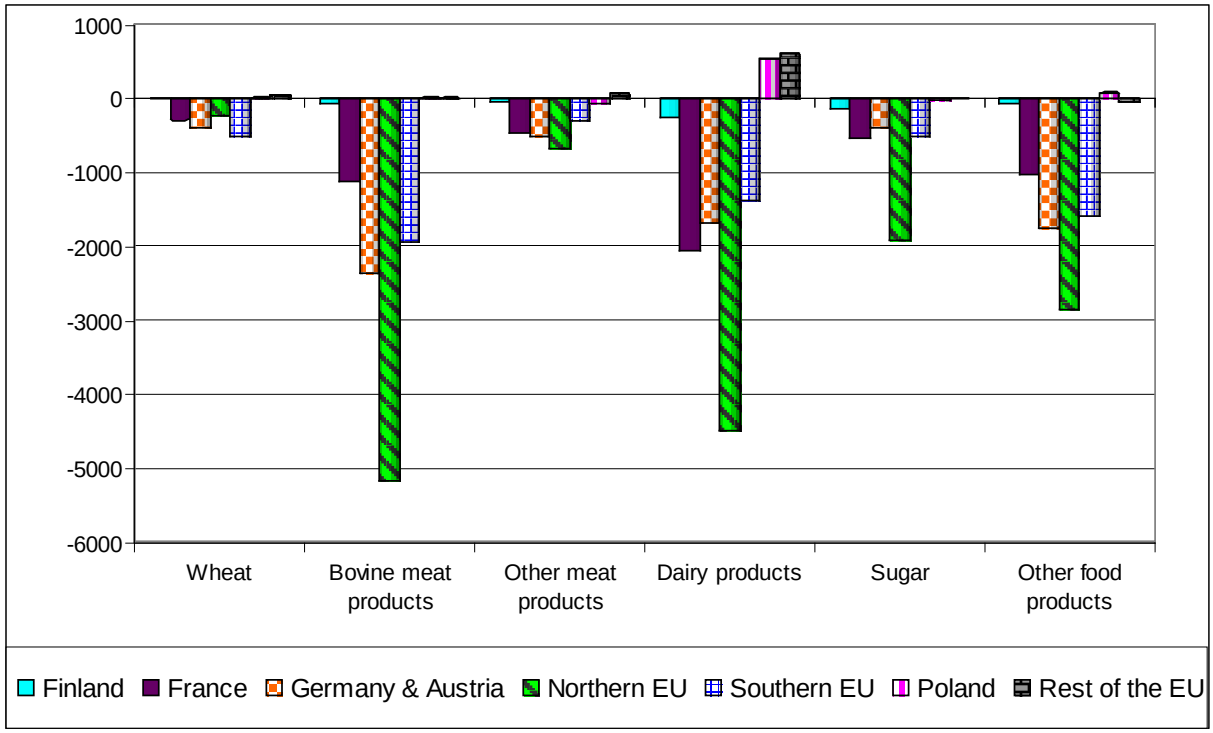

Figure 2. Changes in agrifood production (in value - US$ Million) according to EU region under the EU Proposal for tariff reductions (Reference year 2001 using GTAP version 6 database).

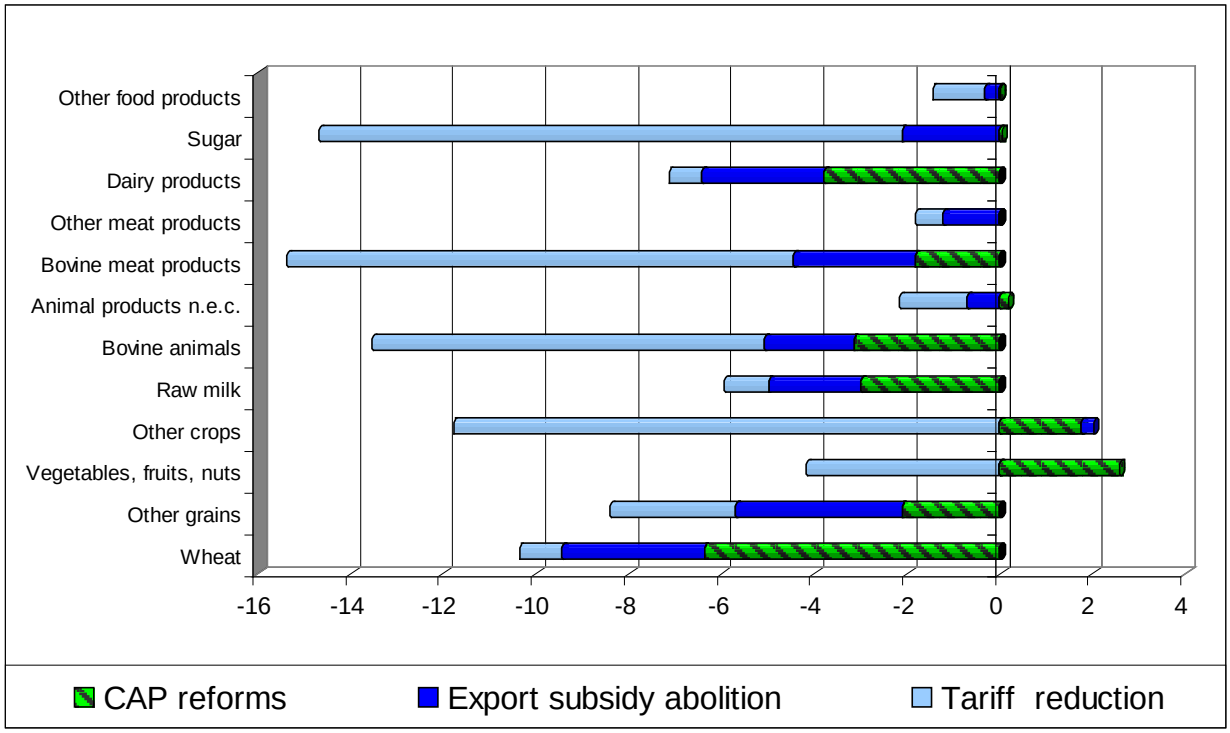

Figure 3. Decomposition of different policy effects on the changes in EU production under the EU Proposal for tariff reductions (Reference year 2001 using GTAP version 6 database).

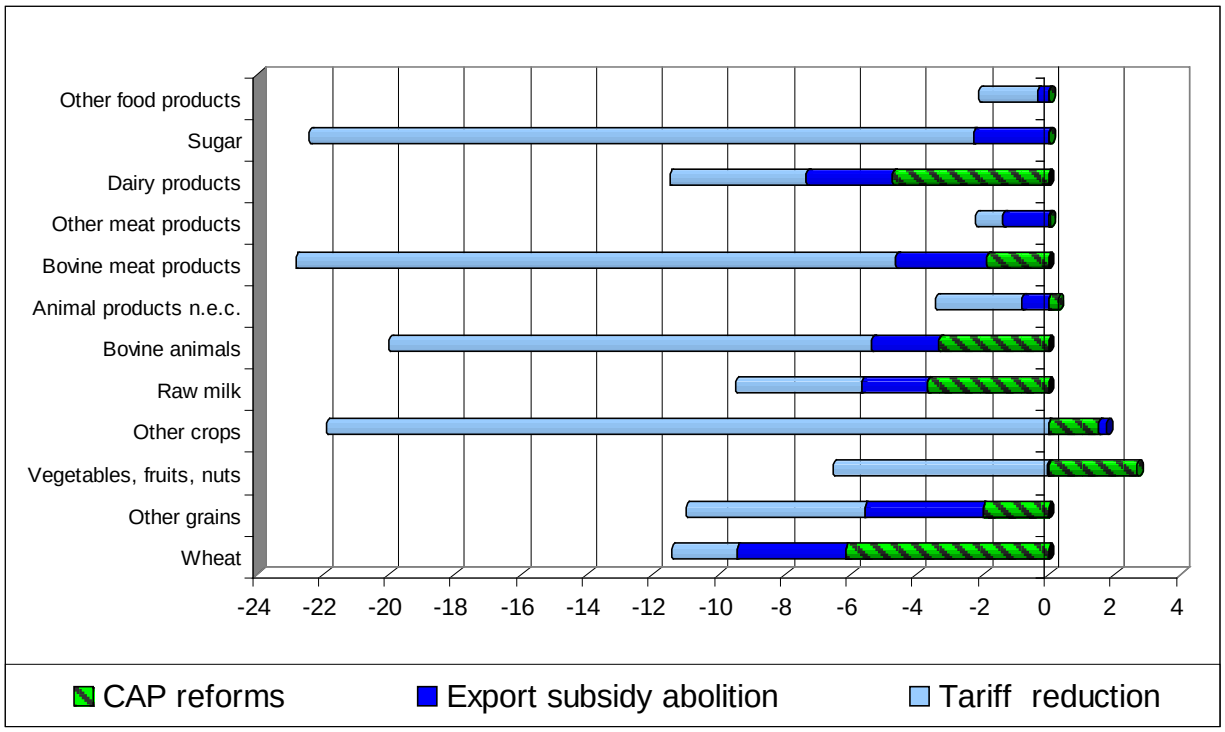

Figure 4. Decomposition of different policy effects on the changes in EU production under the US Proposal for tariff reductions (Reference year 2001 using GTAP version 6 database).

largely responsible for the decrease in production for wheat and dairy products. The decomposition shows that tariff reduction has the greatest contribution to the total drop in the production of bovine meat products in the EU. Out of the 15% drop in production under the EU formula, tariff reduction alone accounts for 11% of the drop compared to less than 5% for both CAP reforms and export subsidy abolition. Under the US formula, out of the 23% drop in production, tariff reduction alone accounts for 18%, and both CAP reforms and export subsidy abolition account for less than 5% of the drop. By comparing the EU Proposal (Figure 3) for tariff reduction with the steeper tariff reduction under the US Proposal (Figure 4), the production of bovine meat products would sharply decrease with further market opening. Therefore, some bovine meat products may be designated as sensitive products by the EU in the WTO in order to protect the domestic production of these products. Designation as sensitive products will give the EU flexibility to shield them from the full force of the applicable tariff reduction formula by applying a lower tariff reduction formula. The decomposition also shows that CAP reforms have the greatest contribution to the total drop in the production of dairy products in the EU. Out of the 7% drop in production under the EU formula, CAP reforms alone account for 4% of the drop compared to 3% for both export subsidy abolition and tariff reduction. Under the US formula, out of the 12% drop in production, CAP reforms account for 5%, tariff reduction accounts for 4%, and export subsidy abolition accounts for 3% of the drop. This is an indication that dairy products are very sensitive to domestic policy reforms. Furthermore, EU production of dairy products will considerably decrease under the US Proposal for tariff reduction compared to the EU Proposal. Thus, some dairy products may be designated as sensitive products in the WTO in order to avoid the full force of the applicable tariff reduction formula.

Exports According to EU Region

In terms of EU exports under the EU tariff reduction formula (Appendix 3), sugar (60%), bovine meat products (57%), dairy products (23%), other grains (22%), and wheat (18%) have the highest percentage reduction in exports, but dairy products (USD 5.6 billion), bovine meat products (USD 4.2 billion), and other food products (USD 2.7 billion) have the highest reduction in the value of exports. Even though the percentage reduction in the exports (Figure 5) of other food products is the lowest, the value of the reduced exports (Figure 6) is high due to the highly processed nature of the food products. On the contrary, the percentage drop in the exports of sugar is large, but the drop in the value of exports is low compared to the other products. Under the US tariff reduction formula (Appendix 4), bovine meat products (72%), sugar (71%), dairy products (28%), other grains (27%), and other crops (22%) have the highest percentage reduction in exports, but dairy products (USD 7.6 billion), bovine meat products (USD 5.3 billion), and other food products (USD 2.9 billion) have the highest value reduction in exports. Similarly, the percentage reduction in the exports of other food products is low (3%), but the value of the reduced exports is high. If the reduction in exports is measured in terms of value (Figure 6), the exports of dairy products are considered to experience the highest level of reduction, followed by bovine meat products and other food products (processed food products). Domestic policy reforms and trade liberalization in the EU may cause reductions in the exports of almost all the examined agricultural products, ranging from 3% to 60% under the EU tariff reduction formula and from 1% to 72% under the US tariff reduction formula. Among the EU countries and regions, Finland may experience the largest percentage drop in the exports of bovine meat products (80% under the EU formula; 89% under the US formula), but the value of exports is

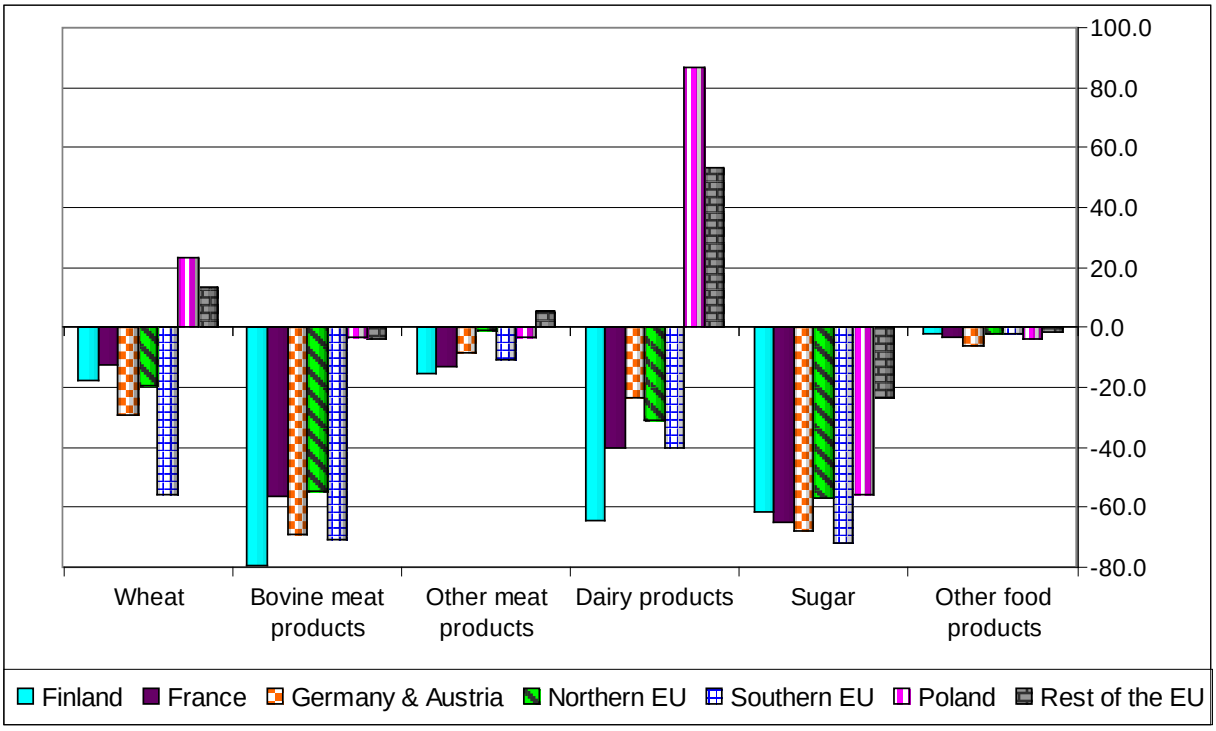

Figure 5. Changes in agrifood exports (in percentage - %) according to EU region under the EU Proposal for tariff reductions (Reference year 2001 using GTAP version 6 database).

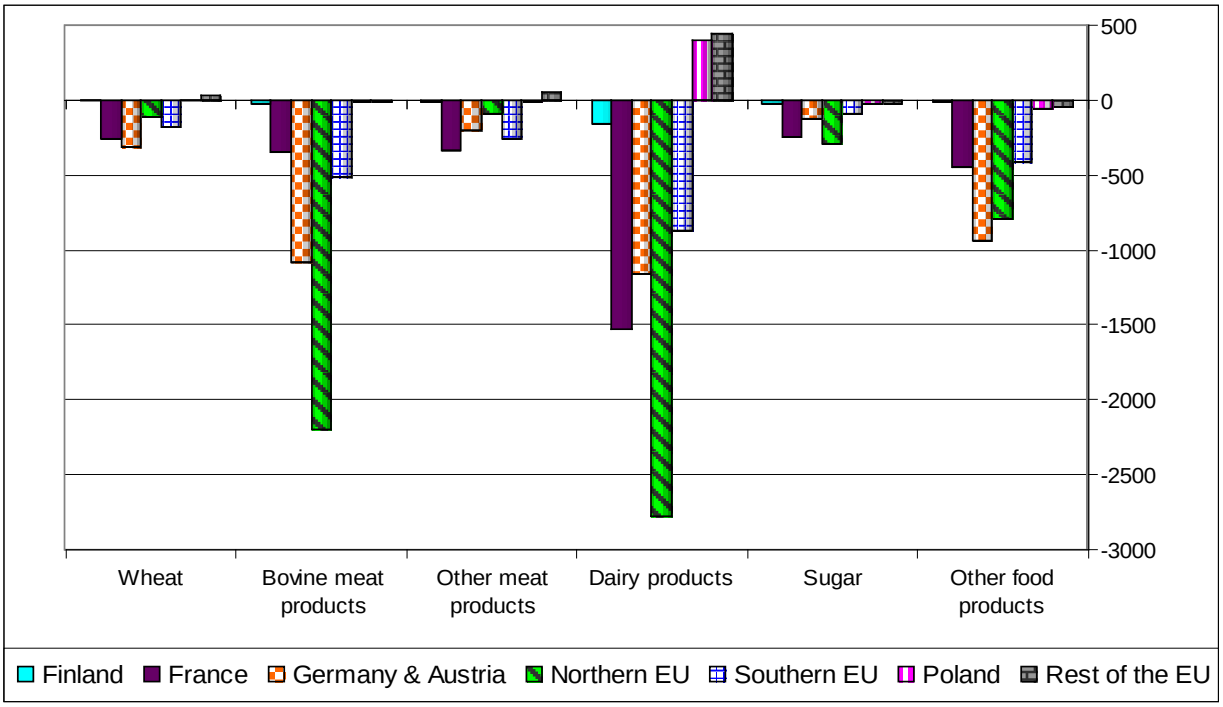

Figure 6. Changes in agrifood exports (in value - US$ Million) according to EU region under the EU Proposal for tariff reductions (Reference year 2001 using GTAP version 6 database)

negligible compared to the other EU regions. Northern EU may experience the biggest drop in the value of exports (USD 2.8 billion under the EU formula) for dairy products, but the percentage drop (31% under the EU formula) in exports is moderate compared to the other EU regions.

Imports According to EU Region

In terms of EU imports under the EU tariff reduction formula (Appendix 5), sugar (65%), bovine meat products (64%), other crops (15%), dairy products (11%), wheat (8%), and other meat products (7%) have the highest percentage increase in imports, but bovine meat products (USD 6.1 billion), other food products (USD 4.8 billion), other crops (USD 3.8 billion), sugar (USD 2.3 billion), dairy products (USD 2 billion), and other meat products (USD 1.2 billion) have the highest value increase in imports. Although the percentage increase (Figure 7) in the imports of other food products is very small, the value (Figure 8) of the increased imports is considerable due to the highly processed nature of the food products. In comparison, the percentage rise in the imports of sugar is extremely high, but the imported value is much lower than for other food products. Under the US tariff reduction formula (Appendix 6), sugar (128%), bovine meat products (124%), other crops (37%), dairy products (33%), other meat products (16%), and wheat (9%) have the highest percentage increase in imports, but bovine meat products (USD 12 billion), other crops (USD 9.6 billion), other food products (USD 8.5 billion), dairy products (USD 5.9 billion), sugar (USD 4.6 billion), and other meat products (USD 2.7 billion) have the

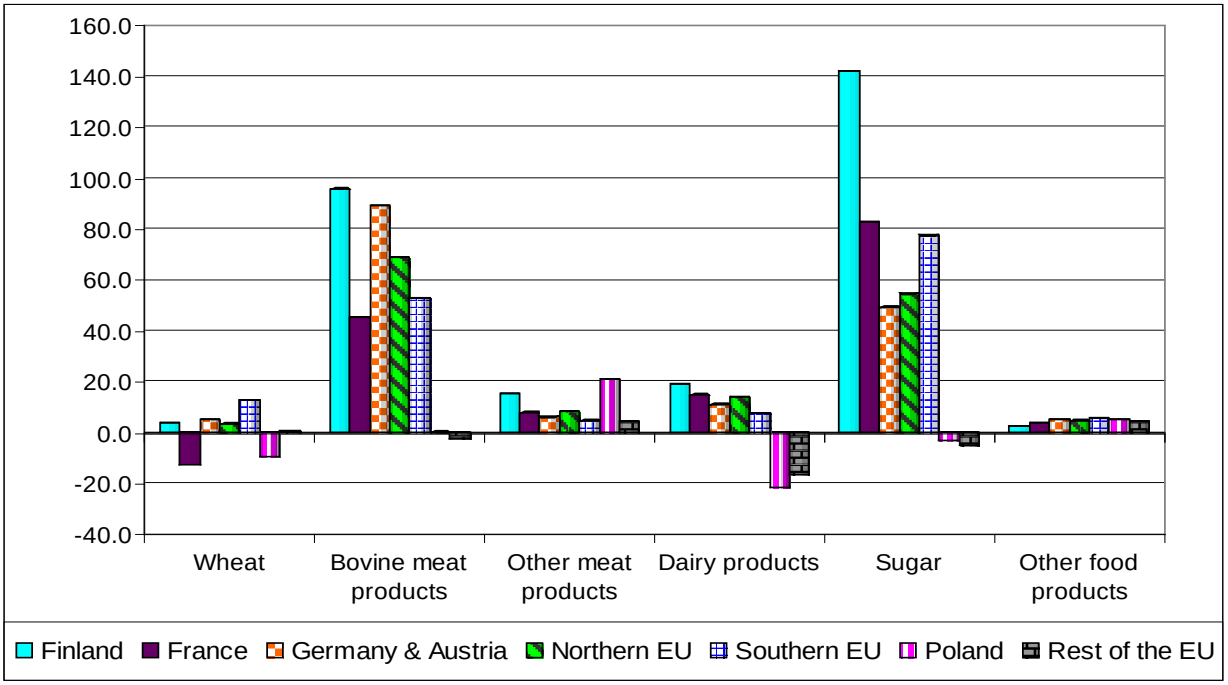

Figure 7. Changes in agrifood imports (in percentage - %) according to EU region under the EU Proposal for tariff reductions (Reference year 2001 using GTAP version 6 database).

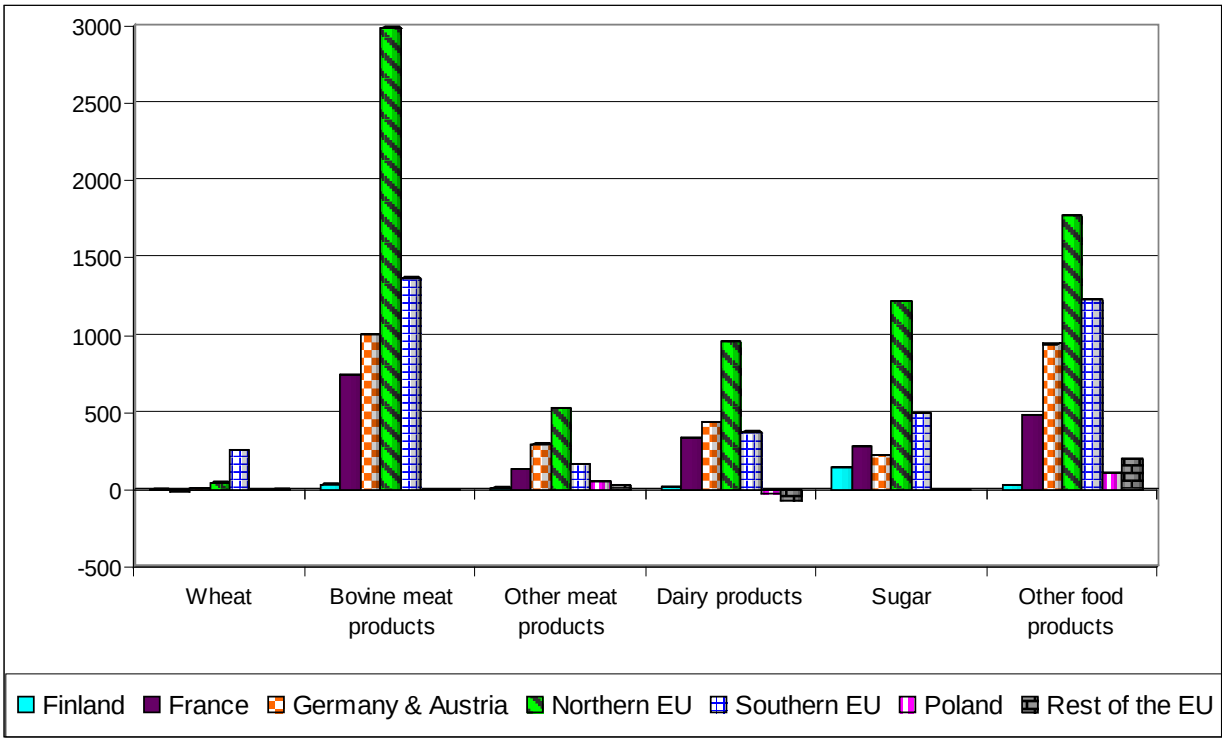

Figure 8. Changes in agrifood exports (in value - US$ Million) according to EU region under the EU Proposal for tariff reductions (Reference year 2001 using GTAP version 6 database).

highest value increase in imports. The percentage increase in the imports of other food products is the same as for wheat (9%), but the value of the increased imports of other food products is 25 times greater than the value of wheat imports. If the increase in imports is measured in terms of value (Figure 8), the import of bovine meat products is considered to experience the highest level of increase, followed by other food products (processed food products) and sugar. Domestic policy reforms and trade liberalization in the EU may cause increases in the imports of almost all the examined agricultural products, ranging from USD 13 million to USD 6 billion under the EU tariff reduction formula and from USD 56 million to USD 12 billion under the US tariff reduction formula. Among the EU countries and regions, Finland may experience the largest percentage growth in imports, especially for sugar (142% under the EU formula; 310% under the US formula), but Northern EU is the region that may experience the largest growth in the value of imports, especially for bovine meat products (USD 3 billion under the EU formula; USD 5.4 billion under the US formula).

Production, Exports, and Imports: US Proposal Versus EU Proposal; Small Versus Large EU Members; Old Versus New EU Members.

The steeper tariff reduction formula of the US Proposal compared to the EU Proposal would cause a larger decrease in EU production and EU exports as well as a higher increase in EU imports of the examined agricultural commodities/sectors (Appendix 8). The scale of production, exports, and imports for France measured in value terms is approximately ten times greater than for Finland. Therefore, France has a major role in the CAP and a major voice in the negotiating position of the EU at the WTO. The most striking impact of the steeper tariff reduction formula (US Proposal) is that the amount of EU imports doubled compared to the milder tariff reduction formula (EU Proposal). The rise in imports of sugar is most profound in Finland, and France has the steepest growth in the imports of bovine meat products compared to the other agricultural products, whereas Poland may experience a dramatic expansion in the imports of other food products. Concerning Poland, the results suggest that the country is very competitive in the production of dairy products; hence the rise in production and exports of dairy products after trade liberalization and domestic policy reforms. Several studies (Gorton et. al 2001, Dries and Swinnen 2004, IFCN 2008) have pointed out that Poland has a lower cost of production for milk compared to the old EU member countries and high scope for productivity improvement stemming from the improvement in investment conditions and catching up with the technological lag.

Trade liberalization and domestic policy reforms would cause production declines in the old EU member countries for all the examined agricultural commodities/sectors, while the new EU member countries may encounter production growth in some of the examined agricultural products (Appendix 9 and Appendix 10). Bovine meat products, dairy products, and sugar may encounter the most drastic decline in exports. In the case of imports, the level of bovine meat product and sugar imports may grow to an extremely high level due to trade liberalization, especially when the tariffs are reduced under the US Proposal, and these sectors in Finland may be flooded by imports of these products. Brockmeier et al. (2006) have shown that the highly protected beef and milk sectors of the EU are particularly affected by the application of the US Proposal for tariff reductions, and the highly protected EU agricultural sectors would experience a severe negative change in their trade balances. The Food and Agricultural Policy Research

Institute (FAPRI 2005) has found that the combined effect of trade liberalization and domestic policy changes would significantly increase beef imports in the EU and substantially decrease EU exports and production. In addition, using comparable methodology for simulating trade liberalization and domestic support reforms in the EU, Jensen and Yu (2005) have shown that EU production of bovine meat products and other agricultural products would significantly drop together with decreasing exports and expanding imports of these products. In comparison, the results are more severe in this study.

Conclusions

This study has aimed to address the question of what would be the overall effects of further trade liberalization and the implemented CAP reforms on EU agricultural production, imports and exports within different EU regions by using the multi-region and multi-sector computable general equilibrium model known as the GTAP model. Moreover, the GTAP model was used to compare a lower tariff reduction formula (EU Proposal) with a higher reduction formula (US Proposal) in order to show how sensitive the examined agricultural commodity/sector is to the different tariff reduction formulae. This will indicate the agricultural commodities/sectors that are vulnerable to further market opening and a extreme reduction in tariffs.

This study has shown that EU imports would escalate and EU exports would plummet with declining EU production because of trade liberalization and domestic policy reforms in the EU agricultural markets and sectors. The results suggest that CAP reforms accompanied by tariff reductions and the removal of export subsidies would cause a reduction in EU production in all the examined agricultural products ranging from 1% to 15% under the EU tariff reduction formula and from 2% to 23% under the US tariff reduction formula. The decline in EU agricultural production would reduce EU exports of almost all the examined agricultural products by from 3% to 60% under the EU tariff reduction formula and from 1% to 72% under the US tariff reduction formula. Additionally, EU imports would increase for almost all the examined agricultural products, ranging from USD 13 million to USD 6 billion under the EU tariff reduction formula and from USD 56 million to USD 12 billion under the US tariff reduction formula. Northern EU and Finland would be the hardest hit region and country, respectively, in terms of decreasing production and exports in combination with increasing imports. The decoupling of the CAP support payments and a drastic increase in input prices such as fertilizers, energy and labor have lowered the incentive for high cost producers to continue production. High cost producers in countries such as Finland, Sweden, and Denmark will only continue to produce with higher prices for food and agricultural products. Otherwise, agriculture is not a competitive industry for labor or capital in these countries.

The decomposition of the different policy effects on EU production demonstrated that tariff reduction has the most powerful impact on the production of sugar, bovine meat products, bovine animals, and other crops, whereas export subsidy abolition has a considerable impact on wheat, other grains, and dairy products. CAP reforms are largely responsible for the decrease in production for wheat and dairy products. The decomposition showed that tariff reduction has the greatest contribution to the total drop in the production of bovine meat products in the EU. Therefore, some bovine meat products may be designated as sensitive products by the EU in the WTO. Designation as sensitive products will give the EU flexibility to shield these products

from the full force of the applicable tariff reduction formula by applying a lower tariff reduction formula. The decomposition also showed that CAP reforms have the greatest contribution to the total drop in the production of dairy products in the EU. EU production of dairy products would considerably decrease under the US Proposal for tariff reduction compared to the EU Proposal. Thus, some dairy products may be designated as sensitive products in the WTO in order to avoid the full force of the applicable tariff reduction formula. The negotiated formula for tariff reductions in the WTO draft proposal[2] for the Agreement on Agriculture is a compromise between the EU and US Proposals. Hence, agricultural commodities/sectors analyzed as sensitive in this study may be declared as comprising sensitive products by the EU in the up-coming Doha Round. The market access pillar of the agricultural negotiations is very difficult for the EU due to its vulnerability to imports.

The most striking impact of a steeper tariff reduction formula (US Proposal) is that the quantity of EU imports would double compared to a milder tariff reduction formula (EU Proposal). The rise in imports of sugar would be most profound in Finland, and France would have the steepest growth in the imports of bovine meat products compared to the other agricultural products, whereas Poland may experience a dramatic expansion in the imports of other food products. Trade liberalization and domestic policy reforms would cause production declines in the old EU member countries for all the examined agricultural products, whereas the new EU member countries may encounter production growth in some of the examined agricultural products. Bovine meat products, dairy products, and sugar may encounter the most drastic decline in exports. Moreover, the imports of bovine meat products and sugar may grow to extremely high levels due to trade liberalization, especially if the tariffs are reduced according to the US Proposal: Finland may be flooded by imports of these products. In order to protect the domestic production of these products, the EU may designate sugar, bovine meat products, and dairy products as sensitive products in the WTO. However, aggregates are deceptive, because the GTAP model could not include products at the level of detail at which tariff lines are specified (for example at the 8-digit level, and the EU tariff schedule includes 2200 tariff lines). Consequently, the assessment of EU agricultural products that are sensitive to trade liberalization cannot be precise in this study.

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[2] Under the WTO draft proposal, tariffs between zero and 20 percent are to be reduced by 50 percent; tariffs between 20 to 50 percent would be cut by 57 percent; tariffs between 50 to 75 percent would be lowered by 64 percent; and tariffs above 75 percent would be decreased by 70 percent (WTO 2008).

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Appendix 1.

Changes in EU agrifood production according to country/region under the EU Proposal for tariff reductions
(Reference year 2001 using GTAP version 6 database)

	EU		Finland		France		Germany & Austria		Northern EU		Southern EU		Poland		Rest of the EU	
	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.
Wheat	-10.4	-1378	-4.0	-2	-9.3	-290	-13.7	-385	-9.4	-238	-27.3	-515	0.9	11	3.4	41
Other grains	-8.4	-1187	-13.9	-44	-11.2	-328	-12.1	-401	-13.9	-284	-5.2	-158	1.6	17	0.9	10
Vegetables, fruits, nuts	-1.6	-838	-2.1	-6	-3.0	-206	-0.5	-21	-4.2	-370	-0.6	-165	-0.5	-21	-2.3	-49
Other crops	-9.8	-6309	-7.3	-47	-5.9	-886	-9.5	-1121	-17.1	-2110	-8.5	-1646	-7.8	-200	-13.2	-298
Raw milk	-5.9	-2589	-10.4	-76	-7.4	-534	-5.2	-563	-9.8	-1215	-5.5	-428	5.6	126	5.5	101
Bovine animals	-13.5	-3537	-6.4	-9	-7.6	-451	-21.6	-728	-20.7	-1588	-10.7	-771	1.0	6	0.4	4
Animal products n.e.c.	-2.0	-1057	-6.1	-35	-2.7	-206	-2.5	-222	-2.8	-409	-1.3	-186	-0.6	-18	0.5	21
Bovine meat products	-15.4	-10605	-6.2	-66	-11.2	-1112	-21.7	-2360	-26.2	-5153	-9.2	-1937	0.4	10	0.6	12
Other meat products	-1.8	-2009	-3.3	-46	-2.6	-463	-2.8	-514	-1.9	-685	-1.3	-308	-0.9	-61	1.4	68
Dairy products	-7.1	-8727	-10.9	-264	-10.3	-2052	-6.4	-1683	-11.3	-4495	-5.9	-1380	16.2	538	17.0	608
Sugar	-14.6	-3517	-9.3	-137	-15.7	-531	-8.2	-402	-24.6	-1913	-21.4	-508	-1.0	-18	-0.5	-9
Other food products	-1.4	-7263	-1.9	-62	-1.6	-1031	-1.5	-1758	-1.8	-2851	-1.3	-1593	0.3	81	-0.3	-50

Appendix 2.

Changes in EU agrifood production according to country/region under the US Proposal for tariff reductions
(Reference year 2001 using GTAP version 6 database)

	EU		Finland		France		Germany & Austria		Northern EU		Southern EU		Poland		Rest of the EU	
	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.
Wheat	-11.4	-1520	-5.4	-2	-12.5	-390	-15.8	-442	-8.0	-204	-28.3	-535	0.4	5	4.0	49
Other grains	-11.0	-1548	-15.6	-49	-15.0	-438	-14.8	-491	-15.8	-322	-7.5	-229	1.0	11	-2.6	-30
Vegetables, fruits, nuts	-3.8	-2022	-4.8	-13	-5.1	-354	-3.3	-151	-7.4	-653	-3.0	-778	-0.3	-13	-2.7	-59
Other crops	-20.1	-13066	-16.4	-106	-13.0	-1965	-21.5	-2551	-31.9	-3946	-18.5	-3572	-14.8	-383	-24.0	-543
Raw milk	-9.5	-4160	-12.5	-92	-10.8	-780	-9.2	-1001	-15.5	-1918	-8.2	-640	6.9	154	6.3	117
Bovine animals	-20.0	-5228	-9.7	-14	-14.6	-863	-29.2	-985	-28.5	-2188	-16.1	-1159	0.0	0	-2.3	-19
Animal products n.e.c.	-3.1	-1665	-7.1	-40	-4.2	-324	-4.7	-421	-3.8	-552	-2.4	-345	-1.4	-42	1.5	59
Bovine meat products	-22.8	-15865	-9.4	-101	-19.2	-1907	-29.8	-3239	-38.4	-7536	-14.4	-3019	-0.4	-10	-2.4	-52
Other meat products	-2.2	-2405	-3.5	-49	-4.0	-711	-5.1	-943	-0.6	-238	-2.1	-502	-1.9	-136	3.5	174
Dairy products	-11.5	-14103	-13.2	-318	-14.5	-2906	-11.5	-3040	-17.9	-7113	-8.8	-2068	19.8	658	19.2	683
Sugar	-22.4	-5445	-15.7	-230	-23.8	-804	-13.9	-684	-36.8	-2866	-33.0	-783	-1.4	-25	-3.2	-53
Other food products	-2.1	-10543	-2.7	-87	-2.4	-1538	-2.4	-2773	-2.4	-3836	-1.8	-2208	0.2	49	-0.8	-150

Appendix 3.

Changes in EU agrifood exports according to country/region under the EU Proposal for tariff reductions
(Reference year 2001 using GTAP version 6 database)

	EU		Finland		France		Germany & Austria		Northern EU		Southern EU		Poland		Rest of the EU	
	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.
Wheat	-18.0	-804	-17.9	0	-12.5	-253	-28.9	-308	-19.7	-104	-56.0	-173	23.3	0	13.7	35
Other grains	-22.4	-728	-31.0	-27	-16.0	-245	-39.7	-255	-34.9	-172	-22.9	-32	-8.7	0	1.0	2
Vegetables, fruits, nuts	-3.4	-569	-1.6	0	-6.5	-135	-2.2	-18	-5.6	-225	-1.5	-135	-10.8	-22	-9.7	-35
Other crops	-12.3	-1574	12.6	1	-16.5	-258	-9.9	-161	-15.1	-973	-2.4	-57	-25.3	-43	-16.2	-83
Raw milk	11.2	4	-4.4	0	-6.9	-1	30.9	3	43.2	2	6.5	1	-3.3	0	-1.5	0
Bovine animals	-13.9	-352	-21.1	0	-3.7	-32	-26.9	-75	-26.2	-221	-21.3	-27	2.0	3	-0.3	-1
Animal products n.e.c.	0.1	-2	-16.1	-17	-5.0	-41	-1.5	-16	3.6	98	-1.9	-16	-8.4	-9	-0.5	-2
Bovine meat products	-57.1	-4170	-79.5	-14	-56.2	-345	-68.8	-1088	-54.9	-2203	-70.5	-512	-3.3	-4	-3.9	-5
Other meat products	-4.5	-850	-15.6	-14	-13.2	-336	-8.3	-204	-0.9	-84	-11.0	-254	-3.5	-11	5.5	53
Dairy products	-22.7	-5648	-64.1	-157	-40.0	-1533	-23.5	-1164	-30.7	-2783	-40.2	-870	86.5	410	53.2	449
Sugar	-59.5	-808	-61.7	-20	-65.0	-242	-68.1	-121	-57.1	-290	-71.9	-91	-55.5	-25	-23.2	-18
Other food products	-2.9	-2691	-1.9	-7	-3.1	-446	-6.3	-938	-2.0	-794	-2.3	-409	-3.9	-57	-1.4	-39

Appendix 4.

Changes in EU agrifood exports according to country/region under the US Proposal for tariff reductions
(Reference year 2001 using GTAP version 6 database)

	EU		Finland		France		Germany & Austria		Northern EU		Southern EU		Poland		Rest of the EU	
	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.
Wheat	-17.7	-800	-23.9	0	-16.2	-329	-31.1	-331	-3.9	-20	-54.7	-169	93.0	0	19.9	50
Other grains	-27.0	-869	-33.7	-29	-20.7	-317	-44.6	-286	-36.9	-182	-27.0	-37	-18.5	-1	-7.1	-17
Vegetables, fruits, nuts	-7.5	-1268	-2.6	-1	-10.1	-211	-7.7	-62	-9.2	-373	-6.1	-565	-10.2	-21	-9.9	-36
Other crops	-21.7	-2800	25.2	2	-30.3	-474	-20.4	-330	-27.2	-1748	-4.1	-96	-32.7	-56	-19.2	-98
Raw milk	24.6	10	1.3	0	2.0	0	44.7	4	63.1	3	18.3	1	7.3	0	13.2	1
Bovine animals	-19.7	-484	-17.0	0	-15.4	-132	-31.6	-89	-25.4	-214	-29.2	-37	-1.2	-2	-6.9	-11
Animal products n.e.c.	-1.4	-88	-19.2	-21	-7.5	-61	-3.4	-36	2.1	56	-3.7	-30	-10.6	-11	4.6	16
Bovine meat products	-71.9	-5258	-89.4	-16	-73.1	-448	-81.8	-1293	-72.1	-2895	-82.2	-597	-4.7	-5	-3.0	-4
Other meat products	0.6	-43	-3.4	-3	-18.2	-464	-10.6	-262	9.1	851	-15.6	-361	-1.6	-5	20.8	200
Dairy products	-27.7	-7559	-70.0	-171	-52.3	-2001	-36.9	-1826	-41.6	-3769	-49.9	-1081	123.8	587	83.2	701
Sugar	-71.1	-962	-58.1	-19	-79.7	-297	-73.6	-131	-69.8	-355	-80.8	-103	-57.9	-26	-41.7	-32
Other food products	-3.1	-2927	-0.8	-3	-3.9	-552	-9.1	-1340	-1.6	-633	-1.7	-302	-4.3	-64	-1.2	-33

Appendix 5.

Changes in EU agrifood imports according to country/region under the EU Proposal for tariff reductions
(Reference year 2001 using GTAP version 6 database)

	EU		Finland		France		Germany & Austria		Northern EU		Southern EU		Poland		Rest of the EU	
	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.
Wheat	8.1	298	3.8	0	-12.5	-15	5.1	11	3.5	47	12.8	259	-9.5	-5	0.7	0
Other grains	0.5	14	-7.4	-1	3.4	4	1.0	4	0.3	3	1.4	17	-9.2	-13	-0.1	0
Vegetables, fruits, nuts	1.3	379	3.1	10	2.4	94	0.9	75	0.3	28	2.6	114	4.0	28	3.0	30
Other crops	14.6	3804	16.2	42	17.3	457	14.0	947	5.1	529	25.2	1411	27.4	190	18.5	227
Raw milk	-13.1	-11	-2.1	0	-6.5	-1	-12.4	-3	-20.1	-7	-8.1	-1	4.9	0	3.8	0
Bovine animals	4.7	110	26.1	0	-11.3	-21	-9.4	-8	11.8	91	3.0	46	2.3	0	6.8	3
Animal products n.e.c.	0.2	13	1.8	1	0.7	5	0.2	4	-3.3	-57	1.1	33	4.9	12	3.9	15
Bovine meat products	63.8	6121	95.9	35	45.3	740	89.5	1001	69.0	2981	53.0	1367	0.4	0	-2.5	-3
Other meat products	7.2	1219	15.4	12	8.0	135	6.2	295	8.4	528	4.8	167	21.3	53	4.8	28
Dairy products	11.3	2025	19.1	22	15.1	332	11.2	440	14.2	958	7.9	373	-21.5	-27	-16.3	-73
Sugar	64.5	2349	142.3	141	83.0	277	49.4	223	54.6	1216	77.6	496	-3.2	0	-5.0	-3
Other food products	5.0	4761	2.8	30	3.9	481	5.4	941	4.8	1767	5.8	1230	5.4	108	4.5	203

Appendix 6.

Changes in EU agrifood imports according to country/region under the US Proposal for tariff reductions
(Reference year 2001 using GTAP version 6 database)

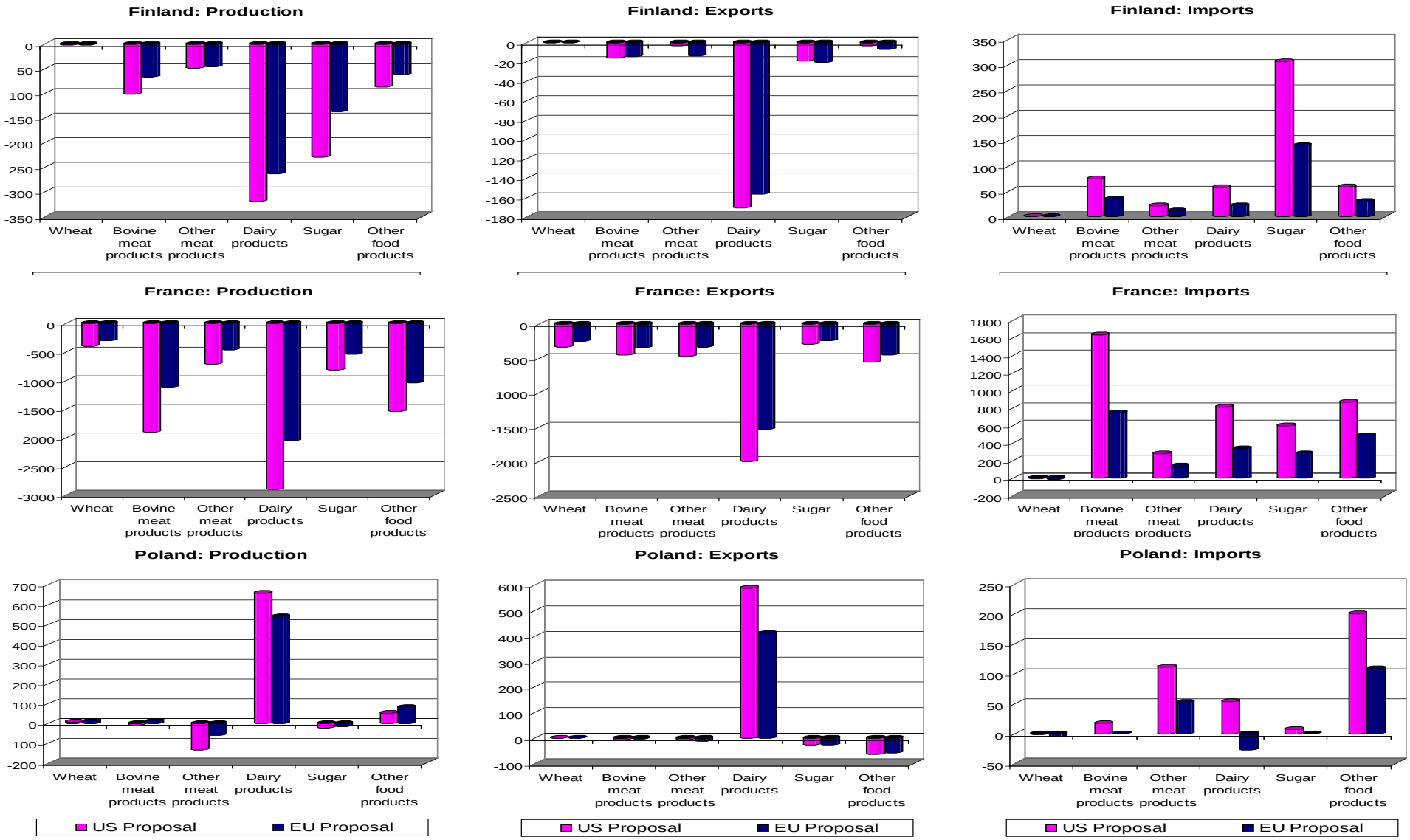
	EU		Finland		France		Germany & Austria		Northern EU		Southern EU		Poland		Rest of the EU	
	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.	%	US$ Mill.
Wheat	9.3	346	5.4	0	-9.3	-11	7.2	16	5.4	73	13.0	262	-2.9	-1	10.3	8
Other grains	1.9	56	-3.1	0	7.6	10	1.9	9	0.5	5	2.2	25	-6.3	-9	7.1	17
Vegetables, fruits, nuts	2.9	853	6.1	20	4.3	165	2.1	175	1.1	117	6.8	302	4.4	31	4.4	44
Other crops	36.7	9562	41.7	108	49.6	1308	35.0	2372	13.4	1394	62.8	3515	56.6	392	38.4	473
Raw milk	-18.0	-15	-4.3	0	-13.1	-1	-15.4	-4	-26.0	-8	-13.3	-2	1.8	0	-1.3	0
Bovine animals	9.3	220	47.6	1	-10.8	-20	-9.3	-8	23.4	180	3.5	54	19.8	1	33.4	12
Animal products n.e.c.	1.8	141	3.0	2	2.5	18	0.7	13	-2.0	-34	3.1	96	8.1	20	7.0	26
Bovine meat products	123.9	11954	208.7	76	100.0	1632	174.7	1955	125.4	5413	108.4	2795	71.3	17	54.3	66
Other meat products	15.9	2691	27.8	22	16.6	281	14.0	664	18.5	1167	9.9	340	44.9	111	18.3	106
Dairy products	32.7	5890	49.2	58	36.5	805	31.5	1236	39.7	2674	19.8	930	42.8	54	29.8	134
Sugar	127.5	4623	309.8	306	178.3	595	119.5	539	99.1	2206	148.1	946	63.2	7	36.5	23
Other food products	8.9	8512	5.4	59	7.1	866	9.7	1698	8.6	3167	10.1	2137	9.9	201	8.4	384

Appendix 7.

