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RESEARCH

Middle Management in Agriculture: Roles, Functions, and Practices

Vera Bitsch and Elaine K. Yakura

Middle managers play a key role in agricultural and agribusiness operations by ensuring a continuous workflow, solving unexpected problems, and maintaining a positive environment. There is little agribusiness research on middle managers; considering their importance, this omission is surprising. Lacking this foundation, businesses are left without appropriate decision support tools and tailored managerial training.

Research on other industries focuses on the coordinative and supervisory role of middle managers, positioned between senior management and employees and often in a position of increased stress and role conflict. A major part of the research posits the demise of middle management through delayering and change. These findings contradict the centrality of middle management in agricultural and agribusiness operations.

In-depth interviews with 15 middle managers of 12 agricultural operations were analyzed through a grounded theory approach to obtain insights into their organizational functions and human resource management practices. This group uses the full array of practices discussed in the managerial literature, including traditional practices, such as training and discipline, and participative practices, such as accommodation and listening. But while some seem to use many of these practices, others use fewer practices.

Managerial education tailored to middle management's specific needs and the distinct features of the agricultural sector, including seasonality, lean hierarchies, and family-owned businesses will help both novice and experienced managers increase sophistication and fulfill their role more comfortably. Novice managers will assume their new role with less anxiety, and experienced managers will have effective practices reinforced and learn to use new ones.

Determinants of U.S. Textile and Apparel Trade

William A. Amponsah and Victor Ofori-Boadu

U.S. textile and apparel industries face challenges related to increasing trade flows from foreign producers. This study evaluates factors affecting the value and direction of textile and apparel trade flows into the U.S. It applies a commodity-specific gravity model, using panel data from 1989 through 2003, to analyze trade flows in textiles and apparel into the U.S. for 13 leading exporting countries.

We conclude that a nation's aggregate output and per unit productivity are important determinants of textiles and apparel trade with the U.S. Additionally, a country's depreciating exchange rate as well as its lower prices relative to that of the U.S., play an important role in determining textiles and apparel trade flows to the U.S. market. Therefore, so long as textile and apparel products are perceived as cheaper abroad, U.S. importers will continue to purchase from abroad and global producers will find it profitable to sell their products in the U.S. market. The Multi-fibre Arrangement (MFA) is found to have slowed down imports of textiles and apparel from leading global exporting countries into the U.S. Consequently, its abrogation in January 2005 is expected to pave the way for greater access to the U.S. market from leading global producers, such as China, India and Pakistan. However, we find that textiles and apparel imports are constrained by distance. Should textile manufacturers want to capture factor-cost differentials on labor while maintaining headquarters activities in the U.S., then industry participants can take advantage of regional and bilateral trade agreements in increasing their investments in other countries where labor and ancillary costs are relatively cheaper. The ability of global competitors in exporting relatively cheaper textiles and apparel to the U.S. must be a troubling source of concern to U.S. textiles and apparel producers and the communities in which they are located.

Differential Earnings of the Agricultural Graduates New Evidence from the Agribusiness Industry

Eivis Qenani-Petrela and Marianne McGarry Wolf

Various studies continue to debate the role and importance of gender in the process of wage determination. Research findings suggest that no matter how the wage gap is measured, women's earnings are below those received by men. The primary objective of this study is to provide new empirical evidence on the status of gender gap in the agricultural industry first, by investigating the determinants of the earnings of agricultural graduates and second, by examining the causes of wage differentials between the graduates. The study is based on survey data of 1106 agribusiness alumni of Cal Poly, San Luis Obispo. Regression analysis indicates that factors such as education, experience, gender, job status and specialty are important determinants of earnings. Characteristics such as, experience gained through a foreign internship during college, specialties such as marketing, accounting and finance and managerial positions all have a relatively high market value. For academia, these findings call not only for strengthening the technical

skills of the students in these specialty areas, but also signal the need for adjusting the curriculum so that domestic and foreign internships are more prominently featured.

Results show that women are paid 81 percent of men's wages, corresponding to a 19 percent wage gap. Differences in human capital characteristics explain to a large extent the gap; however, 45% of the gap remains unexplained. Literature suggests that lifestyle choices that trade greater flexibility to manage work and family versus potentially higher earnings might play a key role in the earnings differential. The implication here for agribusiness companies is to create and expand policies to help women integrate successfully work and family responsibilities, as well as implement strategies aimed at assisting women attain management and leadership positions. This approach will give agribusinesses a competitive advantage to hire and retain the best-qualified employees, male or female.

The Joint Impact of Supply Chain Integration and Quality Management on the Performance of Pork Processors in China *Jiqin Han , S. W. F. (Onno) Omta and Jacques H. Trienekens*

It is widely acknowledged that competition no longer takes place between individual enterprises, but between supply chains. A number of studies have indicated that supply chain integration and quality management have become essential to gaining competitive advantage. To cope with ever-increasing competition and achieve superior company performance, some leading meat processors in China have implemented external cross-functional integration with their strategic suppliers and customers to improve their practical supply chain capabilities. Previous research has indicated the role and benefit of supply chain integration (SCI) can vary depending on the developmental stage of SCI. What is the level of SCI in the pork processing industry in China? Will the level of SCI facilitate the implementation of quality management in the industry? Will inter-organizational supply chain orientation and quality management improve company performance? Considering these questions, the purpose of this research was to examine the interactive relationships among SCI, quality management practices and business performance and to identify critical success factors to the competitiveness of pork processors in China.

The study domain of the research is the dyadic relationship between pork processors and their most important suppliers. In keeping with existing literature, hypotheses were developed incorporating dimensions of SCI and quality management practices and business performance indicators. A survey instrument was developed and data were collected from a field survey of 229 Chinese pork slaughterhouses and processors. After the validity and reliability of the constructs were determined, structural equation modeling (SEM) was applied to test the hypotheses.

The most important results are that significant positive relationships have been found between quality management and company performance and between SCI and quality management practices. As managers put it, "Quality is the life of the enterprise". Equally significant is the indirect link through quality management between SCI and firm performance. This study indicates that businesses need to adopt an integrated approach to the management of pork supply chains in a transitional economy. Furthermore, evaluation of quality management initiatives should be made within the contexts of internal and external supply chains. The results also show that important components of quality management practices contributing to company performance include company quality management, supplier quality management and process management. Notably, long-term quality strategy, policy goals, quality assurance systems and supplier quality management are critical elements in quality management. Therefore, to improve the quality of their products and reduce uncertainty in hog supply chains, companies are advised to invest in quality management and develop more integrated relationships with their suppliers. However, in contrast to earlier studies, the direct link between supply chain integration and company performance was found of little significance. This result may indicate that the Chinese pork processing industry is still at an early stage of SC integration. To exploit the benefit of supply chain integration, managers should apply a more focused approach to developing external integration capabilities, especially the integrated management of information technology and logistics.

Discovering and Promoting Commodity Health Attributes: Programs and Issues *Hoy Carman*

Increased consumer interest in selecting foods based on health and nutritional attributes provides economic incentives to food processors and manufacturers to provide label and promotional information on the benefits of consuming their product(s). Faced with consumers' confusion over a wide array of product claims using undefined and often misleading terms, governments in both the U.S. and the EU have established regulations regarding health and nutrition claims for food products. The requirements for nutrient content claims, such as "calorie free," "low fat," and "light/lite," have been defined and health claims can only be used when supported by sound scientific findings.

Producers of four California crops, almonds, avocados, strawberries, and walnuts, are using mandatory assessments collected by their commodity organizations to fund health and nutrition research. Recent budgets have totaled over $3 million for a portfolio of projects on relationships between consuming each product and cardiovascular disease, weight and obesity, cancer prevention, diabetes, antioxidants, aging, prostate health and bone health. Almonds and walnuts have received qualified health claims from the U.S. Food and Drug Administration regarding consumption of almonds or walnuts to reduce the risk of heart disease. Producer organizations for avocados and strawberries each have a stated goal of obtaining the research results needed to secure a health claim for their product.

Public relations programs based on health and nutrition research have proven to be a very cost-effective method of communicating with consumers. Advertising programs using a health and nutrition message have also been effective for almonds and strawberries.

There is some controversy over food health claim regulations. U.S. rules are still evolving after several years while EU rules are just becoming effective. The interest in evolving rules is warranted since potential costs and returns can be high for food manufacturers, producers, and consumers.

Analysis of Farm Household Preferences in the Management of Invasive Species: The Case of Miconia in Hawaii *Catherine Chan-Halbrendt, Fang Yang, Lynna Thomas, and Archana Pant*

Miconia calvescens is a highly invasive tree species found in Hawaii and was brought in the 1960s as an ornamental plant. Miconia's invasive characteristics include rapid growth, early maturity, large quantities of fruits and seeds, effective seed dispersal, and its ability to reproduce by seed and vegetative growth. Without effective control, the spread of Miconia causes soil erosion threatening the productivity of the agricultural and agro-forestry industries and consequently changing the ecosystem and biodiversity of the environment. With the limited amount of funding for its control, it is important to ensure the available funding is being spent in a way that addresses the needs of the farmers in Hawaii.

The objective of this research is to evaluate the extent of farm households' preference for Miconia control program attributes. This would be indicated by their choices of the different control programs presented to them using the Conjoint Choice Experiment (CCE) methodology. Using CCE, a survey was designed to measure the farm households' preference for the different Miconia calvescens control program attributes. The important program attributes identified are cost, biodiversity loss, extent of spread and soil erosion. The data is analyzed using logit regression.

The results of the CCE suggest that cost is relatively not as important in respondents' choice of control programs. The two most important program attributes are preventing soil erosion (31.30%) and biodiversity loss (29.16%) followed by the extent of spread of Miconia (21.86%). In addition, from the survey results, farm households are willing to pay $14.63 extra to minimize biodiversity loss so as not to lose 100 native species, $12.04 extra to avoid high spread, and $14.21 extra to avoid high levels of soil erosion with severe landslides. This study provides decision makers with the information that farmers are willing to support spending for Miconia control programs if they are effective in preventing severe landslides and huge loss of native species.

The Role of Trust in European Food Chains: Theory and Empirical Findings *Melanie Fritz and Christian Fischer*

In Europe, consumer trust in food has become one of the most important factors for the stability of the food sector. An essential prerequisite for the ability to communicate the trustworthiness of food to consumers (B2C) is the creation, maintenance, and communication of trust between companies across the entire food value chain (B2B). For the management and preservation of trust in food chains it is important to know whether differences occur across European countries or whether distinct product chains show variations regarding trust. Based on a survey in five countries with 747 respondents, this paper assesses the current level of trust between companies together with its influencing structural factors in European food chains and determines criteria allowing the active management of the level of trust in business relations in food chains by estimating a structural equation model.

The most important results are that in the observed European food chains, the perceived level of trust of buyers towards the respective supplier is considerably high. With regard to the structural factors including the country, the stage of the value chain, the product, and the governance form it can be said that only small differences can be observed. The relatively high level of trust in European food chains is a positive prerequisite for the communication of trustworthiness of food to the consumer. For an active management of trust in food chains, the quality of the communication, which is realized by the frequency of communication and the quality of the information, together with the collaboration experience are the most important determinants. It is interesting that personal relationships do not in all observed situations equally impact the level of trust, but they are important when dealing with farmers. It must be said that the emergence of trust to a large extent depends on positive collaboration experiences, which only evolve over time. However, although to a comparatively smaller extent, with the quality of the information communicated impacting the level of trust at a business partner in food chains, a management means to actively increase the level of trust ex ante and ad hoc at the business partners is available even for "first-time" cases where no past collaboration history has existed.

On the Use of Valuation Mechanisms to Measure Consumers' Willingness to Pay for Novel Products: A Comparison of Hypothetical and Non-Hypothetical Values *Andres Silva, Rodolfo M. Nayga, Jr., Ben L. Campbell, and John Park*

Agribusinesses are increasingly interested in developing and marketing novel products. Consequently, managers are looking for analytical techniques to assess consumers' valuation of these novel products and optimize pricing decisions. The use of conjoint analysis and auctions, to elicit consumers' willingness to pay (WTP) for novel products, are increasing in popularity. We review some of the advantages and disadvantages of both approaches and some considerations in the conduct of an experimental marketing study. Using data from field experiments, we focus on

comparing WTP values from two elicitation mechanisms: Becker-DeGroot-Marshak auction mechanism and conjoint analysis. In addition, we also compare hypothetical and non-hypothetical values from these mechanisms and discuss the issue of hypothetical bias inherent in hypothetical valuation experiments. Our results suggest that auction WTP values are higher than conjoint analysis WTP values. Moreover, the hypothetical WTP values are higher than the non-hypothetical WTP values in both elicitation mechanisms. Our results imply that the decision a researcher or manager makes with respect to the elicitation mechanism and their implementation can have a direct impact on estimates of the value of novel products. Since agribusinesses are continuously shifting toward a more consumer and demand-driven marketplace, this finding is of utmost importance due to cost of developing and launching novel products. Having appropriate estimates of consumers' valuation of these novel products can assist agribusinesses in their product adoption and optimal pricing decisions.