Decomposition of different policy effects on the changes in EU agrifood production under the different tariff reduction formulae of the EU Proposal and US Proposal (Reference year 2001 using GTAP version 6 database)

	EU Proposal (in percentage) Effect from				**US Proposal** (in percentage) Effect from			
	EU Total	CAP reforms	Export subsidy abolition	Tariff reduction	EU Total	CAP reforms	Export subsidy abolition	Tariff reduction
Wheat	-10.4	-6.4	-3.1	-0.9	-11.4	-6.2	-3.3	-2.0
Other grains	-8.4	-2.1	-3.6	-2.7	-11.0	-2.0	-3.6	-5.4
Vegetables, fruits, nuts	-1.6	2.6	0.0	-4.2	-3.8	2.7	0.0	-6.5
Other crops	-9.8	1.8	0.3	-11.8	-20.1	1.5	0.3	-21.9
Raw milk	-5.9	-3.0	-2.0	-0.9	-9.5	-3.7	-2.0	-3.8
Bovine animals	-13.5	-3.1	-1.9	-8.4	-20.0	-3.3	-2.0	-14.6
Animal products n.e.c.	-2.0	0.2	-0.7	-1.5	-3.1	0.3	-0.8	-2.6
Bovine meat products	-15.4	-1.8	-2.6	-10.9	-22.8	-1.8	-2.8	-18.2
Other meat products	-1.8	0.0	-1.2	-0.6	-2.2	0.0	-1.4	-0.8
Dairy products	-7.1	-3.8	-2.6	-0.7	-11.5	-4.7	-2.6	-4.1
Sugar	-14.6	0.0	-2.1	-12.6	-22.4	0.0	-2.3	-20.1
Other food products	-1.4	0.0	-0.3	-1.1	-2.1	0.0	-0.3	-1.8

Appendix 8. The US Proposal versus the EU Proposal, Small versus Large EU Members, Old versus New EU Members (Production, Exports, and Imports in US$ Million)



Appendix 9. Percentage increase or decrease in production, exports, and imports under the EU Proposal for tariff reduction

	Finland	France	Germany & Austria	Northern EU	Southern EU	Poland	Rest of the EU
Production: EU Proposal							
0% to 20%						W, G, M, BA, BM, DP, FP	W, G, M, BA, AP, BM, OM, DP
0% to -10%	W, V, C, BA, AP, BM, OM, S, FP	W, V, C, M, BA, AP, OM, FP	V, C, M, AP, OM, DP, S, FP	W, V, M, AP, OM, FP	G, V, C, M, AP, BM, OM, DP, FP	V, C, AP, OM, S	V, S, FP
-11% to -20%	G, M, DP	G, BM, DP, S	W, G	G, C, DP	BA		C
-21% to -30%			BA, BM	BA, BM, S	W, S		
Exports: EU Proposal							
0% to 100%	C		M	M, AP	M	W, BA, DP	W, G, OM, DP
0% to -20%	W, V, M, AP, OM, FP	W, G, V, C, M, BA, AP, OM, FP	V, C, AP, OM, FP	W, V, C, OM, FP	V, C, AP, OM, FP	G, V, M, AP, BM, OM, FP	V, C, M, BA, AP, BM, FP
-21% to -40%	G, BA	DP	W, G, BA, DP	G, BA, DP	G, BA, DP	C	S
-41% to -60%		BM		BM, S	W	S	
-61% to -80%	BM, DP, S	S	BM, S		BM, S		
Imports: EU Proposal							
0% to -25%	G, M	W, M, BA	M, BA	M, AP	M	W, G, DP, S	G, BM, DP, S
0% to 10%	W, V, AP, FP	G, V, AP, OM, FP	W, G, V, AP, OM, FP	W, G, V, C, OM, FP	G, V, BA, AP, OM, DP, FP	V, M, BA, AP, BM, FP	W, V, M, BA, AP, OM, FP
11% to 50%	C, BA, OM, DP	C, BM, DP	C, DP, S	BA, DP	W, C	C, OM	C
51% to 100%	BM	S	BM	BM, S	BM, S		
101% to 150%	S						

W = Wheat; G = Other grains; V = Vegetables, fruits, nuts; C = Other crops; M = Raw Milk, BA = Bovine animals; AP = Animal products; BM = Bovine meat products; OM = Other meat products; DP = Dairy products; S = Sugar; FP = Other food products

Appendix 10. Percentage increase or decrease in production, exports, and imports under the US Proposal for tariff reduction

	Finland	France	Germany & Austria	Northern EU	Southern EU	Poland	Rest of the EU
Production: US Proposal							
0% to 20%						W, G, M, BA, DP, FP	W, M, AP, OM, DP
0% to -10%	W, V, BA, AP, BM, OM, FP	V, AP, OM, FP	V, M, AP, OM, FP	W, V, AP, OM, FP	G, V, M, AP, OM, DP, FP	V, AP, BM, OM, S	G, V, BA, BM, S FP
-11% to -20%	G, C, M, DP, S	W, G, C, M, BA, BM, DP	W, G, DP, S	G, M, DP	C, BA, BM,	C	
-21% to -30%		S	C, BA, BM	BA	W		C
-31% to -40%				C, BM, S	S		
Exports: US Proposal							
0% to 125%	C, M	M	M	M, AP, OM	M	W, M, DP	W, M, AP, OM, DP
0% to -20%	V, BA, AP, OM, FP	W, V, BA, AP, OM, FP	V, AP, OM, FP	W, V, FP	V, C, AP, OM, FP	G, V, BA, AP, BM, OM, FP	G, V, C, BA, BM, FP
-21% to -40%	W, G	G, C	W, C, BA, DP	G, C, BA	G, BA	C	
-41% to -60%	S	DP	G	DP	W, DP	S	S
-61% to -80%	DP	BM, S	S	BM, S			
-81% to -100%	BM		BM		BM, S		
Imports: US Proposal							
0% to -30%	G, M	W, M, BA	M, BA	M, AP	M	W, G	M
0% to 10%	W, V, AP, FP	G, V, AP, FP	W, G, V, AP, FP	W, G, V, FP	G, V, BA, AP, OM, FP	V, M, AP, FP	W, G, V, AP, FP
11% to 50%	C, BA, OM, DP	C, OM, DP	C, OM, DP	C, BA, OM, DP	W, DP	BA, OM, DP	C, BA, OM, DP, S
51% to 100%		BM		S	C	C, BM, S	BM
101% to 150%			S	BM	BM, S		
151% to 200%		S	BM				
201% to 310%	BM, S						

W = Wheat; G = Other grains; V = Vegetables, fruits, nuts; C = Other crops; M = Raw Milk, BA = Bovine animals; AP = Animal products; BM = Bovine meat products; OM = Other meat products; DP = Dairy products; S = Sugar; FP = Other food products

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Farmer Acceptance of Genetically Modified seeds in Germany: Results of a Cluster Analysis

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Abstract

Discussion on plant genetic engineering has experienced increasing momentum with the introduction of Genetically Modified (GM) corn in Germany and other European countries. This paper determines the various groups of German farmers, their attitudes and expected decisions on the use of GM foods using cluster analysis of 370 German farm managers. The results of cluster analysis indicate five main farmer groups who differ in terms of certain demographic characteristics and attitudes towards GM adoption. The study proposes tailored communication and risk management as an important measure that can be used by the biotechnology advocates to improve the level of acceptance.

Keywords: Biotechnology, cluster analysis, German farmers

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Introduction

Acceptance of Genetically Modified (GM) food remains a critical factor that will affect the future growth of agricultural biotechnology (BT). Plant genetic engineering has received more intense discussion than almost every other topic in agriculture. In many countries, the debate on GM revolves around the risks and the benefits of biotechnology in the production of food and feed (Isserman, 2001). Onyango et al., (2004) observe that the discussion on plant genetic engineering has split the public into two. On one side of the debate are the supporters of biotechnology who emphasize its importance to mankind in the form of improved supply of food, feed, and medicine, as well as reduction in insecticide and labour cost which provide economic benefits to the adopters (Isserman, 2001; Gianessi et al., 2002; Payne et al., 2003; Sankular et al., 2005). Brookes and Barfoot (2006) estimate the increase in income for farmers who adopted GM to about $27 billion worldwide for the year 2005. On the other side are the opponents who argue that plant genetic engineering is an interference of nature and may have unknown and disastrous consequences (Nelson, 2001). People on this side have further strengthened their position by arguing that GM may have the tendency to contaminate the non-GM product, such as organic food through processes like pollination.

In Europe, the cultivation of GM-seeds has no meaningful significance. Commercially, only genetically modified BT-Corn is cultivated on few arable lands. This may be attributed to different reasons such as the genetic moratorium of the European Union of 1998 to 2003 and the current law on genetic engineering, which are disingenuous to the cultivation of GM seeds. As the commercial use of plant genetic engineering in Europe is just at its beginning, there are only a few studies that explain the influence of the adoption of the biotechnology by farmers. Until now, the research has almost exclusively concentrated on consumers (e.g. O'Connor et al., 2005; Miles et al., 2005), nearly neglecting the position of farmers in Europe (Breustedt, 2008).

This paper fills this lacuna in the agribusiness literature. We contribute to the discourse on biotechnology in agriculture in two main ways. First, unlike previous studies, which predominantly analyse the GM acceptance from the perspective of the consumers, we take the perspective of producers and analyze the behavioral patterns of German farmers towards plant genetic engineering. Second, we segment the farmers into various groups based on their attitudes and opinions towards genetic engineering.

Our analysis is based on the stated as opposed to actual adoption of GM. This is because biotechnology is still not in commercial quantities in Germany, and as such the farmers' expectation of the likelihood of adoption will be based on information that is obtained from many sources including the media, popular magazines, and public sources.

The remaining sections of the article are organized as follows: the next section provides background information about biotechnology in agriculture in Germany. Following, we present a brief overview of the research on biotechnology in agriculture and present the technology acceptance model by Voss et al. (2008), which will be used as the basis for classifying the farmers. Methodology of the study will be presented in the next section. Cluster solutions and their implications are then discussed and, subsequently, we highlight the limitations of the study and propose direction for future research.

Overview of Biotechnology Research in Agriculture

For the purpose of this paper, terms such as genetic engineering, biotechnology, biologically engineered, and genetically modified will be used synonymously to represent a set of technologies that are used to change the genetic makeup of cells and move genes across species' boundaries to produce novel organisms. This may involve highly sophisticated manipulations of genetic materials and other biologically important chemicals. By altering a plant's trait, genetic engineering facilitates development of characteristics not possible through traditional plant breeding techniques (Fernandez-Cornejo et al., 2002).

Recently, scientific studies on the agricultural adoption of plant genetic engineering have noticeably increased. As a consequence, there is a growing subset of the technology adoption literature that specifically examines the adoption of GM crops (Alexander et al., 2003; Fernandez-Cornejo et al., 2002; Payne et al., 2003).

There are two main research streams on the GM adoption in the food supply chain literature. One stream concentrates on the demand side and measures the level of acceptance or adoption from the perspective of consumers, retailers, processors, and other stakeholders (e.g., Frewer et al., 1995; Saba and Vassallo, 2002; Fortin and Renton, 2003; Onyango et al., 2004; O'Connor et al., 2005). The second stream concentrates on GM adoption from the supply side, which involves adoption by farmers measured in terms of both their revealed and stated preferences (e.g., Van Scharrel, 2003; Payne et al., 2003; Merrill et al., 2005; Voss et al., 2009).

Breustedt et al. (2008) divided the analyses of biotechnology adoption in agriculture into *ex post* and *ex ante* studies. The *ex post* refers to the case where the GM has been launched already. In this situation, it becomes possible for the researchers to conduct their analyses based on information collected on the actual behaviour of the farmers, referred to as the revealed preference approach. The *ex ante* analyses are conducted in a situation where expected behavior of the farmers is determined using methods such as the contingent valuation. This is often referred to as the stated preference. The most common factors that have been analyzed in the adoption literature are expected profitability, risk, required skill level or education, scale or size of farm, alternative or competing technologies, credit availability, and environmental policies (Sundig and Zilberman, 2001).

Hubbell et al. (2000) and Qaim and de Javry (2003), for instance, analyzed the dichotomous choice between adoption and non-adoption of BT cotton in the U.S. and Argentina based on revealed and stated preferences. In both studies, the authors observed that the level of education and farm size relate positively with the likelihood of adoption. Corinne et al. (2005) analyzed the adoption of transgenic corn resistant to corn rootworm (CRW corn) using a probit model with data from Indiana farmers. Their analysis revealed that operator age, farm size, regional, and self-reported measures of rootworm pressure were all statistically significant in explaining the level of adoption by the farmers.

Kolady and Lesser (2006) and Krishna and Qaim (2007) conducted *ex ante* analyses of genetically engineered eggplant adoption in India using varieties of choice-based experiments. Kolady and Lesser (2006) observed that a higher price of BT seed reduces the probability of

adoption in the early years after the launch of the BT varieties, but has no significant influence after it has been launched.

Qaim and de Javry (2003), using a double bounded dichotomous choice model in their experiment, found that the average Willingness to Pay (WTP) for BT eggplants is more than four times the current price of non-BT hybrids.

The situation for BT-seed adoption in Europe is a bit different compared to the U.S. and many developing countries. This is especially significant against the background that many Europeans are more skeptical about the use of BT compared to users in other parts of the world. Their reasons emanate from both ecological and ethical perspectives. In addition, the co-existence law with strong liability rules such as the "adventitous" (Weber et al., 2007) present further burden to the farmers who might want to adopt BT seeds in their farms.

These notwithstanding, there have been recent, although few studies on biotechnology in agriculture from the perspective of European farmers. In a study by Gomez-Barbero et al. (2008), the authors observed an increase in the level of average yield of farmers who adopted transgenic BT corn compared to the non-adopters in Spain for the three growing seasons spanning the years 2002-2004. This further resulted in an increase in the economic benefits for the adopters since no price premium was obtained for the cultivation of the conventional corn. Breustedt et al. (2008) explored the German farmers' willingness to adopt a GM oil-seed rape prior to its commercial release, and estimated the demand for the new technology based on 202 German farmers. Using the multinomial probit estimation, the authors revealed that GM attributes such as gross margin, expected liability from cross pollination, flexibility to return to conventional oil seed, and some farm characteristics significantly affect the likelihood of adoption.

Until now, choice analysis and contingent valuation methods exploring influencing factors in farmers' adoption of BT dominate the agribusiness literature. To the best of our knowledge, none of the studies considered how the farmers can be grouped and characterized based on their attitudes towards the adoption of GM food, especially in the context of Germany. This is particularly important as it will provide a basis for policy makers, the biotechnology industry, and other interest groups to be able to develop a specialized approach and strategy in an effort to address issues on BT adoption since it has been found to provide economic benefits to the adopters. Our research, therefore, provides a new approach to the analysis of farmer acceptance of biotechnology by providing a cluster analysis of German farmers based on the technology acceptance model.

The Technology Acceptance Model

In this section, we provide explanation of the technology acceptance model based on the study by Voss et al.(2009). In this model, Voss et al. (2009) used an exploratory factor analysis to identify sets of factors that influence technology acceptance based on interviews with German farm managers. The model identifies four main constructs that influence farmers' attitude toward GM foods. The factors identified by Voss et al. (2009) confirm and synthesize results of many other GM adoption studies such as by Alexander et al. (2003); Alexander and Mellor (2005);

Darr and Chern (2002); Fernandez-Cornejo et al. (2002) and Merrill et al. (2003), and many other studies as discussed in the preceding section. The factors are manageability of GM seeds, cost effectiveness, acceptance by social environment, and pressure from industry.

The manageability of GM seeds factor concerns the handling of GM seeds, and was identified as the most important factor for the explanation of the attitude towards plant genetic engineering. The model postulates an inverse relationship between the ease with which GM seeds can be handled and their usage rate. This implies that the smaller and the more difficult the handling of plant genetic engineering seed is estimated to be, the higher the negative attitude towards plant genetic engineering. The construct 'handling' combines statements from the use of GM crop yield, as well as for the realization of co-existence with conventional seeds. The second most important explanatory variable, which was identified by Voss et al. (2009), is the acceptance by the social environment. This factor deals with how farmers' decision to use GM seeds are influenced by their social factors such as family, community, and friends.

The cost effectiveness was identified as the third most important decision factor and concerns the estimation of the cost effectiveness of GM seeds. This factor assumes that the cost of GM is taken into consideration by farmers in their decision on whether or not to adopt. It postulates a negative relationship between cost and usage rate indicating that when the cost of usage is low, more farmers are likely to adopt and vice versa. Pressure from industry was the least most important factor and relates to how the industry influences farmers' adoption of GM. The items used by Voss et al. (2009) seem to indicate aspects including pressure from structural changes in agriculture, the usefulness of GM seeds, as well as the influence of GM on agricultural effectiveness.

According to the model, farmers' attitudes toward the GM food is exhibited by their action or intention to use, which is influenced directly by the social environment and pressure from the industry. The manageability of GM seeds, the cost effectiveness, and the acceptance by the social environment influence the action indirectly through their attitudes towards the GM seed.

Methodology

Study-design and operationalization of the constructs

In May and June of 2006, 202 German farm managers in the north-west of Germany were interviewed concerning their attitudes and opinions toward GM seeds by means of personal interviews. The sample selected is a convenient sample with focus on business and future oriented farms, which are considered as the most important customers of the seed industry. The interviewers approached the subjects and briefly explained the purpose of the study and requested their participation.

The interviews were subdivided into two parts: the first section was concerned with the collection of data on general attitudes towards GM seeds, as well as the demographic characteristics of the respondents. The second section was conducted by selecting a case study in order to obtain indepth knowledge on issues concerning GM acceptance. Depending on the cultivation centre, a case study with the Roundup-Ready sugar beet or with BT Corn was

presented. The questions related to acceptance probability of GM seeds based on various aspects of the technology acceptance model by Voss et al. (2009).

We operationalized the technology acceptance model by using the statements used by Voss et al. (2009). The acceptance environment was operationalized with three statements made up of how GM is accepted by immediate family, as well as local community. Two statements, which represent the relationship between acceptance as well as peer influence and future development of agriculture, were used to operationalize the pressure from industry construct. Manageability of the GM seed and the cost effectiveness factors were operationalized with four and two statements, respectively.

In addition, three other factors were included in the analysis in order to further describe the clusters. The factors are the general attitude towards GM seed, which was operationalized with eight statements. The level of informedness and the willingness to take risk of the respondents were operationalized with four and and three items, respectively.

In all cases, a five point Likert scale type set of questions, in which the respondents were asked to rate their level of agreement or disagreement with a set of statements, were utilised.

Statistical Analysis

The empirical analyses were done in multiple phases. In the first step, descriptive statistics were conducted using the SPSS statistical package to describe the demographic characteristics of the sample. In the next step, the principal component analysis with varimax rotation was carried out in order to summarize the variables that were used to operationalize the technology acceptance model of Voss et al. (2009). The measurement scale of the factors were purified by calculating the reliability test using the Cronbach Alpha Test (Gyau and Spiller, 2007). The results of the Principal Component Analysis (PCA) and the reliability test are shown in Table 2.

In the next stage of the statistical analysis, standardized factor scores based on the PCA were subjected to a two-stage cluster analysis. The goal of the cluster analysis is to establish groups so that they are internally as homogenous as possible and externally (that is in comparison to each other) preferably heterogenous (Backhaus et al., 2003). An important question is how many clusters are to be used. This is especially relevant against the background that by increasing the number of clusters, we reduce the dissimilarity within each cluster, but at the expense of a description of the data, which has more degrees of freedom and is, therefore, less parsimonious (Gough amd Sazou, 2005). The question of the optimal number of clusters to use remains an active research topic (Sugar and James, 2003).

For this study, we admit that there is not likely to be an absolute, correct number of clusters. This still leaves the question of how many clusters might be sensible to use. Using the standard form of the statistical package SPSS, we carried out a hierarchical cluster analysis. By examining the dendrogram from the hierarchical cluster analysis, scree test, and plausibility considerations, we identified the optimal number of clusters. This number of clusters was then fed into the k-means cluster analysis to obtain the final cluster solution.

Finally, the Chi-Square Test of Association and Analysis of Variance (ANOVA) were used to determine if there were differences among the clusters. The demographic characteristics, level of informedness, and the psychometric variables concerning attitudes and opinions towards the use of GM were compared among the five clusters in order to further characterize the farmers.

Results

Description of the sample

The structural features of the farms, shown in Table 1, indicate clearly that the sample is not representative. The average farm size of 244.3 hectares in the sample is considerably larger than the national average, which is estimated to be about 30.3 hectares (BMELF, 1998). The average age of farm managers indicates that younger farmers are clearly overrepresented in the controlled sample. The same is to be said for farm managers with an academic education. There are 30.5% of survey participants that have completed an agricultural University degree, which is also considerably higher than the national average of 5.6%.

Table 1. Characteristics of the Sample Farms

Demographic variable	**Number in sample**	**Percentage**
Age of farm manager (years)		
up to 25	29	9.6
26-35	65	21.6
36-45	56	18.8
46-55	95	31.6
56-65	52	17.3
older than 65	4	1.3
Farm size (hectares)		
up to 20	7	2.3
21-50	36	11.7
51-100	109	35.5
101-200	88	28.7
more than 200	67	21.8
Educational level of farm managers		
No agricultural education	13	4.2
Agricultural vocational training	6	1.9
Professional training in agriculture	29	9.3
Agricultural technical school	33	10.6
Further training in agriculture as master farmer	92	29.6
Agricultural college	43	13.8
University degree in agriculture	95	30.5

Factor Analysis of Clustering Variables

In the next stage of the analysis, PCA was conducted using varimax rotation. The factor loadings from the PCA are displayed in Table 2. The factors confirm the dimensions of the technology acceptance model as implemented in Voss et al. (2009). Together, these factors accounted for about 73% of the error variance.

Table 2. Factor Analysis of Cluster Forming Factors

Explained Variance: 72.6 %, KMO: 0.70	FL
Factor 1 "Acceptance Environment," Cronbach Alpha: 0.70	
The use of GM seeds is accepted in my family	0.719
My village community would accept the cultivation of GM seeds	0.851
My local environment would accept the use of GM seeds	0.809
Factor 2 "Pressure from the industry," Cronbach Alpha: 0.63	
The use of GM seeds will become a matter of course with my colleagues	0.828
Structural change in agriculture will make the use of BT corn indispensable	0.828
Factor 3 "Manageability," Cronbach Alpha: 0.65	
Crop yields from GM seeds are suited for feedstuffs	0.718
I am of the opinion that the use of crop yields derived from GM seeds is unproblematic as far as the production of energy is concerned	0.803
I am of the opinion that a co-existence of GM seeds and conventional seeds is possible	0.773
Semantic differential: useful vs. superfluous	0.526
Factor 4 "Cost effectiveness," Cronbach Alpha: 0.69	
GM seeds are advantageous from an economic point of view	0.852
Working efficiency in agriculture will be improved by the use of GM seeds.	0.852

FL= Factor Loading.

Cluster Analysis of the Respondents

By applying cluster analysis to the standardised factor scores obtained from the PCA analysis as shown in Table 2, five groups were obtained based on their similarities on their perception on the GM foods. The mean and the standard deviation of the standardized factor scores and the number of respondents in each cluster are reported in Table 3 (see Appendix 1). The results of the F test were significant among the various clusters indicating that the clusters are as homogenous within and heterogenous among the clusters. In order to further characterize the clusters, three main factors which cover the general attitude and opinions toward the use of GM seeds, risk and level of informedness about GM foods were used. The results on the three additional factors, which were not used in clustering the variables, are shown in Table 4 (see Appendix 2).

Description of Clusters

By examining the responses of the respondents on the four variables that were used for classification as depicted in Table 3, five clusters were obtained:

***Cluster 1 (Supporters)*:** There are 117 respondents in cluster 1, which constitutes about 37% of the sample. This is the cluster with the greatest number of farmers. The farm managers in cluster 1 seem to have no problems with their family and social environment on the use of GM. They showed a positive response on all questions relating to family and social environment. Members of this cluster generally have a positive feeling about the cost effectiveness of GM seeds and believe that the use of GM will lead to improvement in the efficiency of their agricultural activities. They have the strongest belief that GM is good for the production of energy and can

co-exist with conventional products without problems. Their responses generally seem to have a good impression about the use of GM seeds, and hence are labelled as "GM Supporters."

Cluster 2 (Economic Skeptics): There are 42 respondents in this cluster made up of 13.5% of the total respondents. The farm managers in this group indicated that their village and local environment will not accept the GM foods although their immediate families support the use of GM weakly. They generally believe that GM will be unproblematic for the production of energy and can co-exist with conventional seeds. This group of respondents do not see the economic advantages of the use of GM seeds as they objected mildly to the two statements that project the economic benefits of GM. However, their degree of objection is not as high as that of the members in cluster 5. Based on their objection to the two statements on the economic benefits of GM, they are labelled as "Economic Skeptics."

Cluster 3 (Environmentally and Socially Influenced): Farm managers in this cluster are made up of about 30% of the respondents. They generally provide a negative response on all the statements concerning how the use of GM seeds will be accepted by their families. In addition, this group of farm managers objects that GM seeds will be indispensable with structural changes in agriculture. They also object that the use of GM will be accepted by their colleagues. Despite these negative attitudes towards the GM seeds, these farm managers are of the opinion that GM seeds will be advantageous economically and that the efficiency and effectiveness of farm operations can be enhanced with the use of GM seeds. This group is referred to as "Environmentally and Socially Influenced."

***Cluster 4 (Die-hards)*:** The total number of farmers in this group is 59. The farm managers who are in this cluster are referred to as "GM Die-hards" because they seem to show a very strong support to the GM seeds compared to the normal supporters in cluster 1. The managers did not have any problems with their village or community on the use of the GM, as they provided positive responses on all questions on family acceptance. These managers admit that their colleagues will also not have problems with them if they decide to use the GM seeds in their farms and show a very strong acceptance of the statement that GM seeds will become indispensable with the structural changes in agriculture. The respondents in this cluster showed the strongest conviction that the GM seeds will yield economic benefits and enhance work effectiveness when it is used in the farms. They believe that GM can be combined with conventional crops without problems. Based on their strong support for GM, they are referred to as "Die-hards."

Cluster 5 (Strong Opponents): *There were* 28 people who constitute about 5% of the total respondents grouped in this cluster. They constitute the smallest group in the sample. These managers were regarded as the strongest opponents to the introduction of the GM seeds as most of their responses seem to be opposite of those in cluster 4. They indicated a strong objection to the use of GM seeds to be acceptable by their family and local environment. They do not see structural changes in agriculture to be a cause for the use of GM seeds and have the strongest rejection of the economic advantages of the use of biotechnology seeds. The respondents in this cluster do not think the combination of GM and conventional seeds is a possible option.

Evaluation of the Clusters

In order to further characterize the clusters and to design appropriate strategies to deal with their attitudes towards GM seeds, they were evaluated based on three main factors which are considered as important to influence farmers' acceptance of GM. These factors are the level of informedness, willingness to take risks, as well as their general opinions towards the use of GM seeds as shown in Table 4 (See Appendix 2). The results for the various variables, as displayed in Table 4, are discussed in turn.

Level of Informedness

By examining the responses of the various groups, it can be observed that the respondents in cluster 4 are the most informed about the current development in the field of GM. Both the Economic Skeptics and the Strong Opponents are marginally informed. The Environmentally and Socially Influenced group, as well as the GM Supporters, object to the statement that they are well informed about the development in the GM field although the strongest objection comes from the former. All the respondents in the various clusters seem to know about the arguments that are put forward by the GM activists with the strongest knowledge coming from the GM Die-hards and the Strong Opponents. The above seems to suggest a relationship between how strong a farmer will either be for or against GM on the one hand and their knowledge of the various arguments that are put forward by the GM promoters on the other hand. All the various groups did not agree to the statements that "I have been able to make a comprehensive overview over GM seeds," except the Strong Opponents and the Die-hards, implying that those at the extreme ends have analyzed the information on the GM. While all the rest object that they have been able to obtain a detailed picture of GM seeds, the Die-hards and the Strong Opponents agree to the assertion.

Willingness to Take Risk

The ability and willingness to take risk may influence the extent of GM adoption. All the farmers in the various clusters seem to base their decision on the economic benefits that may be associated with the adoption of biotechnology. The strongest agreement to the statement which links the use of biotechnology to the economic benefits is observed from the GM Die-hards followed by the Economic Skeptics. The Strong Opponents showed the least agreement to the statement that, "With me, the decision for the adoption of biotechnology is mainly dependent on the economic benefits."

The GM Die-hards and the Supporters are, respectively, the first and second most willing to take higher risks for greater success in their farms. The Strong Opponents are the least willing to take risks, indicating that those people are risk averse and would always stick to their positions even if that means accepting less income. Thus, the Strong Opponents put their personal principles above economic benefits.

General AttitudesTowards GM

The statements on general attitude towards plant genetic engineering shows that many farmers do not have a clear opinion on the discussion. This implies that the idea that majority of German farmers are against genetic engineering is not confirmed in this study. The farmers in clusters 1 and 4 object to all the negative aspects of GM as used in the general attitudes. Thus, the GM Supporters and the Die-hards generally object to the termination of GM campaigns as well as the continuation of GM protest. Their responses are in sharp contrast to the responses provided by the farmers in cluster 5 who seem to support all the negative statements about GM.

The Economic Skeptics and the Environmentally and Socially Skeptics have a mixed reaction concerning their general attitudes on GM. Managers in both groups object that the protest against GM has to be stopped. Both also object that the implementation of GM must be stopped in Germany. Thus, in general, farmers in both groups do not have a very strong negative attitude or strong support toward GM engineering compared to the supporters and the opponents. Thus, the managers in clusters 2 and 3 are somewhere in between the opponents and the supporters.

Relationship between the Demographic Characteristics and Group Membership

In the next stage of the analysis, we determined how the clusters differ in terms of the demographic characteristics of the participants.

The results of the cluster analysis distinguish between five main farmer groups, which do not differ significantly in terms of farm size and age of the farmers. This implies that whether someone opposes or supports the use of GM is not determined by the age of that person. Thus, farmers of all ages can belong to any of the five clusters identified. This contradicts the study by earlier researchers, such as Alexander and Mellor (2005), who observed that farm sizes were significant in explaining the level of adoption of a transgenic seed that is resistant to the corn rootworm, with younger farmers, showing a higher probability of adoption. A study by Breustedt et al. (2008) also indicates that the age of farmers is also an important variable that influences the level of adoption. The difference in the age variable between our study and the previous ones such as Breustedt et al. (2008) may result from the fact that young farmers were overrepresented in our sample, and hence, the opinion might represent that of young farmers, which may not differ so significantly.

The size of the farms differ significantly among the clusters with cluster 5 differing significantly from the rest. This might suggest that, in general, small-scaled producers are more likely to oppose the use of GM seeds. This supports the results of an earlier work by Alexander and Mellor (2005).

In addition, the level of education is found to have a significant influence on which cluster a farmer belongs. It can be observed that most of the farmers who support the use of GM seeds (Supporters and the Die-hards) constitute a very large percentage of those with high levels of education. The Die-hards and the Supporters represent almost 40% and 35%, respectively of their respective clusters, indicating that farmers with high education are more likely to accept

biotechnology. Only 33% of the Strong Opponents have a college education or University degree. The farmers who belong to this cluster have the least percentage of combined University, College, and degree-level education. The close connection of education and use of plant genetic engineering was also confirmed by the study from Breustedt et al. (2008).

Table 5: Company Structure of the Clusters

	Cluster 1 n=117 / 37.6%		**Cluster 2 n=42 / 13.5%**		**Cluster 3 n=65 / 20.9%**		**Cluster 4 n=59 / 19.0%**		**Cluster 5 n=28 / 9.0%**		**F-Stat**
	μ	σ	μ	σ	μ	σ	μ	σ	μ	σ	
Age	41.6	12.4	45.6	10.5	43.5	12.5	44.6	13.5	45.6	10.9	1.30
Farm size (hectares)	217.8	427.9	315,6	763.6	254.4	629.5	296.4	500.8	123.6	99.6	3.74

Table 6: Company Structure of the Clusters

	Cluster 1 n=117 / 37.6%	**Cluster 2 n=42 / 13.5%**	**Cluster 3 n=65 / 20.9%**	**Cluster 4 n=59 / 19.0%**	**Cluster 5 n=28 / 9.0%**	**F-Stat**
No agricultural education at all	4.3%	2.4%	6.3%	3.4%	3.7%	0,273
Agricultural technical school	1.7%	4.8%	0.0%	1.7%	3.7%	0,870
Agricultural vocational training	6.8%	7.1%	17.2%	10.3%	3.7%	1,708
Technical training in Agriculture	9.4%	21.4%	7.8%	10.3%	7.4%	1,538
Further education as master farmer	28.2%	26.2%	32.8%	19.0%	48.1%	2,100
Agricultural college	14.5%	9.5%	14.1%	15.5%	14.8%	0,211
University diploma	35.0%	28.6%	21.9%	39.7%	18.5%	1,895

Conclusion and Implications

In the foregoing analysis, we identified and characterised the various groups of German farm managers concerning their perception of GM acceptance based on the technology acceptance model by Voss et al. (2009). Five main groups of farmers were identified and their behaviour level of informedness about biotechnology in agriculture, willingness to take risks, general attitude towards biotechnology, and their demographic characteristics were determined. The study revealed that the farmer groups differ significantly on their general attitude towards GM acceptance, as well as the level of education and informedness. The differences in the various characteristics and attitudes among the various groups of farmers suggest that differentiated and specifically designed strategies need to be adopted by the relevant stakeholders in the promotion of GM.

For instance, it is suggested that the use of tailored information could be used as a tool by the biotechnology advocates to improve the level of acceptance by the German farmers. Since the respondents in clusters 2 and 3 have indicated that they are only marginally informed about the various aspects of biotechnology in agriculture, stakeholders who see the promotion of

biotechnology as important for agricultural development through improvement in productivity and farm income can enhance their course by designing information and educational programs according to the specific characteristics of the clusters. As an example, respondents in cluster 2 can be educated and informed about the potential economic benefits of the GM seed. Once they are able to realize the economic benefits that GM can provide, they are more likely to transform from being Skeptics to Supporters and Die-hards. A recent study of BT corn adoption in Spain by Gomez Barbero et al. (2008) published in *Nature Biotechnology* in the year 2008 revealed that Spanish farmers who adopted BT corn had higher economic benefits compared to the non-adopters as a result of increase in yield of the BT corn over the conventional corn. In addition, it was observed in the study that no price premium was obtained for the conventional corn over the BT variety. In addition, respondents in cluster 3 could also be enlightened on the negative campaigns that have been going around about the potential impact of GM seeds by its strong opponents.

While it is admitted generally that provision of information is expected to influence attitudes, Frewer et al. (1995) advocate that the social context in which the information is disseminated is also important to determine the public reactions to that information. This therefore suggests the need for credible, trusted and regulated information sources in order to enhance acceptability (Dittus and Hilliers, 1993; Slovic, 1993). Frewer et al. (1995) argue that the use of proactive information provision by industry and government and the development of effective communication strategies such as the use of "consensus conference approach" can facilitate trust in the information provided through improvement in dialogue among the interest groups. In addition, the media could also be tasked to provide more information on the biotechnology since the media is one major source of such information to the general public. Quality press, television documentaries, and news broadcasts are an important source of trusted information to the general public compared to government and industry sources Frewer et al. (1995).

In addition, since it is observed that the Strong Opponents and the Economic Skeptics also show the strongest belief that the use of GM is associated with risk, some form of risk management tools may be instituted in order to influence the rate of adoption by the German farmers. Fernandez-Cornejo and McBride (2002) have argued that market and production risks faced by producers can be reduced through measures such as contracting, integration, hedging, and time sequencing transactions. Insurance can be instituted for those who would like to transform from the use of non-GM seeds to GM on their farms. These measures can alleviate some of the fears in terms of economic loss about which opponents and the skeptics are concerned. Perry et al. (1977), and Bender and Hill (2000) observed an increase in contracting among growers of GM corn and soybeans as a means to assure producers of market in many countries. Finally, since the Strong Opponents have shown that they are well informed about the arguments, which are put forward by the supporters, we recommend that the biotechnology activists would have to redefine their campaign messages and arguments that are used to defend the use of biotechnology. Thus, their present message might not have gone well with some sections of the population, especially the managers in cluster 5. It is expected that a well defined and efficiently disseminated message may transform the skeptics if not the opponents to accept the use of GM seeds.

Limitations and Future Research

Like many other studies, this study has some limitations that should be taken into account in the interpretation of the results. The unrepresentativeness of the sample used may limit the interpretation of the results. Future research should, therefore, use a more representative sample and replicate the studies in order to confirm our findings. In addition, our research has only considered the adoption from the perspective of German farmers neglecting other actors in the food supply chain such as the food service and the food processing industries. Future research should, therefore, extend the willingness to accept studies by including other actors in the food chains in order to provide a more holistic view of the entire supply chain.

Finally, the theoretical constructs that were used to cluster the managers lack normative variables such as ethical and religious issues that may influence managers' decisions whether to adopt or not. Future research should, therefore, elaborate on the model that was used for segmenting the managers by explicitly including more normative variables.

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Appendix 1.

Table 3. Mean and standard deviations of statements on the clustering variables.

	Cluster 1 n=117 / 37.6%		**Cluster 2 n=42 / 13.5%**		**Cluster 3 n=65 / 20.9%**		**Cluster 4 n=59 / 19.0%**		**Cluster 5 n=28 / 9.0%**		**F-Stat**
	μ	σ	μ	σ	μ	σ	μ	σ	μ	σ	
Acceptance by social environment											
The use of GM seeds is accepted in my family	0.87	0.59	0.12	0.71	-0.06	0.86	1.05	0.66	-1.14	0.85	33.43***
My village community would accept the cultivation of GM seeds	0.41	0.51	-0.15	0.49	-0.45	0.59	0.39	0.70	-0.89	0.79	65.43***
My local environment would accept the use of GM seeds	0.28	0.61	-0.36	0.76	-0.68	0.66	0.80	-0.93	0.72	0.79	44.85***
Pressure from the industry											
The use of GM seeds will become a matter of course with my colleagues	0.27	0.58	0.34	0.57	-0.45	0.59	0.98	0.51	-0.68	0.72	63.23***
Structural change in agriculture will make the use of BT corn indispensable	0.10	0.76	0.29	0.75	-0.45	0.59	0.98	0.51	-0.68	0.72	59.90***
Cost effectiveness											
GM seeds are advantageous from an economic point of view	0.77	0.64	-0.43	0.59	0.44	0.80	1.34	0.51	-0.86	0.80	77.29***
Work effectiveness in agriculture will be improved by the use of GM seeds	0.74	0.62	-0.02	0.84	0.44	0.69	1.39	0.56	-0.44	0.89	45.98***
Manageability of GM seeds											
Crop yields from GM seeds are suited for feedstuffs	0.64	0.74	-0.05	0.76	0.05	0.92	0.76	0.84	-0.78	0.80	22.27***
I am of the opinion that the use of crop yields derived from GM seeds is unproblematic as far as the production of energy is concerned	1.15	0.60	0.59	0.89	0.34	0.91	1.25	0.80	-0.39	0.83	34.58***
I am of the opinion that a co-existence of GM seeds and conventional seeds is possible.	0.95	0.72	0.45	0.83	0.46	0.83	1.19	0.78	-1.07	0.81	47.26***
Semantic differential: useful vs. superfluous.	0.56	1.20	-0.05	1.14	0.18	1.12	0.98	1.36	-1.39	0.88	21.47***

Appendix 2.

Table 4. Mean and Standard Deviation of Information, Risk and General Attitudes towards GM

	Cluster 1 n=117 / 37.6%		Cluster 2 n=42 / 13.5%		Cluster 3 n=65 / 20.9%		Cluster 4 n=59 / 19.0%		Cluster 5 n=28 / 9.0%		F-Stat
	μ	σ	μ	σ	μ	σ	μ	σ	μ	σ	
Level of informedness											
I am well informed about current developments in the field of GM seeds.	-0.04	0.78	0.02	0.92	-0.23	0.81	0.34	0.88	0.07	0.86	3.82***
I know the arguments of the supporters of GM seeds.	0.60	0.68	0.52	0.74	0.48	0.75	0.93	0.61	0.86	0.52	4.76***
I have already been able to obtain a comprehensive overview of GM seeds.	-0.26	0.86	-0.19	0.97	-0.34	0.97	0.08	0.92	0.04	1.00	2.29
I was already able to get a detailed picture of GM seeds	-0.30	0.83	-0.38	0.94	-0.54	0.81	0.08	0.86	0.94	0.94	4.40**
Willingness to take risk											
With me the decision for the adoption of biotechnology is mainly dependent on the economic benefit.	0.89	0.80	0.93	0.46	0.66	0.78	1.02	0.80	0.32	0.86	5.13***
Personally, I am prepared to take a higher risk for a greater success of my farm.	0.42	0.84	0.12	0.83	0.11	0.91	0.61	0.77	0.11	0.96	4.09**
With critical questions I stick to my principles and in turn even accept a smaller income.	0.06	0.82	0.45	0.83	0.48	0.67	0.07	0.91	0.82	0.77	7.84***
General attitude towards plant genetic engineering											
I share the objections of the opponents of GM seeds.	-0.60	0.63	0.02	0.82	-0.02	0.65	-0.76	0.73	0.93	0.66	40.01***
Genetic engineering has a negative impact on agriculture.	-0.46	0.72	0.05	0.66	0.08	0.87	-0.72	0.83	1.04	0.74	31.23***
Protests against genetic engineering have to be extended.	-1.33	0.37	-0.71	0.74	-0.86	0.92	-1.41	0.70	0.04	1.17	23.95***
The implementation of genetic engineering must be stopped in Germany.	-1.20	0.59	-0.54	0.90	-0.62	1.00	-1.44	0.70	0.79	0.92	47.69***
I don't understand the supporters of genetic engineering in agriculture.	-0.85	0.75	-0.26	0.94	-0.53	0.89	-1.20	0.78	0.29	1.01	19.37***

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Assessing Consumer Preferences for Organically Grown Fresh Fruit and Vegetables in Eastern New Brunswick

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Abstract

Very little information is available about consumer preferences for organically grown fresh fruit and vegetables in the Maritimes region of Canada. This study was conducted across two locations in eastern New Brunswick to examine consumer willingness-to-pay a premium to purchase organic fresh fruit and vegetables with environmental and health attributes. Willingness-to-pay the premium was modeled as a function of a series of demographic, socio-economic and knowledge variables, plus degrees of awareness concerning the environment, and risk attitudes. Results suggest that when making food choices, although the environment may be regarded as important, ultimately consumers in eastern New Brunswick prioritize their health over the environment. Moreover, the more income households earn, and the more consumers perceive a potential negative impact on health from pesticides usage, the more likely they would be willing to pay a premium for fresh organic produce.

Keywords: consumer preferences, organic fresh produce, willingness-to-pay

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Introduction

Public perceptions regarding the environmental and health attributes of consuming fresh fruit and vegetables produced without the use of synthetic pesticides has fueled a growing demand for these types of products since the 1990s. Integrated-pest management (IPM) and organic production systems are examples of non-conventional agricultural methods that are perceived as environmentally friendly.

The market for organic produce has become one of the fastest growing agricultural markets in North America. It is estimated that in 2003 U.S. consumers spent almost US$12 billion on organic foods, with annual growth rates for the organic industry reportedly in the 20 per cent range (Batte et al 2004). In 2005, more than four million acres of U.S. farmland were organic, of which 42.5 per cent (1.7 million acres) were cropland and the rest was rangeland and pasture. In the same year, more than 220,000 acres of arable land in California were under certified organic fruit and vegetables production, making California the lead region in producing organic products in the U.S., followed by North Dakota, Montana, Minnesota, Wisconsin, Texas, and Idaho (USDA 2009). Similar trends have been observed in Canada. Macey (2004) reported that Canada was the sixth largest market for organic food and beverages in 2003, with retail sales estimated to be between 1.01 and 1.3 billion Canadian dollars. According to Holmes and Macey (2009) the total volume of organic sales in Canada was estimated to be near two billion Canadian dollars in 2008, having doubled in two years. In 2007, there were a total of 3,782 certified organic farms in Canada, of which 46 certified producers were in New Brunswick, compared to in 1992 where there was less than 15 (Holmes and Macey 2009). Fieldcrops, vegetables, livestock and maple syrup are the main organic products in Canada. According to the 2007 annual report of the Canadian Organic Growers (COG), the total arable land under organic produce was 556,273 hectares, with over 352,000 hectares in additional (wild) lands that will be transformed for farming (COG 2009).

The oldest non-governmental organization in Canada, which has been promoting the production and consumption of organic produce since its inauguration, is the Canadian Organic Growers (COG) Association. The COG is a membership-based education and networking institution that represents various stakeholders from farmers and gardeners to consumers. On July 1 2009, the official Canadian National Organic standard came into effect, prior to this date a system of voluntary organic standards had been in place since 1999, with different requirements across different regions, and different rules as to the use of the term ‘certified organic.’ The COG, along with other industry organizations, worked closely with the Federal government (Agriculture and Agri-Food Canada) to develop a national organic standard. These new organic regulations apply to all agricultural products marketed domestically and internationally for both human and livestock consumption, or those products which bear the logo “Organic Canada.” For the time being, the Organic Products Regulations do not cover pet food, fertilizers, fibers, personal care products, and aquacultural products. It is worth noting that stakeholders within the Canadian aquaculture industry, the Federal government Department of Fisheries and Oceans and Agriculture and Agri-Food Canada have begun a collaborative initiative to establish a set of national organic standards for aquaculture products in Canada (COG 2009).