Bio-ethanol Production from Wheat in the Winter Rainfall Region of South Africa: A Quantitative Risk Analysis *James W. Richardson, Wessel J. Lemmer, and Joe L. Outlaw*

Contrary to developments in other parts of the world, South Africa has not developed a bio-ethanol industry. In spite of interest from government, financial institutions and investors, there are no bio-ethanol plants supported by grains as feedstock established yet. Public and private players expect the national government to issue an investment incentive dispensation for the bio-ethanol industry. In the mean time the government needs a better understanding of the risks and prospects for the industry. The objective of this paper is to quantify the risks and economic prospects that influence the profitability of bio-ethanol production from wheat in the winter rainfall region of South Africa.

A Monte Carlo simulation model of the economic activity for a bio-ethanol plant in the region is developed and simulated for 10 years to quantify the risk that investors will likely face. Under the Base scenario a 103 million liter bio-ethanol plant would not offer a reasonable chance of being economically viable. Average NPV was –R88.5 million and average ROI was -8.4 percent, and there was more than a 97 percent chance that NPV would be negative.

Alternative price enhancing policies were analyzed to determine the type of policy changes needed to make a bio-ethanol plant economically viable in the winter rainfall region of South Africa. The policy scenario which showed the most promise for making wheat bio-ethanol economically viable is to implement a price floor of R3.325/liter that is tied to inflation and to increase the reimbursement on the fuel levy to 70 percent.

EXECUTIVE INTERVIEW

An Overview of the Global Economy: Markets, Competitiveness and Trade Facilitation

Olubukola .A. Oyewumi

The Honorable Carole L. Brookins, U.S. Executive Director to the World Bank, 2001 – 2005

The global economy is growing increasingly more integrated. The dawn of the 21st century was marked with cutting edge technologies creating the platform for greater connectivity and competition among global markets. The evolving economic paradigm is re-defining the way products are moving across markets, regions and continents. The combined effect of technological advances, global political economy and seasonal weather variability has called for dynamism in the way businesses are run. The potential benefit of this development is that it could culminate into increased productivity through the involvement of more people in economic activities across the globe, and the development of new efficiencies and new technologies to better manage our environment and create the right economic blocs. This synopsis is an interview conducted with the Honorable Carole L. Brookins, former Executive Director to the World Bank, 2001-2005. The objective was to relate current and evolving global economic trends to their importance on markets, competitiveness and trade facilitation across the globe. This interview was conducted at the 16th Annual World Forum, Symposium and Case Conference in Buenos Aires, Argentina in June, 2006.

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Middle Management in Agriculture: Roles, Functions, and Practices[1]

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Abstract

The role of middle managers in agriculture and agribusiness has been neglected by applied—as well as disciplinary—research, while gaining increasing importance in practice. This study provides an overview of middle management research and analyzes middle managers' authority in human resource decision-making and human resource management practices based on in-depth interviews analyzed through a grounded theory approach. Results show that these middle managers use both traditional and participative management practices to accomplish organizational goals, but would benefit from training tailored to their industry and specific needs.

Keywords: Case study research method, grounded theory, human resource management (HRM) practices, middle manager, supervisor, supervisory function

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Introduction

Middle managers play a key role in organizations. As "active agents at the frontier of control" (Delbridge and Lowe, p. 411), they are responsible for smoothing the workflow, handling exceptions, overcoming unexpected problems, and reaching goals and objectives. They also manage relationships at the workplace and maintain a positive atmosphere. Middle managers are particularly vital to the functioning of agricultural and agribusiness operations, which are often smaller and leaner organizations, with fewer management levels. Middle managers play additional roles in agricultural operations by promoting family business values while fostering employee retention and job satisfaction (Bitsch and Hogberg). Thus, middle managers gain added significance; however, many agricultural and agribusiness organizations have taken middle management's contributions for granted.

In a similar fashion, agribusiness researchers have all but ignored middle management. Except for an ad hoc study on supervisors in the San Joaquin Valley (Billikopf), middle management research is virtually absent from agricultural and agribusiness journals. A recent search for 'supervisor' and 'manager' in the Agricola database turned up no relevant citations. This lack of research is even more notable given the pivotal role of middle managers in agribusiness, since it implies a lack of theoretical insights to support managerial decision-making.

The absence of middle management research in the agricultural sector contrasts with other economic sectors in the U.S. and in Europe. Traditional research focuses on the coordinative and supervisory role of middle managers, as reflected in many human resource management (HRM) textbooks. This role, positioned between senior management and employees, often results in increased stress (Delbridge and Lowe) and role conflict (Hallier and James). Redman, Wilkinson, and Snaper cite one manager as saying, "I find it difficult in some ways because I've seen the management side of things, and what I've got to do as a manager is to keep staff happy, when perhaps I'm not all that happy myself …" (p. 110). Delbridge and Lowe conclude, "Supervisors still hold key, yet contradictory, positions […] and, as with the conflict and resistance they police, their role must be explored rather than assumed or ignored" (p. 424). While there is research on middle management in different sectors, this research lacks a comprehensive model of how middle management functions are accomplished in managers' daily practice. Dopson and Stewart argue that there is "no comprehensive body of theoretical or empirical knowledge on the role, function and responsibilities of the middle manager" (p. 9).

The goal of this paper is to describe the accomplishment of middle management functions through daily practice and to address the gap in research on middle managers in agribusinesses. Drawing on data from case studies of agricultural operations in Michigan, this paper contributes to the theory on the management of agribusiness by highlighting the role of the middle manager in organizations of this

sector. The paper will focus on the practices for managing the key resource in their organizations: people. We will see that while traditional HRM practices—such as discipline and training—are still used by these managers, many of them have developed participative practices—such as accommodation and listening—to cope with the realities of their changing workforce.

The next section provides an overview of the research literature on middle management. After the methods discussion in the third section, the fourth section consists of a summary of findings based on a modified grounded theory approach originally developed by Glaser and Strauss. The final section concludes with a discussion of the theoretical and practical implications of these findings.

The Research Literature on Middle Management

Few studies of middle managers are available in the U.S. agricultural literature. Most notably, Billikopf interviewed 42 farm supervisors in the northern San Joaquin Valley in California in 1995, using a convenience sample. Included were 19 first-line supervisors (foreman, assistant barn supervisor, working herdsman, crew leader, and lead cowboy), 14 mid- to upper-level managers (supervisor, manager, herdsman, and barn supervisor), and 9 farm employers (grower, dairy farmer, and farm labor contractor) in agricultural specializations such as vineyards, dairy, fruit, vegetable, livestock, and agronomic operations. Overall, interviewees were highly satisfied with their jobs (4.5 on a 5-point scale). Yet, 88% of interviewees identified job stressors, with 69% of these involving people management issues, such as organizing and assigning jobs, counselling, disciplining, and terminating employees, or defending company policies.

Bitsch (2006) analyzes the job attitudes of supervisors and middle managers in the green industry, based on a set of case studies with 16 supervisors in 13 operations. Interviewees were less likely to emphasize negative aspects of their work than positive ones. Achievement, job security, supervision, and interpersonal relationships emerged as contributing primarily to job satisfaction. Recognition, the work itself, organization and structure, compensation, and personal life were more ambiguous, contributing to both satisfaction and dissatisfaction. The only predominantly dissatisfying factor was the working conditions. This was mainly caused by the number of hours supervisors had to work in their operations and their lack of scheduling flexibility compared to non-supervisory employees (Bitsch and Hogberg).

European Research Literature on Middle Managers

For non-agricultural sectors, the key streams of the middle management literature can be divided into research on European organizations versus U.S. organizations; these research streams are quite different in terms of basic assumptions about the

role of the middle manager in the organization as well as theoretical paradigms. The European research stream is informed by a critical paradigm (Alvesson and Willmott). European researchers are concerned with the plight of middle managers (Hallier and James), arguing that the outlook for their future is "profoundly pessimistic" (Thomas and Linstead, p. 72). A growing body of research analyses the challenges to professional identities of middle managers (Sims; Sveningsson and Alvesson; Thomas and Linstead). Middle managers are seen as being squeezed both by structural or cultural changes, as well as by technological streamlining (Beatty and Lee; Scarbrough and Burrell). Further, recent initiatives in large organizations (e.g., delayering or flattening of organizations, self-directed teams, total quality management, etc.) have resulted in particular problems for middle managers. Hallier and James point out that organizational restructuring has increased the pressure on middle managers, and hence contributed to managerial identity problems, which is supported by Balogun's findings (see also Balogun and Johnson; Redman, Wilkinson, and Snaper).

By contrast, Delbridge and Lowe state that the purported "death of the supervisor" in the research literature has been greatly exaggerated (p. 423). Still others, such as Ogbonna and Wilkinson in their study of U.K. grocery middle managers, argue that the data regarding the changing role of middle managers are ambiguous. Hales concludes after analyzing data on first-line managers in different industries, "Even those contemplating the 'end of management' (Handy; Koch and Godden) envisage the demise of an organizational stratum, not the abandonment of management as a function: a world without *managers* is not a world that is not managed. The key question is *where,* or *with whom,* the functions of management and supervision reside" (Hales, p. 497). Thus, while the functions of middle managers will not disappear from organizations, European researchers view middle managers as squeezed and saddled with added responsibilities.

U.S. Research Literature on Middle Managers

In contrast, the U.S. research literature has taken a descriptive approach, focusing on roles and functions (Mintzberg, 1973), as well as managerial practices (Yukl, 1998). Mintzberg's seminal work describes three sets of managerial roles: interpersonal, informational, and decisional. Each set consists of several roles, the significance of which varies with the organizational level and context. Interpersonal roles include the figure head, the leader, and the liaison role. Informational roles include the monitor, the disseminator, and the spokesperson role. Decisional roles include the entrepreneur, the disturbance handler, the resource allocator, and the negotiator role. According to Mintzberg, the leader role is most important. The leader role involves interpersonal relationships, motivational activities, and an integration of individual and organizational roles.

Much of the research on managerial practices overlaps with the research on leadership practices. The overlap of these two streams is further confounded by the unresolved question of the difference between a manager and a leader. Yukl (1989) and Mintzberg (2004) use both terms interchangeably. Yet, Mintzberg's discussion implies a distinction between them: "Leadership is supposed to be something bigger, more important. I reject this distinction, simply because managers have to lead and leaders have to manage. Management without leadership is sterile; leadership without management is disconnected and encourages hubris" (Mintzberg, 2004, p. 6).

Yukl (1998) points out that a person can be a leader without managing (e.g., an informal leader) and a manager without leading (e.g., a manager of financial accounts may have no subordinates). He also cautions that the overlap and relationship between management and leadership is an empirical question and may be tempered by definition. While an exhaustive review of the leadership literature is beyond the scope of this paper, a subset of this literature providing a typology of managerial leadership practices and skills is discussed. Mintzberg (1973) categorizes a number of managerial activities as concerned primarily with leadership: (1) staffing—hiring, training, judging, remunerating, promoting, and dismissing subordinates; (2) motivational—advise on personal issues, positive feedback, suggesting action; (3) meddling—pointing out gaps and inconsistencies, critique, and negative feedback. Most of these activities would be considered HRM practices in management textbooks.

Many of the managerial tasks Mintzberg (1973) identifies focus on the people aspects, rather than operational aspects, of a manager's work. This aligns with Pfeffer's notion that people management tasks are vital to effective managers. Yukl (1998), in his frequently cited taxonomy, also highlights people management practices. He details 14 managerial practices: planning and organizing, problem solving, clarifying roles and objectives, informing, monitoring, motivating and inspiring, consulting, delegating, supporting, developing and mentoring, managing conflict and team building, networking, recognizing, and rewarding. Other taxonomies include two-factor (see Schriesheim and Kerr for a review; see Shipper and Davy for a recent example), three-factor (e.g., Yukl 1998), four-factor (e.g., Pearce et al.), and six-factor models (e.g., Avolio, Bass, and Jung).

According to Yukl (1998), most studies produce different behavioral categories that are difficult to compare across studies. Also, different terms are sometimes used for the same behavior, and the same term may cover different behaviors. Yukl notes, "Behavior taxonomies are descriptive aids that may help us analyze complex events and understand them better. However, it is important to remember that all behavior taxonomies are arbitrary and have no validity in any absolute sense. Unfortunately, there has been too much preoccupation with finding and using the 'correct' set of behavior categories. In many of the field studies on managerial

behavior, only a few 'correct' behaviors were measured, resulting in numerous missed opportunities to collect rich, descriptive information about the overall pattern of leadership behavior" (1998, p. 63).

Middle Management HRM Practices Models

Van der Weide and Wilderom also note the rarity of rich observational data about managerial behavior. In their study, they videotaped actual behavioral interactions of 30 highly effective managers from 20 Dutch organizations, and analyzed these videotapes. Their model is unique since it is based on in-situ observations of managers deemed highly effective. The model describes four categories of behaviors: steering behaviors; supporting behaviors; self-defending behaviors; and sounding behaviors. These managers used three behaviors most often: providing direction (categorized as a steering behavior); verifying (categorized as a steering behavior); and providing positive feedback (categorized as a supporting behavior). They note that sounding behaviors and self-defending behaviors have rarely been reported in the leadership literature.

Compared to the research described in the prior section, the model that Van der Weide and Wilderom propose includes a wider range of behaviors. They conclude that these effective managers have what they termed a "rich repertoire of behaviors to draw upon" (p. 12), since they do not limit themselves to behaviors of a single category or rely solely on "positive" behaviors.