The distribution system for organically grown fresh fruit and vegetables has evolved as the

industry has matured, moving away from a reliance on farm-gate sales to sales through major supermarket chains. Often these stores feature a designated organic produce section where organic fruit and vegetables are sold at a premium relative to their conventional counterparts. Of relevance to the organic sector, and to the sustainability of the recent rates of growth experienced by the sector, is the extent to which consumers are willing to pay a premium for organic produce. Very little information is available on the consumer market for organic products in the Maritimes region of Canada[1].

The main objective of this paper is to identify and examine factors that affect consumers' willingness-to-pay (WTP) a premium to purchase organically grown fresh fruit and vegetables in eastern New Brunswick. In particular, the paper recognizes that there are often multiple reasons for purchasing organics, with two primary motivations being the perceived environmentally friendly nature of organic food production, together with the perceived healthiness of organic food. Thus, consumers may be motivated primarily by wider social goals (public benefits) related to environmental preservation or they may be motivated by direct private benefits related to perceived health benefits from consuming organic foods, or a combination of the two. A secondary objective of this paper is therefore to explore the relative importance of environmental versus health motivations in explaining WTP for organic food among consumers in the eastern New Brunswick region. The analysis is particularly relevant for the organic food industry in the region as it is relatively a young industry. Information from this analysis can assist regional stakeholders in developing marketing strategies and identifying target market segments for organic produce. The analysis focuses on the fruit and vegetables sector given the relative importance of this sector to the agricultural economy in New Brunswick[2] and the potential for concerns over health and environmental effects from the use of synthetic pesticides in conventional agriculture to affect this sector.

The willingness to pay for organic products is modeled as a function of independent and predetermined continuous and dummy variables including gender, age, education, employment status, income, knowledge of production practices, concerns over environmental and health issues, etc. The purpose of this study is to investigate the importance of these predictors on consumers' stated WTP for organically grown fresh fruit and vegetables in eastern New Brunswick. A binary response logit regression model is developed to quantify the impact of factors that affect individuals' WTP a price premium. By using a dichotomous logit model, we are able to segregate specific consumer characteristics and decompose the marginal effects of explanatory variables on the WTP a premium for organic produce.

The remainder of the paper is organized as follows: the next section presents a review of studies that examine consumer attitudes toward, and WTP for, organic produce. The third section briefly explains the methodology used in the empirical analysis and provides reasons for choosing the dependent and independent variables in the econometric model. The fourth section describes the data collection and presents the results of the study. The paper concludes by discussing the implications of the results and suggests some areas for further research.

[1] The Maritimes region consists of three provinces: New Brunswick, Nova Scotia and Prince Edward Island.
[2] In 2003, vegetables, fruit and berries, greenhouse and floriculture combined accounted for 84 per cent of the value of farm cash receipts from crop production in New Brunswick, with potatoes the major component at 52 per cent (New Brunswick Department of Agriculture, Fisheries and Aquaculture, 2003).

Background

The study of consumer attitudes toward fresh produce grown under reduced pesticide production systems comprises several factors affecting the WTP for organic produce. In general, these factors can be classified into three main groups: demographic, socio-economic, and risk attitudes toward human health and the environment. A review of existing literature provides a useful starting point for our analysis, revealing some common threads but also some apparently contradictory evidence. In general, literature shows that, in most cases, gender and income are the two most important determinants of consumers' decisions to purchase organic food products (Govindasamy and Italia 1999; Govindasamy et al 2001). In contrast, other factors, such as concerns about cosmetic surface blemishes, and the retail price of organic fresh produce, have been found to be less important (Goldman and Clancy 1991).

Numerous studies in various countries have measured consumers' WTP a premium to purchase organic products. However, for the sake of brevity we confine our review to two types of studies. First, we consider studies whose methodologies are somewhat similar to ours and were applied to studies of organic fresh produce. Furthermore, we compare the result of our research to those in which a similar response variable is specified. Where discrepancies exist in the definition of dependent variables caution should be used in comparing results across these studies.

Most researchers concur that higher income groups are more likely to be willing to pay a premium for organic products. Loureiro and Hine (2001) estimate that American consumers (in the Colorado area) were willing to pay a premium of US 3.14 cents per pound for organic potatoes. Wealthy and well educated individuals (the upper-class variable) had an average WTP of US 3.65 cents per pound, while age had a negative impact on individuals' WTP. The researchers found that WTP decreases US 0.16 cents per pound as consumers aged one year.

To compare the preferences of organic and conventional fresh produce buyers in terms of their stated willingness to pay a price premium to purchase organically grown food products, Williams and Hammitt (2000) use a data set drawn from 700 food shoppers collected from ten major retail stores in the Boston area. Similar to this study, the authors specified a logit regression model to determine whether a consumer is willing to pay a premium to purchase organic fresh produce. The results showed significant differences between the two groups of buyers (organic and conventional) from various perspectives including lifestyle characteristics, food safety attitudes and beliefs, perceived food safety risks, and valuation of health risk reductions.

Boccaletti and Nardella (2000) assess the effects of socio-demographic and risk perception variables on individuals' WTP for pesticide-free fresh fruit and vegetables in Italy. The authors used an ordered logit model to measure the net benefits to Italian consumers of purchasing organic fresh produce, and concluded that 89 per cent of respondents were generally concerned about health risks from pesticides. As a result, consumers were willing to pay higher prices for pesticide-free fresh fruit and vegetables, but 70 per cent of them would not pay a premium higher than 10 per cent of conventional prices.

Studies evaluating WTP for environmentally friendly production methods, such as Integrated Pest Management (IPM) are also of relevance given our interest in the environmental

motivations that consumers may have for purchasing organic produce. Govindasamy et al (2001) measure the WTP a premium for IPM produce based on various socio-demographic and socio-economic factors using data collected from a consumer survey in New Jersey in 1997. The consumer survey was conducted and administered by Rutgers Cooperative Extension and five grocery retailers. The dependent variable was defined as whether or not the participants would be willing to pay 10 per cent more for IPM products than what they would normally pay for conventional food products. The result showed that females, the youngest age group and the high-earning income group of households were more willing to pay a 10 per cent premium for IPM produce than other consumers. Our study uses a similar definition for the dependent variable (willingness to pay a 10 per cent price premium for organic produce).

Focusing on the Canadian market, Cranfield and Magnusson (2003) conduct a contingent valuation study on a new classification of environmentally friendly food products, so-called "pesticide-free products." The pesticide-free production (PFP) system of farming lies between organic and IPM farming practices. Although pesticide use is prohibited at any time of the growing season under the PFP system, the use of certain fertilizers within the entire farming year, and specific pesticides before seeding, is allowed. In addition, no PFP crops can be grown if pesticides remain "commercially active" in the soil, which means that the PFP crops would be exposed to the pesticides. Cranfield and Magnusson (2003) found that 67 per cent of respondents have a modest WTP of a one to 10 per cent premium and five per cent are willing to pay a premium of 20 per cent over conventional prices. In a related study, Magnusson and Cranfield (2005) seek to assess the market potential for eight different food products produced under a pesticide-free production system. The authors concluded that the following factors have a positive, albeit small, effect on individuals' demand for pesticide-free products: concern over pesticide use and its effect on food and the environment, willingness to switch grocery stores to purchase pesticide-free products, being less than 36 years of age, having less than a graduate level of education, having high average household income and being willing to pay a premium for pesticide-free products.

Larue et al (2004) administer a stated-preference choice experiment survey to 1,008 consumers in Canada examining consumer preferences for functional foods produced from three alternative production systems: conventional, organic, and genetic manipulation. The authors focus on organic tomato sauce and organic chicken breasts to see if there is an opportunity to expand the organic niche food market by introducing foods that have a 'heart-healthy' functional property. Larue et al (2004) found that households tend to pay extra for functional food with clear health benefits, such as anti-cancer or heart-healthy properties. The authors conclude that those consumers who are already paying premiums for organic foods are health conscious consumers, and are willing to pay higher premiums for food to be 'exceptionally healthy.'

The literature reviewed provides a number of insights into the type of consumers that are expected to prefer organic produce, the factors influencing those preferences, and the size of the price premium that consumers may be willing to pay. This study draws on these insights to develop a methodology for assessing consumer preferences for organic food products in eastern New Brunswick, Canada. In particular, the influence of key demographic and socio-economic factors, the impact of media (television, radio and newspapers) attention to environmental and health issues surrounding food, and consumers' attitudes with respect to the impact of pesticide use on health and the environment are investigated in the region of the study.

Methodology

As the preceding discussion indicates, there exists a substantial body of literature dealing with consumer awareness and willingness-to-pay for organic products. Within this literature, contingent valuation (CV) is a popular methodological approach. Contingent valuation allows a direct estimation of WTP for a specific product and is the method employed in this study. The elicitation method chosen for this analysis was a simple dichotomous yes/no variable (i.e., are you willing to pay at least a 10 per cent premium to purchase organically grown fresh fruit and vegetables). Often used in the valuation of non-market goods, the limitations of CV analyses are well known. In particular, CV studies can suffer from hypothetical bias since respondents are faced with hypothetical purchasing situations and are either asked to state a WTP or given the option of a yes/no response to a specific price level; thus consumers may over or understate their true WTP. Incentive compatibility is also a challenge. An elicitation method is incentive compatible if the dominant strategy for an individual is to truthfully reveal his/her WTP. These problems can be particularly acute for non-market goods or new private goods in hypothetical settings. While acknowledging these potential limitations, in our case, the goods considered in this analysis are private, already marketed and therefore deliverable (unlike pure environmental goods for example); this may help attenuate (although does not eliminate) the hypothetical bias and incentive compatibility problems. Nonetheless, the results should be interpreted with these caveats in mind.

A logit model was used to estimate the effects of a variety of factors on WTP[3]. In this model, the dependent variable specifies the probability of observing a success, defined as an individual being willing to pay at least a 10 per cent price premium for organically grown fresh fruit and vegetables, as a function $\pi_i = \pi(\boldsymbol{X}_i)$ in which $\boldsymbol{X}_i$ represents the vector of explanatory variables and is the probability of observing the success. Our reasons for defining the dependent variable in this way are threefold. First, households reveal their consumption behavior in the organic produce markets through how much they would pay to obtain these types of products (Osterhuis 1997). Second, in organic produce markets we expect consumer behavior to be highly influenced by market prices and perceived food quality (Steenkamp and van Trijp 1996). Third, a 10 per cent price premium was chosen to reflect the WTP of the majority of our sample observation, which was deemed reasonable based on previous research (e.g. Boccaletti and Nardella 2000; Govindasamy et al 2001) and observed trends in the local marketplace at the time of survey.

The objective of this study is to explore factors influencing WTP for organic produce among consumers in eastern New Brunswick, including the relative importance of environmental benefits and perceived health benefits. For this reason, we are interested in the effect of consumers' knowledge and information about organic production methods on stated WTP. Also, of interest is the influence of risk perceptions and the extent to which socio-economic and demographic factors explain differences in preferences. Therefore, the explanatory variables for the model were chosen from five categories that captured these factors: (i) demographic

[3] One advantage of using logit models is that their characteristics asymptotically guarantee the predicted probabilities to be in the range of zero to one. Since the data are collected at the individual and not at the aggregate level, the maximum likelihood (ML) method is used to estimate the parameters of the model. The ML estimates are consistent and asymptotically efficient (Peracchi 2001).

variables; (ii) socio-economic variables; (iii) behavioral variables (i.e. shopping behavior); (iv) risk perception variables; and (v) knowledge variables. The choice of variables was also informed by previous studies of consumer attitudes toward organic food produce (e.g. Govindasamy and Italia 1999; Govindasamy et al 2001; Hobbs et al 2005; and Yiridoe et al 2005).

Following previous studies, we control for a number of *demographic* factors including gender, age, marital status, and family size. In some cases, there are clear a *priori* expectation regarding the influence of these variables on WTP. For example, we expect that as consumers become older health perceptions will play a more important role in food consumption decisions, which may result in a stronger WTP for organic food products due to perceptions that these products have lower levels of pesticide residues, etc. In addition, a number of *socio-economic* factors may influence WTP for organic foods, such as income, education, and employment status. For instance, we expect that as households' incomes increase they are more likely to switch consumption from conventional foods to organically grown products, and therefore more likely to be WTP a price premium for organic produce. We hypothesize that as consumers become more educated the likelihood of consuming organic food products increases. What we did not know was the size of these effects on consumers' WTP for organic produce.

While socio-economic and demographic factors can be used to segment markets, *behavioral* traits are often a more useful way of identifying consumer segments. In this study we focused on a number of behaviors that were hypothesized to be relevant to identifying organic food consumers. For example, previous experience with purchasing organically grown fresh fruit and vegetables is expected to be a reasonably reliable predictor of future consumption intentions and of a positive stated WTP for organic produce. While organic produce is sold in most mainstream supermarkets, traditionally an important outlet for organic produce has been farmers' markets. Therefore, identifying consumers who frequent farmers markets is useful. Price sensitivity is a relevant behavioral characteristic in the region sector: a question capturing price sensitivity was included on the survey (namely, whether the consumer regularly visited many grocery stores to buy advertised products). Identifying those consumers who grow fruit and vegetables for self-consumption was also a potentially relevant behavioral characteristic for understanding consumer attitudes toward organic produce (Verhoef 2005).

We expect *risk perceptions* about health and the environment to have an impact on consumers' attitudes toward organic produce, and questions capturing these issues were included in the survey. Finally, consumers are often differentiated by their *knowledge*, including the extent of their knowledge of production methods, and the extent to which different information sources (including the media) shape their knowledge. In this case, knowledge of environmentally friendly production practices such as integrated pest management, and the influence of the media in shaping attitudes about foods safety (e.g. pesticide residues) and environmental impacts of agricultural production methods were anticipated to be relevant to understanding consumer attitudes toward organic produce.

To predict consumers' WTP at least a 10 per cent price premium to purchase organically grown fresh fruit and vegetables in eastern New Brunswick, the following regression model was developed[4]:

$$
\begin{aligned}
WTP_{ORGFOOD} = {} & \gamma_0 + \gamma_1\, gen + \gamma_2\, age1 + \gamma_3\, age2 + \gamma_4\, age3 + \gamma_5\, marit1 + \gamma_6\, marit2 + \\
& \gamma_7\, nch + \gamma_8\, nresid + \gamma_9\, edu1 + \gamma_{10}\, edu2 + \gamma_{11}\, edu3 + \gamma_{12}\, edu4 + \\
& \gamma_{13}\, emp1 + \gamma_{14}\, emp2 + \gamma_{15}\, inc1 + \gamma_{16}\, inc2 + \gamma_{17}\, inc3 + \gamma_{18}\, visg + \\
& \gamma_{19}\, visfm + \gamma_{20}\, purog + \gamma_{21}\, purdmu + \gamma_{22}\, grofv + \gamma_{23}\, trnew + \\
& \gamma_{24}\, pstht + \gamma_{25}\, pstenv + \gamma_{26}\, ipm + \gamma_{27}\, medtv + \gamma_{28}\, arti + \varepsilon,
\end{aligned}
\qquad 1)
$$

Table 1 (See Appendix 1) describes the dependent and independent variables used in equation [1], and presents a priori expectations for the sign of each of the explanatory variables.

One category from each of the group-category independent dummy variables (i.e., marital status, age, education, employment status, and income) was eliminated to avoid perfect collinearity in the model. Thus, the following categories were considered as the base group: singles, a respondent whose age was less than 36 years, a participant with a high school degree, a retired respondent, and a respondent with more than Cdn$80,000 annual income. In addition, it is expected that females, individuals with high incomes, middle-age respondents and seniors, respondents with a high level of education, and those participants who care more about their health status and about the environment are more likely to be willing to pay a premium to purchase organically grown fresh fruit and vegetables in eastern New Brunswick.

Empirical Analysis

Data Description

A consumer survey, intended to collect primary data through a face-to-face interview with consumers, was conducted in two locations in eastern New Brunswick in May 2005: the Champlain Place Shopping Centre in Moncton and the Atlantic Canada SaveEasy Store in Sackville [5]. In both places, a demonstration-booth was allocated to our research team and as consumers approached the booth a two-page survey questionnaire was handed out. The participants were told that their contributions were completely voluntary and they could withdraw from the survey at any time. As indicated in the previous section, the questionnaire contains information related to the demographic variables (e.g., gender, age, marital status, household size, etc.), socio-economic characteristics (e.g., education, income level, employment status, etc.), behavioral characteristics, risk perceptions and knowledge of production methods [6]. The completed questionnaires were collected the same day they were distributed. The survey was conducted during both weekdays and weekend periods at various times of the day. To minimize bias in sampling, the survey was introduced to respondents as a "survey of consumers' attitudes

[4] Details of the econometric model are available from the lead author upon request.
[5] To test the survey instrument, we carried out a pilot survey on a small scale prior to the main survey. The information collected in the present survey was not included in the final analysis.
[6] A copy of the questionnaire is available from the lead author upon request.

toward consuming fresh fruit and vegetables" without mentioning the term organic products prior to the distribution of the questionnaire 8[7].

In total, 310 individuals were approached and 141 questionnaires were completed, yielding a response rate of 45.5 per cent. Those individuals who did not participate in the survey provided various reasons, such as "have no time", "not interested", "not from here" for not participating. Table 2 presents summary statistics for the independent variables used in this study. Of the 141 respondents, 44 per cent were female, approximately 70 per cent of the participants were the primary food purchasers in their households, and 73.6 per cent did not grow fruit and vegetables. Collectively, nearly 73 per cent of the respondents were under the age of fifty, of which 43 per cent were less than 36 years of old. Of the 141 respondents, there were 12 participants who were divorced, 69 respondents were single, and the rest (49 per cent) were married at the time of survey. Only 16 per cent of the respondents had a post graduate degree, while 24 per cent of respondents declared they had an undergraduate degree. More than 28 per cent of the participants in the survey did not continue their education after graduating from high school, and 27 per cent took some courses in colleges. Table 2 also shows that more than 72 per cent of the respondents were employed at the time of survey, 70 per cent of the participants had annual household incomes of less than Cdn$50,000 ad only 11 per cent declared an annual household income of more than Cdn$80,000. In total, more than 86 per cent of the respondents believed that the use of pesticides poses a serious risk to human health, and almost 89 per cent of participants felt that the use of various synthetic pesticides has negative impacts on the environment.

The result of the survey revealed that respondents had little knowledge about IPM. Of the 141 participants in the survey, only 38 per cent were familiar with the IPM farming practice. Despite this, 66 per cent of the participants had heard and seen programs about organic food products in the last six months on radio and television. In addition, 57 per cent of the respondents declared that they have read media articles about organically grown products in newspapers within the past six months.

Finally, the survey found that 63 per cent of the participants were not likely to purchase organically grown fresh fruit and vegetables. In contrast, 67 per cent reported that they would switch grocery stores to purchase specially advertised fruit and vegetables, and approximately, 75 per cent had visited farmer's markets in the past five years. Overall, 60 per cent of the participants reported that they were not particularly enthusiastic to try newly introduced products, while 38 per cent were willing to pay at least a 10 per cent premium to purchase organically grown fresh fruit and vegetables. See Table 2 (Appendix 2).

Estimation Results

The empirical regression model, specified in equation [1], was estimated using the maximum likelihood (ML) approach in LIMDEP (version 7.0). The dependent variable (WTPORGFOOD) was coded as 1 indicating individuals who were willing to pay a 10 per cent premium for

[7] The study recognizes the limitations of consumer surveys that are specific to a time period and geographic location, and the potential problems associated with accurate answers to hypothetical questions about how consumers would react to key demand variables. Nevertheless, the research reported here yields information that should be useful particularly on a regional level.

organically grown fresh fruit and vegetables and zero otherwise 9[8]. Table 3 displays the coefficient estimates influencing respondents' WTP for organic produce and their corresponding marginal effects (MEs). Marginal effects measure the impact of a unit change in each of the independent variables on the probability of a success (herein, respondents would pay at least a 10 per cent price premium). The following points are worth mentioning with respect to the findings from the study and the model specification. First, the results of this study should be interpreted with cautious as limited research funds prevented from a broader sampling of respondents across eastern New Brunswick. Nevertheless, the selected areas represent a fast-growing city (i.e., Moncton) and a unique town (i.e., Sackville) in the region. The town of Sackville, where Mount Allison University resides, was awarded as the "2008 Cultural Capital of Canada" along with the towns of Surrey and Nanaimo in the province of British Columbia, and the town of Morden in the province of Manitoba (Canadian Heritage 2009). Second, the likelihood ratio (LR) statistic test was used to examine the null hypothesis that all slope coefficients are zero. The calculated chi-square statistic (67.70) showed that at least one slope coefficient was significantly different from zero, and therefore the null hypothesis was rejected with 99 per cent confidence. This means that at least some of the explanatory variables are important in explaining consumers' stated WTP. Thirdly, the pseudo R-squared measure, also known as McFadden's coefficient of determination, was found to be 0.393; a reasonable figure for cross section models, although Wooldridge (2006, p. 590) states that "goodness-of-fit is usually less important than trying to obtain convincing estimates of the ceteris paribus effects of the explanatory variables."

Table 3 shows that the gender variable **(GEN)** was negative and statistically significant at the 0.01 level. The negative sign indicated that females, on average, were 31 per cent less likely to pay a 10 per cent premium for organically grown fresh fruit and vegetables in eastern New Brunswick. As mentioned earlier, the result of this research can only be compared to other studies if the dependent variable across the studies is the same. Nevertheless, our finding was consistent with some previous studies (e.g., Boccaletti and Nardella 2000), but differs from the result of Loureiro and Hine (2001) and Govindasamy and Italia (1999).

The sign of the explanatory variable **AGE2**, which refers to individuals with of 51 to 65 years of age, was positive and statistically significant at the 0.05 level. Generally, this implies that as consumers became older, their preferences changed in favor of consuming (paying a premium for) organic produce. Specifically, respondents who fell in this category were 32 per cent more likely to pay the premium for purchasing organic fresh fruit and vegetables than the youngest group-age, i.e., less than 36 years of age. Buzby et al (1995) report a similar pattern of behavior for consumers in the US, while Boccaletti and Nardella (2000) find the opposite for consumers in Italy. The estimated coefficient of the marital status variable, **MARIT1**, suggested that WTP was lower for those who were married. The coefficient was statistically different from zero with 95 per cent confidence holding other explanatory variables constant. The result showed that married people were 43 per cent less likely to pay a premium for organically grown fresh fruit and vegetables than singles in eastern New Brunswick.

[8] The WTP question was asked as a dichotomous choice question in which respondents indicated "yes" or "no", whether they would be willing to pay a 10 per cent premium for organic produce.

Table 3. Estimated Coefficients [a]

Variable name	Estimate	Standard Error	Marginal Effect
Constant	2.4748	2.4164	----
GEN * **	-1.6182	0.6626	-0.3110
AGE1	0.8406	0.9820	0.1607
AGE2 **	2.2990	1.1964	0.3208
AGE3	1.2933	2.0045	0.1990
MARIT1**	-2.2138	0.9708	0.4391
MARIT2	-1.2783	1.3506	- 0.3006
NCH	0.1489	0.7995	0.0305
NRESID	-0.9605	0.2420	- 0.0198
EDU1	-0.0383	0.7231	- 0.0079
EDU2	0.5543	0.8214	0.1072
EDU3	-1.3685	0.9064	- 0.3166
EDU4	1.8276	1.7270	0.2374
EMP1	0.0624	1.4412	0.0129
EMP2	-0.6478	1.5580	- 0.1451
INC1	-1.0480	1.1323	- 0.2274
INC2	1.4416	0.9280	0.2694
INC3*	1.7921	1.0522	0.2730
VISG	-0.4503	0.6349	- 0.0898
VISFM**	-1.4997	0.7471	- 0.2592
PUROG***	2.5158	0.7436	0.4310
PURDUM**	-1.7197	0.8914	- 0.2901
GROFV	-0.3303	0.6309	- 0.0702
TRNEW	0.3611	0.6890	0.0734
PSTHT**	1.8613	0.8969	0.4311
PSTENV	0.4089	1.0870	- 0.0782
IPM	-0.3816	0.6613	- 0.0800
MEDTV	0.5285	0.6148	0.1121
ARTI	-0.4132	0.5946	- 0.0841
Number of observations	128		
McFadden R-squared	0.3933		
Likelihood ratio statistic	67.7045		
Degrees of freedom	28		
Prob [ChiSqd > value]	0.0000386		

[a] After deleting missing data, there were observations from 128 respondents.
* Significant at 0.10, ** Significant at 0.05, *** Significant at 0.01.

Previous literature has found the effect of education on consumers' purchasing decisions for organic produce to be ambiguous. For example, Govindasamy and Italia (1999) and Boccaletti and Nardella (2000) find that individuals with higher levels of education were less likely to be willing to pay a premium for organic produce. In contrast, Magnusson and Cranfield (2005) report a positive relationship between education and the WTP for organic food products, and also find that it varies from one organic product to another. None of the education variables in this study was found to be statistically significant, indicating that education levels did not help explain consumers' willingness to pay for organic produce. As such, the education variables are not discussed further.

We expect that the more income individuals make the higher the likelihood that they would be willing to pay a premium for organic produce. Nevertheless, the result showed that participants

whose annual income was between Cdn$50,000 to Cdn$79,999 **(INC3)** were 27.3 per cent more likely to pay a 10 per cent premium to purchase organically grown fresh fruit and vegetables when compared to those who earning more than Cdn$80,000 per year. The slope coefficient for **INC3** variable was statistically different from zero at the 0.10 level. The other income variables were not significant. Although one might expect, *a priori*, that the higher income group (which is the base group) would result in a higher WTP, our findings are nonetheless consistent with those of Underhill and Figueroa (1996), Govindasamy and Italia (1999), and Batte et al. (2004).

The dummy variable denoting whether respondents had visited farmer's markets **(VISFM)** was statistically significant at the 0.05 level. Surprisingly, respondents who visited farmers' markets were 26 per cent less likely to pay a premium to purchase organic produce than those who did not visit farmers' markets, ceteris paribus. As expected, the independent variable capturing those who regularly bought organically grown fresh fruit and vegetables **(PUROG)** was positive. The marginal effect for this variable was 0.431, implying that respondents who usually purchased organic fruit and vegetables were 43 per cent more likely to pay at least a 10 per cent price premium for organic produce compared with those who purchased primarily conventional fresh fruit and vegetables. The null hypothesis for the **PUROG** dummy variable was rejected with 99 per cent confidence. This finding is consistent with those of Goldman and Clancy (1991), and Govindasamy and Italia (1999). During the survey we noticed that those participants who reacted positively to the consumption of organic produce, to some extent, appeared less concerned about the price when they shopped for organic food products than were other respondents. This pattern of behavior was also reported by Batte et al. (2004, p. 14).

Table 3 shows that the WTP for organic produce declined with households whose primary food purchaser was someone other than the individual who participated in the survey. The dummy variable **(PURDMU)** was negative and significant at the 0.05 level. Those respondents who were not the primary food purchaser in their household were 29 per cent less likely to pay at least a 10 per cent premium than those respondents who made the final decision in purchasing food. The last explanatory variable whose slope coefficient was statistically different from zero with 95 per cent confidence was the dummy variable **(PSTHT)**, denoting whether the participants believed that the use of synthetic pesticides poses a very serious health risk. The results showed that respondents who perceived that health risks existed were 43 per cent more likely to pay a premium to purchase organic produce. Interestingly, the variable denoting whether participants believed the use of pesticides poses a risk to the environment **(PSTENV)** was not statistically significant. Thus, it appears that concerns over health risks are a stronger motivating factor for consumers in eastern New Brunswick to purchase organic produce than environmental concerns. Another possibility for the environmental concern variable being insignificant could have been the presence of an interaction between household income and the dummy variable representing individuals' concerns about the negative effect of pesticides usage on the environment. To examine this hypothesis, a new independent variable was generated from the product of these two variables. The result showed that the slope coefficient was not statistically significant, and thus it was dropped from the model.

The slope coefficients of other explanatory variables used in this study were not statistically significant. In particular, in addition to **PSTENV,** none of the null hypotheses associated with the following dummies could be rejected: growing fruit and vegetables at home **(GROFV),**

willingness to try newly introduced products **(TRNEW),** knowledge of integrated-pest management **(IPM)** production systems, awareness of organic produce from the television of radio **(MEDTV),** and from reading articles in newspapers **(ARTI).**

Finally, interaction effects between explanatory variables could potentially affect the likelihood of WTP for organic produce. Different models were run by generating new covariates obtained from the product of a series of independent variables to test whether the interaction effects between variables could have any impact on the regression estimates. In particular, different combinations of gender, age, education, and income were tested, but none of them led to significant results. In addition, the study did not find a significant correlation between the following independent variables: gender and primary household shopper, number of children under 17 years of age residing in the household and family size, and visiting farmers' markets and purchasing organic produce. Thus, any interaction dummies were dropped from the model in the final analysis.

Conclusions and Implications for Managers

The share of organic produce in North American markets has been steadily increasing since the 1990s, making this an interesting and dynamic market for analysis. Previous studies have assessed a number of factors determining consumer preferences toward organic food products often with contradictory results across different regions and different products. Region and product-specific analyses are therefore of great value to agri-food managers. Little is known about consumer attitudes toward organically grown fresh fruit and vegetables in eastern New Brunswick. Overall, the results of this study confirm that socio-economic and demographic variables (including gender, age, marital status and income) are important determinants of the willingness of respondents from this region to pay a premium for organic food products. As an implication for managers these findings indicate that there exist target consumer segments for the organic food sector in eastern New Brunswick, and this study is a first attempt at identifying some of these consumer segment characteristics. Further research could explore these characteristics in more depth.

A notable finding was that perceptions regarding negative health impacts of synthetic pesticide use were a far more compelling reason motivating a positive WTP for organic produce than concerns linking pesticide use to environmental degradation. It appears that the respondents from eastern New Brunswick who participated in the survey prioritized personal health concerns over broader environmental externalities. Understanding consumer preferences and the factors that motivate those preferences is important for the organic food industry in the region. Nevertheless, the prior expectation was that those respondents with environmental concerns regarding pesticide use would be more interested in organic produce. Moreover, the survey responses show that, in general, consumers in eastern New Brunswick had little knowledge of alternative new farming practices, such as integrated-pest management. This may in part explain why self-declared concerns over the effect of synthetic pesticide use on the environment did not translate into a WTP for higher priced organic produce.

Our results suggest that firms targeting the fresh produce organic sector in eastern New Brunswick are likely to see a stronger consumer response by focusing marketing strategies on the

positive health perceptions of organic produce, rather than the preservation of the environment. Clearly these insights are drawn from a relatively small sample, and further studies are recommended to decompose individuals' attitudes between the perceived health and environmental attributes when it comes to making decisions about organic produce.

A further marketing implication drawn from this study pertains to the potential importance of communication methods regarding alternative agricultural practices. Given the relatively low levels of awareness of agricultural production practices among respondents in this study, any attempts to introduce new agricultural methods in the region may need to be accompanied by plans to raise public awareness and understanding of these technologies in order to foster consumer acceptance. Both the organic industry and the extension division of the New Brunswick Department of Agriculture, Fisheries and Aquaculture and Agriculture and Agri-Food Canada may have a role to play in this regard. Finding an effective and credible means of communicating with consumers will be critical. The results of this study suggest that although many consumers had been exposed to media information about organic food products in recent months, ceteris paribus, this exposure did not appear to affect their willingness to purchase premium-priced organic food products. Nevertheless, understanding how consumers in eastern New Brunswick respond to media and other sources of information about agriculture, food and the environment are useful topics for future research.

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Appendix 1.

Table 1. Variable descriptions for regression analysis

Variable name	Description	Expected sign
WTP$_{ORGFOOD}$	1 if the participant was willing to pay at least a 10 per cent premium to purchase organically grown fresh fruit and vegetables and 0 otherwise;	
GEN	1 if the individual is female and 0 otherwise;	+
AGE1	1if the individual is between 36 to 50 years of age and 0 otherwise;	+
AGE2	1 if the individual is between 51 to 65 years of age and 0 otherwise;	+
AGE3	1 if the individual is over 65 years of age and 0 otherwise;	+
MARIT1	1 if the individual is married and 0 otherwise;	+?
MARIT2	1 if the individual is divorced and 0 otherwise;	+?
NCH	1 if one or more children under the age of 17 reside in the household and 0 otherwise;	+?
NRESID	Family size	-?
EDU1	1 if the completed level of education is some college and 0 otherwise;	+
EDU2	1 if the completed level of education is bachelors degree and 0 otherwise;	+
EDU3	1 if the completed level of education is post graduate and 0 otherwise;	+
EDU4	1 if the completed level of education is other and 0 otherwise;	+?
EMP1	1 if the individual is employed and 0 otherwise;	+?
EMP2	1 if the individual is unemployed and 0 otherwise;	-
INC1	1 if the household income was less than $29,999 and 0 otherwise;	+
INC2	1 if the household income was between $30,000 to $49,999 and 0 otherwise;	+
INC3	1 if the household income was between $50,000 to $79,999 and 0 otherwise;	+
VISG	1 if the individual visited many grocery stores in order to purchase advertised specials and 0 otherwise;	-
VISFM	1 if the individual visited farmer's markets within the past five years and 0 otherwise;	?
PUROG	1 if the individual usually (or always) purchase organically grown fresh fruit and vegetables and 0 otherwise;	+
PURDUM	1 if the participant was the primary food purchaser and 0 otherwise;	?

Table 1. Variable descriptions for regression analysis-Continued

Variable name	Description	Expected sign
GROFV	1 if the individual grew fruits and vegetables for self-consumption at his/her house and 0 otherwise;	?
TRNEW	1 if the individual classified himself/herself as among the very first to try newly introduced food products and 0 otherwise;	+
PSTHT	1 if the participant believed that the use of synthetic pesticide posed a very serious health risk and 0 otherwise;	+
PSTENV	1 if the participant believed that the use of pesticides has negative effects on the environment and 0 otherwise;	+
IPM	1 if the participant had knowledge of IPM prior to taking the survey and 0 otherwise;	+
MEDTV	1 if the participant seen/heard programs about organic food products in the last six months on TV/radio and 0 otherwise;	+
ARTI	1 if the participant read any articles/reports about organic food products in the last six months and 0 otherwise;	+

Appendix 2.

Table 2. Summary statistics for the explanatory variables [a]

Variable Name	Frequency	Mean	S.D.
Gender			
Female	62	0.439	0.4980
Male*	79	0.561	0.4980
Age			
AGE0 (less than 36 years of age)*	60	0.426	0.4962
AGE1 (36-50 years of age)	42	0.298	0.4589
AGE2 (51-65 years of age)	27	0.191	0.3949
AGE3 (over 65 years of age)	12	0.085	0.2692
Marital Status			
MARIT0 (singles)*	60	0.426	0.4962
MARIT1 (married)	69	0.489	0.5017
MARIT2 (divorce)	12	0.085	0.2692
Children under 17 years of age residing in the household			
Yes	51	0.362	0.4822
No*	90	0.638	0.4822
Family Size			
NRESID	141	2.773	1.4754
Education			
EDU0 (high school)*	40	0.284	0.4524
EDU1 (some college)	38	0.270	0.4453
EDU2 (bachelors)	34	0.241	0.4293
EDU3 (post-graduate)	22	0.156	0.3642
EDU4 (other)	7	0.049	0.1856
Employment Status			
EMP1 (employed)	102	0.723	0.4489
EMP2 (unemployed)	18	0.128	0.3183
EMP3 (retired)*	21	0.149	0.3573

Table 2. Summary statistics for the explanatory variables-Continued

Variable Name	Frequency	Mean	S.D.
Annual Household Income			
INC1 (less then $29,999)	47	0.334	0.4731
INC2 ($30,000 - $49,999)	52	0.367	0.4842
INC3 ($50,000 - $79,999)	26	0.184	0.3772
INC4 ($80,000 or more)*	16	0.115	0.3183
Visiting grocery stores to buy advertised specials			
Yes	94	0.667	0.4731
No*	47	0.333	0.4731
Visiting farmer's markets			
	105	0.745	0.4376
	36	0.255	0.4376
Purchasing organically grown fresh fruit and vegetables			
Yes	52	0.371	0.4849
No*	88	0.629	0.4849
Missing data	1	----	----
Primary food purchaser			
Yes	98	0.695	0.4620
No*	43	0.305	0.4620
Growing fruit and vegetables for self-consumption			
Yes	37	0.264	0.4425
No*	103	0.736	0.4425
Missing data	1	----	----
Try newly introduced food produce			
Yes	56	0.397	0.4911
No*	85	0.603	0.4911
Believed in negative impact of pesticides usage on health			
Yes	119	0.862	0.3104
No*	19	0.138	0.3104
Missing data	3	----	----
Knowledge of integrated-pest management			
Yes	53	0.379	0.4856
No*	87	0.621	0.4856
Missing data	1	----	----
Making use of TV and/or radio programs on food safety			
Yes	93	0.664	0.4731
No*	47	0.336	0.4731
Missing data	1	----	----
Reading articles/reports on organic produce			
Yes	74	0.565	0.4976
No*	57	0.435	0.4976
Missing data	10	----	----

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Are Traditional Cooperatives an Endangered species? About Shrinking Satisfaction, Involvement and Trust

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Abstract

Several researchers, who have observed that traditional cooperatives have difficulties in modern markets, mention a number of behavioral concepts characterizing the members. This study attempts to empirically test these concepts. It is based on a survey among members of a large traditional Swedish cooperative. The members perceive the cooperative to be so large and complex that they have difficulties understanding the operations. Hence, they become dissatisfied and uninvolved, and they mistrust the leadership. Moreover, they do not believe that the cooperative can be remodeled to strengthen member control. The findings support the behavioral explanations presented in prior studies.

Keywords: agricultural cooperative, property rights, satisfaction, involvement, trust

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Introduction

During the last decades many traditionally organized agricultural cooperatives in the western economies have undergone profound changes. Some have transformed into another cooperative organizational model, for example by introducing individual ownership by the members (Nilsson & Ohlsson, 2007). Others have disappeared due to mergers or acquisitions (Chaddad and Cook, 2007; van der Krogt, Nilsson and Høst, 2007). A number of bankruptcies have taken place, not the least in North America (Lang, 2006). Some cooperatives have sold a part of their business activities to investors, thus getting a hybrid type of cooperative (van Bekkum and Bijman, 2006). Still others have converted into investor-owned firms (IOFs).

Most cooperatives are still traditionally organized. This implies a high degree of collectivism. A large share of the equity is unallocated capital, built up from retained profits over the years. The control is by the principle of one member – one vote. Equal treatment of the members is essential (Nilsson, 2001). This study concerns traditional agricultural cooperatives in industrialized countries. Many other cooperative structures exist, involving individualized ownership and external co-owners, proportional voting, differentiated member treatment, etc. (Kyriakopoulos, 2000; van Bekkum, 2001).

The problems that many traditional cooperatives have had during the last few decades are most likely to be due to some new structural factors in the business environments. These changes may have forced the cooperatives to adapt in ways that they are not built to handle.

This study attempts to explore some of these factors, focusing on member behavior variables. Hence, the aim of this study is to explore how the members behave in relation to a large, traditionally organized cooperative that is adapting to intensified competition.

The article is organized as follows. The next section comprises a presentation of the theoretical framework, focusing on some studies, which claim that large traditional cooperatives will have difficulties when competition becomes very severe. This account results in a few hypotheses. The methodological bases, including data collection and measures, are explained in the subsequent section. The following section presents results and a discussion, while the last section encompasses conclusions and implications of the study.

Theoretical Framework

Explanations to the Demise of Traditional Cooperatives

The problems of traditional cooperatives have caught the interest of many researchers. Some of these studies are presented here. These are selected as they have fundamentally different theoretical bases. Table 1 provides an overview.

Table 1. A selection of theoretical approaches to explain why large and complex traditional co-operatives may face problems.

Author	Core concept	Driving forces	Ends
Cook, 1995	Vaguely defined property rights	Large size of operations is necessary but then members will free-ride, become uninterested, etc.	Exit, conversions to IOFs, or reorientation to individualized structures
Fulton, 1995	Property rights theory	Technological advancements change the locus of power in the value chain	The cooperatives' power is reduced
Bager, 1996	Population ecology	Techno-economic and institutional changes induce the cooperatives to imitate other businesses	Conversions, or at least the loss of a specific co-operative identity
Harte, 1997	Transaction cost and agency theory	Markets are becoming more open, more transparent, and larger.	Conversions into IOFs or hybrid forms
Holmström, 1999	Corporate governance, capital markets	As the capital markets function better, the cooperatives' investment portfolios become suboptimal.	Traditional cooperative are increasingly inefficient
Hogeland, 2006	The economic culture	Industrialization of agriculture, processing becomes large scale and capital intensive.	Traditional cooperatives face difficulties due to ignorant members

Cook (1995) suggests a life-cycle model for cooperatives: (1) establishment, (2) survival of infant stage, (3) growth and consolidation, whereby problems of so-called *vaguely defined property rights* (VDPR) appear; (4) struggle against the VDPR problems; (5) either exiting, restructuring (including choosing a hybrid model, and involving outside co-owners), or shifting (choosing an individualized cooperative model, implying tradable delivery rights). These problems entail, for example, that members of collective organizations do not want to invest; they do not reap benefits from all the investments in the cooperative; they try to be free-riders; they are not able to control the management. In order to give benefits to the members the cooperatives grow both horizontally and vertically. Increasing size and complexity means that problems in connection with VDPR become increasingly serious.

Fulton (1995) chooses a *property rights theoretical* approach, noting that the locus of power in any value chain is with the party that has the most importance for the other parties in this chain. Historically, agricultural cooperatives have been the most crucial link in the chain to the extent that their members have been able to produce large volumes of products at a high and even quality. Today, agricultural production has become less problematic as a consequence of new technologies and new management techniques – the concept of industrialization of agriculture has become widespread. As production is no longer so problematic, the marketing of the processed products has become the most essential task, and likewise the genetic material has become more important. Hence, retail chains as well as genetics firms have become stronger than the agricultural cooperatives.

Bager (1996) uses *population ecology* to explain why cooperatives gradually lose their cooperative identity. The same view is held by Hind who finds that "co-operatives become more corporate oriented as they develop through time" (1997:1081) and that "in the later stages of the life cycle, the aspirations of the managers, rather than those of the farmers, are realised" (1999:536).

According to Bager (1996), cooperatives constitute one group in the population of formal organizations within an economy and an industry. In the infancy of cooperatives, the number of cooperatives was so large that they formed a tightly connected group, and hence there was "mimetic isomorphism", such that the cooperatives tended to become similar to one another and dissimilar to other business firms. Today, techno-economic and institutional changes have resulted in large-scale cooperatives, operating internationally. Thereby the cooperatives are subject to "noncongruent isomorphic pressures", driving them to adapt to the practices of IOFs. The farmers have social networks not only with other farmers but also with nonfarmers. The employees have IOFs as their optional employers, and so have the managers and even the chief executive officers (CEOs). Most suppliers to the cooperatives are IOFs, and so are their customers. The financial institutions treat cooperatives as they treat IOFs.

The markets, both for agricultural products and for farm inputs, have become larger, more transparent and more liberalized. Therefore, according to Harte (1997), the farmers no longer need cooperatives for the sake of obtaining lower *transaction costs.* Market failures occur less frequently in today's agriculture. Likewise, the internal organization costs are high in partially integrated vertical systems such as cooperatives, especially when these firms become large. Fully integrated vertical systems can be governed with lower *agency costs.* Hence, the conversion of some Irish cooperatives into IOFs has benefited the farmers.

Holmström (1999) compares *corporate governance* of traditional cooperatives with that of IOFs. While the *capital markets* have been liberalized and are characterized by innovativeness, cooperatives are locked out from these. Neither members nor financial analysts scrutinize investments of cooperatives as their stock is not tradable. Hence cooperatives' investment portfolios are suboptimal. Moreover, the collective decision-making in cooperatives contributes to less efficient portfolios. Especially in turbulent times, conflicts between member categories will hamper good investments.

Hogeland (2006) explains the development in terms of *economic cultures* within the farmer communities, including in the cooperatives. The culture that is supportive for the traditionally organized cooperatives becomes successively threatened as the cooperatives expand. "Farmers wanted to use cooperatives to protect their economic independence, but cooperatives needed farmers to be economically dependent on them" (ibid. 67-68). Competition forces the cooperatives to expand. The larger the investments in the cooperatives, the more the cooperatives will have to control their members. Moreover, large size means heterogeneous memberships and thereby "multiple, sometimes conflicting, social or economic objectives" (ibid. 68). With growing management control, the cooperatives come to resemble their investor-owned competitors to the extent that the farmers become alienated in relation to the cooperatives. Trust and identity vanish from the memberships.

The above-mentioned studies have different paradigmatic bases so it is not possible to integrate them, nor choose between them. Still, there seem to be some common denominators:

- *Large and complex cooperatives.* All markets are subject to major changes – the consumer goods market, the raw product market, the capital market, etc. (Fulton, 1995; Harte, 1997; Holmström, 1999). The traditional cooperative attributes are hindrances for

many types of market adaptation. The preferred strategic route is expansion (Cook, 1995; Bager, 1996; Hogeland, 2006). In order to reduce their costs, cooperatives are expanding horizontally, often through mergers. By vertical expansion, they hope to obtain profits in downstream or upstream business activities.

- *Member dissatisfaction.* The large and complex business activities as well as the large and heterogeneous memberships imply that members become less able to control the cooperatives (Cook, 1995; Bager, 1996; Harte, 1997). First, their possibility to influence the decision-making shrinks due to the large memberships. Second, their understanding of the large cooperative's business activities becomes poor, which reduces their influential capacity. (Harte, 1997; Holmström, 1999). As cooperative members normally assess their influence to be important, dissatisfaction is likely to evolve (Hogeland, 2006).

- *Low involvement.* Trust, solidarity, social cohesion, identity, and other traditional cooperative values are vanishing in the minds of the members (Bager, 1996). There is a cultural clash between members and management (Hogeland, 2006). Therefore, the members do not want to invest in the cooperative; they try to be free-riders; they do not control the management adequately, and so on (Cook, 1995; Holmström, 1999). They become uninvolved in the cooperative (Harte, 1997).

- *Mistrust in the leadership.* As the cooperative business firm has to work on market conditions, the management takes control (Bager, 1996). With passive and poorly informed members, management works autonomously from the members (Hogeland, 2006). The board of directors, being highly dependent on the CEO, loses in legitimacy in the eyes of the members.

Four variables are highlighted in the summary above: (1) the size and complexity of the cooperative, (2) members' satisfaction or dissatisfaction, (3) members' degree of involvement, and (4) members' trust or mistrust towards the board and the CEO. Hence, the aim of this study can be stated in a more precise manner – it is to empirically test the effects that large size and great complexity of a traditionally organized cooperative have on member behavior, especially satisfaction, involvement and trust in the leadership.

Hypotheses

The above-mentioned variables are hypothesized to be related to one another as shown in Figure 1, where (a) – (e) express the following hypotheses H1 – H5, respectively. The point of departure is an exogenous variable – the business environments force the cooperatives to apply strategies that require large investments in upstream and downstream business activities, and therefore large size and complex structures. What influences the members' behavior is, however, not the organizational structure per se, but how members perceive this structure.

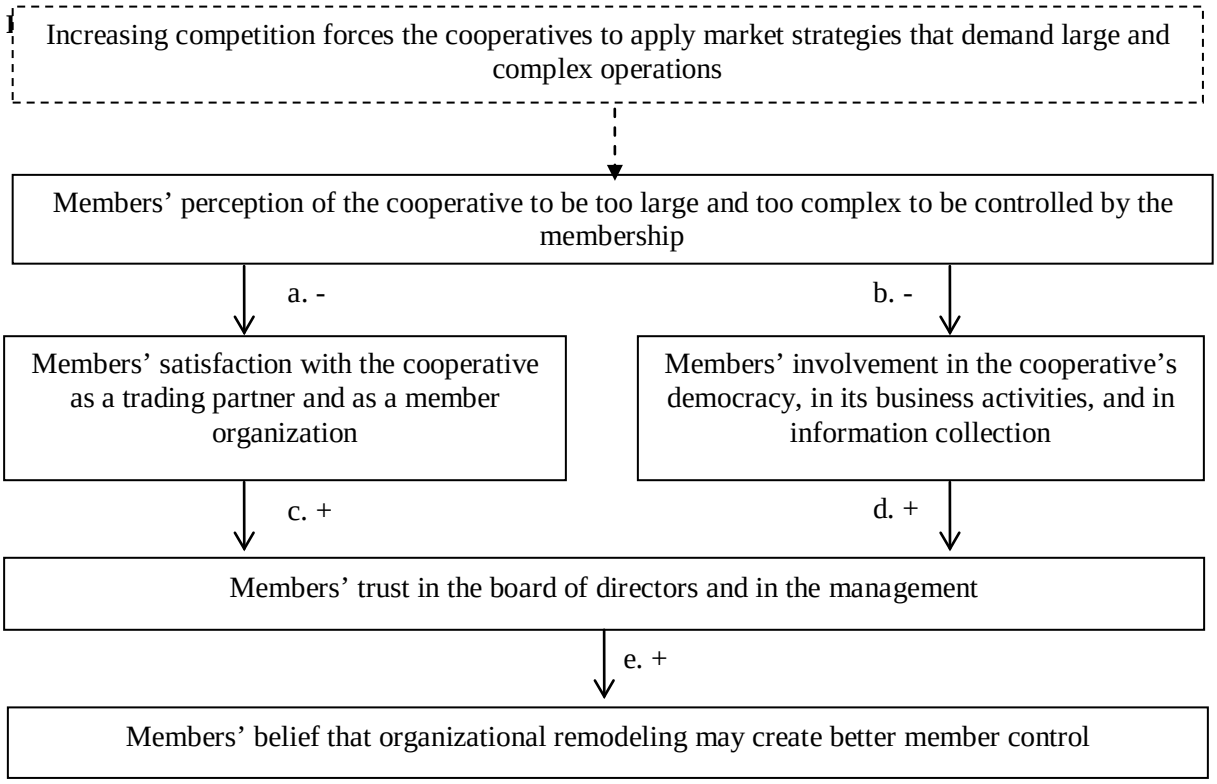

Figure 1. Hypothesized causalities between the latent variables.

The members may consider the cooperative to be so large and complex that they have difficulties keeping informed of the business and assessing what is happening in the firm. Hence, they cannot take part in the governance of the cooperative. Because members tend to consider their influence in cooperatives to be important (Österberg and Nilsson, 2009) they are likely to become dissatisfied with the cooperative. Arrow (a) in Figure 1 expresses hypothesis 1 (the minus signifies that a negative influence is plausible).

H1. *The more the members perceive their cooperative to be very large and very complex, the less satisfied they are.*

The perception of large and complex cooperatives is hypothesized to foster low involvement among the members. Because they have difficulties in understanding the business operations their interest to keep informed will fall. Low involvement also implies that members do not consider it important to be loyal buyers or suppliers (b in Figure 1; minus to signify a likely negative influence).

H2. *The more the members perceive their cooperative to be very large and very complex, the less involved they are.*

Dissatisfied and uninvolved members may have little trust in the leadership of the cooperative, be it the board of directors or the management. In the eyes of the members, the board and the CEO are responsible for the cooperative having developed such that they have become

dissatisfied and uninvolved (c and d in Figure 1; plusses mean that positive influences are expected).

H3. *The less satisfied the members are with the cooperative, the less trust they have in the leadership.*

H4. *The less involved the members are in the cooperative, the less trust they have in the leadership.*

These hypotheses are supplemented with a fifth one. Considering that many cooperatives have been converted from a traditional form into another organizational type, it makes sense to investigate the chances that the large and complex traditional cooperatives have for survival in another organizational form. However, considering the gloomy nature of the four preceding hypotheses, also the fifth one states that remodeling attempts will be difficult to conduct (e in Figure 1; a plus says that a positive influence is expected):

H5. *The less trust the members have in the leadership of a cooperative, the less they believe in remodeling measures.*

Three of the hypothesized relationships (H3, H4, and H5) have been subject to empirical investigation in earlier studies. The two other relationships (H1 and H2) do not seem to have been investigated previously.

Hypotheses H3 and H4: Gray and Kraenzle (1998) found that members' participation (attendance at meetings, serving on committees or as elected officers, and recruiting other farmers to become members) is positively correlated to a number of variables, including "satisfaction with my district director". Although the concepts are not identical, this finding may indicate that involvement and satisfaction are linked to the members' view of the leadership.

Hypothesis H4: A study by James and Sykuta (2006) showed that the farmers' trust in their cooperative is positively correlated with their propensity to patronize this cooperative. It is likely that their preference of the cooperative is a consequence of satisfaction.

Hypothesis H5: Borgen (2001) found a strong link between the members' trust in the management and their identification with the cooperative. Hansen, Morrow and Batista (2002) demonstrated that the members' trust in the management (as well as their trust in each other) is related to the cohesion within the membership – a concept that may have connections to involvement.

Few studies have investigated the relationships between the behavioral concepts, which are in focus in this study. Still, the findings reported in these studies seem to support the hypotheses. The following section explains how the five variables are interpreted so they can be transformed into questions and statements in a questionnaire.

Variables

The Members' Perception of Whether the Cooperative is too Large and too Complex to be Controlled by the Membership.

Organizational size and complexity can be assessed objectively, i.e., in terms of volumes, numbers, and currency units. However, what constitutes the driving force is the members' perception of the cooperatives' size and complexity. Hence, the focus is on the members' opinions.

A cooperative is both a business firm, which the members buy supplies from and sell their products to, and a member organization, where they exert their influence, to which they have applied for membership and where they have invested money. Both the business firm and the member organization are important and should be kept apart. Although the members probably have the same opinion about the business firm and the member organization, one can imagine situations where the two are assessed differently. For example, a local cooperative may have a small member organization, but this cooperative's businesses could be conducted by a federated cooperative that is large and complex.

Therefore, the questionnaire comprises the two following statements, one for each of the member organization and the business firm. Both statements should be answered by the respondents on a five-level Likert scale, running from (1) "do not agree" via (3) "agree to some extent" to (5) "agree completely". The two statements express only one dimension of the members' attitude towards the cooperative's size and complexity, namely their ability to keep informed about the firm's operations, but this dimension is probably one of the most crucial ones.

- *Organizational size:* The cooperative's expansion and internationalization makes it difficult for me to inform myself and to understand the business results.
- *Organizational complexity:* Because the cooperative has become larger and more complex, it is difficult for me to be informed about its business activities, and therefore, I do not attend the annual meetings.

Satisfaction or Dissatisfaction with the Cooperative as a Trading Partner and as a Member Organization

Satisfaction expresses whether a person feels that a need or a desire is fulfilled, in this case the members' demands on the cooperative. Hansen et al. (2002: 45) link member satisfaction to the performance of the cooperatives, saying that satisfaction results when the farmer's expectations as to cooperative performance are met: "assessments … involve both financial indicators of performance … and nonfinancial indicators of performance."

The members' degree of satisfaction or dissatisfaction with the cooperative could refer to the member organization as well as the business organization. Hence two statements are presented, both to be answered on a five-level Likert scale from (1) "very dissatisfied", via (3) "neither nor" to (5) "very satisfied".

- *Satisfaction with organization:* How satisfied are you with the cooperative's member organization (regarding member activities, information giving, treatment, etc.)?
- *Satisfaction with business:* How satisfied are you with the cooperative as a trading partner regarding price levels, offers, treatment, etc.?

Involvement in the Cooperative's Member Democracy, in its Business Activities, and in Information Collection

Involvement is a concept expressing individuals' psychological attachment to a phenomenon. It is related to "identification" (Borgen, 2001) and to "ethics". Given this, Zusman claims it to be of immense importance (1993: 53): "if members' ethical attitudes are too weak to support the cooperative enterprise, it is bound to fail sooner or later". Cooperative members may be involved in the business activities of the cooperative, i.e., be loyal in buying from or selling to the cooperative, as well as involved in the cooperative member organization, for example, taking part in the member democracy. Both aspects are included here. Involvement can be based on cooperative ideology, comprising a set of social values, or on calculative behavior, i.e., the members' view of prices, offers and other factual factors. There is probably an overlap between these two dimensions. Regardless, it is difficult to separate them from one another. Hence, this study does not distinguish between ideological and economic motivational forces.

Four involvement variables are specified, each expressing one type of behavior. Meeting attendance is answered by (1) "yes" or (0) "no"; Loyalty has a five-level Likert scale ranging from (1) "no" to (5) "yes"; Information gathering has a five-level Likert scale from (1) "very little" to (5) "very much"; Voting has a five-level Likert scale from (1) "do not agree", via (3) "neither nor" to (5) "agree completely".

- *Meeting attendance*: Did you attend the cooperative's annual meeting last time?
- *Loyalty:* Do you consider yourself to be a loyal member in the sense that you always or almost always do you business with the cooperative, etc.?
- *Information gathering:* How much do you involve yourself in gathering information about the cooperative's operations and its development?
- *Voting:* My vote makes a difference.

Trust or Mistrust in the Board of Directors and in the Management

A widely accepted definition is that "Trust is a psychological state comprising the intentions to accept vulnerability based upon positive expectations of the intentions or behavior of another" (Rousseau, Sitkin, Burt and Camerer, 1998: 395). To the extent that the members are dependent upon the cooperative for the sake of their incomes, they are vulnerable, and hence they may have more or less trust in the persons who run the cooperative.

The leadership of a cooperative consists of two parties, namely the board of directors and the CEO with his or her management. It is true that the management is selected by the CEO, but the CEO is appointed by the board of directors. Therefore, formally the board is responsible for the CEO's actions. On the other hand, a large share of the daily business activities that the members meet is the responsibility of the CEO. Hence, both the board of directors and the CEO are included.

Two statements are presented to the recipients of the questionnaire. Both are answered with the help of a five-level Likert scale, running from (1) "do not agree" via (3) "agree to some extent" to (5) "agree completely".

- *Trust in management:* The top management works in the best interest of the members.
- *Trust in board:* I have trust in the elected representatives.

Belief that an Organizational Remodeling may Cause Better Member Control

The board of the cooperative under study is trying to find solutions to the problems that the cooperative has. When the survey was conducted, the member organization had just been subject to major changes intended to bridge the gap between members and the elected representatives. Two questions are given to measure the members' reaction to this organizational remodeling, both to be answered with (1) "yes" or (0) "no".

- *Remodeling for democracy:* Do you think it was necessary to remodel the member organization to simplify the member democracy?
- *Remodeling for information:* Has the remodeling of the member organization made it easier for you to keep informed about and to grasp the cooperative's business operations?

Data

Lantmännen (Swedish Farmers' Supply and Crop Marketing Association)

The data were collected through a mail survey among members of Lantmännen (Swedish Farmers' Supply and Crop Marketing Association). At the time of the data collection this was a traditionally structured cooperative in the grain marketing and farm supply industry. The fact that the cooperative operates throughout Sweden contributes to membership heterogeneity. The number of members was 44,000, including 3900 members of 24 local cooperatives, which were affiliated to Lantmännen. The cooperative had nearly 13,000 employees. These figures like all the other data are the latest ones obtainable in early 2006, when the data collection was conducted.

Lantmännen is characterized by vertical integration to a remarkable extent. Its operations are divided into ten business branches, of which only one is doing business with the farmer members. This branch buys grain, oil seed and other crops from farmers and sells fodder, fertilizers, pesticides, etc. to the farmers. The businesses with the farmers are conducted through a network of offices and retail outlets as well as via phone and Internet. Lantmännen is clearly the market dominating firm in virtually all products sold to farmers and bought from farmers. The farmer-oriented business operations account, however, for less than one-quarter of the turnover.

The other nine branches are a retail chain, grain milling, cereal manufacturing, bakeries, broiler slaughtering, plant breeding, agricultural machines and other heavy duty machines, energy production, and an investment branch. The last branch includes, among other things, potato processing, alcohol production, chicken hatching, and pet food. Many of the consumer products are market leaders with very strong brand names.

The total turnover amounts to SEK 33 billions (approximately € 3.5 billions or US$ 5.2 billions). About 65% of this amount is business in Sweden; 15% in the neighboring Scandinavian countries; 15% in the rest of Europe, and the remaining share outside Europe. Lantmännen has operations in 19 countries. The expansion has during the last years been strong in Eastern Europe.

Lantmännen was established in its present form in 2001, after a merger between nine regional cooperatives and the federative organization that was controlled by all the regional cooperatives. The former federative was established in 1895 and a few of the constituent cooperatives were founded in 1880. The reason for the merger was that it would thereby be possible to increase the efficiency through economies of scale as well as economies of scope.

To convince the members of the regional cooperatives to vote in favor of the merger, they were promised that each region would retain a considerable degree of self-rule after the merger. This strategy was successful so the members accepted the merger proposal. However, letting the regions decide about issues such as grain prices, logistics, elevators, and retail outlets implied that the new cooperative got much higher costs than was necessary. Thus, from 2005 the regions were dissolved, so the partial self-rule regime was abandoned, and all business decisions were made at the headquarters in Stockholm.

The centralized decision-making meant that 67 of the 92 elevators could be closed, and this process will continue until there are only 15 elevators remaining. The retail stores, which used to be run by the regional cooperatives, were joined into a nationwide chain. The combined assortment of the retail outlets will be cut from 100,000 items to 15,000 items. Many retail stores have been closed and a few others are being established.

Prior to these reorganization measures Lantmännen's price levels were poorer than the prices of the IOF competitors. This was so both when Lantmännen bought grain from the members and when it sold fertilizers, diesel, seed and other farm inputs to the members. After the cost-saving measures have been implemented, the price levels have been improved. For example, the grain is paid at a ten percent higher price thanks to the cost savings.

From 2006 a new membership organization was introduced. The previously 85 wards were reduced to 32 wards. One echelon in the member democratic hierarchy was removed. The number of elected representatives was reduced drastically. The rationale was to bring members closer to the board of directors. Thereby, Lantmännen hoped for a higher attendance of the yearly meetings. In 2007, 3.6% of the members took part in the meetings, but the participating farmers account for 11% of the supplies sold to members and 13% of the grain deliveries, so the meetings attracted mainly large and active farmers.

Lantmännen's equity capital is SEK 9 billion (approximately € 950 million or US$ 1.4 billion), with an equity share of 37%. Most of the equity (83%) is unallocated, built up over the decades from retained earnings. The shares are redeemed to exiting member at par value. The members get a high interest rate for their investments in the cooperative, and bonus shares are regularly distributed to members. As in all Swedish cooperatives the principle of one member, one vote is applied. The principle of equal treatment of members is included in the Swedish legislation.

Lantmännen conducts regularly measurements of member satisfaction with the cooperative. The satisfaction indices indicate that the members have criticism of the cooperative. The board of directors is worried about the low member support (probably due to the many closures of elevators and retail shops), the low attendance of meetings and the low return on equity – less than 4% in 2006.

Data Collection

Data were collected through a mail survey among members of Lantmännen in early 2007. The fact that members of just one cooperative in one country constitute the data source does, of course, reduce the possibility of generalizing the findings to other settings.

Two regions within Lantmännen were selected – one in the southernmost province of Sweden and the other in mid-Sweden. These two are intensive agricultural areas with many farmers and with a large production volume; hence they are not representative of the entire membership. A random sample of 300 members in each of the two regions received a questionnaire. After one reminder a response rate of 36% was achieved, i.e., 205 recipients filled-in questionnaires. No call-backs to the missing respondents were carried out. Due to the requirement that all the twelve inquiry variables should be answered, the number of usable questionnaires was reduced to 115. This number seems to be low. However, as indicated in the next section the number is large enough to validate correlations of practical importance. For large populations, where the sample values among different farmers can be considered as independent, only the sample size matters, not the proportion selected.

The response rate was probably negatively affected by the fact that the questionnaires were sent in the month of April. At this time of the year Swedish farmers are busy in the fields.

The age span 51-60 years is somewhat overrepresented in the sample in comparison with the total population. In the other age spans as well as genders and production orientation, the respondents correspond roughly to the population at large. Of the respondents, 25% are above 60 years of age; 40% are 51-60; 20% are in the age span 41-50; the rest are below 40. Nearly 90% of the respondents are men, and almost half of them have crop production as their main production line.

Results and Discussion

Assumptions for Statistical Analysis

In the statistical methods used it is assumed that the data can be considered as a sample from a multivariate normal probability distribution. Because the answers are integer-valued, the normal distribution can only be an approximation. However, in most cases, bar charts of the inquiry answers on the Likert scale show unimodal patterns and the dichotomous answers are not extremely unbalanced. Moreover, scatter diagrams of two inquiry variables show elliptical patterns similar to the bivariate normal distribution. Hence, the approximation to the normal distribution is satisfactory for the purposes of this study.

The number of questionnaires (115) with complete answers for the twelve variables corresponds to a low response rate (19%). However, for an estimated correlation coefficient r of two variables, the usual way to express the uncertainty is by the standard error of the estimate given as $se(r)=(1-r^2)/\sqrt{115}$ which for $|r|\geq 0.2$ satisfies $se(r) \leq 0.09$. A confidence interval at the approximate level 95% for the true correlation is calculated by $r \pm 1.96 se(r)$. If r=0.2 the interval is $(0.2 \pm 1.96 \times 0.09) = (0.02, 0.38)$ not including 0. As a 95% confidence interval corresponds to a test at level 5%, the hypothesis of true zero correlation is rejected if $|r|\geq 0.2$ as the confidence interval will not contain 0. Hence, it can be expected that a number of 115 questionnaires is large enough to detect correlations of sizes ≤ -0.2 and ≥ 0.2.

Explorative Factor Analysis

Factor analysis was used as an approach to find latent variables for the inquiry variables. A model including five factors was estimated by maximum likelihood succeeded by rotation according to the varimax criterion (Johnson and Wichern, 2007). The procedure Factor of the statistical package SAS (2004) was used for the numerical calculations. The resulting loadings and specific variances based on the original correlation matrix of the inquiry variables are given in Table 2. The original correlations are presented in Table 6 (See Appendix).

Table 2. Estimated loadings (after varimax rotation) and specific variances $\hat{\Psi}_i$ [1]

Variable	**Factor**					
	1 Org. size and complexity	2 Member satisfaction	3 Involvement	4 Trust in leadership	5 Belief in org. remodeling	$\hat{\Psi}_i$
Organizational size	**0.29**	-0.07	-0.02	**-0.12**	**-0.10**	0.88
Organizational complexity	**0.90**	-0.21	**-0.34**	-0.02	-0.16	0
Satisfaction with organization	**-0.24**	**0.47**	0.21	**0.27**	**0.30**	0.51
Satisfaction with business	-0.15	**0.96**	0.10	0.17	0.13	0
Meeting attendance	**-0.15**	0.08	**0.59**	0.05	0.13	0.60
Loyalty	-0.13	**0.41**	**0.46**	**0.22**	0.14	0.54
Information gathering	-0.10	0.11	**0.97**	0.13	0.15	0
Voting	-0.09	**0.12**	0.04	**0.24**	**0.35**	0.79
Trust in management	**-0.28**	**0.44**	0.20	**0.39**	**0.23**	0.48
Trust in board	-0.16	**0.29**	0.18	**0.90**	0.20	0
Remodeling for democracy	**-0.18**	0.11	**0.20**	0.06	**0.50**	0.66
Remodeling for information	-0.12	0.12	0.15	0.11	**0.97**	0

The communalities, i.e. the part of the variation explained by the factors, can be obtained as the sum of squares of the loadings or equivalently as $1-\hat{\Psi}_i$.

Strong loadings (>0.9 or <–0.9) and other loadings included in the initial structural model studied in the next section are marked in boldface. The factors have been included in decreasing order of absolute loading until they contribute to 90% or more to the communality of the inquiry variable. A tentative interpretation of the factors is: 1) Organizational size and complexity 2)

[1] The loadings in boldface are re-estimated and the others are set to zero in the initial structural equation model, cf. Table 3.

Member satisfaction, 3) Involvement, 4) Trust in leadership, and 5) Belief in organizational remodeling (cf. Section "Theoretical framework" and Figure 1).

Confirmative Factor Analysis

In the model studied in this section, the latent factors are initially modeled with the tentative factor 1) as an exogenous variable and the other factors as endogenous related as in Figure 1. The initial model includes the relationships to the manifest variables as indicated by boldfaced numbers in Table 2. The numerical evaluations for the models in this subsection were performed by the procedure Calis of SAS (2004). The resulting estimates of loadings and coefficients are exhibited in Table 3 and 4.

Table 3. Estimated loadings and specific variances of initial structural equation model.

Variable	**Latent Variable**					
	1 Org. size and complexity	2 Member satisfaction	3 Involvement	4 Trust in leadership	5 Belief in org. remodeling	$\hat{\Psi}_i$
Organizational size	0.25			-0.09	-0.03	0.90
Organizational complexity	1.05		0.11			0
Satisfaction with organization	-0.17	0.29		0.26	0.19	0.51
Satisfaction with business		1.00				0.01
Meeting attendance	-0.11		0.56			0.60
Loyalty		0.29	0.41	0.17		0.53
Information gathering			1.00			0
Voting		-0.07		0.28	0.30	0.79
Trust in management	-0.19	0.16		0.48	0.07	0.46
Trust in board		-0.24		1.07		0.14
Remodeling for democracy	-0.14		0.07		0.50	0.66
Remodeling for information					1.00	0

Table 4. Estimated path coefficients for latent variables in initial model.

Endogenous Variable	**Latent Variable**			
	1 Org. size and complexity	2 Member satisfaction	3 Involvement	4 Trust in leadership
2 Member satisfaction	-0.40			
3 Involvement	-0.55			
4 Trust in leadership		0.63	0.24	
5 Belief in org. remodeling				0.42

The largest difference between the observed correlations and those predicted by the model is 0.19 (the variables *Organizational complexity and Remodeling for information*). Summary indicators for the fit of the model are Akaike's Information Criterion, AIC=−38.5 and Bentler and Bonnet's Normed Fit Index, NFI=0.9536.

Lagrange multipliers and Wald tests can be used to suggest modifications of the model. These indicators were repeatedly used to balance the requirements of simplification and better fit of the model. The AIC value includes this whereas NFI should show only a small decrease when the model is simplified. The modifications result in a final model as presented in Table 5 and Figure 2.

Table 5. Estimated loadings and specific variances $\hat{\Psi}_i$ of final structural equation model.[2]

Variable	Latent Variable					
	1 Org. size and complexity	2 Member satisfaction	3 Involvement	4 Trust in leadership	5 Belief in org. remodeling	$\hat{\Psi}_i$
Organizational size	0.31					0.90
Organizational complexity	1.13				0.29	**0**
Satisfaction with organization	-0.19	0.36		0.21	0.15	0.52
Satisfaction with business		1				**0**
Meeting attendance			0.62			0.61
Loyalty		0.40	0.45			0.55
Information gathering			1			**0**
Voting				0.23	0.31	0.80
Trust in management	-0.24	0.30		0.38		0.48
Trust in board				1		**0**
Remodeling for democracy	-0.18				0.45	0.67
Remodeling for information					1	**0**

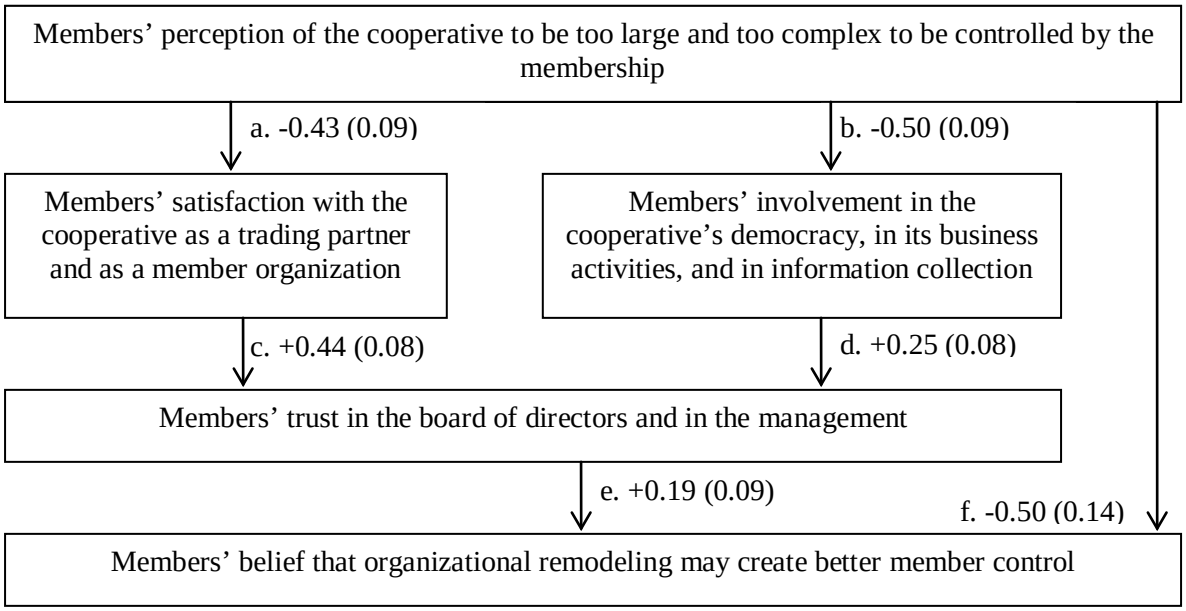

Figure 2. Estimated causalities (with standard errors) between the latent variables.

Several of the path coefficients between latent and manifest variables are removed in the final model, whereas a path is added between the latent variables *Organization size* and *Belief in organizational remodeling.* The goodness-of-fit criteria for the final model are AIC=−58.1 and NFI=0.9567 reflecting about the same fit as the initial one because the NFI value is barely

[2] Figures in boldface are fixed prior to estimation.

changed. However, the improvement compared to the initial model according to the lower AIC value is substantial, due to the removal of non-significant path coefficients.

The standard errors of the estimated loadings in Table 5 vary from 0.06 to 0.14. All except two loadings are significant at level 5% when testing the coefficient to be zero. The exceptions are the one equal to 0.15 (*t*-statistic=1.72) between *Satisfaction with organization* and latent variable 5 and the one equal to -0.18 (t=−1.92) between *Remodeling for democracy* and latent variable 1. Removals of these non-significant loadings lead to higher values of the AIC criterion.

The predicted correlation coefficients using the final model in Table 5 and Figure 2 are compared to the observed correlations in Table 6 (See Appendix).

Discussion

As in Figure 1, (a) – (e) in Figure 2 represent the hypotheses. A new relationship, (f), is included as the statistical test showed that this has a significant explanatory power.

All standard errors in Figure 2 are smaller than half the absolute values of the corresponding path coefficients. Hence, the relationships among the latent variables all show significant results when tested to be zero. The relationships can be explained as follows:

- The more (less) the members think that the cooperative is too large and too complex to be controlled by the membership, (a) the less (more) satisfied they are with the cooperative as a trading partner and as a member organization (H1), (b) the less (more) involved they are in the cooperative's member democracy, in its business activities and in information collection (H2), and (f) the less (more) they believe that organizational changes in the cooperative can improve member control.

  The first two causalities are in accordance with the hypotheses whereas the third one was not foreseen. Rather, it was expected that the causality would be only indirect, via satisfaction, involvement and trust. Nevertheless the perception of too large and too complex an organization turned out to have influence in its own right. A plausible interpretation is that the members have internalized the links between perception of size and complexity on the one hand and satisfaction and involvement on the other hand, so they have given up rescue possibilities beforehand.

- The more (less) satisfied the members are with the cooperative as a trading partner and as a member organization, (c) the more (less) trust they have in the board of directors and in the management (H3).

- The more (less) involved the members are in the cooperative's member democracy, in its business activities, and in information collection, (d) the more (less) trust they have in the board and in the management (H4).

- The more (less) trust the members have in the board and in the management, (e) the more (less) positive they are to organizational changes which are intended to raise member control (H5).

The theoretical model is confirmed by the empirical test. When members of a traditionally organized cooperative consider the cooperative to be too large and too complex to be controlled by the membership, they rank low in terms of satisfaction and involvement. The poor satisfaction and the low involvement are linked to poor trust in the board and in the management.

However, there might be a possibility that the members, in spite of their dissatisfaction, low involvement and lack of confidence in the leadership, are willing to remodel the cooperatives to attain more member control. This study finds, however, that the members do not have much belief in this possibility.

Conclusions and Implications

The findings of this study indicate that traditional cooperatives, when they become very large and get very complex business operations, may face difficulties in relation to their members. The members are no longer able to control the cooperatives, and so they become dissatisfied with the cooperative and they lose their involvement in it. This discontent results in the loss of trust in the leadership who must be held responsible for the development of the cooperative. The consequence may be that the members do not believe that it is possible to restore a well-functioning member control through remodeling the cooperative.

The members may understand that the cooperative must grow or merge and that it has to expand vertically in order to preserve its competitiveness. They may understand that these organizational changes are necessary for the cooperative to offer good prices and good services to the members. Nevertheless, the development implies that the cooperative will act as any other firm on the market.

Another dimension of this development concerns the financial aspects. As the cooperatives expand, the farmers do not want to and are not able to invest sufficiently large amounts of money and so outside investors often become stakeholders in the cooperatives. The external co-owners bring with them another way of doing business, which is often not appreciated by the farmers.

This process is parallel to what Hogeland (2006) describes in terms of changing cultures within the farmer communities. The cooperatives must integrate horizontally and vertically if they are to preserve their competitiveness. A consequence is that the farmers become alienated to the cooperatives. Holmström (1999) explains that the increasing business volume of the cooperatives and the growing assets create problems in terms of suboptimal investments as well as inefficient decision-making.

The shrinking member control in the large cooperatives is, according to Harte (1997), a natural effect of better functioning markets. As the cooperatives can no longer contribute to lower the farmers' transaction costs, the farmers will have less interest in the cooperatives. Bager (1996) supported by Hind (1997; 1999) claims that the management has taken control of the

cooperatives to the detriment of the farmers – also this can be expressed in terms of changing cultures. Fulton (1995) says that changes in the structure of agriculture (industrialization) have decreased the power of the cooperatives. As the cooperatives try to adapt to the new market conditions, the farmers are affected. Thus, the cooperatives are entering the fifth stage in Cook's (1995) life cycle, the one where cooperatives have to conduct major structural changes as the problems of the vaguely defined property rights have become too serious.

All the above-mentioned studies are observations written by insightful researchers. The present study provides rigid empirical support to these studies. It must however be born in mind that this study concerns one single cooperative, based in one country and operating in a specific industry. Hence, these findings can not be claimed to have general validity.

If the board of a troubled cooperatives does not succeed in limited reform endeavors (such as those studied here) it may be compelled to choose more radical organizational changes, notwithstanding weak member support. This will probably imply another ownership structure – the introduction of tradable and appreciable delivery rights, the conversion of the cooperative society into a holding company with the membership as stockholders, and other measures. The common denominator for these options is that there must be a solution to the problems of the so-called vaguely defined property rights. Hence, more individualized ownership is required, by the farmer members, by farmer organizations or by external financiers. If the members do not care much about their cooperative in their patron role, they may become more involved in an investor role.

The board of directors of the cooperative under study has in the spring 2009, after the data for this study were collected, made a decision to remodel its organizational form. Maintaining the cooperative business form, it has increased the individual ownership and offered a market for two new types of shares. The experiences from the spring and the summer 2009 are, however, not very positive. The members have shown only little interest in the new shares and only few shares are traded on the market for these shares. The board has also started a process of focusing the business operations, selling out peripheral units. These new strategy has been successful, also in the eyes of the members.

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Appendix

Table 6. Observed, above diagonal, and predicted correlations from the final model, below diagonal. Figures in boldface correspond to the five pairs with the largest differences of correlations.

	Org. size	Org. complexity	Satisf. with org.	Satisf. with business	Meeting attendance	Loyalty	Info gathering	Voting	Trust in management	Trust in board	Remodeling for democracy	Remodeling for information
Organizational size	1	0.31	-0.16	-0.14	-0.09	-0.06	-0.09	-0.06	-0.20	**-0.20**	**-0.01**	-0.16
Organizational complexity	0.30	1	-0.44	-0.40	**-0.38**	-0.38	-0.47	-0.18	-0.46	-0.31	-0.33	-0.35
Satisfaction with org.	-0.15	-0.43	1	0.59	0.24	0.43	0.36	0.23	0.47	0.52	0.26	0.44
Satisfaction with business	-0.13	-0.40	0.59	1	0.19	0.51	0.26	0.22	0.58	0.50	0.22	0.30
Meeting attendance	-0.10	**-0.30**	0.18	0.13	1	0.28	0.62	**0.03**	0.21	0.23	0.16	0.25
Loyalty	-0.12	-0.37	0.36	0.49	0.33	1	0.55	0.23	0.43	**0.45**	0.19	0.29
Information gathering	-0.16	-0.48	0.29	0.21	0.62	0.53	1	0.14	0.35	0.37	0.30	0.33
Voting	-0.08	-0.16	0.25	0.21	**0.11**	0.16	0.18	1	0.25	0.35	0.24	0.40
Trust in management	-0.15	-0.44	0.48	0.58	0.19	0.37	0.31	0.24	1	0.61	0.26	0.39
Trust in board	**-0.10**	-0.25	0.49	0.49	0.22	**0.35**	0.35	0.33	0.59	1	0.25	0.37
Remodeling for democracy	**-0.13**	-0.33	0.29	0.22	0.15	0.19	0.23	0.22	0.25	0.21	1	0.56
Remodeling for info	-0.17	-0.34	0.44	0.30	0.19	0.26	0.31	0.39	0.35	0.34	0.55	1

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Toward Better Defining the Field of Agribusiness Management

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Abstract

Despite the growth and interest in the agribusiness profession, what constitutes agribusiness management research continues to be a perennial debate. This study argues that the advancement of a field is predicated on defining a field's set of fundamental questions or issues because resolution of such issues serves to elevate the field to a high level of research inquiry. In order to advance the domain of agribusiness management in agricultural economics, this study examines four questions of strategy and outlines the pertinent theories used in resolving such concerns. Theories which we feel can advance agribusiness management to be a distinct discipline include Coase's (1937) treatment on the "nature of the firm," Simon's (1957, 1976) concept of bounded rationality, Penrose's (1959) theory of the growth of the firm, and subsequently Barney's (1986, 1991) Resource-Based View. The relevance and implications of this early work should serve as a guide to those seeking to explain an agribusiness firm's existence, behavior, growth and heterogeneity.

Keywords: Agribusiness management, authority, bounded rationality, diversified growth, resources.

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Introduction

Despite the growth and interest in the agribusiness profession, what constitutes agribusiness management research continues to be a perennial debate (Barry, Sonka, and Lajili, 1992; Harling, 1995; Robbins, 1988). Understanding what is or what is not agribusiness management research is fundamentally dictated by its definition. Since Davis and Goldberg's (1957) seminal definition of agribusiness, [1] agribusiness has subsequently been defined in various ways, such as agro-industrialization (Boehlje 1999; Cook and Chaddad 2000), value, or net chains (Lazzarini, Chaddad, and Cook, 2001) or agriceuticals (Goldberg 1999). These definitions share a common emphasis for the "interdependence" of the various sectors of the agri-food supply chain that work towards the production, manufacturing, distribution, and retailing of food products and services (Boehlje, 1999; Cook and Chaddad, 2000).

Despite such an attention to the interdependent nature of agribusinesses, this interdependence cannot be understood independently of the behavior of the underlying agribusiness firm. Agribusiness researchers contend that the behavior of the agribusiness firm is typically explained by neoclassical economic principles of the production theory of the firm (Barry, 1999; Robbins, 1988; Sporleder, 1992; Westgren and Zering, 1998). This appears to be consistent with Harling's (1995) survey of AAEA members. Harling (1995) found that the majority viewed agribusiness management as a sub-discipline of agricultural economics (52% agreed with this statement) and that agribusiness management was the application of economics to agricultural businesses (53% agreed with this statement). In fact, Casavant and Infanger (1984) and Woolverton et al. (1985) viewed agribusiness as a special case of agricultural economics (see also Robbins, 1988).

Although various agribusiness researchers (e.g., Casavant and Infanger, 1984; Robbins, 1988; Woolverton et al., 1985) have viewed economics as "the appropriate tool for thinking about the management" (Harling, 1995, p. 503) of the agribusiness firm, Harling's (1995) survey, nevertheless, found that 70% surveyed viewed economics and management as distinctly different disciplines. In fact, "99% agreed that more than production and cost functions were needed to understand a business" (Harling, 1995, p. 506). Harling (1995), as well as French et al. (1993), have thus argued that in order to advance agribusiness management as a discipline, there is a distinct need for managerial explanations of firm behavior. This was recognized earlier by Westgren and Cook (1986) who noted, "if inroads are to be made in agribusiness management research, cross-disciplinary efforts are necessary" (p. 488).

Yet, despite such earlier calls, the advancement of agribusiness management as a discipline has been "sporadic" (Cook and Chaddad, 2000). Cook and Chaddad (2000) describe that "the evolution of this field [agribusiness management] has been sporadic with bursts of research activity and then periods of little or no activity" (p. 212). Although there are numerous possible explanations, such sporadic developments can be attributed to a basic philosophical challenge faced by agribusiness researchers: agribusiness researchers "…want to be true to their own predilections towards management yet have to satisfy the majority [agricultural economics] that thinks in terms of economics." (Harling, 1995, p. 509). That is, since agribusiness management

[1] The term agribusiness was originally defined as: "the sum total of all operations involved in the manufacture and distribution of farm supplies; production operations of the farm; and the storage, processing, and distribution of farm commodities made from them" (Davis and Goldberg, 1957, p. 2).

in the USA is generally viewed as a sub-discipline of agricultural economics, agribusiness researchers are subject to the belief systems and scientific rules of appraisal of an economics paradigm,[2] and thus agribusiness management research becomes one of "…satisfy[ing] the majority that thinks in terms of economics." (Harling 1995). Consequently, it comes as little surprise that researchers over the years have found it difficult to distinguish research that is agribusiness management from that of agricultural economics (e.g., French et al., 1993). In fact, agribusiness scholars, such as Akridge and Gunderson (2005), have noted "one might characterize the current state of agribusiness scholarship as fragmented: it has been difficult to generate critical mass around any specific area; no true agribusiness literature has been developed" (p. 5).

Hence, given that agribusiness management operates largely within the domain of agricultural economics, [3] the problem facing the advancement of agribusiness management is then how to develop its research identity? [4] To this end, various agribusiness researchers have called for a greater attention to "strategic management" explanations of the firm (e.g., Cotterill and Westgren, 1994; French and Westgren, 1986; Gray et al., 2004; Harling, 1995; Peterson, 1997; Van Duren et al., 2003; French et al., 1993). This is because agribusiness faces the same research challenges and shares a similar focus to firm level behaviors with that of management rather than that of economics (e.g., Akridge and Gunderson, 2005; Gray et al., 2004; Peterson, 1997; Van Duren et al., 2003). For instance, Micheels and Gow (2008) draw on a market orientation perspective (Slater and Narver, 1995) in conjunction with an entrepreneurial approach to explain the performance of beef cattle producers. Mainville and Peterson (2006) enhance Transaction Cost Economics (Williamson 1975) analysis with a grounded theory approach towards studying the vertical coordination decisions in São Paulo's fresh produce market. Sporleder et al. (2008) examines food product innovation from the context of first mover strategy research (Lieberman and Montgomery, 1998).

However, despite these varied advancements to agribusiness management, the advancement of a field is also predicated on defining a field's set of fundamental questions or issues. For instance, progress in the field of strategic management has and continues to be made through its efforts to define its central issues of concern because resolution of such issues serves to elevate the field to a high level of inquiry (Hoskisson et al., 1999; Rumelt et al., 1994). As a result, since there have been increasing calls to draw on strategic management explanations of the agribusiness firm, understanding some of the central questions or issues of strategy can be important to not only help "frame" the research boundaries of agribusiness management, but such framing can be important to highlighting potential limitations in economic treatments of agribusiness research.[5]

[2] This places agribusiness professors at a disadvantage, Gholson and Barker (1985) explains from Kuhn (1977) that, "it is impossible to claim the objective superiority of one paradigm over any other. This is because the rules to appraise scientific procedures - and experimental results - are supplied by the paradigm themselves…Judgments based on such rules, then, would favor the paradigm from where they were selected" (p. 756).
[3] Harling (1995) also reported that many considered its place in departments of agricultural economics as a place of convenience rather than its association with the discipline.
[4] Nothing in this paper is meant to detract from the substantial work agricultural economics perform for agribusiness firms. This specialized research pertains to many areas, including but not limited to: consumer marketing, quantitative analysis, obesity, horticultural economics, international trade, et cetera.
[5] For a complete exploration of the many and varied elements of strategic management, the reader is referred to Mintzberg et al. (1998).

For instance, as the firm is the primary unit of analysis in strategy, a basic question of strategy research is "why are there firms?" (Rumelt, 1994, p. 39; see also Seth and Thomas, 1994). Such a question is non-trivial because Rumelt et al. (1994) argued that economic explanations take the existence of the firm as a given, and thus provide an "unsatisfactory" explanation of a firm's existence. Second, an economic theory of the firm is incomplete in its explanations of how firms behave (Rumelt 1994). This is because the economic theory of firm is predicated on the rational behaviors of "economic man," and thus does not recognize the inherent cognitive and information limits of managers. Third, how firms grow has been a subject of long standing interest by strategy researchers (e.g., Ng, 2007; Sirmon et al. 2007) because the process of firm growth directly impacts a firm's diversification into new lines of business (e.g., Fréry, 2006; Porter, 1996). In fact, the subject of diversified growth is an important area to agribusiness management research because explaining "what business we are in" has been identified as an important issue in this field (French et al., 1993; Westgren and Cook, 1986). Yet, due to the equilibrium orientation of production economics, such economic treatments of the firm understate concerns about the process of a firm's diversified growth. Lastly, since the concept of strategy is fundamentally based on a unique or differentiated competitive position (Porter 1996), the question of "why are firms different?" (Barney, 1986, 1991; Hoskisson et al., 1999; Mahoney and Pandian, 1992; Rumelt et al., 1994) calls into question production economics' assumption of firm homogeneity.

As the field of agribusiness operates largely within the domain of agricultural economics, this study argues that the examination of these research questions and their associated management theories can provide a reference point to help shape dialogue about the boundaries of agribusiness management research. Specifically, the advancement of agribusiness management faces a basic challenge that not only requires "cross-disciplinary" efforts into management (e.g., Akridge and Gunderson, 2005; Boehlje, 2005; Westgren and Cook, 1986), but such efforts also require clear distinctions from economic explanations of agribusinesses. Such distinctions are important to developing management explanations of the agribusiness firm that could not be explained by economic principles alone. Hence, the objective of this study is to examine some of the key questions of strategy and to outline the pertinent theories used in resolving such concerns. In addressing some of the key questions of strategy, four areas of strategy are examined that involve Coase's (1937) treatment on the "nature of the firm," Simon's (1957, 1976) concept of bounded rationality, Penrose's (1959) theory of the growth of the firm, and subsequently Barney's (1986, 1991) Resource-Based View. The relevance and implications of each of these various explanations to the study of the agribusiness firm are also discussed. We conclude with the contributions and implications of this study.

Some Conceptual Underpinnings of Strategic Management

What is Strategy?

Although there are various definitions of strategy, the origins of strategy have been traced to Alfred Chandler's (1962) seminal work on *Strategy and Structure* in which strategy is defined as "…the determination of the basic long term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out these goals" (p. 13). A strategy is a purposeful plan involving the allocation of a firm's internal

resources to service a particular product-market (or service-market) that yields a superior competitive position relative to rival firms. As such, the concept of strategy maintains that deliberated or purposeful action is a core tenet because the firm is not merely a responder to market prices – as reflected by an economic view of the firm (French and Westgren, 1986; Seth and Thomas, 1994), but rather the firm can create fundamental changes to the market. For instance, the strategy of Howard Schultz, the founder of Starbucks, was to put forth a new or innovative coffee retail concept that not only redefined a model for retailing premium coffee, but has subsequently become a subculture in N. American society. Schultz's strategy of redefining the consumption of coffee as a "lifestyle" experience underscores the essence of strategy, which is about developing a unique competitive position through performing activities that are different from those of its rivals. This reflects Porter (1996) contention that "competitive strategy is about being different. It means deliberately choosing a different set of activities to deliver a unique mix of value" (p. 64). In the case of Starbucks, especially during their earlier years, their competitive strategy rested on activities involving the development of proprietary roasting curves, extensive training of baristas, a streamlined bean-coffee value chain that preserved coffee freshness; all of such activities created a unique and unrivalled coffee experience that served a newly created consumer group (Ioannou 1998).

Given this concept of strategy, the ultimate goal of a firm's strategy is to create and sustain a differentiated or competitive position that yields long-term gains (e.g., Fréry, 2006; Porter, 1996). Such a characterization of strategy renders it distinct from the economic concept of operational efficiency (Porter 1996). This is because operational efficiencies involve "…performing similar activities better than rivals perform them" (Porter, 1996, p. 62). For instance, since production economics typically assumes that firms are homogeneous, the economic firm is thereby involved in activities that are similar to those of others. Differences between economic firms are thereby restricted to differences in scale (Seth and Thomas, 1994) that involve differences in technical efficiencies from producing the "same" output. While, since the concept of strategy is based on developing "different" activities or positions, strategy is, thereby, distinct from such improvements in operational efficiencies (Porter 1996). Hence, in the language of production economics, strategy is not about operating at the frontier of a firm's production function, but rather involve the development of an entirely different one. Another further distinction is that although improvements in operational efficiencies positively contribute to a firm's performance or profits, the economic concept of operational efficiencies cannot be a source of sustainable gain. This is because improvements in a firm's operational efficiencies are predicated on performing the "same" activity better than its rivals. Since these activities are known by rivals, rivals can eventually imitate a firm's operational efficiencies. For instance, despite being the early adopter to EDI (Electronic Data Interchange) systems in the early 1970s, Wal-Mart's improvements in operational efficiencies in inventory management were eventually imitated by its rival K-mart. In short, although strategy is commonly associated with improvements in operational efficiencies, strategy is fundamentally distinct from the concept of operational efficiency because of its distinct recognition that a firm's unique or heterogeneous competitive positions underlie a firm's sustainable gains.

Why do Firms Exist?