In another study, Hamlin asserts that there are universally effective managerial behaviors based on case studies of three U.K. public sector organizations using interviews and questionnaires. He also describes a continuum of criteria for managerial effectiveness, which range from positive (effective organization and planning or proactive management; participative and supportive leadership or proactive team leadership; empowerment and delegation; genuine concern for people or looks after the interests and development needs of staff; open and personal management approach or inclusive decision making; communicates and consults widely or keeps people informed) to negative (shows lack of consideration or concern for staff or ineffective autocratic or dictatorial style of management; uncaring, self-serving management or undermining, depriving, and intimidating behavior; tolerance of poor performance and low standards or ignoring and avoidance; abdicating roles and responsibilities; resistant to new ideas and change or negative approach). In contrast to Van der Weide and Wilderom, Hamlin suggests that managers need to exhibit positive criteria to be considered effective and will be considered ineffective if they exhibit negative criteria, implying a more conventional view of effective managerial behaviors.

Both models focus on the behaviors of highly effective managers, as well as the types of skills that should be developed to be effective as a manager. Although not cited in either paper, these models exhibit parallels to McGregor's Theory X and

Theory Y (1960). McGregor argues that a manager's approach to managing subordinates is explained by underlying assumptions about human nature of two different kinds. A Theory X manager assumes that subordinates need to be watched constantly, because they are unwilling to take responsibility and prefer not to work. A Theory Y manager assumes that subordinates are hard working and willing to take responsibility for their work, and need only support and encouragement. Certain HRM practices stem from Theory X assumptions, such as discipline and close monitoring, whereas other practices, such as providing information and goal setting, rely primarily on Theory Y assumptions. McGregor believes Theory X managers are less effective, in part because their traditional HRM practices are based on a set of limited assumptions, whereas Theory Y managers also include participative practices.

The organizations researched in the Hamlin and Van der Weide and Wilderom studies were large UK and Dutch organizations where managerial development and training are a priority, and managerial effectiveness is deemed highly desirable and rewarded. This contrasts rather starkly with managerial training in the organizations that are the focus of this study. Agricultural operations are, on average, smaller and have fewer hierarchical levels. In addition, seasonal variations in the number of employees are common. Furthermore, the dependence on weather, volatile markets, working with living organisms, the specific characteristics of the agricultural workplace, such as long hours and physical hardship, and the unique workforce, with its large proportion of temporary employees, contribute to great uncertainty. Although middle management is becoming more important as farm sizes increase, training and development in agriculture has traditionally focused on technical aspects of production and neglected HRM skills and practices.

This paper, therefore, presents a set of HRM practices based on data from agricultural operations (Table 1).

Table 1: Agricultural Middle Managers' HRM Practices

Participative HRM practices	Traditional HRM practices
Accommodating employees	Reprimanding employees
Managing relationships with employees	Training employees
Providing information and goal setting	Monitoring and controlling employees
Listening to employees	Dealing with conflict
Providing appreciation and feedback	
Rewarding employees	
Modeling work behavior	
Peer control	
Manager-induced team building	
Training by coworkers	

Because the analysis is based on interviews with managers rather than observational data, this set of HRM practices does not include the self-defending behaviors that are part of the Van der Weide and Wilderom model. Furthermore, categories of managerial behaviors of agricultural middle managers were inductively developed to fit the data, as opposed to testing a model using data from agricultural middle managers. However, for categorizing the practices discussed by the interviewees, we borrow McGregor's terms participative versus traditional, although he did not specify HRM practices, accordingly. Before discussing the managers and their practices in the results section, the next section will describe the methods used in collecting and analyzing data.

Research Methods

Given the lack of research on middle management in agriculture, and Yukl's (1998) critique of many leadership studies as failing to collect rich and descriptive information, this study relies on a qualitative approach. In particular Parry et al., and also Hamlin call for more qualitative research into managerial and leadership behaviors and suggest using a grounded theory approach. Grounded theory is an inductive approach to developing theory in the social sciences, first proposed by Glaser and Strauss (see Clarke for recent developments in grounded theory). Grounded theory can be considered the master metaphor of qualitative research (Bitsch, 2005), used by numerous researchers in a variety of fields in many different ways. For this study, its distinctive approach to data analysis, and in particular, the constant comparison method, is most relevant. Differing from the original grounded theory approach, mixed approaches have become common as qualitative research has grown more prominent in a variety of fields (Charmaz).

In the absence of a theory of middle management, research needs to start with empirically based variable development and theorizing based on data (see the discussion among Sutton and Staw; Weick; and DiMaggio in Administrative Science Quarterly on the difference between theory and theorizing). Therefore, a prerequisite to developing a theory of middle management practice is an interpretive description (Geertz) of middle managers' use of HRM practices. This exploratory research focuses on what specific practices they use (and do not use) and how they accomplish their functions. Relating to grounded theory, this study will develop substantive theory rather than formal theory, and should be positioned with "grounded theorizing" approaches (Clarke, p. xxxiii) rather than purist grounded theory (Suddaby).

Many of the middle manager studies described in the literature section use qualitative research approaches. Case studies of one or more organizations, employing in-depth interviews with middle managers as a stand-alone method or in conjunction with other methods, have been used by Balogun; Balogun and Johnson; Delbridge and Lowe; Hallier and James; Huy; and Ogbonna and Wilkinson. Case

studies of one or more middle managers were carried out by Sims; Sveningsson and Alvesson; and Thomas and Linstead. Recent examples using the case study research method for studying HRM practices in agriculture include Mugera and Bitsch; and Bitsch and Hogberg.

The in-depth interviews analyzed in this paper are part of a set of 14 case studies of HRM practices in agricultural operations (four greenhouse operations, four landscape contractors, and six nurseries). The use of qualitative case studies has been advocated to increase methodological pluralism in agribusiness and agricultural economics research in a number of recent publications (Kennedy and Luzar; Sterns, Schweikhardt, and Peterson). The case study method is particularly well-suited for contemporary phenomena focusing on the perspective of the actors involved (Westgren and Zering). Therefore, for the purpose of describing the accomplishment of middle management functions in managers' daily practice and theorizing about agricultural middle management, the case study method seems especially suitable.

All participating agricultural operations were located in Michigan. The size of these organizations varied, ranging from 1 to 400 employees. The wide range includes seasonal adjustments necessary to this industry. Site visits took place between March and May 2003. The sample of interviews analyzed consists of a total of 15 supervisors and middle managers from 12 different operations. In one of the 14 cases the interviewee perceived herself as a supervisor, but her functions were not comparable to those of other interviewees. In another case the interviewee was reclassified as a senior manager after carefully analyzing the interview. Of the 15 interviewees included in this analysis, 12 are male and 3 are female.

Interviews followed an interview schedule with open-ended questions, and lasted between 45 minutes and over 2 hours. After establishing rapport with the interviewees, the interviewer inquired about job tasks, HRM practices, supervisory behaviors, relationships with other employees and managers, input in decision-making, and job satisfaction. Respondents were encouraged to provide in-depth answers through probing. The order of the questions was adapted to the flow of answers. Topics brought up by the interviewees were explored further.

All interviews were tape-recorded and transcribed. Data coding and analysis were based on the transcripts. The purpose of coding is to enable the comparative analysis of each interviewee's comments within each interview and with each other. For this purpose all comments pertinent to a particular topic under analysis were labeled with a specific heading or code. This is necessary when using in-depth interviews for data collection because respondents may address a question multiple times and in different contexts. Therefore, data addressing a specific research question needs to be identified throughout the transcript of each interview.

Coding is iterative. A coder reads a transcript several times and goes back to comments coded earlier and recodes them if appropriate as the analysis develops. The final decision on coding is suspended until all relevant material has been coded and all comments with the same code have been compared to each other. With more than one coder, the final analysis and interpretation will include the discussion and resolution of any coding differences. For this analysis, transcripts were coded by both authors independently before moving to the interpretation phase. This initial round of coding was followed by four additional rounds as the analysis progressed.

Results

As little is known about agricultural middle managers, we first present basic information about them and their decision-making authority. Next, we analyze the practices they use in managing people. These practices are classified into two groups, traditional HRM practices and participative HRM practices. These latter practices have adapted or built on traditional practices, or been developed to cope with workplace demands and a changing workforce.

Basic Characteristics of the Middle Managers

Similar to previous research (explicitly by Delmestri and Walgenbach; Dopson and Neumann; Dopson and Stewart; Ogbonna and Wilkinson; Redman, Wilkinson, and Snaper; implicitly by Hamlin; Osterman), the organizations' designations of their middle managers were used for this study. While many researchers treat the definition of the terms 'middle manager' and 'supervisor' as unproblematic (e.g., Batt; Delbridge, Lowe, and Oliver; Hallier and James; Harrington and Williams; Sims; Van der Wilde and Wilderom; Zaccaro and Banks), in reality the terms can reflect numerous formal positions in an organizational hierarchy (Delbridge and Lowe), job titles notwithstanding. According to Hales, supervision is "the proximal and immediate direction, monitoring and control of operational work" (p. 474). Thus, supervision is integral to any managerial position with subordinates.

In the request for an interview, the researcher asked to talk to "a supervisor, someone who manages others, is in charge of managing employees." In most cases, the designated interviewees did not include first-line supervisors, who were more likely to be included in the group of non-supervisory employees. However, this issue is problematic in seasonal agricultural operations, because the number of employees supervised varies by time of year, as well as by task. Therefore, a middle manager with no subordinates during the winter months might oversee a large department with 30 or more employees during the summer.

Table 2 shows the job titles provided during the interviews by each interviewee. Of these, two interviewees did not specify a title (indicated by parentheses). As noted in the table, the titles vary widely and are not reflective of other indicators of

Table 2: Job Title, Middle Manager Characteristics, and Number Supervised

	Title	Years Employed	Years in Position	Training	Number Supervised
M1	Foreman	36	10	None	1 to 20 employees, with foremen on larger tasks
M2	Crew leader	9	0.5	None	4 to 6 employees
M3	Grower Manager	1.5	1	S	6 departments, over 100 employees seasonally
M4	(Supervisor)	25	15	None	1 to 10 employees
M5	(Supervisor)	4	4	P	15 to 200 employees
M6	Foreman	3	3	S	1 to 6 employees
M7	Manager	4	4	P/S	30 to 50 employees, with 5 foremen
M8	Manager	17	17*	S	10 to 50 employees, with foremen
M9	Coordinator	13	13	None	Up to 35 employees seasonally, with 7 foremen
M10	Manager	8	8*	None	6 to 12 employees, with 2 to 3 foremen
M11	Supervisor	10.5	8.5	None	20 to 30 employees
M12	Manager	30	30*	None	Over 75 employees seasonally, with 3 managers, 4 to 5 foremen
M13	Office Manager	22	20	None	2 to 4 employees, and a varying number of truck drivers
M14	Supervisor	20	1**	None	2 to 30 employees
M15	Supervisor	3	3	P	50 to 80 employees, with 4 crew leaders

*Held same job title, but additional responsibilities were added over the years
**Was a supervisor upon entering the organization, but spent most of time in sales
P = Training provided by previous employer
S = Seminars, workshops provided by current employer

managerial responsibility, such as the number of people supervised. But the job titles roughly indicate the distance of the middle managers from the top level of the hierarchy, i.e., a crew leader ranks below a manager.

Table 2 also provides the number of years each middle manager has been employed with the organization and the number of years in the position designated. Asterisks in Table 2 indicate managers who did not change job title, but nonetheless performed additional responsibilities over the course of their employment. The number of years in the organization and number of years in the job are both proxies

for a manager's experience; however, several of the interviewees noted during their interviews that they had previously been employed in supervisory positions or owned a business themselves, which indicates additional management experience.

The next column in Table 2 indicates the amount of training that each manager has had. Some of the managers received training from a previous employer (typically consisting of training workshops or seminars). These managers have a 'P' in the training column. For example, one such manager had 10 years of managerial experience in a non-agricultural industry. Other interviewees indicated that they had received training in the form of seminars or workshops on supervisory issues from the current employer. These managers are indicated with an 'S' in the training column. The majority of the managers had no formal training, but some mentioned that they had learned from their own experiences on the job. One middle manager, when asked about training, responded "sink or swim" (M14). Furthermore, for those interviewees who indicated any form of training, it was often minimal and neither formalized nor intensive.

The final column of Table 2 shows the range in the number of people supervised by each interviewee. As noted above, the size of the workforce varies widely throughout the course of a year. Some operations retain only key personnel during winter months (typically including the middle managers and an office person). Other operations try to keep a core crew employed, including some team members in lower ranks. Still others employ a larger permanent workforce by investing in machinery and/or buildings to enable a more continuous workflow.

Much of the European research literature highlights alienation and disenchantment on the part of middle managers (e.g., Hales; Hallier and James), yet most of the agricultural middle managers interviewed identified closely with their organizations, their direct managers, and their CEOs. Many spoke about their organizations in terms of "us" or "we," indicating management or their organizations as a whole. In addition, most interviewees could hardly imagine a situation where they might accept a different job offer. Reactions ranged from "I wouldn't" (M12), "If the place closed" (M10), "If something drastically changed" (M3) to "A lot more money" (M8).

Middle Managers' Functions and HRM Practices

Agricultural middle managers are different from middle managers in other industries, and there are several possible reasons for this difference. In some organizations, they have assumed more authority for HRM decisions because their organizations are flatter. Many organizations have never grown elaborate, bureaucratic structures and therefore, have no need for delayering. These issues can be examined by analyzing middle managers' organizational functions and

decision-making authority. Also, middle managers could depend more on informal management practices than formal authority within agricultural organizations. Table 3 shows several indicators of the decision-making authority of middle managers. Their input into HRM decisions (selection, evaluation, discipline, and termination of employees) varies widely. Four out of fifteen managers are not asked by their managers for input regarding selection. At the other end of the spectrum, seven managers make hiring decisions. Four businesses do not evaluate employees and two businesses evaluate rather informally. Where evaluations are done, middle managers are likely to have input, as only one interviewee was not involved. One manager pointed out that her department had never disciplined or terminated an employee. Three additional managers said they had never terminated an employee, but may have moved employees to other departments or divisions. A third of the interviewees made suggestions regarding disciplinary actions to upper management, but their suggestions may or may not be heeded.

Table 3: Middle managers' authority in major HRM decisions

Middle Manager	Selection	Evaluation	Discipline	Termination
M1	No input	Input	Suggests to upper management	No input
M2	No input	No Input	Suggests to upper management	No input
M3	Yes, with input	Yes	Yes	Yes
M4	Input	Not done	Suggests to upper management	Yes, but not done
M5	Input	Not done	Yes	Input
M6	No input	Input	Suggests to upper management	No input
M7	Yes	Input	Yes	Yes, but not done
M8	Input	Input	Suggests to upper management	Input
M9*	Input	Input	Input	Input
M10	Yes	Yes, but informal	Yes	Yes, but not done
M11	Yes	Yes, but informal	Yes	Yes
M12	Yes	Currently not done	Yes	Yes
M13	Yes	Currently not done	Yes, but not done	Yes, but not done
M14	No input	Input	Yes	Input
M15	Yes	Yes	Yes	Yes

*Member of the management team that makes HRM decisions

Some middle managers have little input into any of these HRM functions (e.g., M1, M2, M6), whereas others (e.g., M3, M10, M11, M12, M15) have full decision-making authority. Based on the managers interviewed, there is no obvious connection between job or management experience (Table 2) and decision-making authority (Table 3). As shown in the following tables, those middle managers with little input have developed informal practices for managing their subordinates effectively. Even more surprisingly, the managers who have full decision-making authority also rely more on informal practices. In addition, input into major HRM decisions does not seem to influence managers' identification with the business, nor their commitment to staying with their current operations.

Given the wide range of HRM decision-making authority across the middle managers interviewed, how do agricultural middle managers keep the work flowing smoothly, overcome problems, and maintain amicable relationships with and between employees? Tables 4 and 5 provide an overview of the HRM practices being used. Each practice is briefly described in the first column, and an example from the interviews is presented in the second column. These excerpts present a glimpse of the reality of the interviewees, as well as the richness of the data.

Since there are many tasks inherent in management jobs it is difficult to identify the full range of possible HRM practices. Further, many of the tasks tend to be points on a continuum, rather than discrete categories that can be readily distinguished one from the other. For example, a manager might communicate with an employee about a deadline for a particular task. However, this type of communication could also be described as feedback, since the manager might mention that this deadline is "more firm" than the deadline for a previous task that the employee had missed. Finally, this communication could also be an opportunity for on-the-job training, as the manager might indicate how the employee's work speed can be improved. Thus, these categories are not meant to be exclusive, but instead present the full range of the practices the middle managers described in their interviews.

Practices have been classified as traditional based on their correspondence with traditional HRM functions as discussed in textbooks. However, these functions were adapted to specific agribusiness contexts, as well as to the middle management level, because the decision-making authority of many of these managers is rather limited (Table 3). For example, the labor relations function typically arises in dealing with conflict, not in formal union contracts. Table 4 outlines the traditional human resource practices used. In contrast, managing relationships with employees is classified as a participative practice (Table 5, *see Appendix A*) because the way it is used has little in common with traditional approaches to labor relations.

Table 4: Description of traditional HRM practices and interview excerpts

Traditional HRM Practices	Interview Excerpt
Reprimanding employees. Activities criticizing employee behavior targeted at changing behaviors including informal approaches, e.g., "giving a talking to," and yelling, as well as formal discipline up to and including termination; reprimanding may include not applying formal discipline in certain cases.	"We worked him very hard that day. If you want to play with fire, you are going get burned. If you want to go out and drink and not be ready to go to work first thing Monday morning when you should be alert. He dug a few holes that day, where he could have done it with a machine … So, I think that's, you know, kind of tough love type thing, so I thought was more than fair" (M6).
Training employees. Activities targeted at familiarizing new employees with their tasks and their work environment and the use of safe work methods, including an initial orientation; showing employees different and/or safer ways to complete tasks on-the-job or arranging for the employee to participate in off-site training; mentoring of employees.	"No, you got to have somebody that can think, training, thinking. It is a teaching job, maybe more so than agricultural. … I kind of like when I get someone new, I always work with them, at least to show them what I expect or so that they have knowledge as to what they are doing. You'd think it is simple, but everyone is different, you know. … But, I work with what I got. Every year it is like spring training in baseball, I'd start all over" (M1).
Monitoring and controlling employees. Activities of assigning tasks, and collecting data on employee work performance, quantity and quality of task completion and outcomes, checking how and when tasks are completed, checking work results against expectations or standards.	"In the morning, I start with small groups. Like this morning, I had about five to six groups, and I direct certain people to go with so and so. And after that I walk around and make sure the work is getting done and also the way they are doing it" (M9).
Dealing with conflict. Activities targeted at moderating or resolving conflict between employees, or between an employee and his or her supervisor.	"You got to be able to get along with your fellow employees whether you like them or not …. I try to explain that to people when they are not getting along, but try to avoid conflict if you can. But other times you got to put people with people that don't like each other and you can explain to them that that's the way it's got to be" (M4).

The classification of practices used by these managers as traditional and participative is not unambiguous. As noted, practice use is a continuum: some traditional practices have been adapted and changed and have, therefore, become more participative, while their original forms are also still used. For example, providing feedback (Table 5, *see Appendix A*) can be interpreted as employee evaluation (a traditional HRM function). However, showing appreciation and providing informal feedback is a conscious choice of many of the middle managers interviewed, often in contrast to upper management. Where a formal evaluation is provided in addition to the informal techniques, this is also included with the participative practices, because formal evaluations are rather uncommon in the industry. In addition to far-reaching modifications of traditional

practices, other participative practices have been developed as a supplement to or replacement of traditional practices by some managers.
Table 5 outlines the participative HRM practices used by the managers interviewed. An example is accommodating employees, where the manager considers opportunities to increase the fit between the requirements of a workplace and an employee. It includes rotating task assignments to decrease boredom or physical strain, allowing flexibility in schedules and work methods, and assigning an employee to a different job than he or she was originally hired to perform. All interviewees were familiar with this practice and used it to some extent.

The HRM practices outlined in Tables 4 and 5 are ordered according to the frequency with which the middle managers interviewed talked about these practices and the number of examples of each practice they provided. The practices with the highest number of comments are accommodating employees, reprimanding employees, managing relationships with employees, training employees, providing information and goal setting, and listening to employees. It is notable that both traditional (reprimanding, training) and participative HRM practices (accommodating, managing relationships, providing information and goal setting, listening) are used with high frequency by these managers. Although we do not have observational data regarding the actual use of these management practices, more frequent comments on a practice and more examples provided are an indication of salience of use.

Each middle manager interviewed described a different combination of practices (traditional practices, as well as participative practices), and talked about some practices more frequently than others. Ranked according to the frequency of their comments on the HRM practices described in Tables 4 and 5, there are three groups of managers: (1) managers who know and are likely to use all or most of these practices and are able to provide many examples of their use, (2) managers who use some practices frequently and can provide examples, but do not or rarely use others, and (3) managers who use practices infrequently and can provide few examples. The third group is likely composed of 'reluctant managers.' Although some managers in this group are inexperienced, there is no obvious correlation with management experience, which could explain the reluctance of some interviewees to employ a broad array of management practices. An example of this group is a manager who thinks of administering discipline as being "mean" to people (M2).

The last three practices in Table 5, although not used by all managers, lead to an interesting observation. Middle managers do at times step back from using their formal authority and relinquish control to their work teams, as predicted by Hales in the context of industry restructuring. Some even go so far as to induce teams to take on more responsibility by using specific team building exercises. While these practices may seem like post-hierarchical approaches, they are mostly used to

relieve the manager of some tasks and free up time during the seasonal peak when organizations are working at capacity.

Conclusions

This study provides a much-needed research contribution to a neglected topic. Middle managers play a vital role in agribusinesses and will not "die out" anytime soon despite the dire predictions of some researchers. These managers occupy the "common ground of middle management responsibility" (Delmestri and Walgenbach, p. 205), which is the capacity and/or responsibility to handle exceptions, solve unexpected problems, reach objectives, and maintain a positive social environment.

HRM Practices

There are two key themes in the findings of this study: one theme related to HRM practices, and another to training. The HRM practices employed by the middle managers in our study range from the more traditional to the participative. Rather than relying chiefly on traditional practices (based on Theory X assumptions) or chiefly on participative practices (based on Theory Y assumptions), middle managers selectively apply practices of both types as appropriate. As a result, the spectrum of HRM practices discussed is wider and more sophisticated than expected based on the dichotomous distinction of McGregor's Theory X versus Theory Y. Thus, while we have categorized the HRM practices as "traditional" and "participative," the middle managers themselves cannot be categorized in this manner. These results correspond with Van der Weide and Wilderom's findings that effective management is not limited to "positive" behaviors, but frequently includes traditional practices such as reprimanding employees.

Delmestri and Walgenbach did expect U.S. middle managers to resemble British managers who avoid getting involved with technical problems and constitute a separate management class. However, many of the participating agricultural middle managers were more like the German and Italian managers in their study, who view themselves as first among equals in work procedures, steeped in technical competency. This greater involvement in technical work issues may be a result of the nature of work in the agribusiness context.

The results reported here also provide an empirical counterpoint to the description of middle managers as resistant to organizational change (Fenton-O'Creevy) or forced by senior management to impose unwanted change on subordinates (Hallier and James). Most interviewees show a remarkable degree of identification with senior management and with their organizations, notably different from previous findings published in the organizational identification literature (e.g., Sims; Sveningsson and Alvesson; Thomas and Linstead). Further, they are also initiators

of change, improving their workplace and the workflow as they see fit. The majority of the interviewees listen to what employees have to say or even actively elicit employee input and suggestions, as part of their HRM repertoire.
Interestingly, these middle managers differ widely with respect to their input into key HRM decisions, such as selection, evaluation, discipline, and termination. Only part of this variation can be explained by the variation in hierarchical levels or in experience. Middle managers' involvement in these decisions also depends on senior management's attitudes toward participation. But this question requires further research. Operations may benefit from involving middle managers in key HRM decisions to a greater extent, since this is likely to increase their effectiveness day-to-day.

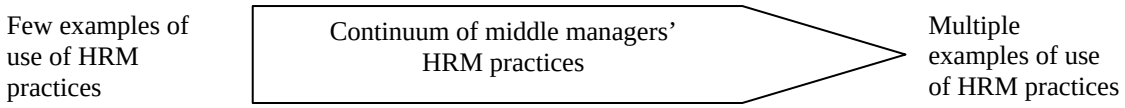

Figure 1: Middle Managers' Knowledge of HRM Practices

Thus, overall, the participating middle managers are active contributors to their operations and command a rich array of management practices. For particular individuals, however, this is not necessarily the case. Similar to Hamlin's findings in public sector organizations, some agricultural middle managers describe only a limited repertoire of HRM practices as compared to others in this study. In addition, our research revealed a group of managers who fall between these two groups—they do not command the fullest range of practices, but exhibited more than a few practices. Rather than a group of Theory X managers versus Theory Y managers, agricultural middle managers appear to range across a continuum (Figure 1). Some managers described few of any type (either traditional or participative) of HRM practices; this group is located at the left of Figure 1. At the other end of the continuum, other middle managers described a full range of practices. The distinction among the participating middle managers is not based on the type of HRM practice, but rather on the number of any type that they described using. We would argue that the managers exhibiting the widest range, with their superior sets of HRM practices, have more resources at their disposal to cope with a broader range of issues and problems. But all managers interviewed could benefit from further training, as we argue in the next section.

Managerial Training

While most middle managers participating in this study had little or no training, the data show that overall these managers' HRM practices span a rich and broad array of practices. This sophistication is also echoed in a commitment to valuing employees in practice. However, the wide range of practices should not be

interpreted to signify that agricultural managers could not benefit from managerial training. While some managers use the complete set of management practices described, others are less flexible and command only a small subset. Thus far, agricultural operations have not increased their training efforts significantly, although there is a growing awareness of this need by senior managers. Similar to other industries, both novice and experienced agricultural middle managers would benefit from professional development opportunities. For example, after HRM workshops organized for agricultural managers by one of the authors, experienced managers often point out how the discussion of practices they were using (and of alternative practices) helped them to further develop their management approach.