As the concept as well as goal of strategy places the firm as the central unit of investigation (e.g., Mahoney and Pandian, 1992; Seth and Thomas, 1994), a question relevant to the study of

strategy is: why do firms exist? (Coase, 1937; Rumelt et al., 1994). From an economics standpoint, a firm's existence is argued by the "given" existence of its production function. Yet, a production theory of the firm ironically does not offer a substantive explanation for why a firm should even exist at all (Coase 1937). This is because, if markets are efficient, then why are activities that could be performed in the market conducted within the firm? As Coase (1937) notes:

> "Yet, having regard to the fact that if production is regulated by price movements, production could be carried on without any organization at all, well might we ask, why is there any organization?" (p. 388).

Namely, if prices are known (which generally speaking means the absence of transaction costs), a firm can technically exist by outsourcing all of its input and output activities through a series of contractual arrangements. If there are no transaction costs (i.e., no costs in finding the relevant prices, and no costs in drafting, negotiating, and monitoring the terms of a market exchange) in the procurement and assembly of input ingredients, a firm can therefore manufacture a product without physically having a facility because the assembly of these ingredients can be outsourced through a series of costless contractual exchanges. Hence, in the absence of transaction costs, there is no reason why a production economic view of the firm should even exist. But as acutely noted by Coase (1937), there is a transaction cost in using the market. A firm exists because of its ability to reduce the transaction costs.

A firm exists because, through virtue of its "authority," it serves to minimize the transaction costs of market exchange (Coase, 1937; Williamson, 1975). Unlike a production economic view of the firm, authority is the defining feature of a firm, which reflects a super and subordinate contractual relationship between that of the employer and their employees. Within the prescribed limits of an employment contract, the employee in exchange for wages agrees to be dictated by the employer in any circumstance not explicitly stated in the original employment contract (Coase, 1937; Langlois, 2007). Such an authority relationship offers a distinct advantage in reducing the transaction costs of market exchange because an employment contract replaces many market exchanges for one (Coase, 1937; Langlois, 2007; Williamson, 1975). Moreover, since the specific details of an employment contract need not be fully specified (Coase, 1937), an authority relationship can more readily adapt to unanticipated changes. This is because the employer can simply instruct or direct the employee to conduct changes in their work responsibilities to account for new environmental contingencies (Langlois, 2007). As a result, a firm exists because its authority relationship economizes on these transaction costs of market exchange and provides a greater ability to adapt to environmental variation.

By substituting the market price mechanism, Coase's (1937) insights on a firm's authority have been instrumental to Williamson's (1975) Transaction Cost Economics (TCE). Transaction Cost Economics underscore that the market and the firm (i.e., hierarchy) reflect distinct governance structures in which the transaction costs associated with the procurement of a given activity between these alternative governance structures dictate the mode of governance. In other words, Transaction Cost Economics (TCE) is concerned with a "make or buy" decision (Williamson, 1975) in which for a given activity, a firm's choice of either procuring this activity from the market (i.e., buy), such as an outsourcing decision, or to perform this same activity within the firm (i.e., make) is dependent on the governance structure that minimizes transaction costs. This

transaction cost minimizing insight has been the basis for Williamson's (1975) arguments in which he contends "make or buy" decisions can be derived by combining "human behavior as we know it," such as bounded rationality or opportunism, with the dimensions of transactions, such as asset specificity, large/small numbers situations, or uncertainty (Williamson 1975).

In particular, Williamson (1975) asserts that the presence of asset specificity and opportunism (such as, cheating, lying, and stealing) favors the replacement of the market in favor of a firm's authority. In the presence of asset specificity, a firm faces few alternative uses for their assets. For example, in recent years there has been an increasing demand for "small" or bite size potatoes by specialty restaurant companies. The harvesting of such "small" potatoes, however, requires specialized and expensive equipment (upwards of $250,000) that can only be utilized for the harvest of potatoes of this size. Since such harvesting equipment cannot be utilized to harvest other potatoes, such as Russet potatoes, it has a low alternative use value. This asset specificity creates a problem for market-based transactions because, with opportunism, the buyer of the potatoes could "hold-up" the potato producer by demanding price concessions on the sale of their small potatoes. This 'hold up' arises because the specialized harvest equipment has limited alternatives uses, so the potato producer has little choice but to accept this lower price. Due to this hold-up problem, a market-based exchange is avoided because the potato producer would have to incur costs in monitoring and enforcing the terms of the sales agreement with its buyer. In that, due to such higher transaction costs, TCE would argue that this market-based exchange be supplanted by a firm's authority. This is because as an authority relationship enables the direct monitoring and enforcement of employees' actions, a firm's authority can circumvent such problems of hold-up. The potato producer would, thus, favor the integration of a buying activity into the firm, such as a forward integration into potato distribution.

An important distinction of Coase's (1937) insights and its subsequent developments to Williamson's (1975) transaction costs analysis is that they have been instrumental to explaining the vertical integration of agribusinesses. Vertical integration/coordination decisions have been examined in a variety of agribusiness industries, such as pork, cattle, and chicken (e.g., Barry et al., 1992; Cook and Barry, 2004; Cook and Chaddad, 2000; Purcell and Hudson, 2003; Sporleder, 1992). As a result, by addressing the question of why firms exist, Coase's (1937) and Williamson's (1975) insights not only offer a different basis for explaining the nature of the existence of the firm, but their insights have yielded significant implications to explaining vertical integration decisions that cannot be explained using a production economics framework.

How do Firms Behave?

Another salient distinction between strategic management and production economics pertains to their assumptions about firm behavior (Rumelt et al., 1994; Seth and Thomas, 1994). A defining feature of economics is its quest to explain phenomena as the results of rational choice (Rumelt, et al., 1994). For instance, from a production economics standpoint, a firm's profit maximizing behavior is typically modeled by the first order condition where marginal revenue is equated with marginal costs. Such a rational explanation of firm choice is appealing because the underlying mathematical formulism provides unambiguous predictions on the firm's optimal choice of output and subsequent price. Such profit maximizing behaviors are predicated, however, on the assumption that managers face no limitations in their information set and/or abilities in computing their optimal scale and prices.

However, unlike the rational premises of economics, strategic management is founded on a "realist" approach to the examination of the firm (e.g., Godfrey and Hill, 1995; Peterson, 1997). A "realist" approach favors a more holistic understanding of the complexities and details that confront real world businesses (e.g., Godfrey and Hill, 1995; Peterson, 1997). A realist approach recognizes that individual decision making is flawed or at best incomplete. Strategic management research is distinctly cognizant of this fact in which it recognizes that a manager's decision making behaviors are "boundedly rational" (Hoskisson et al., 1999; Rumelt et al., 1994; Seth and Thomas, 1994; Simon, 1957). Specifically, according to Simon (1957), the concept of bounded rationality refers to:

> "The capacity of the human mind for formulating and solving complex problems is very small compared with the size of the problems whose solution is required for objectively rational behavior in the real world or even for a reasonable approximation to such objective rationality" (p.198).

A basic tenet of Simon's (1976) concept of bounded rationality is that he rejects the "motivational and cognitive assumptions underlying the rationality of 'economic man'" (Seth and Thomas, 1994, p. 173). This is because with "economic man" maximizing behavior requires a complete knowledge of all possible states, as well as a complete understanding of their consequences (Simon, 1957, 1976). Simon (1976) argues the more realistic "administrative man" – as opposed to economic man – makes decisions through a mental model that is based on a highly simplified view of the world. As Seth and Thomas (1994) note, the "administrative man" has a limited ability to "formulate comprehensive models of the world and to process information; thus maximizing behavior becomes impossible" (p. 173). As the "administrative man" is not able to maximize amongst all available alternatives, decision making is driven instead by "satisficing."

Satisficing is a heuristic that economizes on an individual's limited cognitive faculties. With satisficing, the administrative man does not seek an optimal or best solution, but rather "…looks for a course of action that is satisfactory or 'good enough' " (Simon, 1976, p. xxix). Simon (1987) explains "satisficing" with an analogy in which he likens the optimizing behaviors of economics to "looking for the sharpest needle in the haystack" (optimizing), while comparing satisficing to "looking for a needle sharp enough to sew with" (satisficing) (p. 244). Hence, unlike the first order calculus of economic agents, managers do not optimize a firm's profits through equating marginal revenue with marginal costs. Instead, managers satisfice by seeking an "adequate" level of profit, "fair price," or some "acceptable" level of market share (Simon 1976).

To elaborate, such satisficing behavior arises when managers are dissatisfied with a current solution or strategy. Dissatisfaction induces a search for a new or alternative course of action. Yet, due to limits imposed by bounded rationality, this search for a new solution does not involve a comprehensive search for all possible alternatives. Rather, the search concludes with the first solution that satisfies or meets the managers' expectations. Such expectations are commonly referred to as a target level of performance (such as a firm's historical performance) and have been commonly described by a firm's "aspirations" (Cyert and March, 1963; Simon, 1976).

Because satisficing stimulates a firm's search, the concept of satisficing has also been instrumental to explaining a firm's risk behaviors (March, 1988; March and Shapira, 1987, 1992). Specifically, when a firm's performance (e.g., profit) falls below its aspirations, the resulting dissatisfaction leads to a search for more attractive and riskier alternatives (March and Shapira, 1987, 1992). This follows directly from prospect theory (Kahneman and Tversky, 1979), which finds individuals tend to be risk seeking in losses. For instance, during the late 1990s when the breakfast cereal industry was facing increasing competition from private label brands, Kellogg experienced increasing financial losses. During this period, the CEO of Kellogg, Mr. Gutierrez, undertook increasing risks by investing in R&D to develop new food breakfast cereal products, such as developing the Nutribars product category (Boyle 2004).

The search for riskier alternatives is, however, arrested with success or when a firm's performance exceeds or satisfies its aspirations (Chen and Miller, 2007; March and Shapira, 1987, 1992). With success, a firm does not want to risk losing what it has earned. Success, thus, leads to risk-averse behaviors that involve a commitment to the status quo (March, 1988). For instance, Chen and Miller's (2007) study of U.S. manufacturing firms found that when a firm's performance exceeded its aspirations, there was an associated reduction in the firm's R&D intensity (measured as R&D as a percentage of sales). Such findings have also been supported by prospect theory, which finds that individuals become increasingly risk averse as they realize increasing gains (Kahneman and Tversky, 1979).

The concept of bounded rationality and subsequent notion of satisficing raises two significant behavioral implications for a theory of the agribusiness firm. First, agribusiness researchers (Westgren and Cook, 1986) have called for a greater psychological or behavioral basis of agribusiness firm behavior. Hence, the behavioral assumption of bounded rationality not only yields a greater consideration for the cognitive constraints of management, but as a consequence distinctly recognizes the decision realities faced by managers. More significantly, however, such an appeal to a more realistic explanation of managerial behaviors not only distinguishes the behavior of the agribusiness firm from that of production economics explanations, but also raises deep-seated philosophical and methodological implications regarding what truly constitutes agribusiness firm management research (e.g., Peterson, 1997).

An appeal to realism yields a second implication that is of direct interest to practicing managers. Since bounded rationality results in "satisficing" behaviors, satisficing impacts an agribusiness firm's response to risk. Namely, during conditions of financial duress, satisficing predicts that an agribusiness firm is more likely to undertake greater risk, such as those risks involved in the exploration of new product initiatives (e.g., Kellogg). Such risk taking involves a form of "explorative" search that extends the firm's existing competencies, technologies, and experiences (March, 1991). For instance, during the early 1990s, increasing public concern over cholesterol led to significant declines in the consumption of eggs in the North America. Egg producers responded by undertaking greater risk-taking activities, including adding new functional attributes to eggs, such as Omega-3, that reduced the incidence of heart diseases. As a result of such risk taking efforts, these explorations led to the development of the Omega-3 egg product (e.g., Bouphasiri et al., 2003; Katz, 1999).

Conversely, as a firm's risk taking behavior is curtailed by success, success favors lower risks activities that involve a commitment to "exploitive search" (March, 1991). Unlike the risk taking behaviors of exploration, exploitive search involves a deepening or a refining of a firm's existing competencies, technologies, and experiences (March, 1991). For instance, SYSCO's commitment to exploit its cost efficiencies in distribution and logistics can be explained by such risk adverse behaviors in which its historic success may limit its ability to extend operations beyond the food service segment (64% of sales in food service) (SYSCO Annual Report, 2007). This is consistent with Prahalad and Bettis' (1986) notion of "dominant logic" in which a firm's success commits its behaviors to those that were successful in the past.

How do Firms Grow?

Bounded rationality has also been the basis for Penrose's (1959) theory of the growth of the firm. However, according to Penrose (1959), a firm's growth is not only subject to limits on a firm's bounded rationality (that is a firm's growth is limited by the imaginations and cognitions of its managers), but Penrose (1959) also argues that a firm grows through a process of diversification. Namely, as one of the most seminal influences to strategic management research (Hoskisson et al., 1999; Kor and Mahoney, 2000; Mahoney and Pandian, 1992; Ng, 2007), Penrose's (1959) theory of diversified growth reflects a distinct departure from the "equilibrium" orientation of production economics in which she attributes a firm's diversified growth from an internal inducement to seek better or varied uses from its heterogeneous, indivisible, and discrete resources.

To explain, Penrose (1959) argues that a firm's resources are heterogeneous insofar as they can render multiple related and even unrelated products/services from the same set of resources (i.e., assets). Resources can be applied in different ways to yield different productive services or uses. For example, should a cheese plant emphasize innovation in the production and sale of cheese (e.g., Leprino Foods) or instead in the production and sale of the co-product whey (for example Hilmar Cheese)? Heterogeneous resources are also indivisible or lumpy, which can create excess capacity. This stands in contrast to the free disposal assumption of the Leontief production function in which Penrose (1959) argues excess resources are not costlessly disposed, but rather are a primary inducement for a firm's growth (again the case of Hilmar mentioned above). However, to fully utilize excess resources, lumpy resources are used in discrete or complementary proportions, whereby the greater utilization of one set of heterogeneous and lumpy resources requires the use of another set of related yet lumpy resources (Montgomery and Wernerfelt, 1988; Penrose, 1959). As these resources are combined in complementary proportions, they yield synergies that favor the discovery of new but related products. Hence, due to the heterogeneous, lumpy, and discrete nature of resources, firms tend to grow in a process that favors related product diversification.

Because one of the research questions of agribusiness involves determining "what business are we in?" (French et al., 1993; Westgren and Cook, 1986), Penrose (1959) can contribute to agribusiness management research by offering an approach to explaining the scope of the agribusiness firm. In particular, a key insight of Penrose (1959) is that the heterogeneous, discrete and lumpy nature of resources can offer internal opportunities for an agribusiness firm to diversify into new and related productive services and products.

For instance, rather than respond to the conditions of market demand, ADM's growth strategy has traditionally been one of building and utilizing its excess processing capacity through discovering new and related product streams (Goldberg and Urban, 1997). Such excess processing capacity stemmed from the fact the investments in processing assets were not incremental in cost (Goldberg and Urban, 1997). The lumpy nature of these assets not only affords internal opportunities to exploit economies of scale, but also scope economies. This is because ADM's processing plants have heterogeneous or multiple uses whereby processing plant assets can not only be used for processing corn for human (e.g. high fructose corn syrup) and animal consumption (e.g. animal feed), but also for the production of corn-ethanol. Hence, ADM's excess processing capacity not only reflected the lumpy resources described by Penrose (1959), but the processing plants exhibited heterogeneous uses. Furthermore, diversification into the corn-ethanol market also requires that the heterogeneous and lumpy nature of ADM's plant assets be combined with other complementary assets. That is, diversification into the corn-ethanol market also requires the greater use of procurement assets in transportation and distribution. Since related diversification stems from developing products that draw on a common pool of assets, ADM's diversification into the corn-ethanol market is thereby reflective of the related growth processes described by Penrose (1959).

One implication of Penrose's (1959) theory of diversified growth is that the heterogeneous nature of resources or assets provides an important extension to economic explanations of technological growth. Penrose's attention to the heterogeneous nature of resources underscores that the discovery of new uses from a firm's lumpy and discrete resources can be an internal catalyst for the development of new production possibilities. This is a significant departure from production economic explanations of firm growth because growth in a firm's production function (i.e., outward shifts in the production frontier) is primarily attributed to exogenous technological advances in the market. Yet, since Penrose (1959) underscores that the growth of the firm is largely a function of a management's ability to seek new varied uses from its lumpy, and discrete resources, a firm's growth is, thereby, not exclusively dictated by the technological developments of the market.

Why are Firms Different?

The emphasis on heterogeneous resources is not only a key underpinning to Penrose's (1959) theory of firm growth, but has subsequently become a defining feature of the ubiquitous Resource-Based View (RBV) (Barney, 1986, 1991; Hoskisson et al., 1999). The RBV (Barney, 1986, 1991) has been argued by many as one of the most significant developments in strategic management research (Hoskisson et al., 1999). This is because as the objective of strategy is to develop a "sustainable" competitive position (e.g., Fréry, 2006; Porter, 1996), the RBV contends that a firm's heterogeneous resources are central to explaining systematic differences in a firm's performance (Barney, 1986; Hoskisson et al., 1999). Specifically, Barney (1986) emphasizes that a firm's resources are heterogeneous in terms of their value, rareness, and inimitability (VRI).[6] These resource traits determine the degree to which a firm can sustain above normal levels of economic performance (Barney 1986).

[6] In subsequent work, Barney (2002) argued the importance of a firm's organization to being able to capitalize upon success once a firm's product or service satisfies the valuable, rare and inimitable (VRI) characteristics.

In explaining Barney's (1986) VRI framework, valuable resources refer to the extent to which a firm's resources can exploit and/or neutralize threats from its environment. For instance, food processing firms that adopt Hazard Analysis and Critical Control Points (HACCP) protocols are considered a valuable resource because it addresses a market need for food safety. A valuable resource, however, is a necessary but not sufficient condition for sustaining a firm's competitive advantage. This is because although HACCP protocols can be viewed as a valuable resource, such protocols are widely and uniformly adopted in food processing industries, and thus cannot be a source of competitive advantage. [7] Furthermore, even if a firm possesses a valuable yet rare resource (for example patents held by an agricultural biotechnology firm), such a resource only offers a temporary source of competitive advantage. That is, patents are inherently imitable because patents require full disclosure to which such public knowledge is provided in exchange for a limited number of years of protection. Hence, as patents expire, patents will eventually be imitated by rivals, and thus are not a sustainable source of competitive advantage. For instance, the ongoing expiration of Monsanto's various patents forces Monsanto to undertake ongoing product innovations to preserve margins. This constant need to evolve gives emphasis to how very difficult it is to achieve inimitability.

Barney (1986), thereby, argues that a firm's sustainable competitive advantage depends on the inimitability of a firm's valued and rare resources. Namely, as inimitable resources incurs a high cost of imitation, inimitable resource precludes other rivals from competing for the rents associated with a firm's valued and rare assets and thus amongst resource traits, inimitability is the linchpin of a firm's sustained competitive advantage (Fréry, 2006; King and Zeithaml, 2001, p. 75). One example of such a linchpin would be Beef Products Incorporated's (BPI) high-protein meat production technology. This technology converts packing plant trim into lean beef trimmings. BPI's technology enables an exact protein percentage standardization of hamburger while simultaneously reducing the probability of an **E coli 0157:H57** contamination in that hamburger. This later and very important result occurs due to increased pH levels in the meat (Salvage, 2003). Such technical advancements are largely unrivaled by BPI's competitors. This is because much of BPI's innovations stem from on ongoing trial and error experimentation processes that involve continually improving upon their established conversion technologies. As such a process involves learning curve experiences that take time to develop, BPI's ability to continually develop innovations that convert meat trim into lean and safe ground beef is thus costly to imitate and thus a source of sustained competitive advantage (Kay, 2005).

A more esoteric concept of inimitability pertains to causal ambiguity. Causal ambiguity refers to the idea that the managers of potentially imitating firms (and even managers within the focal firm) may not be able to fully comprehend or may not be aware of the relationship between a firm's resources and its effect on performance (Barney, 1991; King and Zeithaml, 2001). For instance, managers who are boundedly rational have imperfect judgments about the performance implications of its rivals' resources. Various agribusiness firms appear to be subject to some form of causal ambiguity. Specifically, an agribusiness firm's culture and reputation, for instance, that of Blue Bell Creameries, may be causally ambiguous because this organization's culture is difficult to replicate in an environment that is external to the firm (e.g., Barney, 1991; King and Zeithaml, 2001).

[7] Again, recall Porter's (1996) notion of competitive positioning.

A manager can also experience causal ambiguity pertaining to his or her own firm's competitive advantage (King and Zeithaml, 2001). For example, a manager can fail to understand how his or her own firm's competitive advantage was developed. King and Zeithaml (2001) suggest such a lack of understanding can limit a firm's ability to leverage it resources internally. For instance, many agribusinesses have evolved from small family-farm-owned operations to larger, more complex organizations. With such added complexity, top and middle agribusiness managers are likely to exhibit different interpretations of the key factors contributing to their firm's success. For example, an operational manager will perceive factors that relate to improvements in production efficiencies and cost control as key factors of success, while senior managers might view innovation as a more important factor of success. As a production and innovation focus reflects very different organizational priorities, such differences in perception across the organization's internal hierarchy can contribute to a lack of understanding and communication regarding a firm's critical success factors (Bowman and Daniels, 1995; see also Porter, 1996). Hence, a basic implication of this form of causal ambiguity is that, as agribusiness firms evolve towards greater complexity, internal sources of causal ambiguity may limit their ability to effectively leverage its competitive positions.

Conclusion

The advancement of agribusiness management as a field has been sporadic (e.g., Cook and Chaddad, 2000). Early advancements of a field are often marred with a lack of a research identity (e.g., Kuhn, 1970). Agribusiness management can be thought of being in the pre-"paradigmatic" stage of science, as was strategic management in the early 1970s and 1980s (see Rumelt et al., 1994; Hoskisson et al., 1999). During this period, progress in strategic management has and continues — to a lesser extent — struggle with delineating its central domains of research interest (e.g., Hoskisson et al., 1999; Rumelt et al., 1994). This is because strategic management is inherently a pluralistic field that embraces not only economics, but also fields such as psychology, organizational behavior, sociology, evolutionary biology, etc. Nevertheless, over time, strategic management has matured as an established field of inquiry, as evidenced by the growth in membership for associations such as the *Academy of Management* and *Strategic Management Society* and the growth in highly ranked management journals, such as *Academy of Management Review, Academy of Management Journal, Strategic Management Journal, Administrative Science Quarterly, Organization Science, Journal of Management Studies,* and *Journal of Management*, etc. One factor contributing to this growth has been a focus on a set of central concerns/issues in which their resolution has elevated the disciplinary status of this field (e.g., Rumelt et al., 1994).

However, the advancement of agribusiness management as a field cannot simply be a replication of the model of scientific development used in strategic management. Agribusiness management is distinct from strategic management because it has historically operated within departments of agricultural economics. Hence, the advancement of agribusiness management faces a basic challenge that not only requires "cross-disciplinary" efforts into management (e.g., Akridge and Gunderson, 2005; Boehlje, 2005; Westgren and Cook, 1986), but such efforts also require clear distinctions from economic explanations of agribusinesses. Such distinctions are important to developing management explanations of the agribusiness firm that could not be explained by economic principles alone. In fact, in Harling's (1995) study, he found that 88% surveyed disagreed (7% agreed) with the following statement: "The economic theory of the firm provides

a fully satisfactory explanation of the business for the purposes of agribusiness management" (p. 507). As a result, this suggests agribusiness management could focus on areas that are not well treated by production economic explanations.

Thus, the purpose of this study was to outline four concerns and theories of management that can help define those areas in which a production economics approach would not be a sufficient explanation of agribusiness behavior. For instance, in response to the question of "why are there firms?" Coase (1937) argues that the omission of transaction costs in production economic analyses significantly understates a firm's "authority." "Authority" is instrumental to explaining vertical integration decisions that could not be explained by production economics alone. Second, the question of "how do firms behave?" (Rumelt et al., 1994) emphasizes that managers do not "optimize" in a fashion dictated by production economics, but rather managers make decisions through satisficing heuristics that involve a process of trial and error experimentation. Third, the question of how a firm grows offers an alternative to the equilibrium orientation of production economics. In particular, as the concept of an equilibrium is based on a long term outcome, production economics cannot sufficiently explain a firm's short-run adjustment process, especially in regards to a firm's related diversified growth. Lastly, the question of why firms differ? extends production economic explanations of firm performance. Namely, the RBV extends product economic explanations by not only underscoring the heterogeneous nature of a firm's assets, such as a firm's brand and culture (e.g., Starbucks), knowledge capital (e.g., 3M, Google), technologies (e.g., Monsanto, BPI) etc., but also argues that the Value, Rareness and Inimitable nature of such resources impacts a firm's sustainable competitive advantage.

These four questions of strategy and associated theories can, thereby, serve as one basis for shaping the research opportunities of agribusiness management. However, it is also important to note that these areas of management should not be interpreted as the definitive basis of agribusiness management research, because the advancement of any field is a product of its contributing members. Hence, the purpose of this study is not to provide a comprehensive review of all the central questions and associated theories in strategic management, but rather to provide a point of reference for agribusiness management researchers in identifying a set of research questions, as well as research approaches in examining the behavior of the agribusiness firm. Furthermore, we believe the advancement of agribusiness management not only requires greater attention to management theories but also requires engaging a dialogue between agribusiness management researchers and agricultural economists.

For instance, since agribusiness firms operate in a market environment, agricultural economics offers understanding of markets that can directly impact the functioning of the firm. For instance, the determination of market prices through analysis of factors influencing shifts and movements along demand and supply are important to determining a manager's pricing strategies. Furthermore, agricultural economics research, especially those drawing from Industrial Organizational Economics (e.g. Carlton and Perloff, 2000), finds that market concentration can impact an industry's market power. Market concentration, such as in pork and chicken processing industries, can thereby influence management's ability to exert price discrimination. Agricultural economics is, thus, particularly suited to advancing agribusiness management research on issues relating market level phenomena to which have not been a primal focus of the firm level emphasis of management research. As a result, dialogue between agricultural

economics and agribusiness along these different levels of analyses serves to advance the pluralistic nature of agribusiness management.

Furthermore, inter-firm levels of analysis are also another important feature of agribusiness management research. This is because in addition to the market level orientation of agricultural economics, the agribusiness firm also operates within a complex value chain. Originating from sociology research, value chain networks underscore that pattern of social exchanges amongst value chain members provides a source opportunity as well as constrain (Lazzarini et al., 2001; Omta et al., 2001). A basic premise of social networks and related alliance research in agribusiness studies is that the agribusiness firm is not an atomistic entity but rather the agribusiness firm is "socially embedded" in a pattern of mutual relationships that can advance the interests of the firm (e.g. Lazzarini et al. 2001; Ng et al., 2006). That is, an agribusiness firm's vertical as well as horizontal social exchanges are an important means to accessing external resources that are necessary in the provision of food products and services. This is an important aspect of agribusinesses because the production of food products are services are often the result of multiple technologies that are not held by any given firm.

As a result, this study argues agribusiness management is fundamentally a multi-disciplinary endeavor because it operates at various levels of analysis - firm, inter-firm and market- that requires different disciplinary approaches. As a result, dialogue between the fields of management, sociology and economics and other related fields serves to not only highlight the unique approaches to examining various levels of analysis in agribusiness management research but as a consequence serves to advance the pluralistic nature of this field. Hence, it is such pluralism that serves to uniquely identify agribusiness management as a field in its own right.

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World Soybean Production: Area Harvested, Yield, and Long-Term Projections

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Abstract

Soybeans (*Glycine max*) serve as one of the most valuable crops in the world, not only as an oil seed crop and feed for livestock and aquaculture, but also as a good source of protein for the human diet and as a biofuel feedstock. The world soybean production increased by 4.6% annually from 1961 to 2007 and reached average annual production of 217.6 million tons in 2005-07. World production of soybeans is predicted to increase by 2.2% annually to 371.3 million tons by 2030 using an exponential smoothing model with a damped trend. Finally, three scenarios and their implications are presented for increasing supply as land availability declines. The scenarios highlight for agribusiness policy makers and managers the urgent need for significant investments in yield improving research.

Keywords: Soybean, production, yield, land use, long-term projection, exponential smoothing with damped trend

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Introduction

Soybeans *(Glycine max)* are one of the most valuable crops in the world not only as an oil seed crop and feed for livestock and aquaculture, but also as a good source of protein for the human diet and as a biofuel feedstock. Rapid soybean demand increases in the last decade challenge the reliability of supply, stock levels, and reasonable pricing. In just the past two years soybeans have topped $16.00 per bushel (July 3, 2008) and Argentina, the world's third largest producer, had a 30% reduction in output due to drought in 2009. In order to meet the demand, there are two alternatives: increase planted hectares or increase yield (tons/ha).[1] This paper examines the long range forecasts of soybean production as well as area harvested and yield using time series model and scenario analysis. The results and the accompanying scenario analysis demonstrate for policy makers and managers both the challenges of meeting demand growth with limited supplies of arable land, and the need for public, private, and farmer investments to increase yields.

Increasing soybean hectares by: substituting for other crops (e.g. sunflower in Argentina or cotton in the United States); utilizing pasture (e.g. Santa Fe, Argentina or Mato Grosso, Brazil); or replacing native vegetation (e.g. cerrado in Brazil) has been the most expedient manner to increase soybean output. World soybean production increased 36% since 2000 (Figure 1). World-wide soybean harvested acres though increased 28% and drove 81% of the increased production. Yield increased only six percent since 2000 and contributed only 19% to the increase. Going forward available farmland for soybean production will be limited by decreasing quantities of land not already in production, increased farmland loss for urbanization, heightened sensitivities about agricultural uses of land, and weak property rights in regions such as Africa that constrains the employment of modern agricultural methods (Goldsmith 2008b).

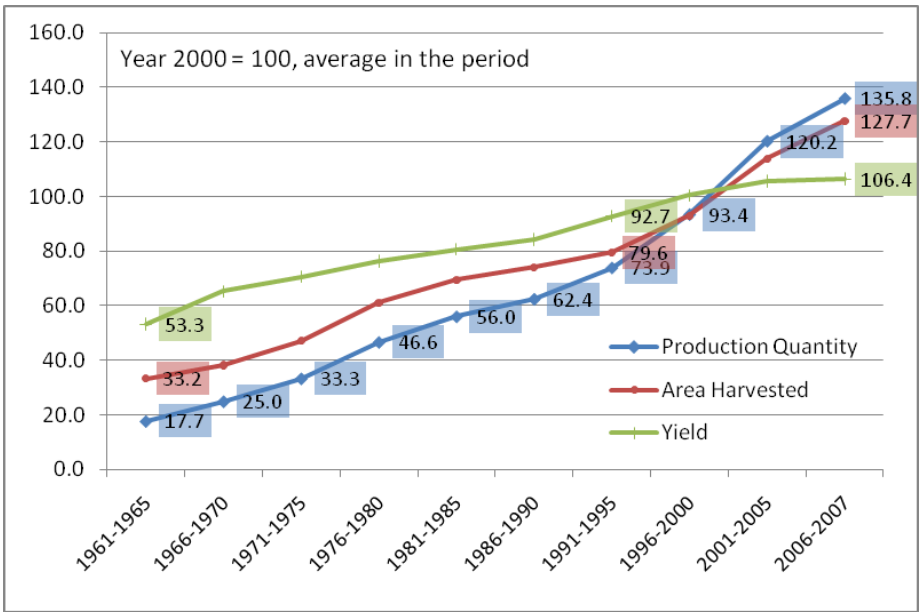

Figure 1. World Soybean Production and Area Harvested: 1961-2007
Source: FAOSTAT and authors' calculation.

[1] Reducing losses also increases the available supply, but would have minor impact on the overall supply-demand balance.

This paper has four objectives: 1) examine the contribution of increased land use as a component of overall production; 2) analyze the contribution of yield to overall production across major producing countries; 3) estimate the long range production quantities of soybeans at country and international levels; and 4) use scenario analysis to help policy makers and mangers think about the implications of these trends on policy and strategy.

Soybean Production: Historical View (1961-2007)

Production

The world annually produced 28.6 million metric tons of soybeans in 1961-65, and reached 217.6 million metric tons in 2005-07. The quantity increased 7.6 times during the half century. The USA produced more than 50 percent of the world soybean production until the 1980s but that share has declined to 37.0% in 2005-07(Figure 2). Brazil and Argentina though have significantly increased their shares steadily over the same period. Brazil is the second largest producer with 53.9 million tons, or 24.8% of world production. Argentina ranks third producing 41.4 million tons and 19.0% of world output. The top five countries; United States, Brazil, Argentina, China, and India, produce more 92% of the world's soybeans.

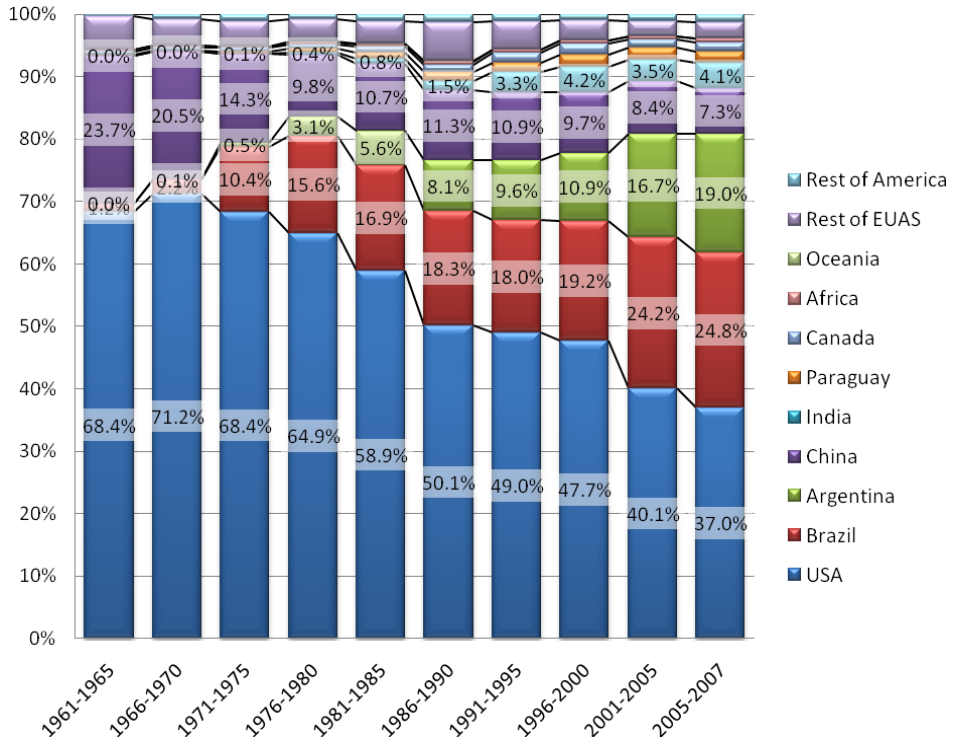

Figure 2. Shifts of Soybean Production Shares of Top 7 Countries plus Continents
Note. 5-year average. 2005-2007 is the three-year average.
Source: FAOSTAT and authors' calculation.

Land Use

The area harvested rose significantly with the dramatic increase in production outside the United States. The world soybean area harvested approximately quadrupled from 24.7 million ha in 1961-65 to 94.1 million ha in 2005-07. During the half century, the USA and China decreased their shares of soybean area harvested to 31.7% (29.9 million ha) and 9.8% (9.2 million ha) respectively in 2005-07, while Brazil and Argentina increased their shares to 23.3% (21.9 million ha) and 16.0% (15.1 million ha), respectively, (Figure 3).

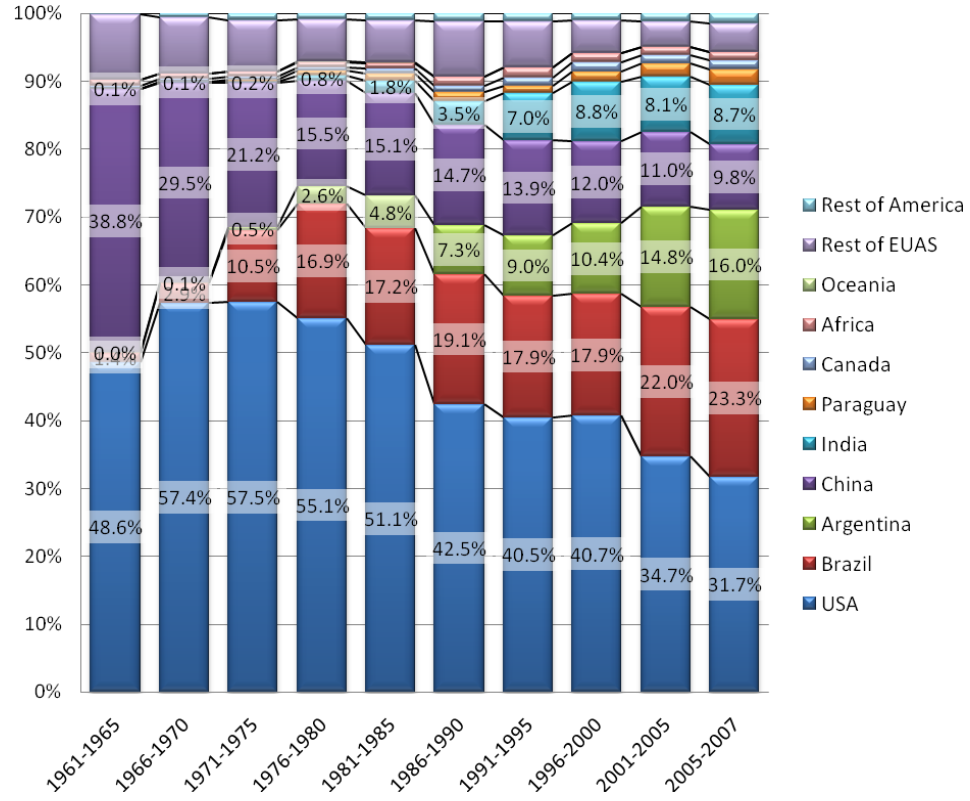

Figure 3. Shifts of Soybean Area Harvested Shares of Top 7 Countries plus Continents
Note. 5-year average. 2005-2007 is the three-year average.
Source: FAOSTAT and authors' calculation.

Yield

The world average soybean yield doubled from 1.16 metric tons per ha in 1961-65 to 2.31 metric tons per ha in 2005-07 (Figure 4). Out of the top 5 soybean production countries, Argentina reached 2.74 metric tons per ha while India produces about one metric tons per ha. The quadrupling of the area harvested and a doubling of the yield since 1961 has increased world soybean production 7.6-times. During the same period, the main production area has shifted from the USA and Asia (China and India) to the USA and South America, especially Brazil and Argentina.

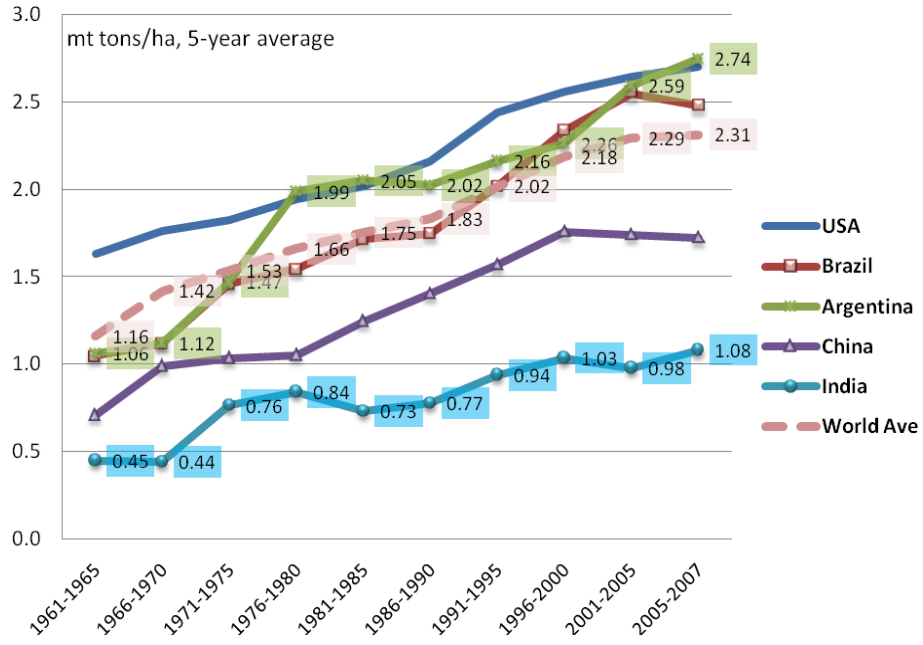

Figure 4. Changes in Soybean Yield by Country and World Average: 1961-2007
Note. 2005-2007 is 3-year average.
Source: FAOSTAT and authors' calculation.

Literature Review

A number of models have been used to forecast soybean production. Rosegrant et al. (2001) provide both baseline projections and alternative scenarios of global food supply, demand, trade, and malnutrition in 2020. Their International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) model analyzes impacts on alternative scenarios but does not provide the data granularity at the country, land use, and yield levels. OECD-FAO (2009) provides only a 10-year assessment of future prospects in the major world agricultural commodity markets though 2018 and aggregates all oilseeds into one class. This does not allow focus on the special case of soybeans. The USDA (2009) also provides 10-year projections for the agricultural sector including soybean sector through 2018 but focuses on U.S. agriculture.

Box-Jenkins ARIMA (Autoregressive Integrated Moving Average) estimation provides excellent flexibility for time series forecasting not only for addressing auto-correlated errors, but exploring non-zero trends, the smoothing of trends and levels, and dampening forecast estimates. Exponential smoothing helps correct for the large fluctuations common in production data (Ferbar et al, 2009). In our case data quality is problematic and adds to large fluctuations because we require a methodology suitable for all 179 countries in our dataset. Additionally, previous research has found improved forecast performance when a dampening coefficient is employed, especially when forecast length approaches fifty percent of the historical series (Miller and Liberatore, 1993). In our case we project 23 years into the future.

Finally, when using Box-Jenkins ARIMA approach to forecast a constructed variable, in our case production as a function of area and yield, $P = A \times Y$, it is not clear whether it is better to forecast *A* and *Y* separately to produce the forecast, or to forecast *P* directly (Kennedy, 2003). While there is no conclusive evidence as to the choice between the direct forecast of aggregated variables (production, *P*) and the indirect forecasts as the product of forecasts of the components (area harvested, *A*, and yield, *Y*), indirect forecasts tend to outperform direct forecasts (Kang, 1986).

Methodology

Our overall objectives are to estimate and analyze country-level projections through the year 2030, focusing on land and yield as components of production. We forecast explicitly A and Y then produce P following Kang (1986) and consistent with Rosegrant et al. (2001 and 2002) and OECD-FAO (2009).[2] We define the following: soybean production in terms of *P* (metric tons); area harvested in terms of hectares, *A* (ha); and soybean yield, *Y* (tons/ha) as *P* divided by *A*.

This yields the following relationship:

$$P = (P/A) \times A = Y \times A.$$

Production growth rate ($\dot{P}$) is disaggregated into yield growth rate ($\dot{Y}$) and area harvested growth rate ($\dot{A}$) to obtain:

$$\dot{P} = \dot{Y} + \dot{A}.$$

Multiplying area harvested (A) and yield (Y) after estimation derives soybean production quantities (P). The two variables by country and continent are estimated individually as univariate time series (Equation 1). Box-Jenkins ARIMA type univariate time series models can be exponentially smoothed and include a damped trend in order to improve forecast performance (See Gardner and McKenzie, 1985; Hamilton, 1994; Mills, 1990). Introducing a damped trend into exponential smoothing makes sense as growth rates in yield and expansion of harvested land begin to plateau over time.

Following Gardner and McKenzie (1985) and Gardner (1985), the general damped-trend linear exponential smoothing model is as follows:

$$A_t = \mu_t + \beta_t t + \epsilon_t \quad (1)$$

where A is area harvested or yield at time t, μ_t is the level of area harvested or yield at time t, β_t is parameter at t, *t* is the time trend or year, and ϵ_t is error term at t.

The smoothing equations are:

Level: $L_t = \alpha A_t + (1-\alpha)(L_{t-1} + \phi T_{t-1})$, and

[2] We also provide the readers forecasts of direct estimation in the Appendix.

Trend: $T_t = \gamma(L_t - L_{t-1}) + (1-\gamma)\phi T_{t-1}$

where L_t = smoothed level at *t* of the series, computed after A_t is observed,
α = smoothing parameter for the level of the series,
ϕ = trend modification or damping parameter,
T_t = smoothed trend at the end of period *t*, and
γ = smoothing parameter for trend.

The error-correction form of the smoothing equations is:

$L_t = L_{t-1} + \phi T_{t-1} + \alpha e_t$, and
$T_t = \phi T_{t-1} + \alpha\gamma e_t$

where $e_t = A_t - \hat{A}_t(1)$ is a one-period-ahead forecast error.
The forecast for *k* period(s) ahead from origin *t* is:

$\hat{A}_t(k) = L_t + \sum_{i=1}^{k} \phi^i T_t$.

If $0 < \phi < 1$, the trend is damped and the forecasts approach an asymptote given by the horizontal linear line or plateau: $L_t + T_t\phi(1-\phi)$. The equivalent process is ARIMA (1, 1, 2)[3] process that is written as:

$(1-\phi B)(1-B)A_t = (1-\theta_1 B - \theta_2 B^2)\epsilon_t$,

where $\theta_1 = 1 + \phi - \alpha - \alpha\gamma\phi$, and
$\theta_2 = (\alpha - 1)\phi$.

If $\phi = 1$, the model is equivalent to the standard version of Holt's (1960) model and the trend is linear. The equivalent process is ARIMA (0, 2, 2):

$(1-B)^2 A_t = (1-\theta_3 B - \theta_4 B^2)\epsilon_t$

where $\theta_3 = 2 - \alpha - \alpha\gamma$, and
$\theta_4 = \alpha - 1$.

Model permutations are commonly compared using both mean squared error (MSE) and mean absolute deviation (MAD) statistics. See Gardner (1985) and Ferbar et al. (2009) for excellent applications of MAD and MSE when comparing forecast models. The MSE gives more weight to large errors and is thus a more conservative fitness criterion than the MAD. The MSE is chosen as the error measurement in this study in order to avoid over amplifying the forecast estimates for the period (2008-2030). For the damped trend, $\phi = 0.98$ is set as the default when attempting to identify the best combination of level and trend parameters (α and γ). For a few countries a lower damped default coefficient was employed as the default of $\phi = 0.98$ was too high and drove trends negative.

[3] In the general ARIMA (1, 1, 2), $-1 < \phi < 1$.

Table 1. Parameters for Exponential Smoothing

a. Area Harvested

Coutry/continent	Level	Trend	Damped	Fcst MSE*
USA	0.90	0.05	0.98	1.943E+12
Brazil	0.90	0.10	0.98	1.247E+12
Argentina	0.70	0.30	0.98	1.908E+11
China	0.90	0.05	0.98	3.777E+11
India	0.90	0.20	0.98	7.709E+10
Paraguay	0.80	0.20	0.98	1.058E+10
Canada	0.60	0.10	0.98	2.693E+09
Rest of EUAS	0.90	0.30	0.98	6.688E+10
Rest of America	0.10	0.25	0.98	1.509E+10
Africa	0.90	0.05	0.98	6.782E+09
Oceania	-	-	-	-

b. Yield

	Level	Trend	Damped	Fcst MSE
USA	0.20	0.05	0.98	4.143E-02
Brazil	0.40	0.05	0.98	4.998E-02
Argentina	0.30	0.05	0.97	8.137E-02
China	0.50	0.05	0.98	1.064E-02
India	0.60	0.05	0.98	2.393E-02
Paraguay	0.40	0.30	0.80	5.083E-02
Canada	0.10	0.05	0.95	6.781E-02
Rest of EUAS	0.90	0.05	0.98	7.888E-03
Rest of America	0.30	0.05	0.98	2.694E-02
Africa	0.90	0.05	0.98	6.704E-03
Oceania	0.40	0.05	0.98	1.004E-01

Notes. *Forecasting mean square error is minimized to determine the level and trend parameters. Sample period is 1961-2007. The number of observation is 47.