Management training can provide outside validation of HRM practices adopted to accomplish organizational and personal goals. This would relieve some of the anxieties of inexperienced managers, who might otherwise be reluctant to assume a management role. In addition, when first appointed to a supervisory position, future managers often struggle (Bitsch and Hogberg). Focus group discussions with agricultural managers show that managers at all levels can benefit from educational seminars and workshops on HRM functions, including selection, training, legal issues, discipline, and termination (Bitsch 2004, Bitsch and Harsh, Bitsch et al.). For example, when workshops included high-involvement management practices, those with experience were able to share examples with other participants, who were eager to hear about practical applications. Managerial training can reinforce effective practices of experienced managers, further broadening their repertoire, as well as assist them in training assistant managers for succession.

The industry could also benefit from strategic managerial training to better align HRM practices with industry characteristics. Since the organizations studied operate in highly seasonal Midwestern industries, their management differs in many ways from operations with a more continuous workflow. For example, there is less need for terminating employees, because underperforming employees can simply be given fewer work hours and/or not be rehired for the following season. With respect to performance, the same process often replaces formal discipline. Managerial education tailored to the industry could emphasize using feedback to increase performance, while reducing resistance. Hence, managers would be able to use industry characteristics often deemed unfavorable, such as seasonality, to their advantage. In addition, managerial training designed to increase their sophistication and become more efficacious in their jobs would reward these key actors in the agribusiness industry and be beneficial to both the managers and their organizations.

Future Research

Although this study addresses a neglected research area, there are several limitations for future research to overcome. The small sample allowed us to understand the HRM practices these middle managers employ and provided insightful examples. However, future research should move to larger samples, building on the foundation laid here. Representative studies of one or more agricultural sectors, including different states in diverse production regions, would allow more generalizable findings about middle management in agriculture.

The results are specific to this industry with its peculiar characteristics (lean organizations, seasonal workforce, family ownership). To determine the extent to which these findings apply to industries beyond agriculture requires further testing. Within agriculture, very large and less seasonal operations (e.g., pork producers) would allow for testing relationships among performance indicators, business characteristics, hierarchy levels, and managerial practices. In addition, a larger sample representing a cross section of the industry would allow for testing relationships between manager characteristics, such as experience and management training, and their decision-making authority, as well as variety in, frequency of, and preference for HRM practices used.

Middle managers are crucial to agribusiness with its lean organizations—often family-owned and operated—and its seasonal workforce. Considering the key role middle managers play in accomplishing work objectives, it is surprising how little attention middle management has garnered in agribusiness research. Describing middle managers' HRM practices is the first step toward a model of HRM practice use of agricultural middle managers. Moreover, describing the concrete practices middle managers employ contributes to the literature beyond agriculture, since published descriptions of what middle managers do are generally vague and unspecific (Hamlin; Van der Weide and Wilderom). Hence, this study also serves as a foundation for future research on HRM practices in agribusiness, as well as other industries.

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Appendix: A

Table 5: Description of Participative HRM Practices and Interview Excerpts

Participative HRM Practices	Interview Excerpt
Accommodating employees. Allowing for flexibility in employees' schedules, work assignments, and work methods; rotating work assignments to make work more interesting or fitting work assignments to employees' skills and preferences; accommodating health problems or unwillingness to work in teams, in a specific team, or with a specific person.	"We look at who works good with certain people. Some people don't like to work with certain people and ah, so we try to get them to, that they like to work together. So that when at the end of the day, they are not, a lot of times we have two or three people working together, some crews we have like 12 on a crew. But, when we have two or three people working together, we try to get the people that like each other or get along with each, it don't happen all the time, but we try to do that so that their daily routine is, they get along" (M12).
Managing relationships with employees. Managers frequently perceive tension between being a supervisor and being a friend and work on striking the right balance, including showing respect to employees and being respected, caring about them, showing or losing patience, or limiting or welcoming joint activities outside of the workplace.	"I would say our relationship … is very formal to be honest. Everybody was wonderful and friendly to me when started and I felt very comfortable with them, but as I became a supervisor and then manager, I think … it was very easier for me because I didn't have long steady relationships with people here. … I continued to keep that separation and you know, just for example, certainly if somebody has a member of their family pass away, I will always go to the funeral home. I would do, what I would normally do as a person. But extended invitations to go to somebody's home or something like that it's something that I shy away from" (M3).

Table 5: (Continued)

Providing information and goal setting. Sharing information about the business and the work plan, communicating work goals and overall goals, letting employees know exactly what is expected, changing work processes to improve safety or make work easier.	"I try to always keep them informed.… Like if we have a special order that needs to get out in the beginning of the week, I tell them, you know this is an important order we need to get out, let's work together to try to accomplish this and get things done so that we can all prosper and get ahead of this. But as far as we are talking about goals, usually at the end of the year, I will sit down and write down the goals for the employees. You know, every employee is different. So, I will write down different goals for each employee" (M15).
Listening to employees. Activities targeted at collecting information and input from employees, ranging from observing whether they are comfortable with their work or showing any health problems, through encouraging questions, taking suggestions and criticisms from employees, and being open to being approached with any problems.	"I walk around 3 or 4 times a day. I often come in on the weekends as well and what I would do is simply go to people and say, is there anything in your mind that you would like to share with me? On an informal basis I probably get the majority of the information that way. People will not speak out in a group no matter how good a team they have. Some people are just too shy. A small portion comes up in a team environment; a lot of it comes up in those informal walks around. There have been times when people just stop and say, I have got an idea, why don't we try this kind of thing?" (M3).
Providing appreciation and feedback. Thanking employees for their job in general or a specific task completed; specific feedback addressing job performance, up to and including informal and formal evaluation, but not in a training context.	"I try to tell them if they are doing a good job. You know, I will say something to them. And … like with [the CEO], he's you know, he is way up here, you know, so I'm in here telling them, … 'cause they do do a good job, … people do 138 percent of what they were supposed to do. I mean that's a good job. And it shows, that's why it is up there, they did 130, … they did a good job and it is showing everybody else who takes a break in here, they are doing a good job and who is doing it" (M14).
Rewarding employees. Providing employees with unexpected breaks or early time off, or rewards for their performance, e.g., food or drink, presents for a special occasion; but not including wage increases, which are beyond the decision-making authority of a typical middle manager.	"I like to treat them. I bring in candy and some biscuits and they love that. So, in here, you do things to motivate them. What they like is, motivate them and lets them do some better work and they get to like you and they wanna do good for you. To make you look good" (M2).
Modeling work behavior. Manager functions as a role model of desired work behavior, works along with employees, and is knowledgeable about each task.	"I try to set the pace myself. I'm not one of the guys that, I don't stand there and just tell everybody what to do, I work right along with them, you know. So, I work faster to try to get them to work faster" (M4).

Table 5: (Continued)

Peer control. Manager's use of peer pressure to coerce an employee to adapt to desired behavior and work speed, or to exit the work unit or organization, if the desired fit or behavior is not accomplished.	"I can think of a few cases where people come and they'll work maybe a couple weeks and they just don't fit in. You can tell and I think some of them, maybe the workers that do work here made them feel uncomfortable enough where they just quit. I mean they could tell that they weren't fitting in or whatever" (M4).
Manager-induced team building. Activities targeted at integrating employees into productive teams and work processes; fitting employees within the organizational culture and transmitting unspoken norms; socialization in so far as it is a conscious effort by the manager, but not reliance on other employees to do so (peer control, training by coworkers).	"I usually try about once a month to do, we have weekly staff meetings, but usually in one of those staff meetings, once a month involve some kind of teamwork building exercise. So, it's really my goal to continue doing that. We do everything from the yoga, to here is some stuff and see who can build the tallest structure, to things that are a little bit more involved. So, I would like to continue to do that for some time. It seems in terms of the people that we have here I have noticed that people are staying longer. For some period of time we had a little bit more turnover but that has really decreased" (M3).
Training by coworkers. In addition to or instead of training through the supervisor, coworkers are put in charge of training a new employee, mostly through modeling the appropriate work behavior and basically completing the task in the presence of the new employee.	"When they come in to punch in, in the morning, they are introduced to all the foremen and as they come out, you know, we'll tell them, you know, you go out with the rest of the guys; they'll find something for you to do. … They'll start sweeping, they'll start greasing machines, getting the day rolling, so-to-speak. And most people that we've had in here follow along very well. So that is the type of training they get. If they can see it and see other people doing it, then they follow along for the most part" (M6).

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Determinants of U.S. Textile and Apparel Trade

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Abstract

A gravity model using panel data is applied to determine factors affecting textiles and apparel trade flows into the United States. The study confirms that a nation's aggregate output and per unit productivity serve as important determinants of textiles and apparel trade into the U.S., and the exporting country's depreciating exchange rate as well as its lower prices relative to U.S. prices for textiles and apparel play an important role in determining textiles and apparel trade flows to the U.S. market. Since the WTO's multilateral trade restraining policies of the multi-fibre arrangement (MFA) is found to have slowed down imports, its abrogation in 2005 should lead to greater textiles and apparel imports to the U.S.

Keywords: brand equity; brand valuation; real options; food firms; growth option value

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Introduction

For the past twenty years, U.S. textile and apparel industries have faced challenges related to increasing trade flows from foreign producers that sell their products at relatively lower prices. Therefore, the U.S. industry complex stands to lose its once strong hold on the U.S. domestic market, at least in part because recently negotiated trade agreements have provided freer access by foreign producers into the U.S. market. For years, the industry had been a thorn in the side of policymakers attempting to do the right thing by liberalizing textiles and apparel trade. Trade agreements and other trade liberalizing initiatives have had to be abandoned, curtailed, or saddled with red tape to accommodate the industry's unwillingness to compete. According to Ikenson (2005), the time has come for the Bush administration to cut the textile industry lobby's cord. He states further that the industry complex has used threats and extortions to achieve its objective of protectionism, often saddling consumers with stealth taxes, and dragging down market prospects for other industries.

Trade flows are generally determined on the basis of the principle of comparative advantage in a free trade system (Salvatore, 2004, p.35). Gelb (2005) writes that as trade barriers are further removed, lower wage rates in developing countries along with labor-intensiveness of textile and apparel manufacturing would give developing countries a comparative advantage in textile and apparel manufacture. Thus, we expect textile and apparel manufacture to continue shifting to developing countries following trade liberalization. The Economic Research Service of the U.S. Department of Agriculture, in its briefing room on cotton, also states that competition with imported products has reduced capacity in the U.S. textile and apparel sectors, and the domestic textile industry no longer consumes the majority of the cotton produced in the United States. As a consequence, analysis of the U.S. textile and apparel industries is an important part of understanding cotton production and prices

.

Despite such anecdotal evidence, there is paucity of research on trade flows of textiles and apparel manufacture. Therefore, the determinants of trade flows for the sector and their economic implications are not clearly understood. Accordingly, the objectives of this study are to evaluate factors affecting the value and direction of textile and apparel trade flows into the U.S. from leading exporters. Special attention is given to deriving implications arising from textiles and apparel trade for U.S. agribusiness. The rest of the paper is organized as follows: in the first section, we provide background information on the textiles industry complex. In the second section, the rationale for using the gravity model in determining trade flows of textiles and apparel is presented. In the third section, we present the reduced form of the gravity model that is applied to statistically evaluate the determinants of trade in textiles and apparel to the United States. In the fourth section, we provide information on data sources and estimation procedure. The fifth section

presents the results, and the sixth section offers concluding comments and implications from the study.

Background

By gleaning U.S. Department of Labor data, in 1994 the U.S. textile and apparel industry complex employed about 1.5 million workers. Additionally, from 1994 through 2003, the industry complex produced output worth at least $50 billion every year. However, as textile and apparel trade liberalized over the last few years, production has shifted to countries with lower wages and imports increased into the United States. As a result, many U.S. textile and apparel plants closed; some firms went out of business and others relocated production overseas. The U.S. lost more than 900,000 jobs over 1994-2005 (U.S. Department of Agriculture, Economic Research Service1). In particular, this industry has lost 441,800 jobs from January 2000 through April 2005 (U.S. Department of Labor). The National Council of Textile Organizations (NCTO, 2005) reports 354 plant closings from 1997 through 2005, of which 131 and 80, respectively, occurred in North and South Carolina. Additionally, Kletzer (2001) found that increased imports of textiles and apparels since the mid-1990s have contributed significantly to job losses. Both textiles interest groups and the popular press also blame job losses and plant closings on import surges to the United States (ATMI, 2001; Patterson, 2004).
It can be observed from Figure 1 that U.S. exports of textile and apparel grew from $12 billion in 1994 to $15 billion in 2003. At the same time, the U.S. imported $45 billion worth of textile and apparel in 1994 and $82.8 billion in 2003. These imports contributed to more than doubling the textile and apparel trade deficit from about $33 billion in 1994 to $68 billion in 2003. The share of imports relative to domestic consumption grew from 37% in 1994 to 66% in 2003 (U.S. Department of Agriculture, Economic Research Service2). Therefore, it appears that growth in U.S. textile exports has been relatively small while imports as a share of domestic demand have continued to increase.

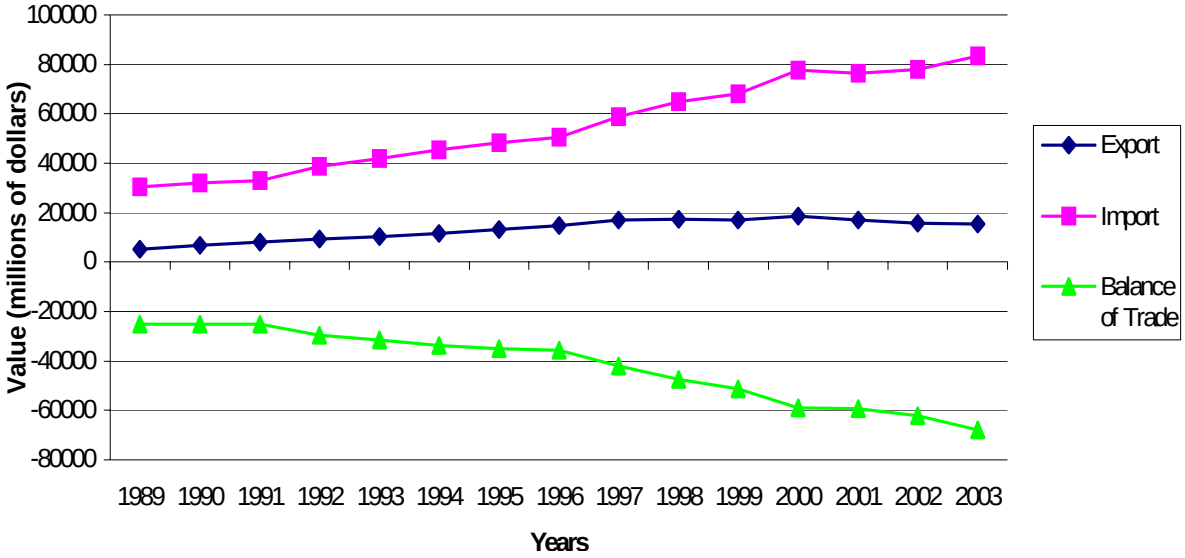
Trade in textiles has historically been governed by quantitative restrictions. From 1974 through 1995, the Multi-fibre Arrangement (MFA) governed the bulk of world textile and apparel trade, but textile and clothing quotas were negotiated bilaterally between trading partners. Among other things, the MFA provided for quantitative restrictions when import surges of particular products caused or threatened to cause damage to the industry of an importing country. The WTO ratified the Agreement on Textiles and Clothing (ATC) in 1995 to phase out quotas established under the MFA by January 1, 2005. Consequently, the world textile market effectively became fully integrated into the WTO when the ATC ended. This integration also ended U.S. government control of the imports of textiles and apparel into the United States.

MacDonald et al. (2001), by using a dynamic computable generalized equilibrium (CGE) model simulation, found that the 2005 trade reforms in textiles and clothing

would improve economic welfare in every region in the world, and would cause world textile, apparel, and cotton production to rise. In particular, the study documented that U.S. production would decline for cotton as well as for textiles and apparel, although U.S. cotton exports potentially would rise. Therefore, it appears that conditions are currently rife for global exporters of textiles and apparel to demand even greater access into the U.S. market. Yet, over the years many developed countries, including the U.S., which were expected to lift their import quotas, have been reluctant to do so because many developing countries, such as China, pose a threat in increasing their exports of textiles and apparel to their markets.

Moreover, the textiles complex is a sector where relatively modern technology can be adopted even in poor countries at relatively low investment costs. These low investment costs have made this industry suitable as the first rung on the industrialization ladder in poor countries, some of which have experienced very high output growth rate in the sector (Nordås, 2004). Indeed, the latest statistics from the WTO show that developing countries took 55% of the global textile exports, which stood at $1.369 trillion, in 2003. Also, developing countries accounted for 71% of the global apparel exports. Moreover, relative prices of textiles and apparel generally tend to be higher in the U.S. than in its trading partners (U.S. Department of Agriculture, Economic Research Service2). Therefore, despite imposition of barriers to trade, U.S. imports of textile and apparel products have increased over time (see Figure 1). The leading sources of textile imports in 2003 were China, Pakistan, India, Mexico, Taiwan, South Korea, Thailand, Indonesia, Japan, Hong Kong, Philippines, Canada, and Sri Lanka (U.S. Department of Commerce). These countries are included in the panel analysis below.

Figure 1: U.S. Trade in Textile and Apparel



Source::On-Line Database of the U.S. International Trade Commission: ITC Trade Dataweb, Washington, DC, 2004 *http://dataweb.usitc.gov*

Development of the Gravity Model

Research on trade flows has used spatial equilibrium models in the past. Examples of such studies include Takayama and Judge (1964), Bawden (1966), Koo (1984), Sharples and Dixit (1989), and Mackinnon (1976). In these studies, trade flows are explained by the relative prices of commodities in importing and exporting countries and transportation costs between countries. However, as Thompson (1981) and Dixit and Roningen (1986) indicate, spatial equilibrium models perform poorly, especially in explaining trade flows of commodities that could be distorted by both exporting and importing countries' trade programs and policies.

Gravity models analogously determine trade flows between two or more countries as a function of their respective economic masses, the distance between the economies and a variety of other factors. The gravity model derives application from the partial equilibrium model of export supply and import demand as presented by Linemann (1966). Anderson (1979), Bergstrand (1985, 1989), Thursby and Thursby (1987), and Helpman and Krugman (1985) apply microeconomic foundations in deriving the gravity model which show that price variables, in addition to conventional gravity equation variables, are statistically significant in explaining trade flows among participating countries. Generally, a commodity moves from the country where prices are lower to the country where prices are higher. Therefore, trade flows are expected to be positively related to changes in export prices (Karemera et al., 1999).

The gravity model has found empirical application in determining trade flows and policy analysis (Koo and Karemera, 1991; Koo et al., 1994), boarder effects inhibiting trade (McCallum, 1995; Helliwell, 1996 and 1998), and impacts of currency arrangements on bilateral trade (Rose, 2000; Frankel and Rose, 2002; Glick and Rose, 2002). The gravity model has also been applied to evaluate bilateral trade flows of aggregate commodities between pairs of countries and across regions (Oguledo and Macphee, 1994).

Classical gravity models of trade generally have used cross-sectional data to estimate trade effects and trade relationships for a particular time period. But, Koo and Karemera (1991) and Rahman (2003) have applied panel data to the gravity model. Koo and Karemera reveal that using panel data to determine factors affecting trade flows of a single commodity result in more robust results than cross-sectional data alone. Furthermore, Rahman states that the advantages of this method are that panels can capture the relevant relationships among variables over time, and panels can monitor unobservable trading–partner pairs' individual effects. In addition, the combination of time series with cross-sectional data can enhance the quality and quantity of data in ways that would be impossible to achieve by using only one of these two dimensions (Gujarati, 2003). Conceptually, the difference in the nature of individual effects can be classified into the fixed

effects which assume each country differs in its intercept term; and the random effects which assume that individual effects can be captured by the difference in error terms.

Model Derivation

In this study, the traditional gravity model for aggregate goods is re-specified as a commodity-specific model to analyze trade flows in textiles and apparel among 13 countries (China, Pakistan, India, Mexico, Taiwan, South Korea, Thailand, Indonesia, Japan, Hong Kong, Philippines, Canada, and Sri Lanka) and the U.S. The traditional gravity model incorporates three variable components: (1) economic factors affecting trade flows in the origin country; (2) economic factors affecting trade flows in the destination country; and (3) natural or artificial factors enhancing or restricting trade flows. We follow the approach used by Koo and Karemera (1991) and Koo et al. (1994), where they derive a single commodity gravity model to analyze the determinants of wheat and meat trade policies, respectively. The approach derives its foundation from Linneman (1966) and Bergstrand (1985, 1989), where the gravity model is specified as a reduced form equation from partial equilibrium demand and supply systems.

From the derived model (see Appendix for model derivation), the applied empirical reduced form of the gravity model we use to evaluate factors explaining textile and apparel trade between the U.S. and the 13 key trading partners is specified in equation (1) below. The variables and summary statistics are presented in Table 1 and the explanation of expected signs on independent variables is provided in Table 2.

Table 1: Descriptive Statistics Analysis

	Mean	Std. Deviation	Minimum	Maximum	Skewness
TEXIMP	496.96	538.74	3	3885	2.51
APPIMP	2412.14	3483.75	61	41146	7.49
GDP_i (Billion)	586.6	1074.70	6.98	5283.05	3.04
PCI_i	8244.73	10488.44	317.08	42071.92	1.31
GDP_{us} (Billion)	8013.06	1771.75	5438.7	11004	0.17
PCI_{us}	30039.12	5409.86	22159.88	39011.87	0.15
$EXRATE_{ius}$	0.95	0.35	0.22	2.61	1.57
$PRICED_{us}$	2.99	1.05	1.55	5.4	0.86
$PRICED_i$	6.92	7.13	-3.96	57.64	2.78
$DIST_{ius}$	11151.84	4265.74	733.89	16370.82	-1.44
DMFA	0..31	0.46	0	1	0.84

Table 2: Explanation of Expected Signs on Independent Variables

Variable	Expected Sign	Explanation
GDP of importing country	+	As income increases purchases are likely to increase. Thus increased income results in increased imports.
GDP of exporting country	+	Higher GDP indicates potential to export more textiles.
Per capita income of importing country	+	A higher per capita income indicates greater potential to demand higher quality and more exotic imports.
Per capita income of exporting country	+	A higher per capita income indicates higher productivity of labor (skill content) in output and would potentially lead to greater exports.
Distance	-	Proxy for cost of transportation. The further the distance, the less imports of goods from a country.
Exchange rate	-	The lower the exchange rate of the exporting country to the dollar, the cheaper its goods will be on the importing country's market. This results in an increase in imports.
Price Deflator_{us}	+	Importing country with high price deflator (a proxy for inflation rate) would substitute domestically produced goods with foreign imports.
Price Deflator_{i}	-	An Exporting country with a relatively high price deflator/inflation would be less competitive in the world market.
Effect of Multifiber Arrangement (Agreement on Textiles and Clothing)	-	MFA restricted trade in textiles and clothing until January 2005 for a majority of the countries trading with the U.S (but it allowed bilateral agreement to grant access). Therefore, MFA would lead to less import from trading countries to the U.S.

We use dummy variables to differentiate countries receiving policy benefits associated with the MFA governed by the WTO. But similar to the approach used by MacDonald et al (2001), we distinguish countries by whether or not trade in textiles and apparel was restrained by the MFA. Therefore, among the countries whose exports to the U.S. were restrained by the MFA, we include China, India, Pakistan, Taiwan, South Korea, Thailand, Indonesia, Japan, and Hong Kong. However, the Philippines and Sri Lanka (as less developing countries enjoying preferential trade

treatment) were free from trade restraint. Canada and Mexico, by virtue of their NAFTA membership, were also free from trade restraint.

To conform to the approach used by MacDonald et al. (2001), this study abstracts from the issue of whether importing or exporting countries capture rents from MFA quotas, and it assumes that these rents are dissipated by rent-seeking behavior. That is to say, the MFA does not create either a price gap per se between domestic and border prices or quota rents for the restraining country (the U.S.). Instead the restraint merely causes difficulty for some countries (especially developing countries that do not benefit from preferential access) in exporting their textile and apparel products to the restraining country.
To be sure, one limitation of the study is that it does not capture the reduced import protection over time associated with the ATC. Therefore, it does not adequately capture the potential increase in export efficiencies attained by some exporting countries with trade reform; such as China following its bilateral trade agreement with the U.S. in 1999.

Therefore, the reduced form of the applied model is as follows:

$$TEXIMP_{iust} = \beta_0 + \beta_1 GDP_{it} + \beta_2 GDP_{ust} + \beta_3 PCI_{it} + \beta_4 PCI_{ust} + \beta_5 EXRATE_{iust} + \beta_6 PRICED_{ust} \beta_7 PRICED_{it} + \beta_8 DIST_{ius} + \beta_9 DMFA_{it} + \varepsilon_{iust} \quad (1)$$

Where:

$TEXIMP_{iust}$	=	value of annual textile/apparel imports (in million dollars) by the United States from the exporting country i;
GDP_{it}	=	Gross domestic product of the exporting country i;
GDP_{ust}	=	Gross domestic product of the United States
PCI_{it}	=	Per capita income of the exporting country i;
PCI_{ust}	=	Per capita income of the United States;
$EXRATE_{iust}$	=	Exchange rate of the currency of country i to the U.S. dollar;
$PRICED_{ust}$	=	Price deflator (proxy for inflation rate) of the U.S.;
$PRICED_{it}$	=	Price deflator of te exporting country i;
$DIST_{ius}$	=	Distance in kilometers between the exporting country i and the U.S.;
$DMFA_{it}$	=	Dummy variable identifying whether country i was free from trade restraint (1 if country i was free from restraint in year t, and 0 otherwise); and
ε_{iust}	=	error term
t	=	time (represents the time series from 1989 through 2003)

Unlike the traditional gravity models of aggregate good trade in Bergstrand (1985, 1989), Anderson (1979) and Linneman (1966), the commodity-specific gravity model (Koo and Karemera, 1991; Koo et al., 1994) can incorporate the unique characteristics and policies associated with trade flows of the specific commodity in exporting and importing countries. In the model, the GDP serves as a proxy for

levels of income. The exporting country's GDP can also be interpreted as its production capacity, while the importing country's GDP represents its level of effective demand. It is expected that trade flows are positively related to exporting and importing countries' GDP. Per capita income for the exporting country is also included as a separate independent variable and as a proxy for greater productivity of labor (Deardoff, 1997).