Data

Soybean production and area harvested data are provided by FAOSTAT, which is commonly used in agricultural economic analysis and for projections (e.g., OECD-FAO (2009) and Rosegrant et al. (2001)). Specifically we estimated forecasts for the 21 soybean producing countries that produce 99 % of the world's soybeans. We selected for analysis the seven top producing countries (USA, Brazil, Argentina, China, India, Paraguay, and Canada) and 4 continents (Africa, Oceania, Rest of Eurasia, and Rest of America). These seven countries represent more than 95% of world soybean production in 2005-07. We analyzed soybean production, yield, and area harvested from 1961 to 2007 for each country and continent.

Estimation Results

The world soybean production compound annual growth rate for 1961-2007 (46 periods) is, $\dot{P} = \left(\frac{216.144}{26.882}\right)^{\left(\frac{1}{46}\right)} - 1 = 4.6\%$, and can be disaggregated into $\dot{A}$ = 3.1 % and $\dot{Y}$ = 1.5 %. In the long term, of the 4.6% annual growth in tonnage produced, the increase in yield accounted for 1.5%, or 33% of the growth in production. After 1990s, however, the contribution of yield growth to production growth declined. The compound annual growth rates of world average soybean yield were 1.4 % in 1990-95 and 1.3% in 1995-2000, then 0.0% in 2000-05 and -0.9% in 2005-07 (Figure 5). The world soybean production growth rates during the above four periods (3.2%, 4.9%, 3.8% and 0.4%) are supported by the area harvested growth rates (1.8%, 3.5%, 3.8%, and 1.3%).

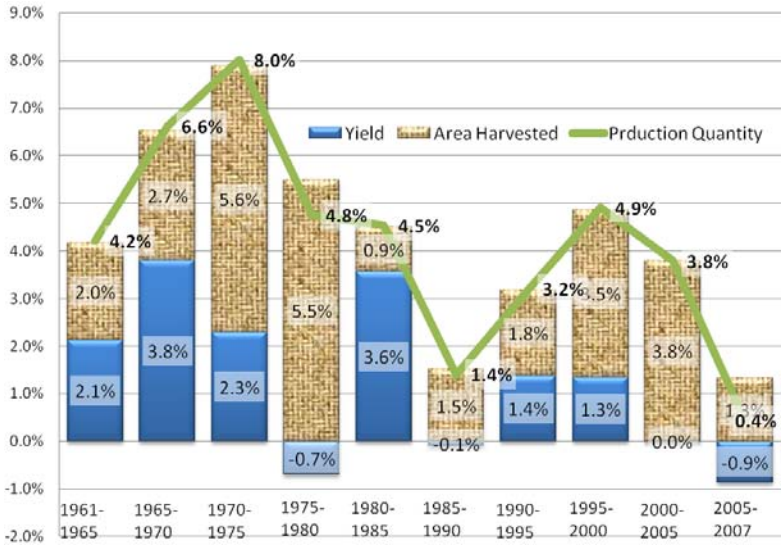

Figure 5. Annual Growth* of World Soybean Production, Area Harvested, and Yield
Notes. *Compound Annual Growth Rate = $\left(\frac{Ending\ Value}{Beginning\ Value}\right)^{\left(\frac{1}{\#\ of\ periods}\right)} - 1$.
The production growth rate is disaggregated into area harvested and yield growth rates. 1961-65 is 4 periods. 2005-07 is 2 periods. Others are 5 periods.
Source: FAOSTAT and authors' calculation.

The world soybean production is projected at 311.1 million metric tons in 2020 and 371.3 million metric tons in 2030 (Table 2). The annual growth rates are 2.9% from 2005-07 to 2010, 2.5% from 2010 to 2020, and 1.8% from 2020 to 2030. The estimated quantity level in 2030 is approximately 1.7 times greater than that in 2005-07.

During the forecast period, Argentina's production rises rapidly by 4.5% annually from 2010 to 2020 and 2.8% from 2020 to 2030, when it reaches 108.4 million metric tons in 2030. At that time, Argentina is projected to become the top soybean grower, producing 29.2% of the world's output.

Table 2. World Soybean Production Projection Summary

a. Soybean production and share

Country/continent	metric mil tons				Share			
	2005-07	2010	2020	2030	2005-07	2010	2020	2030
World Total	217.6	243.9	311.1	371.3	100.0%	100.0%	100.0%	100.0%
USA	80.6	85.1	92.9	99.5	37.0%	34.9%	29.9%	26.8%
Brazil	53.9	60.0	78.3	94.8	24.8%	24.6%	25.2%	25.5%
Argentina	41.4	52.9	81.9	108.4	19.0%	21.7%	26.3%	29.2%
China	15.8	15.8	16.6	17.2	7.3%	6.5%	5.3%	4.6%
India	8.9	10.7	15.0	18.9	4.1%	4.4%	4.8%	5.1%
Paraguay	3.9	4.1	5.2	6.5	1.8%	1.7%	1.7%	1.7%
Canada	3.1	3.1	3.5	3.8	1.4%	1.3%	1.1%	1.0%
Rest of EUAS	5.8	6.2	8.1	9.6	2.7%	2.6%	2.6%	2.6%
Rest of America	2.7	4.1	7.4	10.1	1.2%	1.7%	2.4%	2.7%
Africa	1.4	1.6	2.1	2.5	0.6%	0.7%	0.7%	0.7%
Oceania	0.0	0.0	0.0	0.0	0.0%	0.0%	0.0%	0.0%

b. Compound annual growth rate

Country/continent	Compound annual growth rate		
	2005/07-2010	2010-2020	2020-2030
World Total	2.9%	2.5%	1.8%
USA	1.4%	0.9%	0.7%
Brazil	2.7%	2.7%	1.9%
Argentina	6.3%	4.5%	2.8%
China	0.1%	0.5%	0.4%
India	4.7%	3.5%	2.4%
Paraguay	1.3%	2.4%	2.1%
Canada	0.0%	1.1%	0.8%
Rest of EUAS	1.6%	2.6%	1.8%
Rest of America	11.4%	6.0%	3.2%
Africa	4.2%	2.5%	1.8%
Oceania	-10.3%	0.9%	0.7%

Source: FAOSTAT and authors' estimation.

The United States becomes the second largest producer (99.5 million metric tons) and its share declines to 26.8%. Brazil becomes the third largest soybean producer in the world and produces 94.8 million metric tons (25.5%) of soybeans in 2030. China and India will continue to increase their production quantities to 17.2 and 18.9 million metric tons in 2030, respectively. China decreases its share to 4.6% while India increases its share to 5.1% in 2030. These top 5 countries will still produce more than 90 percent of the world soybean supply.

Out of the annual 2.5% and 1.8% production growth in the decades of the 2010s and in 2020s, the area harvested contributes 1.9% in 2010s and 1.3% in 2020s, respectively (Table 3). The world total soybean area harvested increases to 140.9 million ha in 2030, which is 1.5 times larger than the area harvested in 2005-07. Argentina and Paraguay steadily increase their

soybean harvest areas and reach 31.4 million ha and 5.0 million ha, respectively, in 2030. India also increases its area harvested to 14.6 million ha. These three countries also increase the shares of area harvested in the world. Since the USA and Brazil's areas harvested increase moderately, their shares decline to 25.0% and 21.7%, respectively, in 2030.

Table 3. World Soybean Area Harvested Projection Summary

a. Soybean area harvested and share

Country/continent	million ha				Share			
	2005-07	2010	2020	2030	2005-07	2010	2020	2030
World Total	94.1	102.5	123.6	140.9	100.0%	100.0%	100.0%	100.0%
USA	29.9	31.3	33.5	35.2	31.7%	30.5%	27.1%	25.0%
Brazil	21.9	22.4	26.9	30.6	23.3%	21.9%	21.8%	21.7%
Argentina	15.1	18.5	25.6	31.4	16.0%	18.0%	20.7%	22.3%
China	9.2	9.0	9.0	9.1	9.8%	8.7%	7.3%	6.4%
India	8.2	9.5	12.3	14.6	8.7%	9.3%	10.0%	10.4%
Paraguay	2.2	2.7	4.0	5.0	2.3%	2.7%	3.2%	3.5%
Canada	1.2	1.3	1.5	1.6	1.3%	1.2%	1.2%	1.1%
Rest of EUAS	3.9	4.4	5.6	6.6	4.1%	4.3%	4.5%	4.7%
Rest of America	1.4	2.1	3.8	5.1	1.5%	2.1%	3.1%	3.6%
Africa	1.2	1.3	1.5	1.7	1.3%	1.3%	1.2%	1.2%
Oceania	0.0	0.0	0.0	0.0	0.0%	0.0%	0.0%	0.0%

b. Compound annual growth rate

Country/continent	Compound annual growth rate		
	2005/07-2010	2010-2020	2020-2030
World Total	2.2%	1.9%	1.3%
USA	1.2%	0.7%	0.5%
Brazil	0.6%	1.9%	1.3%
Argentina	5.2%	3.3%	2.1%
China	-0.7%	0.1%	0.1%
India	3.8%	2.6%	1.7%
Paraguay	6.1%	3.8%	2.3%
Canada	1.7%	1.4%	1.0%
Rest of EUAS	2.9%	2.5%	1.6%
Rest of America	10.8%	5.8%	3.1%
Africa	2.8%	1.4%	1.0%
Oceania	-10.2%	0.0%	0.0%

Source: FAOSTAT and authors' estimation.

During the same projection period, the world average soybean yield contributes 0.6% in 2010s and 0.5% in 2020s to supply (Table 4) and reaches 2.64 tons per ha in 2030. Argentina's yield increases steadily and exceeds 3.0 tons per ha in 2020 then approaches 3.5 tons per ha by 2030. Brazil's yield reaches 3.0 tons per ha by 2030. The growth of yield in the USA, starting from a higher base, continues to increase moderately but plateaus in 2030 at 2.8 tons per hectare. The yields of China and India are 1.90 tons per ha and 1.29 tons per ha, respectively, in 2030 and both do not reach 2.0 tons per ha.

Table 4. World Soybean Yield Projection Summary

a. Soybean yield

Country/continent	metric tons / ha			
	2005-07	2010	2020	2030
World Average	2.313	2.379	2.516	2.636
USA	2.703	2.722	2.777	2.823
Brazil	2.477	2.679	2.909	3.098
Argentina	2.745	2.864	3.205	3.457
China	1.720	1.771	1.841	1.898
India	1.080	1.120	1.216	1.294
Paraguay	1.816	1.503	1.316	1.296
Canada	2.659	2.491	2.408	2.358
Rest of EUAS	1.500	1.424	1.447	1.466
Rest of America	1.876	1.923	1.955	1.981
Africa	1.154	1.222	1.350	1.456
Oceania	2.205	2.106	2.312	2.480

b. Compound annual growth rate

Country/continent	Compound annual growth rate		
	2005/07-2010	2010-2020	2020-2030
World Average	0.7%	0.6%	0.5%
USA	0.2%	0.2%	0.2%
Brazil	2.0%	0.8%	0.6%
Argentina	1.1%	1.1%	0.8%
China	0.7%	0.4%	0.3%
India	0.9%	0.8%	0.6%
Paraguay	-4.6%	-1.3%	-0.2%
Canada	-1.6%	-0.3%	-0.2%
Rest of EUAS	-1.3%	0.2%	0.1%
Rest of America	0.6%	0.2%	0.1%
Africa	1.4%	1.0%	0.8%
Oceania	-1.1%	0.9%	0.7%

Source: FAOSTAT and authors' estimation.

Scenarios

The following three scenarios highlight the interplay between land use and yield when addressing the future forecasted soybean demand of 371 million metric tons. The pressure to dedicate current or new agricultural lands to soybeans will be great unless yields can be increased. This pressure to meet demand is not simply an agricultural question of crop substitution. Societies and their governments will increasingly wrestle with preserving native biomes versus converting land to crop agriculture.

Arable land for soybeans is limited over the long run and a yield plateau appears to exist around 3.00 tons per hectare for most producing countries. Only Argentina appears to be on a trajectory to reach 3.50 tons per hectare by 2030. Specht et al. (1999) discuss the biological limit to

soybean yield improvement in the USA and argues the 4.00 tons per ha milestone could be achieved by 2029 but would more likely take significantly longer. Recent research in Illinois shows little yield growth in public variety trials since 2000 (Goldsmith 2008a). The USA and Argentina currently hold the highest yields at, 2.7 tons/ha, 17% greater than the world average yield.

We propose three future yield scenarios where the forecasted production of 371 million metric tons is held constant:

- *Scenario 1:* This is the benchmark case and reflects the above forecast where world average yield increases annually by 0.5% and reaches 2.64 tons per ha. World total area harvested increases annually by 1.7% and reaches 140.9 million ha in 2030 assuming moderate yield growth (Figure 6).

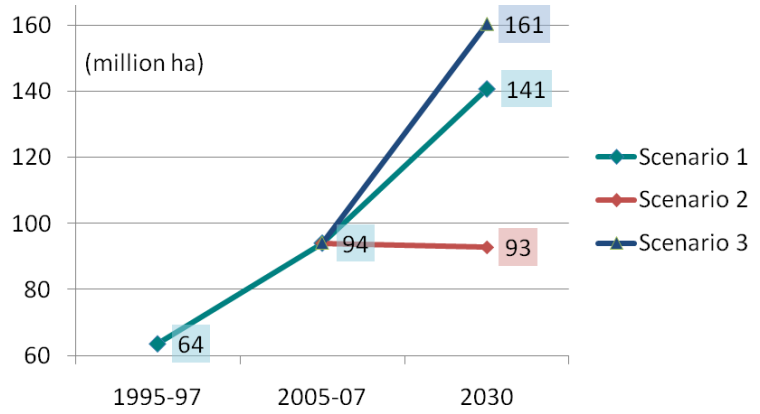

Figure 6. Scenarios for World Soybean Area Harvested and Yield to 2030

- *Scenario 2:* The "Specht" scenario imagines a high annual growth rate in yield where world average yield rising from current levels of 2.31 metric tons per hectare to 4.00 tons/ha by 2030. Such a scenario would involve significant investment in agricultural research, but would lead to large dividends in terms of reducing land use pressures to meet growing demand.

- *Scenario 3:* This scenario is pessimistic in that the annual yield growth rate slows from the forecasted level of 0.55% per year to 0.00% per year. Reduced levels of agricultural research investment occur as public priorities shift, say to alternative crops, or private priorities follow crops with higher returns on investment. Numerous authors have identified monopoly rents arising from patent, trademark, and trade secret practices as a key driver in seed innovation and associated productivity gains in agriculture (Quaim and De Janvry, 2003; Lapan and Moscini, 2004; Endres and Goldsmith, 2007). Weak intellectual property (IP) rights directly challenge the formation of monopoly opportunities and incentives for private sector investment. Private seed firm research investments are diverted from IP vulnerable crops such as soybeans to an IP protected

crop[4] such as maize (Goldsmith et al., 2006). Thus differing returns to research across crops dramatically affect private investment flows and resulting productivity growth rates. Public or farmer led investment may then be necessary to fill the void where public priorities for investment remain high but private incentives are weak.

Scenario 1: Annual Yield Growth remains at its current trend of 0.55% during the forecast period

As a benchmark scenario, world average soybean yield reaches 2.64 tons/ha in 2030 when the annual growth rate of the world average yield increases 0.55% per year during the estimation period. This is the most likely case and reflects the estimation using the above damped-trend exponential smoothing model. The world total soybean area harvested grows by 1.70 % annually and reaches 140.9 million ha in 2030 to meet expected demand. Such land expansion would be 1.5 times greater than 94.1 million ha in 2005-07.

Scenario 2: Specht optimistic scenario: yield level reaches 4.00 tons/ha in 2030

Specht et al. (1999) state that the United States soybean yield could reach 4.00 tons per ha by 2029. Accelerating investments in genetics, cultural practices, and technology transfer mechanisms, combined with a focus on low-but potentially high yield settings, would be necessary to achieve these goals. Currently (2005-07 average) the soybean yields in the USA, Brazil, and Argentina are 2.70, 2.48, and 2.75 tons per ha, respectively. On the other hand, China and India's yields are 1.72 and 1.08 tons per ha, respectively. To reach the 4.00 tons per ha target, the average yield growth needs to accelerate from its base level of 0.5% to 2.3% per year. During the period, the world total soybean production increases annually by 2.2% and reaches 371.3 million metric tons (Table 5). Under this optimistic yield growth scenario the world soybean area harvested would decline to 92.8 million hectares thus requiring 1.3 million fewer hectares to meet demand of 371.3 metric tons in 2030.

Table 5. Scenarios for World Soybean Area Harvested and Yield to 2030

World Total/Average	**Year 2005-07**	**CAGR**	**Year 2030**	
	a		b	b/a
Production (mil. metric tons)	217.6	2.2%	371.3	1.7
Scenario 1 (estimation results)				
Area Harvested (mil. ha)	94.1	1.7%	140.9	1.5
Yield (tons/ha)	2.3	0.5%	2.6	1.1
Scenario 2 (higher yield growth)				
Area Harvested (mil. ha)	94.1	-0.1%	92.8	1.0
Yield (tons/ha)	2.3	2.3%	4.0	1.7
Scenario 3 (lower yield growth)				
Area Harvested (mil. ha)	94.1	2.3%	160.6	1.7
Yield (tons/ha)	2.3	0.0%	2.3	1.0

[4] Due to hybridization

Scenario 3: Annual yield growth slows to 0.00%

Weak intellectual property rights limit private incentives to invest in soybean research (Goldsmith et al., 2006). As well increasing demand for liquid biofuels such as ethanol makes maize investment increasingly attractive in regions such as the Midwest U.S. and Argentina where the complementarity between maize and soybeans has declined. Soybean yield growth could decline in the future with reduced soybean research and farmer investment in soybean production. Greater land expansion, though unlikely, would be needed to meet demand under such a scenario. Declining availability of land, higher productivity from competing crops, and greater sensitivity to maintain native biomes will limit the rate of soybean area expansion. Nevertheless, to meet production forecasts world soybean hectares would need to increase over 65 million hectares to 160.6 million, if yield growth fell to 0.0% per year. At that level, the world average yield would remain at 2.3 tons per ha.

Discussion and Concluding Remarks

This paper projects soybean area harvested, yield, and production quantities by major counties and by continent, using Box-Jenkins model employing exponential smoothing with a damped trend. The world soybean production is forecasted at 371.3 million metric tons in 2030. If 4.00 tons per ha in 2030 is set as the yield target, the world average yield growth needs to increase by 2.3% per year and the area harvested would decline to 92.8 million hectares in 2030 (Scenario 2). On the other hand, if the average yield growth remains at 0.0% per year (Scenario 3), approximately 160 million ha of soybean area harvested will be needed in 2030 to meet world demand.

Arable land on the globe is limited and the competition from other crops restricts soybean area expansion. The expansion of farmland will continue to be constrained as the international community values environmental stewardship and biome preservation. Since 1990 areas of arable land and permanent crops in the high growth countries of Brazil and Argentina have increased 17% or 14.5 million hectares (Figures 7 and 8). During the same period, the forest areas have decreased 9% or 47.8 million hectares.

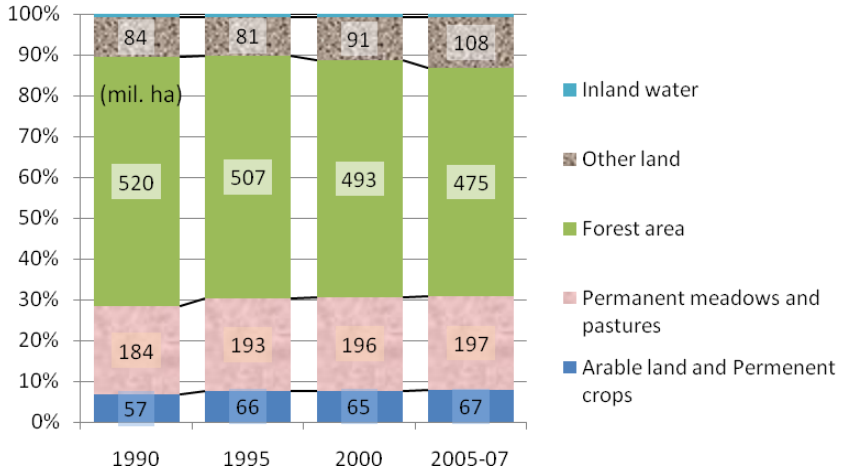

Figure 7. Land Use Changes in Brazil (1990-2007)
Source: FAOSTAT and authors' calculation.

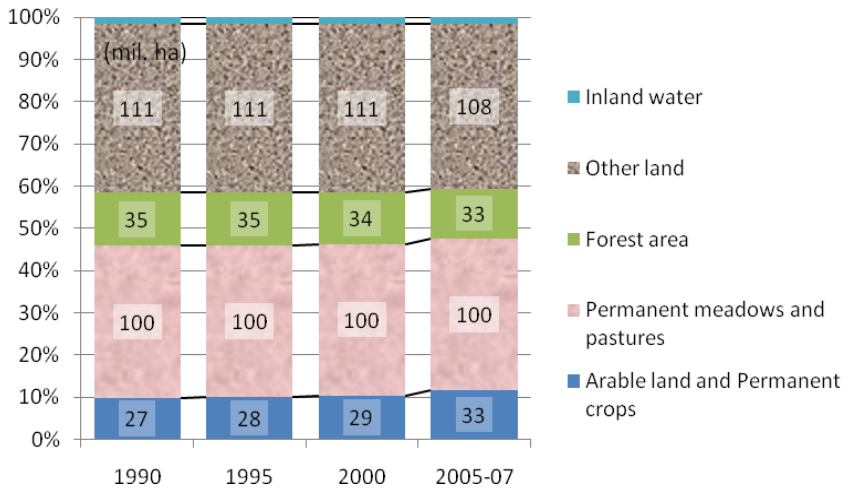

Figure 8. Land Use Changes in Argentina (1990-2007)
Source: FAOSTAT and authors' calculation.

According to the estimation results or Scenario 1, Brazil's soybean area harvested increases from 21.9 million ha in 2005-07 to 30.6 million ha in 2030 and Argentina's soybean area harvested grows from 15.1 to 31.4 million ha (recall Table 2). In 2005-07 soybean area harvested already shares 33% of the cropland in Brazil and 46% in Argentina. The soybean areas harvested under Scenario 1 is expected increase 1.4 times in Brazil and 2.1 times in Argentina by 2030. Competing crops will be crowded out, pasture will be converted, and pressure to convert native biomes will remain in such a scenario.

Therefore, policy shifts and research investment are needed to generate the yield improvements necessary to meet demand projections. Social and political pressure on land use expansion in agriculture will only accelerate in the coming years if yields continue to lag. Raising yield might take either or both of two directions: i) substantial R&D investments in genetics and agronomics in advanced soybean producing areas to achieve the biological limit, or ii) technological transfers to low-yield areas under protection of IP rights to help lower producing counties increase yields.

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Appendix

Direct and Indirect Estimation Results

Following Kang's (1986) suggestion, A (area harvested) and Y (yield) were forecasted separately. Then P (production) was calculated as the product of A and Y (P=A×Y). However, according to Kennedy (2003), it is not clear whether it is better to forecast A and Y separately to produce the forecast, or to directly forecast P. The direct soybean production estimation was 362.9 million tons in 2030 (Table 6); is 8.4 million tons or 2.3% lower than 371.3 million tons of the indirect estimation result (Figure 9). Both forecasts performed comparably at the country level and each time period, thus any differences do not impede the overall results and discussion in the paper.

Table 6. Direct Estimation Results: World Soybean Production

Country/continent	Metric mil tons				Share			
	2005-07	2010	2020	2030	2005-07	2010	2020	2030
World Total	217.6	246.1	310.4	362.9	100.0%	100.0%	100.0%	100.0%
USA	80.6	82.8	90.4	96.6	37.0%	33.7%	29.1%	26.6%
Brazil	53.9	64.1	84.2	100.7	24.8%	26.0%	27.1%	27.7%
Argentina	41.4	53.7	81.2	103.7	19.0%	21.8%	26.2%	28.6%
China	15.8	16.2	17.3	18.3	7.3%	6.6%	5.6%	5.0%
India	8.9	10.5	14.0	16.8	4.1%	4.3%	4.5%	4.6%
Paraguay	3.9	4.2	4.7	5.1	1.8%	1.7%	1.5%	1.4%
Canada	3.1	3.2	3.7	4.1	1.4%	1.3%	1.2%	1.1%
Rest of EUAS	5.8	5.8	6.4	6.8	2.7%	2.4%	2.1%	1.9%
Rest of America	2.7	4.1	7.4	10.1	1.2%	1.7%	2.4%	2.8%

Africa	1.4	1.6	2.1	2.5	0.6%	0.7%	0.7%	0.7%
Oceania	0.0	0.0	0.0	0.0	0.0%	0.0%	0.0%	0.0%

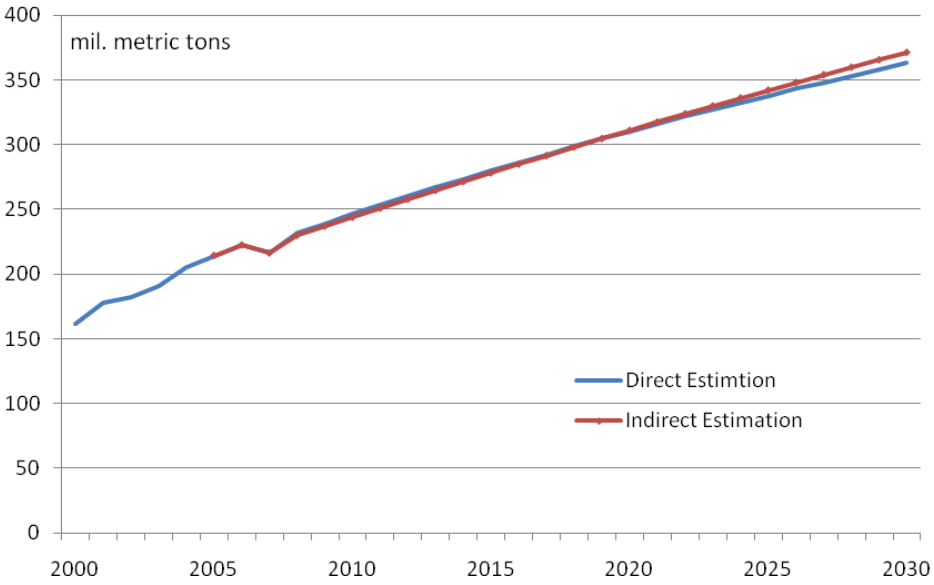

Figure 9. Direct and Indirect Estimation Results: World Soybean Production
Note. Forecasts start from 2008.
Source: FAOSTAT and authors' calculation.

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Do Private Labels Generate Loyalty? Empirical Evidence for German Frozen Pizza

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Abstract

The increase in private labels within the food retailing industry and retailers' high expenditures for establishing them raise a central question: Do consumers really consider private labels "real" brands and do they develop loyalty towards them? We analyse a four-year household panel data set of frozen pizza purchases of 14,000 households in Germany to study differences in consumers' repurchasing behaviour between national brands and private labels. We consider dynamic aspects of repurchase behaviour as well as household characteristics applying a hazard approach. Our results show differences between national brands and private labels.

Keywords: food retailing, private labels, brand loyalty, panel data, hazard analysis

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Introduction

In most Western economies the retail food industry has been subject to considerable changes in recent decades. During the 1970s, food retailing companies were seen as the vicarious agents of food processors. Over time retailers were able to grow very fast and gained significant market shares (Nieschlag et al. 1994). Today, retailers mostly dominate the agri-food business and the food processors. The cumulative market share of the top ten retailers surveyed in Germany in 2006 is about 87 percent. The same holds for other European countries (Wrigley 2002), such as Sweden, France, Belgium, and Switzerland, where the respective top ten retailers' cumulative market share is more than 90 percent (BVL 2008). This level of concentration indicates that retailers face fierce competition. Due to the rivalry between the top retails, private labels were introduced to be silhouetted against the competitors (Choi and Coughlan 2006; Moore et al. 2000). The key concept is retail branding, i.e. many retail firms establish retail brands (private labels) by converting their shop name to a brand itself (Dhar and Hoch 1997, Sayman et al. 2002). Thus, for some years retailers have been using retail branding more intensively, mirroring a steady increase in the market share of private labels (Cotterill and Putsis 2000). For example in Germany, private labels already account for 40 percent of the market share. As Figure 1 demonstrates, private labels play a major role not only in Germany but in most European countries.

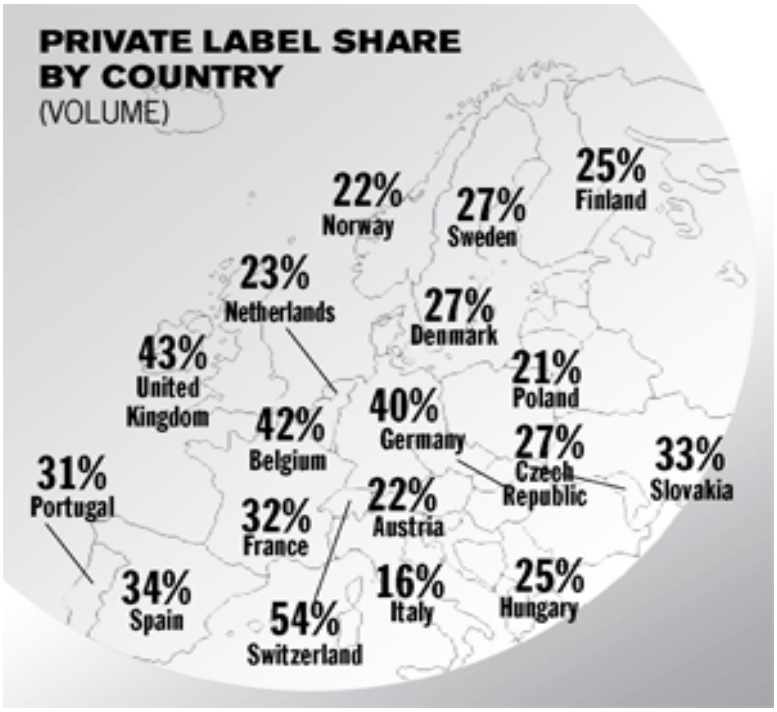

Figure 1. Private labels - share in total sales volume of non-durable goods by country, PLMA 2008

During the past ten years, growth of private labels is observable in the premium market segment. Now German retailers spend several hundred million Euros annually on brand management. One of the aims of branding is to generate customer loyalty. Loyal consumers are less likely to switch

to competitors and are more tolerant to increases in price than non-loyal consumers (Reichheld and Sasser 1990, Reichheld and Teal 1996). In their seminal article, Jacoby and Kyner (1973) show that brand loyalty is a biased (i.e. non-random), behavioural response (i.e. purchase), expressed over time, by some decision-making unit, with respect to one or more alternative brands out of a set of such brands, and a function of psychological (decision-making evaluative) processes. In other words, brand loyalty describes a preference which is manifested in an actual behaviour towards a certain brand out of a set of alternative brands. Hence, for analysing brand loyalty, consumer repurchases of a certain brand over a longer time period is a good proxy. Particularly since Assael (1984) suggests that, "Success depends not on the first purchase but on repurchase."

Creating loyal customer behaviour can be considered one of the success factors of retailers (Grewal and Levy 2007). In this context the question arises whether whether consumers consider private labels to be a “real” brand and therefore, wether retailers are able to generate loyal customers with a repurchase beahaviour comparable to that of national brands. In this paper we address these questions by analysing a panel data set of 14,000 households. We study consumers’ repurchase behaviour between strong national brands and private labels. For this study we proceed as follows. First we elaborate on household characteristics and how they influence repeat purchases of private labels as an indicator of brand loyalty. And second we conducted an empirical analysis for the German frozen pizza market regarding brand loyalty. This market has has experienced a dramatic increase in volume over the last ten years. (Deutsches Tiefkühlinstitut 2008). The paper concludes by discussing our results and presenting an outlook for further research.

Consumer Patterns of Loyal Behaviour

In addition to developments observed in the retail sector, changes are also occurring on the consumer side. Gianluigi Zenti, executive director of Academia Barilla, suggests, "In the future the quality of food will split into different directions: there will be one consumer segment that is looking for higher quality and one bigger segment that is looking for lower quality at a lower price. … So overall we are in a situation, where consumers are changing dramatically, because their expectations are changing" (Hartl 2006). These changes in consumer behaviour lead to new markets with specific consumer segments. To capture such a specific consumer segment it will be more and more important to understand the characteristics of such a specific consumer segment and which of these characteristics influence their repurchase behaviour.

Repurchase behaviour is a necessary condition for brand loyalty (e.g. Jacoby 1971; Jacoby and Kyner 1973; Jacoby and Chestnut 1978), and loyal consumers are a central aim of consumer relationship management. The reason is that those consumers who repeatedly buy the same brand are less likely to switch to competitors. Therefore, such behaviour goes along with higher profits and success (Assael 1984). For instance, loyal consumers spread positive word-of-mouth advertising. Also it has been shown that loyal customers are more are more tolerant to price increases than non-loyal consumers, so firms can achieve a price premium (Reichheld and Sasser 1990, Reichheld and Teal 1996).

Several researchers (Allenby and Rossi 1991; Chiang 1991; Gönül and Srinivasan 1997; Gupta and Chintagunta 1994) have incorporated demographic characteristics in brand choice models which were estimated using scanner panel data. The general finding across these studies is that the impact of demographic variables on brand choice is neither strong nor consistent. These findings are puzzling given that one would expect certain demographic variables, such as income, to have some impact on brand choice behaviour. Baltas and Doyle (1998) investigate in their study the effects of several consumer characteristics, preference heterogeneity, and choice dynamics on private label purchasing behaviour. These researchers were the first to examine all these issues using panel data. The empirical identification of permanent inter-individual differences suggests that there exist two market segments of consumers interested in national brands and private labels, respectively. The private label consumer is likely a "switcher" and not a "shopper", with a stable, narrow brand repertoire. Examining the reasons for buying a private label, Baltas and Doyle (1998) note that private label buyers shop more frequently. Furthermore, the lower price of private labels and a lack of advertising create an image that appeals to particular consumers. Baltas and Doyle (1998) have shown that both price and consumer preferences affect choices. Despite the common conjecture that a private label product is purchased solely based its low on price, they find that some consumers buy private labels because they prefer them. This finding reflects the serious quality improvements made by retailers in recent years (e.g. Schulze et al. 2008), as well as the introduction of premium private labels. The study suggests that the private label consumer is a price-cautious but promotion-insensitive consumer.

We test these findings by using German household panel data, which include information on actual consumers' purchase behaviour, as well as information on household characteristics. Hence, as suggested by Richardson et al. (1996), first we are able to employ a behavioural measure so that the results will be approximations of real repurchase behaviour. Thereby, we use data over a period of four years so that we are able to provide some implications based on the observations of former actual behaviour, which is an important extension of previous models. Second, we consider the households' characteristics. This facilitates a classification between specific household segments and the influence of their characteristics on the repurchase behaviour.

Empirical Analysis

Whereas conceptually brand loyalty is clearly defined (e.g. Day 1969; Jacoby 1971; Jacoby and Kyner 1973; Dick and Basu 1994; Oliver 1997; Oliver 1999), there are different ways to measure brand loyalty. Jacoby and Chestnut (1978) reviewed over 100 studies and found 33 different measures of brand loyalty. These approaches are divided by Jacoby and Chesnut (1987) into the following four categories: I) Approaches which only considers the sequence in which different brands are purchased in determining the degree of loyalty (e.g. Tucker 1964). II) Approaches focusing on the proportion of purchase measures (e.g. Copeland 1923; Cunningham 1956). III) Other approaches aim to measure the probability of purchase (e.g. Lipstein 1959; Frank 1962). IV) Synthesis measures (e.g. Massy et al. 1968) which combine sequential, proportional or probability based brand loyalty indices.

More recently, the method of event history analysis (hazard analysis) as a type of probability of purchase measurement is more often implemented to quantify brand loyalty (e.g., Duwors and

Haines 1990; Gould 1997; Boatwright et al. 2003). Strength of this approach is that it is possible to include implications based on the observations of former actual behaviour. Thus, measuring loyalty has been of ongoing concern to both academics and marketing practitioners.

While previous studies have in most cases focused on the interpurchase time (e.g. Gould 1997; Boatwright et al. 2003), in this paper we examine *repurchase periods,* i.e. time periods of repeated purchases of individual brands as approximate indicators of brand loyalty.[1]

After introducing the data, we present our analytical approach, which focuses on the question whether the duration of repurchase periods as well as this duration's determinants differ systematically between private labels and national brands. Results are presented and discussed at the end of the section.

Data

We use a household panel data set (January 2000 to December 2003) reflecting food purchases of 14,000 households in Germany on a daily basis. The data is compiled by GfK market research group (GfK 2008). The 14,000 households in the sample are representative of the German population. The data input took place by hand scanner and manual input. The data reflects actual purchase behaviour of individual households rather than attitudinal statements as often documented by surveys or choice experiments. The data allows us to observe actual repurchase behaviour which is used here to measure brand loyalty. Variables reported are quantities and prices of products and brands bought, information on the store type, display and promotion of brands in the store, and some demographic information on the household such as household size and composition, household income, and the age of the household's head.

Two producers of frozen pizza dominate the German market. In our sample, 53 percent of purchased units carry one of the two major national brands, "Dr. Oetker" or "Wagner", whereas 34 percent of packaging units carry private labels (34 brands owned by supermarket chains and discounters). In our study we compare national brands with private labels, each of these brand types taken as a group.

Per capita demand on average over the households in our sample amounts to 4.8 frozen pizzas per year, of which 3.3 are national brands and 1.5 private labels. The consumption figure and the share of national brands and private labels have remained nearly at the same level over the four years observed. Consumption was well above average in households with heads under 30 years (6.7 pieces per capita) particular in households of young singles (10 pieces) while it was low (3 pieces) among older couples without children and families with small children. The share of private label pizzas was 30 percent on average (70 percent for national brands) and varied in the remarkably narrow range between 26 and 34 percent for a number of quite different household types defined by composition, per capita income, and age. Only households with a monthly per capita net income of less than 500 Euro consumed a higher share (37 percent of all pizzas purchased) of private label pizzas.

[1] The number of purchase repetitions (rather than the time span covered by them) can be considered another informative representation of brand loyalty, as suggested by an anonymous referee. To complete the picture of repurchase behaviour this will have to be addressed in further studies.

Our data reveals that this remarkably widespread 30/70 ratio of private labels and national brands is not only due to a mix of different consumer types with constant choice of brand type but also to a large number of households which purchase a mix of brands: 29 percent of all households have indeed chosen only national brands over the whole observation period while 13 percent have purchased no other than private label pizzas. These households are obviously loyal to a brand type, perhaps to individual brands. However, the remaining 52 percent of households have purchased both, private labels and national brands, almost half of them have even mixed both brand types in each individual year. The existence of loyal and brand type switching households suggests to analyse repurchase behaviour as well as factors it is associated with.

Analytical approach

We analyse the length of repurchase periods as measure of brand loyalty. Our definition of a repurchase period can be illustrated by the following example: For each household all daily purchases are considered, i.e. the dates when the household purchases any quantity of frozen pizzas of any brand. A repurchase period for a national brand begins with the day of the first purchase of that brand type and lasts as long as this brand type is repurchased.[2] Hence, as figure 2 illustrates in stylized way for a hypothetical household a repurchase period covers two or more purchases of the same brand type national brand (N) or private label (P).

Our analysis focuses on households that frequently buy frozen pizza[3]. Observed repurchase periods range from one day to nearly the total observation period of four years. Very long periods are rare. Ninety-seven percent of the loyalty spells are less than one year.

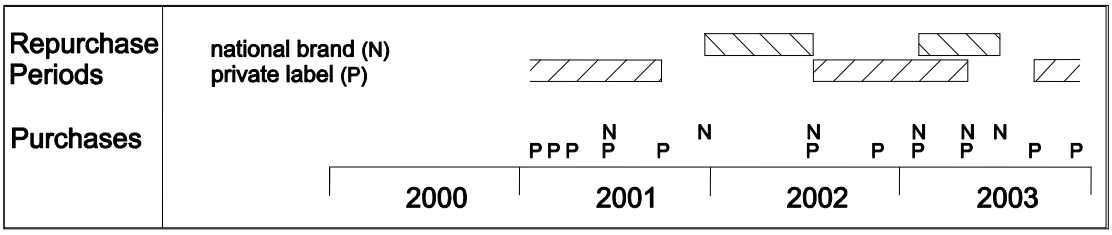

Figure 2. Illustration of the definition of repurchase periods

Statistical analysis of the repurchase periods observed must account for their nature as duration data; their distribution cannot be assumed to be normal, and for many of the periods considered, we do not know their total length because the beginning or the end, or both, could not be observed in the survey period (censored observations). Hence, inference on the distribution of

[2] We consider periods of repeated choice of the same brand type as a reasonable proxy for periods of brand loyalty. An alternative definition has been tried referring to terms (of *a* days) in which at least *n* pizzas of the respective brand type were bought, conditional that these purchases represented at least *p* percent of all frozen pizzas purchased during that term. A period of loyalty is then understood as the time span incorporating consecutive terms of loyalty to the same brand type. The definition we choose is superior in terms of clarity.

[3] Households that purchased an average of less than 6 frozen pizzas per quarter during their presence in the panel are excluded from the analysis. This avoids misinterpreting very long periods with no intermittent purchases as periods of particular loyalty.

these duration data based on standard measures of location and distribution (means, percentiles, variance, etc.), as well as regressions using duration as an endogenous variable would yield biased results (e.g., Cleves et al. 2004). Therefore, we use hazard analysis techniques (survival analysis), which are appropriate in this context.[4]

In particular, we estimate hazard functions $h(t,\boldsymbol{x})$, which express the instantaneous probability of a repurchase period ending after a duration of t, conditional on having lasted for that duration. This conditional probability (hazard rate) is modelled as depending on duration t and a number of household characteristics $\boldsymbol{x}$, i.e. the covariates. From the information embedded in the hazard function, we derive expected values of the duration of repurchase periods as well as time- (and covariate-) dependent probabilities of switching between brand type. The hazard function provides a convenient definition of duration dependence. In our context we speak of positive duration dependence if $h(t,\boldsymbol{x})$ increases with the length of the repurchase period ($\partial h(t,\mathbf{x})/\partial t > 0$) and vice versa. For the hazard function $h(t,\boldsymbol{x})$ we choose the popular specification of

$$1)\quad h(t,\mathbf{x}) = h_0(t)\exp(\mathbf{x}\beta_{\neq 0}),$$

where $h_0(t)$ represents the baseline hazard, i.e. the hazard rate after duration t with the covariates x_j at a reference level, usually their mean.[5] We speak of a proportional hazard model because levels of x carry over to $h()$ proportionally, i.e. independent of t. For the functional form of the baseline hazard, we use the Weibull specification:

$$2)\quad h_0(t) = pe^{\beta_0}t^{p-1}.$$

The shape parameter p indicates duration dependence: A value below (above / equal to) unity indicates negative duration dependence (positive / no duration dependence). The baseline hazard is jointly determined by p and the location parameter β_0.[6]

From the information available in the data source, we have selected six household characteristics x_i to test their impact on repurchase behaviour of a brand type (Table 1).[7]

[4] For an exhaustive description of the methodology, see Kalbfleisch and Prentice (2002).
[5] This means that non-binary covariates are scaled to have a mean of zero.
[6] The Weibull specification restricts $h(t,\boldsymbol{x})$ to follow a path over the total range of t, which is uniformly determined by p and β. In particular, the specification cannot reflect any change from positive to negative duration dependence or vice versa. We find this restriction to be justifiable for our data through comparison with a less restrictive (semiparametric) Cox proportional hazard specification. Visual inspection of the Cox functions plots indicate that the hazards are almost perfectly monotonous (decreasing). Moreover, the covariates' parameters do not differ much between the Cox and Weibull specifications. Approximating a Cox model by the parametric Weibull specification yields a gain in efficiency (provided the distributional assumptions are justified) and facilitates the prediction of durations and hazard rates for the entire domain of t.
[7] Since cardinally-scaled characteristics like net income or the age of the main earner are coded as categories in the data set and not all of these categories have the same width, their use as cardinal variables is inappropriate. We have recoded the strata to binary variables to achieve an appropriate yet parsimonious specification.

Table 1. Household characteristics used as explanatory variables

Characteristic	Variable	Type	Definition
Household size	HSIZE	integer	Number of household members
Per capita monthly net household income	LOWINC	binary	Under 500€ per household member
Age of main earner	YOUNG	binary	Under 30 years
Family Type	FAM	binary	Family with adolescent children
	YSINGLE	binary	Household of young single person
Frequency of pizza consumption	PPPQ	continuous	Number of pizzas (packaging units) purchased per quarter

The relative preference for a highly processed convenience product such as frozen pizza is likely dependent upon economies of scale in consumption and on home time available. Hence, the household size (HSIZE) and three variables specifying a household's position in the family life cycle have been included as explanatory variables: the binary variable YOUNG indicates a main earner under 30 years of age, while FAM and YSINGLE indicate specific family types. These variables are used to test the influence of specific household characteristics on repurchase behaviour. Per capita income (LOWINC) is considered a potential determinant of the choice between national brands and the usually lower-priced private labels (e.g. Dölle 2001). Finally, a behavioural characteristic likely to be relevant for brand choice is the frequency of purchase of frozen pizza (PPPQ), which in the sample ranges between the set minimum of six and 80 pizzas per quarter, with a mean of 12. Baltas and Doyle (1998) have found the purchase frequency of tea to be related with the probability of choice of private labels.

We estimate a hazard model using data for purchases of frozen pizza. In order to test for behavioural differences between national brands (Dr. Oetker and Wagner) and private labels we introduce a dummy variable for private labels (RETAIL) and interaction terms of this dummy with the household characteristics, respectively.[8] Our choice of a proportional hazard model implies that hazards at all durations are shifted proportionally by changes in these variables.

Results and Discussion

The overall explanatory power of the model is confirmed by likelihood ratio tests. The null hypothesis of a constant-only alternative is rejected at the 0.1 percent significance level. Results of individual parameters are presented in Table 2(*a*). The deviation of the parameter p from unity signals the extent of duration dependence, which is significantly negative (0.723 1 = 0.277).[9] We can hence establish negative duration dependence as our first central result: ending a repurchase period, which means switching to the other brand type, becomes less likely the longer a consumer patronizes a brand. Consumers who are loyal to a brand for a long time are likely satisfied with their choice and do not expect any advantage by switching to another brand.

[8] For many households the sample contains more than one repurchase spell. The similarity of effects shared by spells for identical households has to be assumed. To infer from this information, we applied a ‚shared frailty' specification (StataCorp 2007: 326).

[9] The parameter *p* and its standard error is computed from the coefficient of ln(p) and its distribution.