A higher output per person indicates potential efficiency in production or increased productivity which may potentially lead to greater exports. However, a high population may lead to decreasing exports, especially if there is a higher domestic demand for the product. As a country's market develops and, especially, if the level of development is matched by innovation in the production of new or higher quality products, then more goods are demanded as imports by other countries (Frankel and Wei, 1993). For similar reasons, as a country develops, consumers with higher per capita income are able to afford higher quality and more exotic imported goods (Rahman, 2003).

We also use the GDP deflator as a proxy for price of goods in each country, since consistent time series data for prices of all categories of textile and apparel products for all the countries are not immediately available. Additionally, in the model, we maintain the exchange rate values between the U.S. and the respective textiles and apparel exporting countries so as to measure the terms of trade between those countries and the U.S. Additionally, we substitute distance between the exporting country and the U.S. for cost of transportation, since data on the latter is not readily available.

Data Sources and Estimation Procedure

The empirical evaluation of equation 1 is based on secondary data obtained from the following sources: (i) GDP, exchange rate, price deflators and population for the calculation of per capita income were obtained from the International Marketing Data and Statistics (2004); (ii) distance in kilometers between the U.S. and the exporting country was obtained from the research aid website of the Macalester College of Economics; and (iii) trade values were obtained from the United States International Trade Commission's trade data website. Textile and apparel trade values, classified in SIC codes 22 and 23, respectively, were used for years 1989-1996. The new NAIC code, which commenced in 1997, was used for the years 1997-2003. Under this new industrial code, NAIC 313 and 314 are specified as equivalent to the old SIC code 22 (for textile products); and NAIC 315 is equivalent to SIC 23 (for apparel products).

Results and Policy Analysis

Equation (1) was estimated by a SAS program using distinct panel data sets for

textile and apparels, respectively. The Hausman test was run to check if the fixed or random effects model is more efficient. We use the Hausman's (1978, p. 1261) notation where equation 9 in the time series and cross-section framework is written as:

$$X_{iust} = Z_{iust}\,\beta + \mu_{ius} + \mu_{iust} \qquad (2)$$

where

X_{iust} = trade observation from exporting country i to the U.S. at time t (t = 1,…,T);
Z_{iust} = a corresponding trade determinant vector of exporting country and the U.S.;
μ_{ius} = the trade effect associated with an exporting country and the U.S.; and
μ_{iust} = the error term.

By assuming individual effects, we proceeded to test if μiust is fixed or random. According to Greene (2003, p.301), Hausman's null hypothesis is that "the covariance of an efficient estimator with its difference from an efficient estimator is zero." Results indicate a Hausman m-statistic of 27.44 and 25.84 for the specified models for textiles and apparel imports, respectively, where the critical $\chi 2$ value for 8 degrees of freedom at the 1% level is 20.09. Thus, we reject the random effects in favor of the existence of individual country fixed effects, and use the fixed effect model commonly known as the covariance model. We used a SAS estimation procedure that automatically corrects for potential econometric problems associated with panel models by applying the Parks (1966) and Kmenta (1986) methods.

Table 3: Gravity Model Estimates on the Import of Textiles and Apparel

	Textile		Apparel	
Variable name	**Point Estimate**	**P-value**	**Point Estimate**	**P-value**
Intercept	13.627	0.0001	17.262	0.0001
GDP_i	0.451***	0.0001	0.236***	0.0001
PCI_i	0.0129***	0.0001	0.043*	0.0848
GDP_{us}	13.206***	0.0001	10.154***	0.0001
PCI_{us}	18.182***	0.0001	11.720***	0.0001
$EXRATE_{ius}$	-0.463***	0.0001	-0.331***	0.0001
$PRICED_{us}$	1.640***	0.0001	1.079***	0.0001
$PRICED_i$	-0.022***	0.0001	-0.002**	0.0064
$DIST_{ius}$	-0.785***	0.0001	-0.332***	0.0001
DMFA	-0.695***	0.0001	-0.085***	0.0016
R^2	0.98		0.86	
N	195		195	

*** Refers to significance at 1% level
** Refers to significance at 5% level
* Refers to significance at 10% level

Table 3 presents estimated logarithmic (log-linear) results for the gravity models on textiles and apparel imports, respectively, from the major exporting countries to the U.S. For the textile results, all parameter estimates have the expected signs and are statistically significant at the 1% level. For the apparel results, all estimated parameters are of expected signs and are significant at the 1% level, except for the parameters on per capita income and inflation rate for the exporting countries that are significant at the 10% and 5% levels, respectively. The fit statistics indicate R2 values of 0.98 and 0.86 for textiles and apparel, respectively, indicating that parameters of the regression models provide a good fit in explaining trade flows of textiles and apparel commodities.

As explained previously and in Table 2, GDP and per capita income of exporting countries are used, respectively, to represent their aggregate production capacity and productivity per capita of labor in output. Both estimated variables are positive as hypothesized and differ significantly from zero at the 1% level for the textiles results. For the apparel results, per capita income for exporting countries is significant at the 10% level, while the GDP for exporting countries is significant at the 1% level. This implies that a rise in exporting countries' total output and per capita productivity lead potentially to increase in exports of both textiles and apparel. The magnitudes of both variables are smaller than 1.0 in both models, implying that the values of textiles and apparel traded are not sensitive (inelastic) to the countries' production capacity or individual productivity of labor. This insensitivity in exporting countries may be attributed to either their excess production capacity, or their respective government's domestic support of the industry complex so as to encourage textiles and apparel firms to increase exports.

The parameters of GDP and per capita income for the U.S. were also of the expected signs and were significant at the 1% level for both textiles and apparel models, although the values were all larger than 1.0. The sensitivity of U.S. import demand for textiles and apparel implies that as incomes rise in the U.S., import demand for foreign-made textiles and apparel rise and vice versa. It may also imply that U.S. firms are willing to import more foreign-produced textiles at least in part because of relative price differences.

Indeed, the estimated coefficients on the price deflators in the U.S. and exporting countries were all of expected signs as hypothesized, and were all significant at the 1% level, except for the price deflator for exporting countries that was significant at the 5% level. The U.S. exhibited sensitivity to changes in domestic prices for both textiles and apparel imports. Therefore, as prices rise domestically, it is expected that less domestically produced commodities would be demanded, but more foreign-made products would be imported. Foreign-made products serve as good substitutes for domestically produced products. Therefore, it appears that increasing GDP deflator (signaling potential higher prices) in the U.S. would cause

the U.S. to increase imports of textiles and apparel from its trading partners. Likewise, decreasing prices in the exporting countries caused them to export more textiles and apparel to the U.S. These results reflect potential import substitution of textiles and apparel during periods of rising relative prices for textiles and apparel in the U.S., especially since relatively lower prices in exporting countries would make foreign-made textiles and apparel more attractive in the U.S. market and would increase the values traded. These results are consistent with results obtained by Oguledo and Macphee (1994) and Karemera et al. (1999).

The estimated parameter for exchange rate is significant at the 1% level, and is of the expected sign for both textiles and apparel. It shows that a proportional decrease in the exchange rate of local currency of the exporting country to the U.S. dollar will result in a proportional increase in value of textile and apparel imports to the U.S. Indeed, depreciation of an exporting country's currency relative to the dollar makes the exporting country's textiles and apparel products cheaper in the importing country's market, leading to increased trade flows. The variable for distance shows a negative and significant relationship at the 1% level with import values for both textiles and apparel, although the parameters are not sensitive to imports of textiles and apparel. The results may explain the possibility that as distance between the U.S. and its trading partners increases, the value of imported textiles and apparel declines. This may imply, ceteris paribus, that trade in textiles and apparel between the U.S. and countries in proximity, such as Mexico and Canada, must be expected to increase more than that with far distant countries, such as China.

Lastly, the significant (at the 1% level) but negative parameters on the dummy variable for MFA in both the textiles and apparel models indicate that generally imports of textiles and apparel were constrained by trade policy restrictions imposed on access to the U.S. market of foreign-produced textiles from most of the leading exporters as a result of the ATC. Consequently, in tandem with the results of potential greater substitution of domestically produced products with foreign-produced products, the phase-out of the MFA in January 2005 should open the U.S. market to greater imports of foreign-produced textiles and apparel.

Concluding Comments and Implications

Although the popular press and textile and apparel interest groups decry the patterns of persistent imports of textiles and apparel products from abroad, to date, no empirical study has been conducted to explain the pattern of textiles and apparel trade between the U.S. and its trading partners. A major objective of this study is to fill that gap by providing econometric estimates to explain some of the key underlying factors supporting recent textiles and apparel trade flows into the U.S. We summarize some of the key policy findings from the study, and derive implications for U.S. agribusiness.

First, a nation's aggregate output and its per unit productivity serve as important determinants of textiles and apparel trade with the U.S., indicating that countries that produce relatively higher quality textiles and apparel would be able to stimulate greater trade with the U.S. Second, U.S. imports of foreign-made textiles and apparel have grown over time, especially as relative price differences between U.S. and foreign-manufactured products have grown, and U.S. importers have found greater substitution of domestic products with foreign-made products. Therefore, consistent with expectations of economic theory, a country's depreciating exchange rate as well as its lower prices relative to that of the U.S. play an important role in determining textiles and apparel trade flows to the U.S. market. In addition, although the aggregate nature of the variables used in the gravity model for this study does not allow a measure of the relative costs of inputs in the textiles and apparel production such as labor relative to capital, nevertheless, we are able to conclude from the results of aggregate price deflators that so long as textile and apparel products are perceived as cheaper abroad, U.S. importers will continue to purchase from abroad and global producers will find it profitable to sell their products in the U.S. market.

Third, the MFA is found to have slowed down imports of textiles and apparel from leading global exporting countries into the U.S. during the study period. Therefore, the abrogation of the MFA in January 2005 is expected to enable products from leading global manufacturers, such as China, to gain greater access to the U.S. market. However, the study finds that textiles and apparel imports would be constrained by distance.

Several implications can be drawn from this study. The study reveals that in tandem with the comparative advantages stemming from relative factor costs and output prices enjoyed by leading global exporters of textile and apparel trade, the phasing out of the MFA will increase imports of textiles and apparel into the United States. Obviously, if this trend is sustained, sizable portions of the U.S. market captured by importers from U.S. producers, causing relatively lower demand for U.S. textile products. Any lowering of demand for U.S textile products would negatively impact demand for U.S. cotton, with potential deleterious implications for the U.S. cotton industry. This is consistent with the conclusion by MacDonald et al. (2001). Additionally, the resulting freer trade and further increase in competition in the sector will likely lower prices of textile and apparel products, and further lead to decreasing U.S. employment in the industry complex. Potential gainers would be U.S. consumers of textile and apparel products, but losers would include those workers and communities that rely on cotton, textile, and apparel production for incomes to catalyze economic growth.

However, textile production (such as yarn and fabric) is more capital-intensive than apparel production. Therefore, U.S. textile producers could stand to gain a portion

of the global market, to the extent that they are able to diversify their marketing strategies to include targeting foreign buyers of U.S. textile yarns. If successful, this could cause demand for U.S. cotton to rise and potentially yield higher cotton prices. Although beyond the scope of our findings, we note that coordination between apparel and textile producers could be further enhanced when both textile and apparel products are manufactured in the same country or region. Consequently, U.S. textile manufacturers may find it beneficial to locate in proximity to apparel producers who are their customers. In fact, Kravis and Lipsey (1993) suggest that labor outsourcing has led to a shift toward more capital- and skill-intensive production in the U.S., as particularly unskilled–intensive production has been allocated to affiliates in developing countries, in part through foreign direct investment. Hudson et al. (2005) also conclude that textile manufacturers would be more interested in capturing factor-cost differentials on the labor component while retaining headquarters activities in the United States. Thus, U.S. textile manufacturers may want to take advantage of regional and bilateral trade initiatives to increase investment in apparel production in countries where relative labor and ancillary costs of production may be cheaper, and to transport their products back to the United States.

Despite the special safeguards imposed by the WTO to control for import surges from China, the ability of global competitors such as India and Pakistan in exporting relatively cheaper textiles and apparel to the U.S. following the January 2005 abolition of the MFA, must be a troubling source of concern to U.S. cotton, textiles and apparel producers and the relatively poor Southeastern U.S. rural communities in which they are located. Those communities are distressed by job losses and relatively low incomes prospects, stemming from earlier plant closures. Coupled with a low tax base, the communities would continue to be hard-pressed in maintaining public services such as spending on local education. Nevertheless, regardless of feckless efforts by interest groups and industry lobbyists to redefine the problem facing the industry complex, it appears to be driven by international trade fundamentals.