Table 2. Estimation Results

Number of observations (purchases) = 31457

Parameter estimates (a)

Variable	**parameter**	**Standard error**	**z**	**P>|z|**
Constant	**-3.115**	0.035	-88.200	0.000
ln(p)	**-0.324**	0.011	-30.080	0.000
p (derived value)	**0.723**	0.008		
RETAIL	**-0.098**	0.038	-2.540	0.011
Characteristics variables				
HSIZE*RETAIL	**-0.076**	0.025	-3.010	0.003
FAM	-0.058	0.045	-1.290	0.198
SINGLE*RETAIL	-0.194	0.163	-1.190	0.232
LOWINC	-0.053	0.081	-0.660	0.509
LOWINC*RETAIL	-0.132	0.123	-1.070	0.284
YOUNG*RETAIL	**0.236**	0.097	2.440	0.015
PPPQ	**0.017**	0.003	5.050	0.000
PPPQ*RETAIL	**0.022**	0.006	3.730	0.000

Predicted hazard function after alternative durations (b)

	National labels	**Retail labels**
One day	0.0321	0.0291
One week	0.0187	0.0170
One month	0.0128	0.0116
Three months	0.0094	0.0085
Six months	0.0078	0.0071
One year	0.0063	0.0057

Predicted durations (c)

Standard deviations in parentheses

	National labels	**Retail labels**
Median of predicted durations	44	53
	(6.2)	(18.2)
Arithmetic mean of predicted durations	89	107
	(12.6)	(37.0)

Source: Own computations based on GFK Consumer Scan data

Note: Coefficients in bold types are significantly different from zero (from one in the case of *p*) at the 10% level.

From the parameter *p* (and the constant) we can compute the baseline hazard function which indicates the probability that a repurchase period ends after a given duration t conditional on having lasted up to that duration. It refers to baseline or reference conditions in respect of the characteristics variables (covariates) included in the model: the sample mean for the numeric variables (HSIZE and PPPQ) and the value zero for the binary variables (RETAIL, LOWINC, YOUNG, FAM, and YSINGLE). The solid line in Figure 3 shows the baseline hazard function for durations from 1 to 400 days; the baseline hazard function, i.e. the conditional probability of a reference household purchasing national brand pizza to switch to a retail label. The small absolute values are due to the brevity of the time-unit (day) relative to the typical length of repurchase period.

For the continuous variables (HSIZE, PPPQ) coefficients refer to a one-unit change of the variable. The coefficients of the binary variables (RETAIL, LOWINC, YOUNG, FAM, YSINGLE) represent factors shifting the hazard for the particular group relative to the

households/purchases not belonging to this group, i.e. the baseline. For example, the coefficient value of 0.098 for RETAIL indicates that for consumers of private label pizza (RETAIL=1) the hazard of switching to the other brand type is (for any duration) nearly ten percent lower than for households patronising national brands (RETAIL=0).[10] While the statistical significance of the coefficient of RETAIL indicates that the inclination to brand type switching is weaker among private label consumers than among national brand consumers, the difference in hazards is quite small (compare the hazards for selected durations in (Table 2(*b*). As far as we can interpret repurchase behaviour as an indicator of loyalty we can conclude with regard to our research objective that brand type loyalty is very similar for private labels and national brands.

The dashed line in Figure 3 shows the hazard function with all covariates at their baseline value except for RETAIL which takes the value 1 for private labels. We see that for private labels the hazards of brand switching are only slightly lower than for national brands. We can conclude that suppliers of national brand pizzas and private label pizzas can expect their customers to show a similar degree of brand loyalty. Suppliers of private labels have obviously achieved to generate a consumer perception of quality or value-for-money with regard to their product that is similar to the one that national brand consumers have for national brand pizzas.

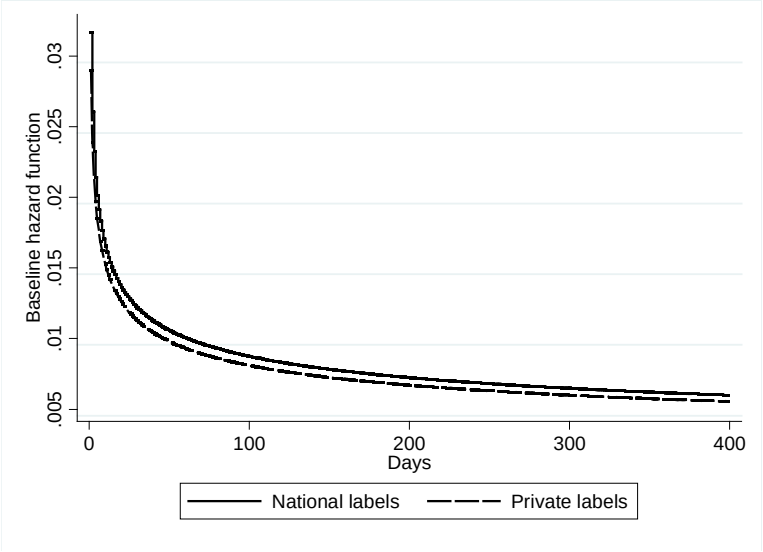

Figure 3. Baseline Hazard Function

Table 2(*c*) lists measures of the expected duration of repurchase periods. The figures, carrying the same parametric information as the hazard function, indicate the approximate length of typical periods of loyalty to a brand type and is computed as median/arithmetic mean (over all spells) of durations predicted by the estimated hazard functions. (Arithmetic means are roughly twice the value of the median because very few long periods exert a strong positive bias. Hence, these means are not values to be typically encountered in the sample.) The expected duration of repurchase periods (median) is 53 days for the private labels and 44 days for the national brands, which reflects the same ranking as the hazard functions. Again we find that median (and mean) predicted durations are shorter for national brands than for private labels.

[10] To be exact, in the case of our proportional specification, the hazard ratio hr_i for covariate x_i is $hr_i = d\ln h(x,\beta)/dx_i = \exp(\beta_i)$ and the percentage change in effect of x_i is $(1- hr_i)*100$. (1-exp(-0.098)*100=-9.32 %).

The estimated coefficients of the household characteristics in Table 2 reflect the impact of household characteristics on the repeated purchase behaviour. Coefficients of interaction terms establish whether the characteristics affect repurchase behaviour of national brand and private label customers differently. We can say that the higher a positive (or the less negative) coefficient is, the higher the tendency to switch brands and the lower the loyalty to the brand type originally patronized.

Focusing on the significant findings, we first consider the interaction term with RETAIL for the household size (HSIZE). Larger households consuming private label pizzas are more likely to repeat their choices. This may be connected to the difference in the average price per 350g unit of frozen pizza which was (converted into Euro) 1.17€ for private labels and 2.04€ for the national brands Dr. Oetker and Wagner. If private label customers perceive a monetary advantage, the budget effect is more pronounced due to the larger quantities consumed to meet the household needs. Our result with regard to HSIZE is consistent with what Baltas and Doyle (1998) found for British tea consumers: larger households have higher repurchase tendencies toward private labels than do smaller households.

For the dummy variable YOUNG we find that private label consumers with household heads under 30 years of age have a considerably higher tendency to switch the brand type than other households.

For the variables indicating specific household types as well as per capita income the estimated coefficients are not significant. With respect to the income variable this is contrary to results of other studies that have found significant income effects on the choice between national brands and private labels. In our estimation such effects may in part be hidden by collinearties between the income dummy variable LOWINC and other household characteristics.

The only behavioral household characteristic considered here is the frequency of frozen pizza purchases (PPPQ). Its impact on repurchase behavior as its interaction term with RETAIL is significant. Each additional pizza per quarter increases the hazard of ending a repurchase period on any given day by about two percent (parameter 0.017) for national brand consumers and by about four percent (1.017*1.022) for private label consumers. Frequent buyers are less loyal. A high purchase frequency reduces the tendency to repurchase brands significantly more for private labels than for national brands.

This last finding suggests implications for management. Particularly for private labels, high frequency buying bears the risk of losing former customers. Product managers can reduce this frequency of choices by offering larger packaging units containing two or more frozen pizzas. The pervasiveness of such packs for private label pizzas indicates attempts of private label owners to retain customers in a highly competitive market.

Summary and Outlook

The increase of private labels in the food market over the last two decades and retailers' high expenditures for establishing them raise some questions. The first question is whether retailers are able to commit customers to their own brands, i.e., whether consumers repurchase retail

branded products. The second question is whether consumers consider private labels to be a "real" brand, i.e., do they compare private labels with strong national brands. In order to test our research questions, we use a panel data analysis of the frozen pizza purchases of 14,000 households in Germany over a four-year period. We use the length of repurchase periods as an indicator of loyalty. Thereby, we focus on repurchase periods as an indicator of brand loyalty because repurchase behaviour is a necessary condition for being a loyal consumer.

As an important extension of previous models we include the dynamic aspect of repurchase behaviour. In addition, we consider household characteristics. This facilitates a classification between specific household segments and the influence of their characteristics on repurchase behaviour.

In sum, we conclude that the endeavours of retailers to establish their brands are successful. Retailers are able to commit customers to their own brands to basically the same degree as national brand suppliers can. We find that in general differences in the repurchase behaviour between national brands and private labels are small though statistically significant. We recommend that retailers' marketing strategies address their target groups more directly. If certain products are known to be typically purchased by certain household types, the knowledge of type-specific differences in repurchase or brand switching tendencies can help to identify successful marketing strategies and pricing considerations.

Considering the term brand loyalty as a source of profit and growth is it perhaps not enough to analyse the length of repurchase periods only? As Jacoby (1971) suggests, repurchase is a necessary condition of brand loyalty. But as defined in the marketing literature, the term brand loyalty is not synonymous with repurchase behaviour. Some researchers (e.g. Day 1969; Jacoby 1971, Jacoby and Kyner 1973, Jacoby and Chestnut 1978; Dick and Basu 1994; Oliver 1997; Oliver 1999) emphasize that brand loyalty is only one source of repeated purchasing behaviour. It is important to consider consumers' purchasing patterns as well as their underlying attitudes. Thus, brand loyalty includes both a behavioural (purchase) component, which results in repeated purchases, and an attitudinal component, which results in a dispositional commitment to a brand and associates a unique value to it. However, this attitudinal component of brand loyalty cannot be observed directly by using panel data. This might be a challenge for further research. Our preliminary thoughts on this subject show that analysing cross-buying effects or consumers' tolerance towards price increases could be a possibility for future research. For example, if a repeat buyer of a particular pizza brand is found to have a significant inclination to becoming a buyer of frozen vegetables of the same brand, this could be interpreted as an indicator of brand loyalty. Likewise, a consumer who repeatedly buys the same brand even though the price has increased and/or the prices of other alternative brands have decreased, can probably be regarded as a loyal consumer as well.

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Trade-offs between Shopping Bags Made of Non-degradable Plastics and Other Materials, Using Latent Class Analysis: The Case of Tianjin, China

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Abstract

Tianjin, China's fifth largest city, suffers from severe environmental problems due to a high prevalence of plastic bag usage. This problem occurs in China's other major cities as well. On June 1, 2008, a law requiring large retail stores in China to charge for bags was enacted in an attempt to curtail plastic bag consumption. As a result, many plastic bag manufacturing plants were closed. However, because of the wide-spread usage of plastic bags, they are still being manufactured and consumed. It is possible that the current plastic bag cost of 0.3 CNY is too low to change customers' consumptive behavior. The purpose of this study is to explore people's attitudes regarding the substitution of plastic bags with bags made from alternative materials, and their willingness to pay for such substitutes. This study used a conjoint choice experiment to measure Tianjin residents' preferences for degradable and non-plastic materials bags. The results show that most people do not like non-degradable plastic bags and would use bags made of other materials if they were sold at a reasonable price. Based on the latent class and socio-demographic segmentation results, there are preference distinctions among age groups. Also, there are niche markets for paper, cloth, and degradable plastic bags where costs are of a lesser concern in consumer decisions. Manufacturers can use this information to more efficiently manufacture appropriate bags for different markets. This will help maximize revenue while continuing to meet demands.

Keywords: white pollution, plastic bag ban, conjoint choice experiment, willingness to pay, latent class analysis, China, degradable plastics, cloth, paper

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Introduction

Pollution from the over-use of plastic bags is extremely damaging to the environment. These bags are costly to recycle, pose a danger to wildlife and take over 300 years to photo-degrade in a landfill. Plastic bags first came into use in the developed world during the 1980s. Now a worldwide problem, they have become very popular with consumers in developing countries, as they are cheap, strong, lightweight, and functional. Users perceive them as a clean way of carrying food and other items (Worldjute.com). It has been estimated that around 500 billion plastic bags are used worldwide every year. Only about one in 200 of these is recycled. Discarded plastic bags produce numerous harmful effects. They release toxins into the environment, stay in landfills for hundreds of years while breaking down, and they get into our food supply when animals ingest the plastics. Furthermore, the toxic chemical ingredients needed to make plastic produce pollution and the energy needed to manufacture and transport the disposable bags creates additional greenhouse gas emissions.

As knowledge of environmental pollution grows, prohibiting or discouraging the use of plastic bags has become a global imperative. As early as 1994, a number of countries began introducing legislation to ban the use of plastic bags. France unanimously passed a law in 2005 to ban all non-biodegradable plastic bags by 2010 (Environment Daily 1962, 2008). In 2006, Italy also passed a similar law banning the use of non-biodegradable bags. In densely populated Hong Kong, the government promoted a hugely successful 'No Plastic Bag Day' campaign in 2006. Participating retailers recorded an over 40% decrease in plastic bag usage (China Daily 2006). On March 28, 2007, San Francisco's City Council became the first U.S. city to ban the use of plastic bags at large supermarkets (Nzherald.co.nz. 2007).

In China, home to one-fifth of the world's population and a fast growing economy, the consumption of plastic bags per capita is expected to grow exponentially in coming years. Unless China begins to curtail its widespread consumption or finds alternative to plastic bags, the worldwide environmental implications could be devastating. There are a number of remedial measures, which could be taken to offset consumption of plastic shopping bags. These include: reusing plastic bags, choosing biodegradable alternatives, or using reusable cloth or paper bags (Googobits.com 2009).

Background

Thin plastic bags are commonly used in China. In 2007, China's supermarkets reported consumption of 50 billion plastic bags (China Packaging Industry 2008). They are so common that the sight of plastic bags everywhere has led to the creation of the phrase *bai se wu ran,* or "white pollution", due to the most common color for plastic bags. Plastic bags are made from petroleum, a non-renewable resource. According to a survey by the China Plastics Processing Industry Association, manufacturing one billion super-thin sacks per day for one year requires 37 million barrels of oil (Zaleski 2008). To prevent this white pollution, the Chinese government has launched a campaign to slow down demand for plastic bags. Since June 1, 2008, China has banned the production of super-thin plastic bags (defined as less than 0.025 mm or 25 microns thick) and has banned supermarkets and larger retailers from giving out free plastic bags (Notice of the State Council on limiting production, sales and use of plastic bags, 2008). It is predicted

that the ban will effectively drop consumption by two-thirds (Sohu.com 2008). However, some experts argued that the prediction is far too optimistic because shoppers are still willing to pay for them at the current price of 0.3 Chinese Yuan (CNY) per bag. This is very cheap, considering that cloth bags can cost as much as 3.0 CNY. Additionally, the price demand for plastic bags is quite inelastic. According to Dr. Atiq Rahman, Director of the development think tank Bangladesh Center for Advanced Studies, "The trouble is [that] the plastic bag has become an integral part of life. We have learned [from Bangladesh's experience] that to say absolutely no to them is not an option. Most supermarkets and small shops now use paper bags, but there is still a demand for the very flimsy, thin plastic ones." (Vidal 2008). Experiences from Bangladesh and other countries show that charging for plastic bags and banning production might not totally stop the use of plastic bags. Furthermore, the ban also creates negative economic consequences. China's largest producer, Huaqiang Company, has already discontinued all manufacturing operations and closed down many small factories which produce plastic bags, resulting in the lay-off of many employees (SolveClimate.com 2008). Critics of banning plastic bags question whether substituting with bags made out of biodegradable or other materials will ever deliver net substantial environmental, social or economic benefits. However, perhaps with information on consumer willingness to pay for alternative-material bags, entrepreneurial bag manufacturers could be attracted to lessen the economic upset created by a ban on free plastic bags. Clearly, if 1.3 billion Chinese people continue to use plastic bags on a regular basis, there will be dire consequences on China's environment, as there already is in the major cities of Beijing, Shanghai, Guangzhou and Tianjin. Actions must be taken to reverse this destructive trend, before its impacts become irreversible.

Objectives

The objective of this study is to determine consumer preferences for shopping bags made from alternative materials and to determine the tradeoffs among the important purchasing attributes for the purchaser of these alternative-material bags. Specifically, these research objectives are: (1) to evaluate the attributes of shopping bags which are important to consumers, (2) to determine the socio-economic demographics which might affect their buying preferences, and, (3) to discuss the results and marketing implications. To accomplish the objectives, a survey was conducted to ascertain consumer preferences for bags made of alternative materials and to see which combination of price and other bag attributes are preferred by consumers. This information can assist the manufacturers in producing more environmentally acceptable, yet still profitable bags. To accomplish the objectives of the study, we: (1) developed a conjoint choice experiment survey to collect data on consumer preferences, (2) conducted the survey and collected data from several markets in Tianjin, (3) analyzed the data with latent class method and, (4) made conclusions and examine the implications.

Method

In this study, we used a Conjoint Choice Experiment (CCE) to find out Tianjin consumer preferences for different types of shopping bags. The following paragraphs summarize previous studies using CCE and describe how the design of the CCE was developed.

Conjoint Choice Experiment (CCE)

We used a conjoint choice experiment for this study. The CCE technique was initially developed by Louviere and Woodworth (Louviere and Woodworth 1983). As an empirical method, CCE originated in market research and transportation literature and has only relatively recently been applied to other areas, such as the environmental studies discipline (Hensher 1994). Since the mid-1990s CCE has been increasingly applied to various environmental problems. It has been used for valuating environmental amenities such as recreational moose hunting in Canada (Adamowiczet al., 1994; Boxall et al., 1996), woodland caribou habitat enhancement in Canada (Adamowicz, et al. 1996), preferences for deer stalking trips in Scotland (Bullock, et al., 1998), and remnant vegetation in Queensland (Blamey et al. 1999). A summary of environmental applications is given in Hanley, Mourato, and Wright (Hanley et al., 2001).

The CCE technique is based on the idea that any good can be described in terms of its attributes or characteristics, and levels of these attributes. In our case, the attributes of alternative materials shopping bags are: costs, materials used to make the bags, number of times a bag can be reused, and the length of time it takes a bag to degrade naturally in the environment. The potential impacts from changing these attributes might influence purchasing decisions. Using CCE can tell us which attributes are significant determinants of the values people utilize when purchasing shopping bags. This information also tells us their willingness to pay for bags made with alternative materials. With this information, bag manufacturers can decide whether it is profitable to make bags using alternative materials instead of plastic.

Why Choose the Conjoint Choice Experiment (CCE)?

This study was conducted through a survey of Tianjin residents (approximate population 10 million) in China using a conjoint choice experiment method to elicit willingness to pay for alternatives to plastic bags. A conjoint choice experiment approach directly asks for respondents' preferences based on a set of structured survey questions. The approach measures the value of environmental goods and services by asking about hypothetical scenarios and their valuations such as alternative bag materials and shorter times for a bag to degrade in nature.
A relatively new concept in environmental valuation, a conjoint choice experiment is an evolved form of the more traditional conjoint analysis introduced in the 1980's. While the traditional conjoint analysis presents all the choices to respondents at one time, in conjoint choice experiment models, respondents typically are asked to evaluate two profiles at a time with varying levels on each attribute. It then asks the respondent to pick the profile that they would most prefer from that set (Chan-Halbrendt et al. 2007).

Experimental Design of CCE

Table 1 shows the design stages of a CCE (Cattin and Wittink 1982; Green and Wind 1975; Halbrendt et al., 1991).

Table 1. Design and Estimation Stages for a Conjoint Choice Experiment

Stage	Description
1 Selection of attributes	Selection of relevant attributes related to purchasing shopping bags. This is done through expert interviews and literature review. The interviews also help to identify the possible environmental impacts (attribute outcomes) important to respondents associated with using bags made of different materials, as well as the monetary cost of the bag.
2 Assignment of attribute levels	After identifying the important attributes, the range of each attribute is determined through literature review and expert interviews. The levels should be realistic, practically achievable, and span the range over which we expect respondents to have preferences.
3 Choice of experimental design	Statistical design theory is used to combine the levels of the attributes into a number of alternative program profiles to be presented to respondents. Depending on how many choice sets and/or profiles are included in the experiment, one can have either complete or fractional factorial designs. In our case, we have a fractional factorial design to reduce the number of attribute level combinations while allowing the efficient estimation of the effects of the individual attributes ('main effects').
4 Construction of choice sets	Using a software program, the profiles identified by the experimental design are then paired and grouped into choice sets to be presented to respondents. In our study we used a program purchased from Sawtooth Software, Inc.
5 Method of collecting preference data	Choice of administering the survey either by face-to-face interviews or by mail surveying is dependant on the complexity of the topic and project budget. This study chose face-to-face interviews as this survey approach is better for enhancing respondents understanding.
6 Data estimation	Decide on the choice of the estimation method to achieve project objectives. One can use traditional logit analysis or latent class approach. In our study, we chose a latent class approach, as we believe this is a more appropriate estimation tool when dealing with people generally of heterogeneous backgrounds.

Literature reviews and interviews were conducted in order to identify the important attributes consumers consider when substituting plastic bags and the levels of those attributes. Literature

reviews involved reading papers in the relevant field and searching information on the Internet. In-depth interviews involved discussion with randomly selected residents. The first step of our CCE design was to find the product attributes and levels. Studies such as Tang et al., (Tang et al. 2003) and Wang and De (Wang and De 2008) have shown that attributes such as materials, costs, number of reuse times, degradable period and extent of damage to the environment are important factors for consumers when they make their shopping bag choices. After an extensive literature review and interviews, the four most important attributes selected were: (1) type of material used to make the shopping bags, (2) cost of a single, medium sized bag (which holds approximately 6 kilograms) (3) number of times the bag can be reused, and (4) how long it takes for the bag to degrade naturally in a landfill. The rationale for these attributes was as follows:

1. *Material*. Through the literature review (Tang et al., 2003) and direct observation in the city, we have decided on four types of material: non-degradable plastic, degradable plastic (distinguished from non-degradable bags by a logo), paper, and cloth.

2. *Cost.* Cost is a vital economic factor that often affects consumer decision making. When deciding on the levels of this attribute, the researchers collected the prices of plastic, paper, and cloth bags from many large supermarkets and retail stores. The average price per bag ranged from 0.3 to 3.0 CNY. Supermarkets in Tianjin currently charge 0.3 CNY for a medium-sized plastic bag. A cloth bag of comparable size costs 3.0 CNY, and a paper bag costs about 1.5 CNY. Thus, the levels used for this study are 0.3, 1.5 and 3 CNY per bag.

3. *Number of times a bag can be reused.* The levels of this attribute were determined by randomly interviewing 30 consumers in Tianjin city. Interviewers asked random consumers how many times they use each kind of bag (non-degradable and degradable plastics, cloth, and paper) before they throw it away, and the answers were mostly 1, 5 and 30 times. For this study, the levels selected were 1, 5, and 30 times.

4. *Degradation time for bag materials*. How long it takes a certain material to degrade was identified as an important environmental attribute through the literature review. Degradable plastics, paper and cloth degrade in the natural environment between 45 to 90 days (Tang et al. 2003). Non-degradable plastics take a much longer time to degrade. Therefore, the chosen levels for this attribute were: 0.125, 0.25 and 100 years (representing long term persistence).

Table 2. Attributes and Their Levels

Attributes	**Levels**			
Material	Non-degradable plastics	Degradable plastics	Cloth	Paper
Cost/bag (CNY)	0.3	1.5	3	
Times to reuse	1	5	30	
Degradation (year)	0.125 (1.5 months)	0.25 (3 months)	100 years	

The third and fourth stages of designing the CCE involve choice of experimental design and construction of interview questions to be presented to survey respondents. Program profiles are constructed by selecting one level from each attribute and combining across all attributes. In this study, there are four attributes, of which one has four levels (bag material), and the rest have three levels each. Thus, the number of possible profiles totaled 4x3x3x3 or 108. A complete factorial design would use all the 108 profiles, which is undesirably difficult for respondents to evaluate. Instead, a fractional factorial design was utilized. A fractional factorial design is a sample of attribute levels selected from a full factorial design without losing information, to effectively test the effects of the attributes on respondent's preference (Halbrendt et al. 2007). The most commonly used method of constructing fractional factorial design in conjoint measurement is the orthogonal array. Orthogonal arrays build on Graeco-Latin squares by developing highly fractionated designs in which the scenario profiles are selected so that the independent contributions of all main effects are balanced, assuming negligible interactions (Green and Wind 1975). This study constructed different profiles based on degrees of freedom requirements to estimate all of the main effects within the orthogonal design (Louviere 2000). From all possible profiles, pairs of profiles were randomly developed and separated into 7 sets with 12 pairs each using software developed by Sawtooth, Inc. Having only 12 pairs to evaluate from ensure the duration of the surveying exercise does not adversely impact a respondent's responses.

For data collection, the designed experiment was carried out. All seven sets were administered in approximately equal proportion (i.e. each set to about 30 of the 205 respondents). Respondents were then presented with one set of 12 pairs of profiles from which to make their choices. The experiment requires respondents to choose one product profile from each pair. Table 3 shows an example of a pair of product profile scenarios from which the respondents chose.

Table 3. Example of a Pair of Product Profile Scenarios

Attributes	**Program A**	**Program B**
Material	Non-degradable plastics	Cloth
Cost/bag (CNY)	0.3	3.0
Number of Times to Reuse	5	10
Degradation Period (year)	100	0.25 (3 months)

Data Collection

Survey Location

Tianjin is a modern industrialized city typical of Chinese urban areas. International tourist influence is less than in other metropolitan cities such as Beijing and Shanghai. The survey was conducted mainly in supermarkets and vegetable and fruit markets, and respondents consisted of a random selection of Tianjin residents.

Table 4. Survey Locations and the Respective Sample Size

District, City of Tianjin	Survey Location	Sample size
Nankai	Renrenle Supermarket	30
	Good Harvest Supermarket	30
	Carrefour Supermarket	30
Hebei	Vanguard Supermarket	28
	Milan Supermarket	27
Heping	Vegetable Market	30
Hedong	Vegetable Market	30
Total		**205**

Sample Population

Two hundred and five surveys were completed during 11 days from June 10th to June 20th, 2008. Every fifth person was selected to conduct the face-to-face interview. As almost everyone has experience using a shopping bag and has basic knowledge of the different bag materials, it was not difficult to explain our experiment and administer the survey. Table 5 shows the socio-demographics of respondents as compared with the Census data of Tianjin residents. In the survey, about 60.5% of the respondents were female and 39.5% were male, whereas the general population Tianjin is 49.6% female and 50.4% male. The gender distribution of the respondents has more females and does not exactly match the demographic characteristics of Tianjin. There were also more young respondents in the sample. Generally, in China, women and younger people shop more than men and older people. The household income of respondents is somewhat similar to the household income of Tianjin residents. Forty-eight percent of the respondents have a monthly household income less than 3,000 CNY, thirty-one percent have a monthly household income between 3,000 to 5,000 CNY, and twenty percent of the respondents have a monthly household income over 5,000 CNY. In comparison to the educational background of Tianjin residents, the respondents have the following training: Proportions of respondents possessing an elementary school diploma (19.0%) and junior high school diploma (31.7%), matched the demographic characteristics of the Tianjin population, while more respondents had high school diplomas (48.8%) and less had a college degree or above (0.5%). Typically more educated people do less shopping for food and dry goods for daily consumption. Overall, the survey respondents are shoppers from different socio-demographic background and in most instances matched well with Tianjin residents' profiles, except that they are younger and more respondents have a high school education.

Table 5. Socio-demographics of Survey Respondents and Tianjin Residents.

		Survey Respondents (%)	Tianjin residents (%)
Gender	Female	60.5	49.6
	Male	39.5	50.4
Age*	16-29	41.9	25.4
	30-39	20.0	17.4
	40-49	17.1	21.8
	50 and over	21.0	35.4
Income	< ¥3，000	47.8	40.0
	≥¥ 3，000 to < ¥5，000	30.7	40.0
	≥¥ 5，000	21.5	20.0
Education	Elementary school diploma	19.0	21.9
	Junior high school diploma	31.7	37.7
	High school diploma	48.8	21.9
	College degree and above	0.50	14.1

*People under 16 were not interviewed because they are still in secondary school.
Source of Tianjin resident's data: Tianjin Census Book 2007 (ISBN 978-7-5037-5127-1/F 12427)

Sample Size

Based on an analysis of 21 CCE studies, Orme, (2006) concluded that increasing the number of choice sets for each respondent can obtain statistical gains similar to a greater number of respondents. Thus, Orme (2006) recommends that a general sample size range from 150 to 1,200 respondents. This study is based upon 205 surveys, which are within the range recommended by Orme's study, and each respondent was provided with 12 choice sets from which to choose.

Survey Instrument

The survey questionnaire consisted of two sections. Section one was the set of 12 pairs of shopping bag profiles from which respondents choose. Section two consisted of questions

regarding the respondents' socio-demographic and economic background such as age, income, education and other characteristics. Section one data provided the attribute-specific preferences. The data was analyzed using latent class analysis software Latent Gold Choice, Version 4.0 developed by Statistical Innovations Inc.

Survey Technique

Data were collected using face-to-face interviews. To establish a minimum level of knowledge on the issue prior to conducting the survey, a brief description of the law banning plastic bags and its potential impacts was read to every respondent regardless of her/his knowledge of the law and its environmental impacts. Each respondent was then given 12 pairs of product profiles with differing levels of attributes and asked to select one from each pair. The response rate for the survey was 80%.

Conjoint Choice Model Using Latent Class Analysis (LCA) Approach

Conjoint choice method using latent class analysis is an improvement on the traditional (i.e. one class) aggregated model. The standard aggregate model generally suffers from violations of the independence of irrelevant alternatives (IIA) problem, which distorts the predictions of market niches. Latent classes account for the different segments with different utility preferences and IIA holds true within each segment. This resolves the problem and improves market niche predictions. (Vermunt and Magidson 2000).

LCA is used to evaluate respondent choice behavior by capturing both observable attributes of choice and unobservable factors found in the heterogeneity of individuals' behavior (Greene and Hensher 2003; Milon and Scrogin 2006). In other words, respondents are placed into distinct classes (groups) based on their choices when answering the conjoint choice experiment questions. In LCA studies, the probability of making a specific choice among a pair of product profiles is based on the perceived value of product attributes, and covariates of respondents (such as respondent's age and income) (McFadden 1974). The value respondents placed on product attributes and respondents' socio-demographic factors were major factors evaluated in this study. In a conditional logit model, the probability (Pni) that individual n chooses profile i can be represented by the following equation (McFadden 1974):

$$(1) \qquad P_{ni} = \frac{\exp(\eta X_{ni})}{\sum_{h=1}^{I} \exp(\eta X_{nh})}$$

Where η denotes a scale parameter, usually normalized as 1.0. X_{ni} is the deterministic component that is assumed to be a linear function of explanatory variables. Equation (1) can be represented as equation (2) for LCA:

$$(2) \qquad P_{ni} = \frac{\exp(\eta\beta Z_{ni})}{\sum_{h=1}^{I} \exp(\eta\beta Z_{nh})}$$

Where Z_{ni} are explanatory variables of X_{ni}, including a profile-specific constant, product attribute of profile *i*, and socio-demographic factors of respondent *n*. β is a vector of estimated parameter coefficients.

In a latent class analysis, respondents are sorted into *M* classes (groups) in terms of individuals' choice of observable product attributes, and the unobservable heterogeneity among the respondents. The value of estimated parameter coefficient β is different from class to class because this parameter coefficient is expected to capture the unobservable heterogeneity among individuals (Greene and Hensher 2003). Then the choice probability of individual *n* belong to class *m* (m = 1, …, M) can be expressed as equation (3):

$$(3) \qquad P_{ni \mid m} = \frac{\exp\left(\eta_m \beta_m Z_{ni}\right)}{\sum_{h=1}^{I} \exp\left(\eta_m \beta_m Z_{nk}\right)}$$

Where η_m is the class-specific scale parameter and β_m is the class-specific estimated utility parameter.

The first step of the latent class analysis was to determine the optimal number of distinct classes for the dataset. Using the Bayesian Information Criterion (lowest BIC value for best results) first proposed by Schwartz (Schwartz 1978), it was shown that the five-class model was needed to provide the best grouping for the dataset.

Results

LCA Model Specification

The probability for individual *n* in class *m* choosing shopping bag *i* is measured by two types of characteristics: (1) shopping bag attributes, including cost (C), bag materials (M), number of reuse times (T) and time it takes to degrade naturally (D); and (2) individual socio-demographic factors, including age (A), gender (GE), household income (HI), education (ED) and household plastic bag consumption per week (CO). The preference model is specified in equation (4).

$$(4) \qquad P(i) = f(C, M, T, D, A, GE, HI, ED, CO)$$

where:

P (i) = Probability of choosing product profile A vs. B,

C = Shopping bag cost, taking values of 0.3 CNY, 1.5 CNY, or 3.0 CNY.

M = Types of materials, biodegradable plastics, degradable plastics, paper, and cloth.

T = Number of reuse times, taking values of 1, 5 and 30.

D = Time it takes for the material to naturally degrade, taking the values of 1.5 month, 3 months, and 100 years.

A = Age group: 16 to 18, 19 to 29, 30 to 39, 40 to 49, 50 and above.

GE = Gender: Male or Female.

HI = Household income group (per month) : <3,000 CNY, 3,000 to 5,000 CNY, and > 5,000 CNY.

ED = Educational attainment group: elementary school diploma, junior high school diploma, high school diploma, bachelor degree and above.

CO = Plastic bag consumption per week, per household: <10, 10 to 20, and >20.

Latent Class Analysis

The results in Table 6 show the estimated parameters, signs and their significance levels for each class. Of the four attributes shown, the significant attributes that determined the bag choice for

Table 6. Parameter Estimates of the Five Classes

Attributes	Class 1	Class 2	Class 3	Class 4	Class 5
Material					
Cloth	0.1483	-0.0064	1.3825**	0.4491*	-0.0624
Degradable plastics	0.2626**	0.6057**	0.0947	0.0918	-1.1506
Non-degradable plastics	-0.2565*	-0.7898**	-2.9304**	-0.9790**	-0.9627
Paper	-0.1544	0.1905	1.4533**	0.4381	2.1756**
Cost	-0.0971*	-0.1378	-0.1642	-0.6943**	-2.8350**
Reuse Times	0.0016	0.0442**	0.0100	0.1278**	0.0470*
Degradation	-0.0040**	-0.0445**	-0.0120**	-0.0117**	-0.0131

* significant at 0.05 level, **significant at 0.01 level.

Class 1 are degradable plastics (+ sign) and non-degradable plastics (-), cost (-) and degradation period (-). Therefore, Class 1 respondents prefer bags made of degradable material, lower cost, and less time for the material to degrade naturally. These signs are expected and significant at the 0.05 or 0.01 levels. For Class 2, the significant attributes found in this group are degradable (+) and non-degradable plastics (-), reuse times (+), and degradation period (-). Again, the signs are expected and they are all significant at the 0.01 level. Cost has the expected negative correlation in this class, but was not significant. Class 2 respondents prefer degradable plastics and bags that

can be used many times, and do not prefer non-degradable plastic bags that take a long time to degrade. Cost and bags made of either cloth or paper are not important for this group. For Class 3, the significant attributes are cloth (+), non-degradable plastics (-), paper (+), and time it takes to degrade (-). These parameters are all significant at the 0.05 level. In Class 4, all parameters except for degradable plastics and paper are significant and have the expected signs. Class 5 respondents do not prefer high cost (-). They prefer paper (+), and higher number of times the bag can be reused (+). These parameters are significant at the 0.05 or 0.01 level.

A relative attribute importance (RI) test for all the attributes was calculated to determine their rankings within each class (Table 7). Calculating the relative importance of different program attributes is a way to examine the weight the public places on each attribute. In this case, the RI of the four program attributes, Cost (C), Type of Material (M), Number of Reuse Times (T), and Time it takes to Degrade (D), was examined for each class. The methodology of estimating the RI is detailed in the article by Halbrendt et al (1995).

Denote *i* as an attribute, and the relative importance of attribute *i* (RI_i) is measured by the ratio of the range of utility change estimates of different levels of the attribute *i* (UR_i) over the sum of such ranges for all attributes of the product $\sum UR_i$

$$RI_i = 100 \times \frac{UR_i}{\sum_{i=1}^{n} UR_i}$$

where, RI_i is the relative importance of attribute i, UR_i is the utility range of attribute i.

Table 7. Relative Importance of Each Class in Percent and Significant Socio-demographics

Program Attributes	Class 1	Class 2	Class 3	Class 4	Class 5
Material	42.29%	18.62%	69.36%	17.46%	24.36%
Cost	21.35%	4.97%	7.02%	22.91%	56.05%
Times	3.67%	17.10%	4.6%	45.32%	9.98%
Degradation	32.69%	59.31%	19.02%	14.31%	9.61%
Significant Socio-demographics	All ages except 40-49	Ages 16-18	Not significant	Ages 40-49	Not significant
% of Respondents	30.30	26.60	19.10	16.24	7.76

Respondents in the same class share similar utility, however, each class put different weights on each attribute. In order to find out the respondent characteristics of each class, we evaluated the significant socio-demographic information according to the classes. The only significant demographic variable is age, which is so for three out of the five classes. This signifies that age has a large influence on consumer preferences for shopping bag attributes. Below is the summary of the results of each class by attribute importance and age.

Class 1 is the largest group with 30.30% of the respondents. Respondents in this group are less likely to be between ages of 40-49. This is the *'degradable plastics'* group. They prefer degradable plastic bags, favoring materials (42.29% relative importance), which degrade quickly and are low cost (21.35%).

Class 2 is the environmentally conscious, *'idealist'* and younger age group, with 26.59% of the respondents. The respondents from this class mainly come from residents aged between16-18 and they place a significant weight on how long it takes for the bags to degrade naturally in a landfill (59.31% relative importance) with little regard to cost (4.97%).

Class 3 places the type of material as the most important decision attribute, with 19.10% of the respondents. Respondents in this class place about 70% of the weight on the type of material used to make the bags. They prefer paper and cloth bags and are generally less concerned with the number of times the bags can be reused or the cost of the bag. This is the *'no plastics'* group.

Class 4 has 16.24% of the respondents. Respondents in this class are between ages 40-49. They are the *'practical'* consumption group who care much about the number of times the bags can be reused (45.32% relative importance). They also place importance on the cost (22.91%). The consumers in this group generally are the principal wage earners in their families. This group shops frequently and prefers cloth bags, which can be reused numerous times.

Class 5 is the *'cost conscious'* group, with 7.76% of respondents. Cost is the most important attribute of their choice (56.05% relative importance), followed by the type of material used to make the bags (24.36%). They prefer paper bags and care less about the degradation time (9.61%) and reuse times (9.98%) of the bags.

Valuation of Alternative Materials Used to Make Environmentally Friendly Bags using Expenditure Equivalent Index (EEI)

One of the purposes of this study is to examine respondents' willingness to pay for alternative materials, which would have environmental and economic implications. Holding other attributes and their levels constant while independently changing the significant bag materials for each class, the expenditure equivalent index (EEI) of this attribute can be estimated. EEI is used to measure the change in price corresponding to the change in product attribute, which in this study is the bag material (Payson, 1994).

This study uses equation (5), which was developed by Payson (1994), to calculate the EEI of alternative materials for the five classes.

$$EEI_j = 1 - \frac{\sum_{j=1}^{J} \beta_j B_j}{\theta C} \quad (5)$$

Where, β_j is the estimated parameter for the attribute j, B_j is the change of the levels in the attribute j, θ is the estimated parameter for cost, and C is the base level of cost. In this case, the base level of cost is 0.3 CNY, which is the cost of non-degradable plastic bags. Using the baseline as a comparison, the EEI shows the proportional changes in respondents' average

willingness to pay (WTP). Thus, a respondent's WTP for alternative materials, which have corresponding environmental implications, can be calculated by multiplying the EEI with base cost of 0.30 CNY. The results are presented in Table 8.

Table 8. WTP for Shopping Bags Made with Alternative Materials to Non-degradable Plastics

Attributes	**Class 1**		**Class 2**		**Class 3**		**Class 4**		**Class 5**	
	EEI	*WTP*	*EEI*	*WTP*	*EEI*	*WTP*	*EEI*	*WTP*	*EEI*	*WTP*
Non-Degradable Plastics (Base case)	1.00	0.30	1.00	0.30	1.00	0.30	1.00	0.30	1.00	0.30
Degradable Plastics	10.01	3.00	15.65	4.70	--	--	--	--	--	--
Paper	--	--	--	--	30.50	9.15	--	--	3.56	1.07
Cloth	--	--	--	--	29.07	8.72	3.16	0.95	--	--

Note. -- means that WTP was not calculated as the parameter for this material in the specific class was not significant.

The baseline bag used for EEI calculation is the current non-degradable plastic bag at 0.3 CNY per bag that can be reused 3 times, and takes a long time to degrade. The table shows that Class 1 and Class 2 are willing to pay more for degradable plastic bags, Class 3 and Class 5 are willing pay more for paper bags, and Class 3 and Class 4 are willing to pay more for cloth bags. The table also shows that for degradable plastic bags, the range of additional WTP per bag is from 3.0 to 4.7 CNY. For cloth bags, the range of WTP is from 0.95 to 8.72 CNY, and for paper the WTP range is from 1.07 to 9.15 CNY. The WTP range is largest for paper, followed by cloth and then degradable plastics, which has a much smaller range. Class 3, the *'no plastics'* group, stands out as the group of respondents that are willing to pay a lot for cloth and paper bags. Since the degradable plastics material is not significant in this class, it be can considered that respondents in this class do not care for plastics whether they are degradable or not. Also, it appears that certain consumers are willing to pay at least 1.0 CNY more for cloth or paper bags. Finally, degradable plastic bags are quite popular with a large segment of the population, as 56% of the respondents are willing to pay between 3.00 to 4.7 CNY more per bag. From these results, manufacturers can compare the WTP with their own production costs to decide which alternative materials would be best for producing an environmentally friendly bag, while also targeting the right market and continuing to make a profit.

Conclusions

The results of this study can provide crucial information to bag manufacturers and marketers, who should capitalize on the market information provided to maximize their revenues. Specifically, the age factor has a large influence on consumer preferences for the type of shopping bags Chinese consumers buy or use. As a producer and marketer of bags, it might be a good strategy to discover where the different age groups shop. Large modern shopping malls are often frequented by the younger generations, who, according to this study, clearly prefer biodegradable plastics. For a majority of the respondents, cost was negatively correlated, as was

expected. Thus, it is crucial for bag manufacturers who produce for large markets to be cost conscious, although it should be noted that some consumers might be willing to pay more if the bags are made of an environmentally friendly material. When thinking about producing bags using alternative materials, bag manufacturers should gauge the willingness to pay generated from this study against their production costs structure.

The implications of the results clearly emphasize the need to find a substitute for non-degradable plastic bags, particularly in light of the current ban on giving out free plastic bags at large retail stores. Due to the distinct characteristics of plastics (water-proof, easy to carry, etc), many people will choose degradable plastic bags as a replacement. For others, cloth or paper bags are a consideration. In fact, as cloth bags can be made from a wide range of patterns, it has become fashionable among young people to carry a self-designed cloth bag while shopping. Business people have also taken advantage of this trend by giving out free environmentally friendly shopping bags with advertisements and company logos on them. One thing is for sure: China's economy and environment will gain from using less fossil fuels and switching to other types of materials to manufacture bags.

Until now, China's plastic bag ban has been carried out for more than a year with success. According to a recent report from China Chain Store & Franchise Association, consumption of plastic bags in China's supermarkets has been dramatically reduced by 66% (WWW.NEWS.CN). However, the current ban excludes thin bags used in open markets in the cities. Furthermore, although most supermarkets are located in large cities, we must not forget plastic bag consumption in rural areas, which contain 55% of the Chinese population (National Bureau of Statistics of China). Rural residents believe it is practical to use plastic bags for holding poorly packaged or unpackaged items such as fresh produce and cooked foods. Therefore, to promote using less plastic bags throughout China, the government must focus on adopting different strategies for open and rural markets such as closing down illegal plastic bag manufacturers; educating rural residents about the harmful effects of using plastics and encouraging people to carry reusable containers when they shop for fresh produce.

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Strategic Decision Making Under Uncertainty: Innovation and New Technology Introduction during Volatile Times[1]

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Abstract

This case study outlines the strategic, marketing, and organizational issues facing the farm machinery and equipment division of Deere and Company as it tries to continue to grow. Deere Ag Division is considering the development of products in the information domain, which encompasses many opportunities, but faces uncertainties and challenges, as well.

Instructors can use this case to discuss uncertainties and tools to mitigate risk. Readers must think strategically about innovation and the uncertainties associated with each innovation project. Beyond a listing of uncertainties, readers are also challenged to think about ways to mitigate risk through the use of real options, an options portfolio, and organizational structure.

Keywords: Deere and Company, uncertainty, real option, organizational structure, option, risk, innovation

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IAMA Agribusiness Case 12.4

Introduction

The agricultural equipment division of Deere and Company was facing a number of challenges and opportunities in the spring of 2007. The fundamental challenge was to continue to improve their financial performance with an increased focus on growth without sacrificing profitability. Although improving profitability was hard to implement, the approach was well understood—lower cost, reduce assets or increase asset utilization, increase sales, and improve price realization by reducing discounts and similar price-cutting programs.

Growing the business was going to be more difficult. The U.S. farm machinery and equipment business was a relatively mature market. Clearly, there were opportunities for significant growth globally—Brazil, Argentina, the countries of the former Soviet Union, and eventually China and India provided significant potential. Furthermore, Deere had been quite successful in growing its non-traditional ag business and its consumer products segment, which focuses on products such as small tractors, lawn mowers, golf course equipment, and other consumer products and tools. However, Deere Ag Division was responsible for the growth strategy in the U.S. farm machinery and equipment business, a much tougher market to grow given that cultivated acreage was not increasing and sales were cyclical and highly dependent on farmers' incomes. But, CEO Robert Lane had not let the division off the hook. Growing the agricultural business in the United States was also important, and that required continued commitment to innovation and new product introductions. Lane challenged the team to bring new products and services to market that would meet Operating Return on Assets (OROA) and Shareholder Value Added (SVA) goals, as well as grow the division at a rate almost twice the industry growth rate of the past 20 years.

Deere was known in the farm equipment industry as an innovator with a constant stream of new products in power, tillage, planting, and harvesting equipment. Many of the most successful innovations of the past couple of decades were primarily product enhancements during a period of reduced labor use and rapid mechanization in the farming sector. The challenge going forward was how to grow the farm machinery and equipment business in a period of increasing competitive pressure, a relatively mature U.S. agricultural market, high market uncertainty (ethanol, farm bill, gas prices), high technological uncertainty (GPS), and shortened cycle time in the innovation process because of market and competitive pressures. Despite the challenges, the Ag Division management team had a number of alternatives that it could pursue, actually too many for its budget. Consequently, the team needed to develop and implement a systematic process for assessing each innovation's potential and to use that process to allocate financial and personnel resources to the highest payoff innovations that would meet corporate growth-rate goals and yet mitigate the aforementioned uncertainty.

Deere's History: A Commitment to Quality and Innovation

The legendary agribusiness Deere and Company was founded in 1837 by John Deere, a Vermont blacksmith who, a year earlier, had created an innovative design for self-scouring plows for the Midwest prairie soil. More than a century later, Deere's "leaping deer" logo is known and trusted universally in the marketplace and continues to symbolize innovative engineering and rugged construction in agriculture equipment and tractors.

Continuous innovation and new product introductions are a result of a major commitment of resources to research and development (R&D) and new product commercialization. Deere's resource commitment to R&D is summarized in Table 1; commitments to R&D have consistently been strong compared to competitors. Exhibit A summarizes some of the major innovations and new product introductions during the past 50 years. Innovations have involved improvements in tractors, combines, implements, and sprayer machinery (sustaining innovations), and more recently, in some new information and electronic-based technology, such as global positioning systems (GPS) guidance products.

Table 1. Sales and R&D Expenditures for Deere and its Competitors

$ (in million)	**Net Sales**	**R&D Expenses**	**R&D as a percent of net sales**			
	Deere	*Deere*	*Deere*	*AGCO*	*CNH*	*CAT*
2006	19,884	725.8	3.70%	2.40%	3.00%	3.50%
2005	19,401	677.3	3.50%	2.20%	2.60%	3.20%
2004	17,673	611.6	3.50%	2.00%	2.30%	3.30%
2003	13,349	577.3	4.30%	2.00%	2.60%	3.20%
2002	11,702	527.8	4.50%	2.00%	3.00%	3.50%
2001	11,077	590.1	5.30%	2.00%	3.40%	3.70%
2000	11,168	542.1	4.90%	2.00%	3.60%	3.40%

Source: Annual reports from Deere and Company, AGCO, CNH, and Caterpillar

The Lane Challenge

The 170-year history of Deere and Company is characterized by both innovation and quality. Even during the agricultural recession of the 1980s, Deere maintained its focus on delivering quality products that customers valued, and Deere gained market share as other major agricultural equipment companies stumbled or fell by the wayside. But financial performance was cyclical, and Deere typically earned a competitive return on capital for only a few years in a row before it encountered a significant downturn in performance (Table 2). When Robert Lane became CEO and chairman in 2000, his goal was "building a business as great as our products" (Nickum, 2005).

Lane's basic strategy to meet this goal was relatively straightforward—to achieve exceptional operating performance and disciplined growth and to do it through high-performance, aligned team work. Operational performance has been improving through the classic approaches of cost reductions, improved asset utilization and margin enhancing/value pricing, and metrics and reward systems that enable the organization to reach new levels. Growth was and continues to be a more difficult challenge since Deere already enjoys a strong market share position in the American and Canadian farm machinery and equipment markets, and that market has been growing only at the modest rate of 3 to 5 percent per year. Growing, therefore, required a continued commitment to innovation and new product introductions.

As noted earlier, Deere's financial commitment to innovation had been unwavering. This commitment to R&D and innovation was the key to avoiding what Lane described as

"commodity hell" where tired products and services result in "me too" products that may satisfy current customer needs but do little to anticipate future needs or opportunities, thus precluding earning above-average profits.

Table 2. Deere's Financial Performance

Deere and Company			Revenues by segment				
$+ millions	*Net sales of Equipment*	*R&D*	*Ag Equipment*	*Commercial & Consumer Equipment*	*Construction & Forestry*	*Credit/Financial services*	*Total # of employees*
2006	19,884	726	10,232	3,877	5,775		46,500
2005	19,401	677	10,567	3,605	5,229		47,400
2004	17,673	612	9,717	3,742	4,214	1,276	46,500
2003	13,349	577	7,390	3,231	2,728	1,347	43,200
2002	11,702	528	6,792	2,712	2,199	1,426	43,100
2001	11,077	590	6,269	2,667	2,086	1,439	45,100
2000	11,168	542	5,934	2,966	-	1,323	43,700
1999	9,701	458	5,138	2,648	-	1,136	38,700
1998	11,925	444	7,217	2,124	-	971	37,000
1997	11,081	412	7,048	1,772	-	818	34,400
1996	9,640	370	-	-	-	-	33,900
1995	8,830	327	-	-	-	-	33,400
1994	7,663	276	-	-	-	-	34,300
1993	6,479	270	-	-	-	-	33,100

Source: Deere and Company's annual reports

But a financial commitment to innovation is unlikely to be successful without a disciplined approach to new project selection. An Accelerated Innovation Process (AIP) had been implemented at Deere to evaluate new product/service initiatives more systematically and quickly. The AIP starts by identifying areas of opportunity for innovation where it is perceived that Deere has the capacity and ability to participate. This step is followed by opportunity identification where internal capability is matched with current and future customer needs; this step requires intense and sometimes contentious discussion and dialogue between the marketing/sales staff who represent the customer's perspective and the engineering/technology personnel who focus on the capability and capacity of current and future technology. The entire process is driven by a set of financial performance metrics that maintain consistency and indicate the expected contribution of an innovation to Deere's financial performance.

An additional dimension of Deere's approach to innovation had been to broaden the focus beyond the traditional emphasis on mechanization. Much of Deere's history had been built on sustaining innovations that generally involve improving the performance and/or lowering the cost of current product/service offerings to current customers. In contrast, breakthroughs or disruptive innovations are new product/service offerings to new or underserved customers; these innovations frequently require capabilities and capacities that may be beyond the current skill set of the organization, and they may require a more intimate knowledge of potential new customers which may not be the focal point of the current sales/marketing initiatives.

One of those potential breakthroughs or disruptive areas of innovation was in the realm of information management/precision/traceability—an opportunity that is increasingly evolving because of the high demand for quality and food safety attributes across the food production and distribution value chain, and the increased capability and capacity of information technology and telemetry to automatically, in real time, measure, analyze, and deliver critical data and information to improve management decision making. As just one example, Robert Lane had described "[…] the shift to intelligent machinery. The technology is becoming available to us to bring to the customer intelligent, mobile machinery. And these machines will be doubly smart, because every day out in the field has different weather conditions and growing conditions. To send a smart machine into an environment that is changing every day it has to be intelligent enough to be adaptive (Houlihan, 2007)."

Deere was well aware of the traditional approach to thinking about growth in terms of both customers and products as reflected in Figure 1. Their perspective was that more focus needed to be placed on new products offered to old customers, as well as new customers, but these opportunities were characterized by high technical, as well as high market uncertainty. The Deere Ag Division found the current discussion about precision agriculture and traceability across the food production/distribution value chain interesting. But were its customers and other participants in the food production/distribution value chain ready to adopt these new disruptive innovations? And, was the information technology available and adaptable to the agricultural production and food distribution industry? Those were some of the questions at the top of the agricultural team's mind as it contemplated the critical decisions it had to make.

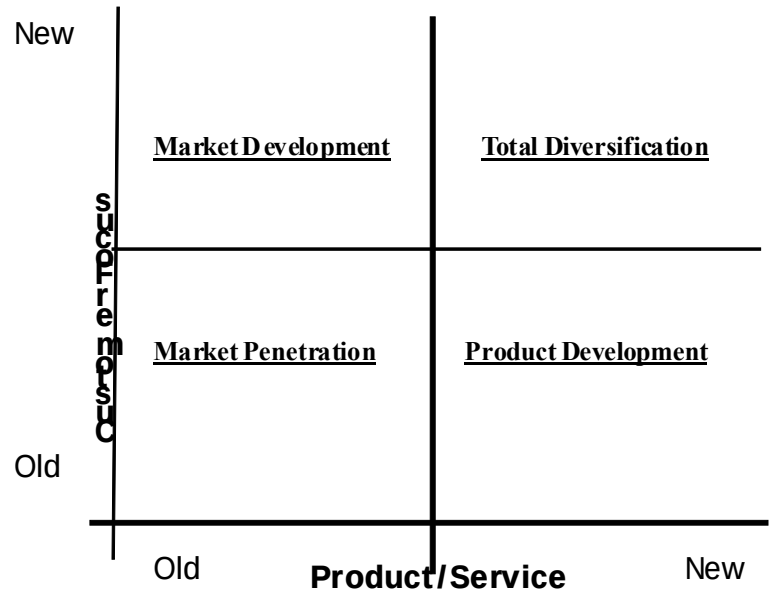

Figure 1. Ansoff's Product/Market Growth Matrix
Source: Ansoff (1957)

Although Deere had been a leader in commercializing new products and services in the farm machinery and equipment industry, it also had been focused on maintaining high-quality products that provide reliable and consistent services and experiences for its customers. So in

some cases, Deere's historical approach to innovation might be best described as a "fast follower" or "close second" rather than a "first mover." A key component of Deere's commitment to quality had been the Enterprise Product Development Process (EPDP), which is a well-defined stage gate process that products must go through to assure reliable performance before a commitment to launch or commercialize is made. This process assures quality in products; however, as an integrated process, it can take more time than the marketplace may accept. The concern became then, that in the information/electronics domains, the rapid rate of technical change meant that the cycle time for successful innovation had to be accelerated and that some of the processes Deere had historically used to assess innovations maybe needed to be revamped.

Customer Segmentation

Deere had historically focused on and had a strong market position in power, implement and combine equipment with traditional commercial producers in Midwest corn/soybean agriculture. This historical dominance with this customer base had reinforced the perception that the U.S. market was mature, and growth potential was limited. But, by reassessing the market with a customer segmentation focus, a different story began to emerge.

Indeed, Deere's segmentation analysis suggested that there are eight different and important customer segments in the farm machinery and equipment market (Figure 2) with different attitudes, goals, behaviors, and needs. Deere's focus on the traditional segment, which had been historically the most important segment in the industry, had been the source of its success in the

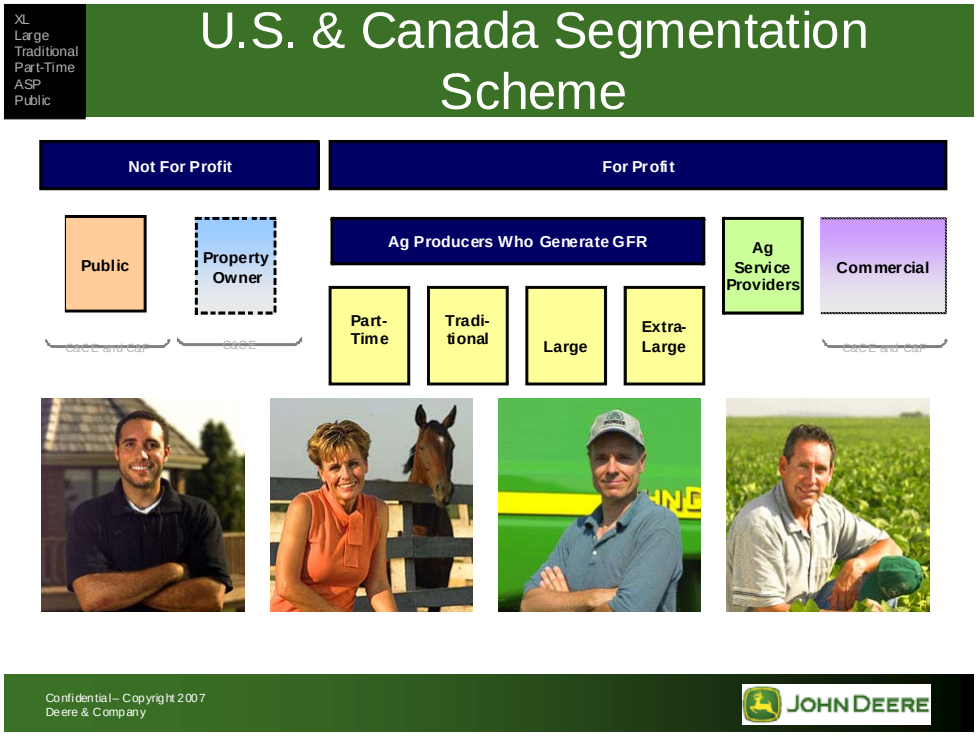

Figure 2. Deere's U.S. and Canada Segmentation Scheme
Source: Provided by Deere and Company

past. But, the industry was changing rapidly, and the other segments were becoming increasingly more important (Figure 3). Some of these new growing segments—particularly the large/mega farm, the ag service provider/custom contractor, and some of the not for profit (state and federal government, etc.)—needed machinery and equipment with different features. Larger scale growers and specialty crop producers were increasingly concerned about precision and process control systems. They were more likely willing to adopt electronic technology as long as it was simple to use and reliable.

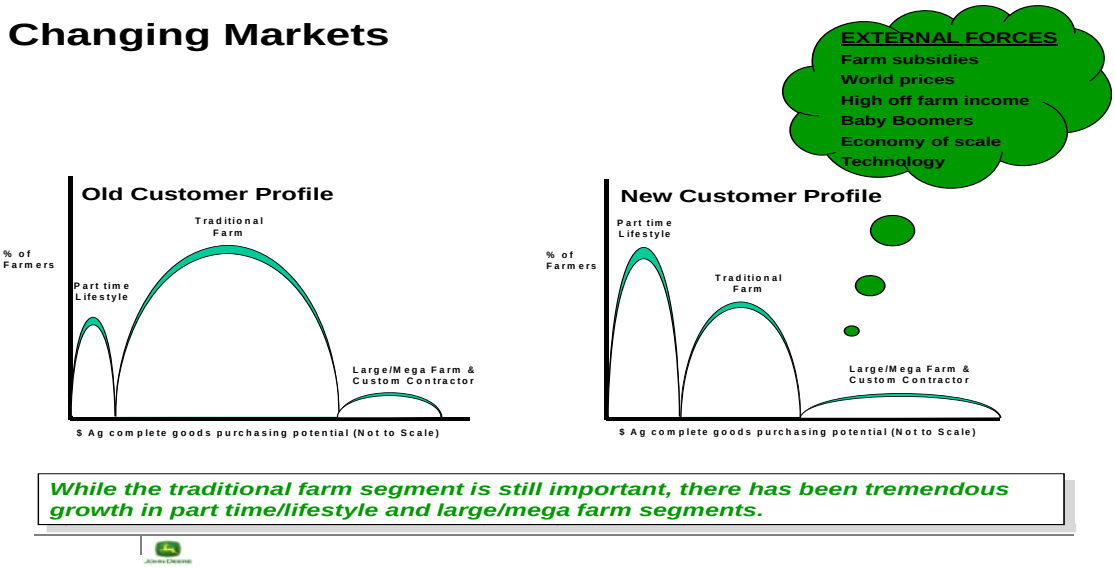

Figure 3. Evolution of Deere's Customer Segments
Source: provided by Deere and Company

These segments were currently underserved by Deere both in terms of market share and features, thus providing significant growth opportunities. Also, proving the information based technology in terms of reliability, ease of use, and value for these segments, combined with the continuous cost reductions and technological advances of electronic-based technology, would allow Deere to market these products to traditional and smaller producers in the future. Results from Deere's market segmentation work suggested that, in fact, the U.S. farm machinery and equipment industry may have substantially more growth potential than was perceived, and that new information/precision/electronic-based technology (i.e., precision farming) had the potential to be the entry point and the lynch-pin to capturing this growth potential.

The New Product/Service Choices

The Ag Division had identified five basic domains of innovations in the area of precision farming that might be offered to the market: (1) advanced autotrack/guidance/headland management, (2) variable rate seed/fertilizer/chemical application, (3) telematics, (4) information/data management along the value chain, and (5) synchronized and autonomous equipment.

Precision farming dates back to the first yield mapping system presented by the company Ag Leader in 1992, shortly after GPS technology became available to the public. Precision farming recognizes to the concept of in-field variability. It results in performing the right task, in the right place, at the right time. Most precision farming systems consist of a GPS receiver, display unit, and desktop software. John Deere's history in precision farming dates back to 1994, with the introduction of a yield-mapping system, and has evolved into five distinct categories: guidance, machine control, telematics, information management, and robotics.

Guidance—The ability to pilot farm machinery through a field via GPS satellite signals to reduce overlap and improve efficiency (by increasing speed of operation, allowing more work at night and/or in low visibility conditions, making the operator less tired).

Machine control—Systems that automate tractors, sprayers, planting, and implement functions, such as speed, hydraulic control, on/off control, and rate control to reduce inputs, decrease costs, and be more environmentally responsive.

Telematics—A wireless communication system between a vehicle and a remote site, transmitting information about the vehicle and its environment. Maintenance information can be recorded; location of the equipment can be known at all time; productivity, idle, and transportation times of the equipment can be calculated. In short, the systems can be used for efficiency and equipment management.

Information management—Collecting data about fields, including field location, seed variety planted, seeding depth or planting height, tillage depth, application depth or height, amount of products applied, crop yield, harvest moisture level, and weather conditions to make maps and informed decisions. The information can be transferred along the value chain to improve efficiency and quality control.

Synchronized and autonomous/robotic multi-unit operations—Wireless operation and control of multiple machine units (tractors, swathers, harvesters) by one operator.

The Ag Division faced several challenges in these five domains. First, customer adoption behavior had propelled the direction of precision farming solutions in several ways. The rapid adoption of guidance and machine control products was the result of customers directly reaping the benefits of increased productivity, ease of operation, and reduced input costs. Documentation and information management solutions struggled due to the inability for customers to see a direct benefit. Precision farming products overall had met complexity and price resistance adoption challenges.

Second, having products that were compatible with older John Deere equipment, as well as competitive equipment, was an eminent priority. John Deere battled enabling compatibility with their first systems and the rest of the industry. Full integration of precision farming products into John Deere equipment was challenging as a result of different product life cycles varying between precision solutions and equipment vehicles.

Third, competition was, of course, an issue. With high potential for growth in the market, many other companies tried to capture this emerging global business. Those companies included:

Trimble, Topcorn, Outback, Leica, AutoFarm, Ag Leader, and Raven, for example. Trimble and Topcorn offered guidance, application, water management, and information management systems (software for planning and documentation). Outback and Leica sold guidance/steering systems. Autofarm and Ag Leader provided guidance/steering systems, as well as data collection products. In addition, Ag Leader also marketed application control systems. Raven focused on the application control domain. Furthermore, the major ag machinery equipment manufacturers (such as CNH, AGCO, and CAT) also offered precision farming technology.

Finally, the agricultural team was concerned about dealer support. They had just begun training dealers on auto-trac products. This was a necessary, but time-consuming process. Now, they were also under pressure to develop training material for the other domains and convince dealers to spend more time away from their dealerships for training.

The Market

Farmers have adopted information technology in fits and starts. Although the use of computers and access to the Internet had expanded in recent years as reflected in Figure 4, farmers continued to lag behind other industries in the broad use of electronic technology for business decisions (in fact only about 30 percent of farmers used computers for business purposes in 2003), making the adoption of precision products a challenge. Adoption of precision farming technology has paralleled that of computer technology, but maybe with even more uncertainty. Data from the Agricultural Resource Management Survey (ARMS) shows that yield monitors and guidance systems were being adopted at a relatively rapid pace, but other technologies, such as variable rate application of fertilizer, lime, pesticides, and seed, as well as yield mapping, geo-referenced soil mapping, and remote sensing were lagging in their adoption rates (Table 3).

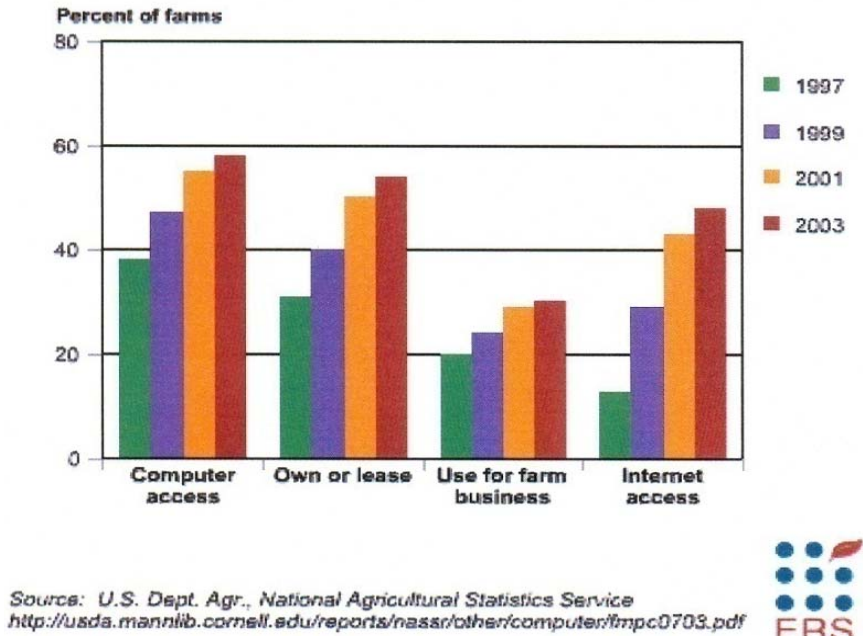

Figure 4. U.S. Farms Using Computers, 1997–2003
Source: Daberkow et al. (2006)

Economic analysis of the benefits to precision farming techniques indicated that guidance systems had the fastest payback, and variable application of lime also had financial benefits, but other precision farming technologies and techniques were not yet seen as highly profitable. Academic studies and budgeting analyses of various precision farming practices underscore the uncertainty of the economic and financial payoff to producers adopting some of these practices. Analyses of the investments in auto guidance technology indicate a 20 percent increase in field speed (Watson and Lowenberg-DeBoer, 2002). Yield monitoring technology does document variability in yields in different fields with different soil types, but explicit links to differences in fertility and other management practices to enhance yields is less clear (Lowenberg-DeBoer and Aghib, 1999; Peone and Lowenberg-DeBoer, 2004). Site specific and variable rate applications of lime would appear to have significant economic benefits, but precision applications of seed and fertilizer do not have the same potential at prevailing product prices and fertilizer and chemical costs (Bullock et al., 1998; Doerge, 2002).

Table 3. Share of U.S. Acreage Using Precision Agriculture Technology[1]

Technology Sun	flower 1999	Potatoes 1999	Sugarbeets 2000	Rice 2000	Barley 2003[2 3]	Sorghum 2003[2 3]
Yield monitor	17.1	10.4	1.0	17.6	17.0	14.4
Yield map	3.8	10.2	*	5.1	4.6	2.0
Geo-referenced soil map	3.8	18.7	28.6	9.5	7.3	7.3
Remote sensing	4.4	20.5	35.2	4.7	2.8	4.4
VRT used for:						
Fertilizer/lime	2.8	13.1	11.9	1.6	12.9	4.7
Seed	*	1.5	2.2	1.2	8.0	3.5
Pesticides	*	3.6	1.3	2.6	10.4	2.7
Guidance	NA	NA	NA	NA	14.7	10.4

*= less than 1 percent. NA = survey not conducted. VRT = variable-rate technology
[1]These estimates are revised from previous published estimates based on updated weights from the ARMS.
[2]Prior to 2002, respondents were asked if the soil characteristics of the field had ever been geo-referenced. Beginning in 2002, respondents were asked about geo-referencing in the current and previous years.
[3]The question was reworded in 2002 to better define the term "remotely sensed.*
Source: Daberkow et al. (2006)

A survey of retail agronomy dealerships concerning precision agriculture services indicated similar uncertainty in adoption. While more than 80 percent of the 340 respondents used some form of precision technologies in their dealerships, the applications were primarily dominated by service offerings to customers and manual control/light bar GPS guidance of application equipment (Figure 5). Specific service offerings over time have grown erratically since the mid-1990s and still did not exceed 50 percent of the respondents as of 2006 (Figure 6). Midwest dealers were significantly more likely to offer most precision services compared to other regions of the United States (Figure 7).

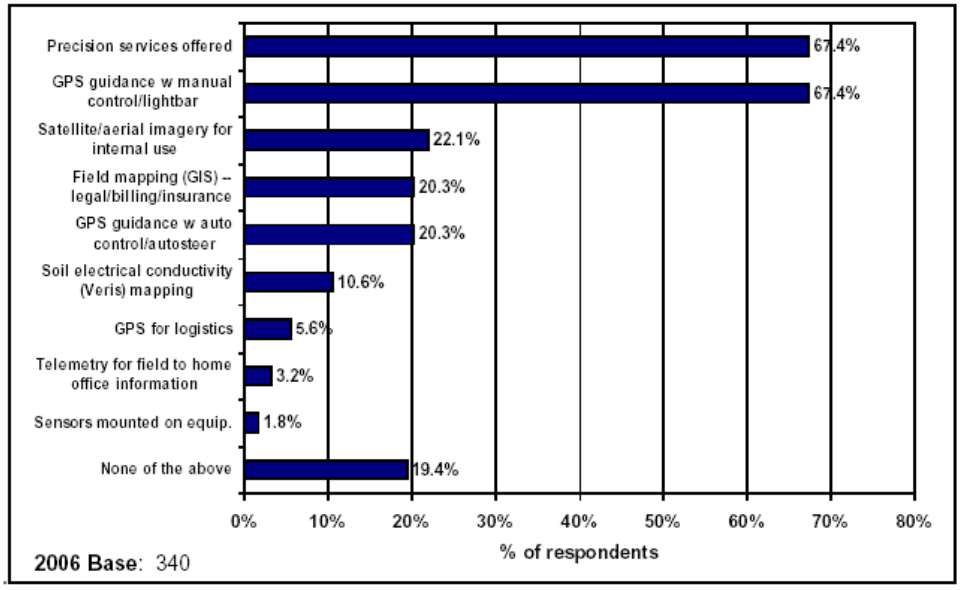

Figure 5. Use of Precision Technology in 2006
Source: Whipker and Akridge (2006)

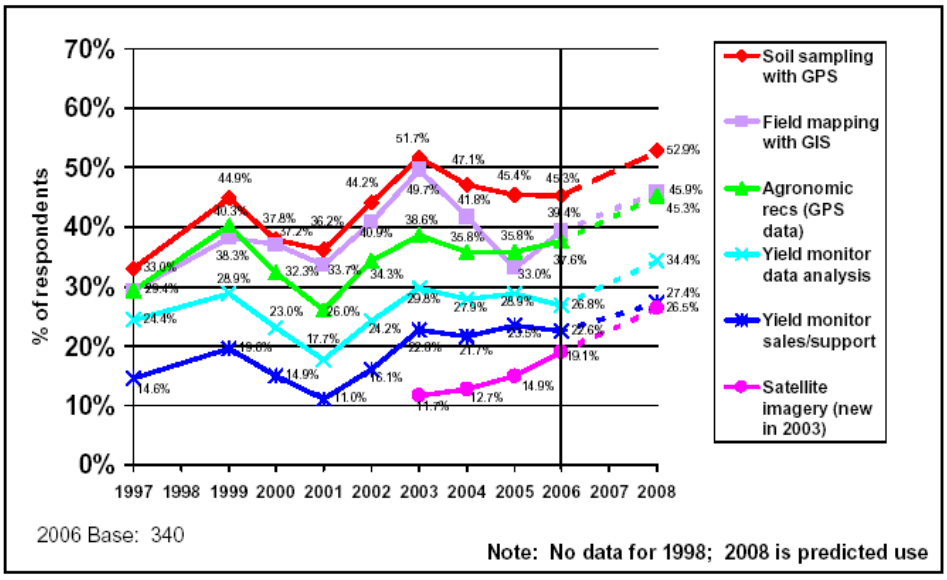

Figure 6. Precision Ag Services Offered Over Time
Source: Whipker and Akridge (2006)

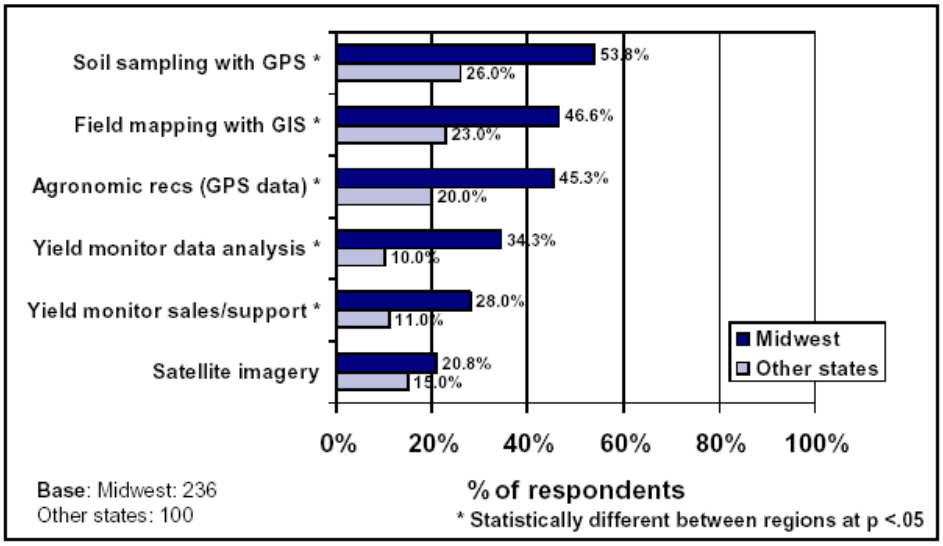

Figure 7. Precision Ag Services Offered by Region in 2006
Source: Whipker and Akridge (2006)

Data from surveys of Ohio farmers in 1999 and 2003 suggested that adoption of precision farming practices was progressing at a slow to moderate pace. As summarized in Table 4, the most frequently adopted precision farming practice was geo-referenced grid soil sampling—adoption increased from eight percent of the respondents in 1999 to 15 percent in 2003. Variable rate application of plant nutrients showed similar rates of adoption and growth in adoption since 1999. Yield monitor adoption nearly doubled from 6 percent to almost 12 percent from 1999 to 2003; precision guidance was not generally commercially available in 1999 and had been adopted by 5 percent of the survey respondents by 2003. Approximately one-third of the surveyed farmers had adopted one or more of the precision farming practices in 2003, compared to less than 25 percent in 1999. As expected, larger farmers adopted precision farming techniques more rapidly and were using a larger number of such techniques compared to smaller farmers.

From a global perspective, the data is only available on yield monitor use and indicated that the United States and Germany appear to have the highest use, with lower utilization in Denmark, Sweden, and Argentina (Table 5). Success in expanding their footprint in precision farming technology in the United States would allow Deere to better understand customers' needs, which could then possibly be leveraged in other countries.

Table 4. Percent of Ohio Farmers who had Adopted Various Precision Farming Components in March 1999 and 2003

	Percent Adopting	
	2003	1999
Georeferenced (i.e., map-based or location specific) grid soil sampling	15.3	8.1
Variable Rate Application of Phosphorus	14.1	7.3
Variable Rate (i.e., rate varied across field) Application of Lime	14.0	6.7
Variable Rate Application of Potassium	13.4	7.3
Yield Monitor	11.6	6.0
Boundary Mapping	9.8	4.3
Variable Rate Application of Nitrogen	7.7	6.3
Satellite GPS Receiver	7.6	2.2
Georeferenced Field Scouting for Weeds	6.0	2.3
Variable Rate Application of Herbicides	5.3	5.7
Precision Guidance (light-bar navigation or autopilot system	5.2	
Aerial or Satellite Field Photography	5.2	2.7
Georeferenced Field Scouting for Insects, Pests, or Disease	4.9	2.0
Variable Rate Seeding	4.2	3.4
Variable Rate Application of Other Nutrients	4.1	3.9
GPS or Sensor-Directed Spot Spraying of Herbicides	3.0	1.3
Variable Rate Application of Pesticides	2.8	2.9
GPS or Sensor-Directed Spot Spraying of Pesticides	0.9	
Percent who have adopted one or more of above	31.8	23.6

Source: Batte et al. (2003)

Table 5. Yield Monitor Use by Country

Estimated	**Yield Monitors**			
Country	Number	Year	Source	per 1,000,000 acres
Americas				
United States	30,000	2000	Daberkow et al.	136
Argentina	560	2002	Bragachini	10
Brazil	100	2002	Molin	1
Chile	12	2000	Bragachini	8
Uruguay	4	2000	Bragachini	3
Europe				
U.K.	400	2000	Stafford	43
Denmark	400	2000	Stafford	100
Germany	150	2000	Stafford	7
Sweden	150	2000	Stafford	48
France	50	2000	Stafford	2
Netherlands	6	2000	Stafford	11
Belgium	6	2000	Stafford	6
Spain	5	2002	4ECPA	<1
Portugal	4	2002	Conceicao	3
Other				
Australia	800	2000	Bullock et al.	17
South Africa	15	2000	Nell	1

Source: Lowenberg-DeBoer (2003)

The Key Questions

The challenge was clear. How might the Ag Division deliver on this challenge? Although there were numerous opportunities for new product and service introductions in the traditional areas of enhancing the performance and productivity of Deere's power, tillage, and harvesting equipment, the Ag Division felt that the most potential, but also the most uncertainty, might be in the five new domains of precision farming. Some of the top-line questions the Ag Division management team had decided to focus on were:

1. What are the types/dimensions of risk/uncertainties associated with innovations in the information domain? Give specific examples in each dimension related to Deere and the information domain.

2. What kinds of customers (in terms of age, size, crops produced, etc.) provide the most potential for adopting the products/services in these domains?

3. What are the capacities needed to develop, produce, and commercialize information domain products? Does Deere have the capabilities? If not, how should Deere go about getting the capabilities?

4. How can Deere manage the risk/uncertainties associated with investing in the information domain? Think about flexibility and the concept of real options, and suggest a framework(s) to use this concept.

5. Should Deere collaborate with specialty electronics companies such as Raven, Ag Leader, etc.? Which characteristics should Deere look for in the collaborators/partners involved in the development of new technology in these domains, and what organizational structure might be used to benefit both Deere and the collaborators?

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Appendix 1.

Exhibit A. Innovation Chronology

1957: Six-row planters and cultivators, John Deere innovations, reach the market. They provide 50 percent more planting and cultivating capacity for row-crop farmers in corn- and cotton-producing areas.

1958: The John Deere Credit Company, financier of domestic purchases of John Deere equipment, begins operations.

1963: John Deere surpasses IH to become the world's largest producer and seller of farm and industrial tractors and equipment. The company ventures into the consumer market, deciding to produce and sell lawn and garden tractors, in addition to some attachments, such as mowers and snow blowers.

1991: Lawn-and-grounds-care equipment operations in the United States and Canada become a separate division. Since 1970 they had been part of the farm-equipment operations. The company acquires SABO, a European lawn mower manufacturer.

1992: A program is launched to encourage installation of rollover protective structures and seat belts on older tractors. In 1966, John Deere introduced the first commercially available rollover protective devices for farm tractors, later releasing the patent to the industry without charge.

2001: Two mapping softwares—JDmap and JDmap Deluxe—are introduced.
Development of parallel tracking to reduce overlap.

Creation of a new service CropTracer that provides the necessary components of a full service traceability program. Launch of Field Doc, an electronic notebook that makes collecting and recording information about operations exceptionally easy.

Introduction of the GreenStar™ AutoTrac assisted steering system to reduce the amount of time an operator needs to spend steering the tractor.

2002: Development of JD Office, an extended version of JD map. Creation of a new JDLink Machine Messenger, a wireless communication and information system for John Deere agricultural tractors that makes automated fleet management a reality.

2003: John Deere Introduces GreenStar™ AutoTrac Assisted-Steering for wheeled tractors. Introduction of several product enhancements for Parallel Tracking (a manual guidance system) and expansion of the GreenStar™ AutoTrac Assisted Steering line-up with the introduction of Auto-Trac for 8020 series tractors with MFWD or ILS.

Development of JDLink™ Machine Messenger, a wireless communications system for the new John Deere twenty series tractors, which allows owners to monitor tractor performance and usage from a secure Internet Web site.

2004: Further advances in new products include recently introduced self-propelled sprayers; the 4720 and 4920 models are the Deere's largest and most-productive sprayers ever. Expansion of the GreenStar™ AutoTrac Assisted Steering System on more vehicles.

Development of StarFire RTK system with the repeatable guidance that only Real-Time Kinematic (RTK) GPS systems can deliver.

2005: Major new-product introduction for model-year 2006 with John Deere 8530 tractor; the most powerful row crop tractor ever (275-hp) that allows operators to get more done in less time. Equipped with new 9.0-liter engine, this tractor is more fuel-efficient than the previous model. Advanced precision-guidance product, which can direct equipment in the field with sub-inch accuracy, is introduced.

2006: Deere introduces a high-capacity 4930 self-propelled sprayer; the 120-foot boom makes it the most productive sprayer ever built by John Deere. Innovations such as iGuide, for perfectly straight rows; iTEC Pro for automated end of row turns, and GS2 Rate Controller to expand the capabilities of the GS2 system by acting as a controller for sprayers; reach the market.

John Deere 8430 tractor, powered by the company's clean-burning engine technology, sets fuel-efficiency record for its size class. Advanced products appear in the 6030 premium series and 7030 full-frame tractors.

A new line of productive round balers is launched.

Source: Deere and Company's Web site, Deere and Company's annual report, and "The John Deere Way: Performance that Endures" by David Magee (2005).

Appendix 2.

Addendum to the Case Study

The case study was used at an executive management education program focusing on innovation in April 2009. The executive program was a four-day session for executives from Syngenta. Prior to the case study presentation and discussion, presentations and discussions focused on how Syngenta innovates, how to create a culture of innovation, how to implement innovation, and how to communicate to customers the innovation taking place.

Case Setup

To prepare program participants for the case study discussion, a succinct presentation was given. The customer segmentation of Christensen and Raynor (2003) was introduced: over-served customers, under-served customers, satisfied customers, and non customers. Then, based on Christensen (1997), the definitions of disruptive and sustaining innovations were presented.

Sustaining innovation refers to improving a current product, while disruptive innovation refers to the creation of a new product, business model, or service.

The framework developed by McGrath and MacMillan (2000) was also presented. This framework (Figure 8) graphs the innovation projects along the dimensions of market and technical uncertainty to determine whether risk is being diversified and how the portfolio of innovations evolves over time. Market and technical uncertainties are scored using the scorecards developed by McGrath and MacMillan (2000).

Major sources of uncertainty are the potential revenue/demand, regulatory aspects, associated cost, and upstream supply chain reaction to the innovation project. Market uncertainty refers to the lack of knowledge at the market and demand level. Technical uncertainty comes from the lack of information about the viability of the innovation. The firm does not know whether or not the technology can be developed, and which inputs and skills are needed. The firm also does not know how, or if, the user will be able to adopt the product.

Figure 8 maps the variety in the chosen innovation activities. Innovation through positioning options creates the right to wait and observe. Innovation through stepping stones options gives low-risk access to potentially high upside opportunities. Innovation through scouting options can be seen as entrepreneurial experiments. Innovation through enhancement launches represents improvement to make today's product faster, better, or cheaper. Finally, innovation through platform launches consists of establishing the company in a leading position, ideally in an emerging area with strong growth potential—next generation advantages. The participants were given an illustration of the framework with Deere's example of innovation projects, excluding the information domain (Figure 8).

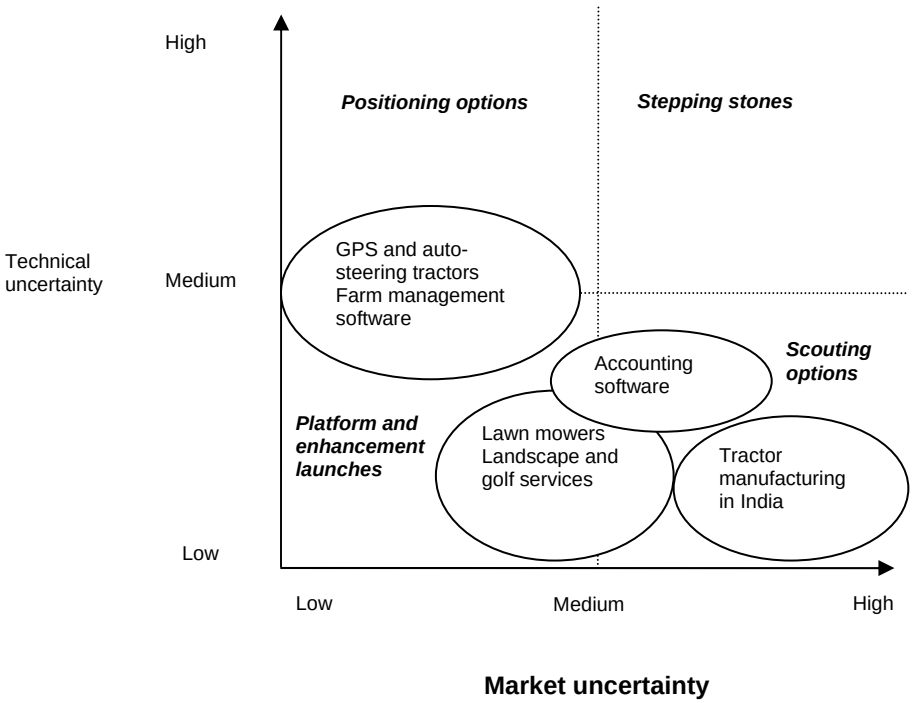

Figure 8. Portfolio of Options to Innovate

Participants' Discussion

The participants were then asked to break up into groups of four to five people and answer questions 2, 3, and 5. The other questions were not investigated because the participants had already discussed the implementation of innovation and the customer aspect of innovation at length. After the break-out session, participants presented their answers, which are described below.

McGrath and MacMillan's framework was proposed to determine the appropriate portfolio of innovation projects to fund and to manage this portfolio over time (see Figure 9). Advanced autotrack/guidance/headland management and variable rate seed/fertilizer/chemical application can be considered platform launches for Deere. They have medium technical uncertainty, but low to medium market uncertainty as the values of those technologies are fairly easy to communicate to the customers. Telematics and information management are examples of scouting options for Deere. They use developed technologies (we have telematics in our cars, planes, and trains), which limits the technical uncertainty. However, the market uncertainty is high. Sales representatives may find it more difficult to convince farmers of the benefits that these technologies bring than for products such as autotrack. Alternatively, these products may service a smaller number of farmers than autotrack systems in the short term. Synchronized and autonomous/robotic multi-unit operations are stepping stones for Deere. Requiring the use of new technologies, these products have high technical uncertainty. For the same reasons as telematics and information management products, synchronized and autonomous/robotic multi-unit operations also face high market uncertainty.

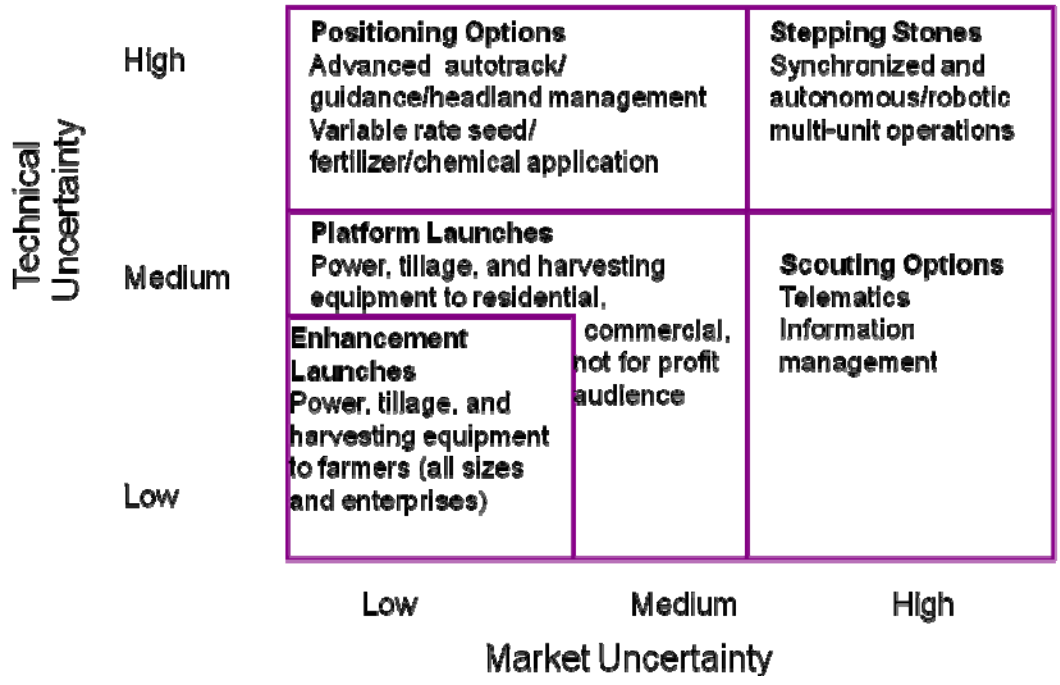

Figure 9. McGrath and MacMillan's Framework

One of the participants mentioned that the McGrath and MacMillan's framework did not take into account the market attractiveness. The instructor mentioned how the size of the circles as illustrated in Figure 8 could be adapted to represent the market attractiveness; the bigger the circle, the more attractive (in terms of generated revenue) the market.

Regarding the question on whether Deere should collaborate/partner with a specialty electronic company, most participants recommended collaboration and presented the reasons to justify this recommendation as summarized in Table 6.

Table 6. Factors Affecting the Choice of Governance Structure

Partner Don't	Partner
Access technologies	Oblige customers to use the whole Deere package
Access new customers	Nobody was better
Successful with past partnership experience	Expected payoffs
Differentiation	Culture
To mitigate risk	Provide the right quality
Flexibility to experiment with the idea and then buy the partner if it's successful	Avoid lawsuits on intellectual property rights
Speed to market	
Access to capabilities	
Share costs	
Secure channels	
Competitive advantage	

Deere's core business up until now has been machinery. For the company to enter the information domain, Deere will need to develop competencies in electronics, computer, and information technology by either buying electronic companies or collaborating with them. These electronic competencies will have to be developed throughout the supply chain. The research and development teams will have to learn about electronics, in addition to continuing their understanding of machinery. The manufacturing processes will have to be adapted to produce electronics. Deere will need to find and build relationships with suppliers of electronics. Quality controllers will have to learn about electronics. Deere's marketers and sales representative will have to learn about electronic features to market the product properly and to its fullest. Deere's dealers also have service teams at the dealership and on-site; those teams will need to have electronic experts on staff.

Participants also stressed the need for Deere to educate dealers on selling precision farming products. Both the dealers and the service teams will need to be motivated and rewarded for their effort in learning about and selling new products. They will need to understand the reasons behind the introduction of those new products or, in other words, be told about Lane's challenge. To make sure dealers devote time to selling information domain products, a dedicated salesforce could be put together. Dealers could also be encouraged and rewarded for trying to sell the information domain products as an add-on to equipment already in the field.

As a follow-up to the discussion, Dave Ehlis, director of advanced marketing at Deere and Company, provided insights regarding the discussion that had previously taken place. He noted that Deere had been prototyping and producing its precision farming products in-house with the help of selected universities and the acquisition of companies, such as NavCom technologies, to gain capabilities in navigation technologies.

There are several reasons behind these decisions. First, Deere and Company has extensive knowledge and a competitive advantage in complex machinery/product design and manufacturing suggesting a fairly hierarchical governance structure. Deere is also well known for high-quality products. This competitive advantage is best obtained with extensive monitoring (i.e., a hierarchical governance structure). Second, Deere has historically focused on and has substantial experience in producing in-house, at least partially because of the challenges in negotiating the property rights associated with a less hierarchical governance structure. Third, these products were expected to generate high profits, and Deere wanted to reach the maximum profit. Finally, those products were expected to reach current Deere customers, so the market uncertainty was fairly low, and Deere dealers could provide more of a one-stop shopping location to the farmer. The acquisition and the collaboration with universities were useful strategies to gain capabilities Deere did not have. Finally, at the commercialization level, Deere has had experience working with its dealer network, thus relying on the dealers' human capital to attract and retain customers.

Ehlis followed his case discussion with a presentation on Deere's innovation projects— its past innovations and current innovation strategy. He noted the presence of an advisory council made of diversified members from an education, culture, and experience standpoint. He also discussed and showed a video, which had been shown to all Deere employees, presenting the six dimensions/issues in which Deere is looking for innovative solutions: 1) machine productivity, 2) worksite solutions, 3) environmental sustainability, 4) renewable energy, 5) connecting land and lifestyle, and 6) water management. Ehlis ended the presentations with a question and answer session.