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Appendix: A

Linneman (1966) and Bergstrand (1985, 1989) assume that a generic import demand equation for a specific commodity can be derived that allows for imperfect substitution in consumption between trading countries, by maximizing a constant elasticity of substitution (CES) utility function (U_{ij}) subject to income constraints in the importing country as follows:

$$U_j = (\sum_{i=1}^{N} X_{ij}^{\theta_j})^{1/\theta_j} \quad \textbf{(1)}$$

Where:

X_{ij} = the quantity of a commodity imported from country i to country j (and N is the number of exporting countries).

It is assumed that a commodity can be differentiated by country of origin such that in the exponent, $\theta_j = (\sigma_j - 1)/ \sigma_j$, where σ_j, is the CES among imports. Consumption expenditures are limited by the income constraints (Y_j) of importing country *j* as:

$$Y_j = \sum_{i=1}^{N} \bar{P}_{ij} X_{ij} \text{; Where } \bar{P}_{ij} = P_{ij} T_{ij} C_{ij} / E_{ij} \qquad \textbf{(2)}$$

Where:

P_{ij} = the unit price of country i's commodity sold in country j's market;
T_{ij} = $1 + t_{ij}$ where t_{ij} is import tariff rates on j's imports;
C_{ij} = the transport cost of shipping i's commodity to country j; and
E_{ij} = the spot exchange rate of country j's currency in terms of i's currency.

By using the Lagrangian function to maximize utility (equation 1) subject to income constraint (equation 2), deriving the first order conditions and solving generates the import demand equation as:

$$X_{ij}^{d} = Y_j P_{ij}^{-\sigma j} T_{ij}^{-\sigma j} C_{ij}^{-\sigma j} E_{ij}^{-\sigma j} (\sum_{i=1}^{N} \bar{P}_{ij}^{1-\sigma_j})^{-1} \qquad \textbf{(3)}$$

Where: X^d_{ij} = the quantity of i's export to country j; and all other variables are as previously defined.

The model of trade supply equation is derived from a firm's profit maximization procedure in exporting countries. The total profit function of the producing firms is given as follows:

$$\Pi_i = \sum_{j=1}^{N} P_{ij} X_{ij} - W_i R_i \qquad \textbf{(4)}$$

Where:

P_{ij} = the export price of i's commodity paid by importing country j;
X_{ij} = the amount of i's commodity imported by country j;
W_i = country i's currency value of a unit of R_i;
R_i = the resource input used in the production of the commodity in country i.

R_i is allocated, assuming imperfect substitution in factor inputs for producing the export commodity, through a constant elasticity of transformation (CET) production defined as:

$$R_i = [(\sum_{i=1}^{N} X_{ij}^{\phi_i})^{1/\phi_i}]^{1/\delta_i} \quad \textbf{(5)}$$

Where in the exponent, $ø_i$ is the parameter on the production function for each exporting country indicating production with fixed factor proportions, and $\delta_i = (1 + \gamma_i)/\gamma_i$ and γ_i is the CET among exporters. Furthermore, we assume that income is a limiting factor in producing textile and apparel in the exporting countries. Therefore, $Y_i = W_i R_{i,,}$ where Y_i is the allocated income. Substituting equation 5 into equation 4, maximizing the resulting profit function, and solving yields the export supply equation as follows:

$$X_{ij}^{s} = Y_i P_{ij}^{\gamma_i} (\sum_{i=1}^{N} P_{ij}^{1+\gamma_i})^{-1} \quad \textbf{(6)}$$

General equilibrium conditions require demand to equal supply. Therefore:

$$X_{ij}^{d} = X_{ij}^{s} = X_{ij} \quad \textbf{(7)}$$

Where X_{ij} is the equilibrium or actual quantity of the commodity traded from country i to country j. By equating equation 3 to equation 6, the commodity specific gravity equation is derived as in a reduced form as follows (where all the variables have previously been defined):

$$X_{ij} = Y_i^{\frac{\gamma_j}{\sigma_j+\gamma_i}} Y_j^{\frac{\sigma_j}{\sigma_j+\gamma_i}} T_{ij}^{-\frac{\gamma_i\sigma_j}{\sigma_j+\gamma_i}} C_{ij}^{\frac{\gamma_i\sigma_j}{\sigma_j+\gamma_i}} E_{ij}^{\frac{\gamma_i\sigma_j}{\sigma_j+\gamma_i}} (\sum_{i}^{N} P_{ij}^{1+\gamma_i})^{-\frac{\sigma_j}{\sigma_j+\gamma_i}} (\sum_{j}^{N} \bar{P}_{ij}^{1-\sigma_j})^{-\frac{\gamma_i}{\sigma_j+\gamma_i}} \quad \textbf{(8)}$$

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Differential Earnings of the Agricultural Graduates New Evidence from the Agribusiness Industry

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Abstract

Utilizing an original data set, we use regression analysis to estimate the impact of various factors on the earnings and the gender wage gap of the agribusiness graduates. Findings indicate that factors such as education, experience, gender, job sector, status and specialty, etc., are important factors in determining earnings. In particular, characteristics such as experience through a foreign internship during college, marketing, accounting and finance specialties are associated with a relatively high market value. Despite progress in recent years, results suggest that a 19 % wage gap still exists between men and women due to differences in human capital characteristics, differences in labor force participation behavior and individual lifestyle choices.

Keywords: Agribusiness, determinants, earnings, gender wage gap

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Introduction

Extensive research and numerous studies have long confirmed that despite the rise in women's active participation in the labor force, important gender differences remain in wages received (Blau and Kahn 2000, 2007, O'Neill, Leonhardt). Data from the Bureau of Labor Statistics (BLS) show that in 1999, women earned approximately 77 percent as much as men did. Recent evidence from the General Accounting Office study (GAO) confirms that though the gap in earnings has diminished in recent years, women on average still earn about 80 percent of what men earn.

In a comprehensive study of the gender wage gap, Blau and Kahn (2007) analyze the progress made over the years in the US. The evidence shows remarkable progress in narrowing the gap starting in the late 1970s and continuing throughout the 1980s and early 1990s, but slowing down in the late 1990s. According to Blau and Kahn, the wage gap has closed due to improvements in gender specific factors, such as increases in women's labor market experience, increases in the number of women employed as professionals and managers, improvements in women's wages due to the decline of unions, and lastly, a decrease in the "unexplained" portion of gender differential.

Though magnitudes of the estimated gender wage gap vary (due to methodology, type of data and variables used in the analysis), studies from various fields (Goldin, Fuller and Schoenenberger, Blau, Barkley, Stock and Sylvius) collectively agree that women continue to earn less than men in every sector of economy.

Much debate, however, exists around the causes of this wage disparity with explanations ranging from differences in human capital characteristics (such as education levels, work patterns, etc.), segregation of men and women with respect to occupation or industries, to the existence of gender discrimination in the labor market.

Though empirical studies on gender differences are numerous, very few have dealt with the gender wage gap in agriculture (to the authors' knowledge the study of Barkley, Stock and Sylvius is the only one). The primary objective of this study is to provide new empirical evidence on the status of gender gap in the agribusiness industry by first, investigating the determinants of the earnings of agricultural graduates and second, exploring the possible causes of wage differentials between the graduates.

Results from this study should prove helpful to students when choosing their academic and career path by providing a list of potential factors influencing their future earnings. Also, findings might prove helpful to the industry when crafting their human resource policies, as well as to the academia when designing the course

curriculums. Further, this study complements gender gap literature with evidence from the agricultural sector. A better knowledge of the process of wage determination from various sectors of the economy will improve chances of successful policy measures to address the existing wage gap.

Data

This study uses data collected by a survey of agribusiness graduates of California Polytechnic State University, San Luis Obispo, one of the largest agribusiness departments in the nation. The purpose of the survey was to learn about the careers of the program graduates by asking a wide variety of questions including wages, job characteristics, work history, demographics, etc. A total of 2800 surveys were sent to agribusiness alumni during the summer of 2002 with a 40 percent response rate.

Respondents were required to be employed at the time survey was completed in order to be included in the sample for this analysis. The sample was further truncated to include data only on respondents aged 20 to 64 years that were working full time. Data on starting wages were deflated to 2002 dollars using the Personal Consumption Expenditure Index (U.S. Department of Commerce).

The Model

Following the standard Mincer specification, a wage regression equation that relates yearly individual earnings to a set of independent variables is specified. The following regression is estimated:

$$\ln W_i = \mathrm{X}_i \beta_i + \varepsilon_i \qquad (1)$$

Where the dependent variable $\ln W_i$ represents the natural logarithmic wage, vector X_i contains sets of explanatory variables, i denotes individuals within the sample, and the error term is assumed to have mean zero and constant variance σ^2. The first set of explanatory variables consists of individual and family related characteristics containing demographic information such as educational background, gender, marital status, and presence of children less than 18 years old living in the same household. Following literature, interaction terms between gender, marital status and children are also included to capture interactions between these qualitative factors on earnings.

The second set of explanatory variables includes a measurement of past work experience, as well as measurements of extra curricular activities during school years. To deduce past work experience a “potential experience” variable is constructed, which is essentially the number of years since graduation.

The job related set of independent variables includes variables that specify work related characteristics such as the field of employment, type of employment, position status, job benefits offered by the company, and the starting wage.

While the difference of average annual wages of men and women gives a first idea of the gender pay gap, it conceals the contribution of particular factors that are of interest to be explored. To examine the gender wage gap, the most commonly used decomposition procedure for cross-sectional data as defined by Oaxaca is followed. This technique is used to determine the share of the difference in wages between two groups (male and female) due to differences in human capital stock—(explained factors) and the share of the difference in wages that could not be attributed to human capital characteristics — (unexplained factors).

Specifically, if the fitted values of earnings for men and women evaluated at the means of the independent variables ($X's$) are:

$$\overline{\ln(W_M)} = \overline{X_M}\,\hat{\beta}_M \qquad (3)$$

$$\overline{\ln(W_F)} = \overline{X_F}\,\hat{\beta}_F \qquad (4)$$

then the raw wage differential between men and women is expressed by the difference in the logarithmic mean wages:

$$\overline{\ln(W_M)} - \overline{\ln(W_F)} = \underbrace{\left(\overline{X_M} - \overline{X_F}\right)\hat{\beta}_F}_{Explained} + \underbrace{\overline{X_F}\left(\hat{\beta}_M - \hat{\beta}_F\right)}_{Unexplained} \qquad (5)$$

where $\hat{\beta}$'s are the estimated coefficients and M and F represent male and female respectively. The first term on the right side of equation (5) expresses the difference in wages due to the remuneration of different human capital characteristics that affect productivity of the two groups when both groups are treated the same. This component is offered referred to as the explained component of the difference in wages (*or the characteristics effect*). It implies that if women as a group have lower average human capital characteristics, then it is expected that they earn a lower average wage. Oaxaca suggests that the structure of wage for either men $\hat{\beta}_M$ or women $\hat{\beta}_F$ can be used as the prevailing (nondiscriminatory) market wage structure. In this study, the wage structure of men is used as the non-discriminating wage structure as specified in equation (5) since most authors argue

that in the economy, men form the largest group of workers and that face virtually no discrimination. The second term of equation (5) expresses the portion of the gap in wages due to differences in the remuneration of the human capital characteristics. It measures how much less than men, women are earning if they possess the same human capital as the average man, but receive a woman's return to that human capital. This component of the difference in wages is referred to as the unexplained portion (*or the remuneration effect unrelated to productive characteristics)*.

Results

The model specified in the equation (1) is estimated by the ordinary least squares method. We first describe results from the general model and then comment on the findings of separate regressions to explore the gender gap. Table 1 summarizes the estimated results for the overall regression model. Diagnostic measures were performed on the data. Normal probability plots of the residuals reveal no violations of the normality assumption. Further, the Breusch-Pagan test indicates that the data are consistent with the assumption of a constant variance of the error term. However, variance inflation factors (VIF) [1] revealed that "work experience" variables were collinear, but they are kept in the model since estimates are still unbiased and these variables are statistically significant. The model is statistically significant and explains 41 percent of the variation in the current earnings of the graduates. Results indicate that "work experience" variables are important factors in determining the status of current earnings. Estimates show that labor market rewards each year of additional experience with a 3.3 percent increase in earnings; however, the relationship between earnings and years of experience evolves overtime with a decreasing rate.

Experience gained during college years through a "foreign internship" increased wages by 26 percent. Businesses have expanded internationally to increase their markets and the importance of foreign internship variable may be a proxy for the ability to work in a global environment. The impact of job characteristics was considered in the model by including variables such as type of employment, field of employment, position in the firm, and starting salary.

Agriculture and sectors directly related to it, remunerated graduates up to 12.4 percent less than other sectors of economy. Specialties such as marketing, accounting, and finance both in the agricultural and nonagricultural sector had higher returns. Positions in marketing and accounting within the agriculture sector increased wages by 25 and 21 percent, respectively, *ceteris paribus.* As expected, job status influenced earnings. Positions in upper management were compensated about 48 percent more than non- management positions, whereas proprietors

[1] VIF's were above 5 for "experience" and "experience square" variables.

earned about 70 percent more on average than professional agriculturalists, holding everything else constant. Starting salary significantly impacted future earnings. Among benefits that increased salaries, health insurance and retirement benefits were quite important. Retirement packages increased earnings 21 percent on average and health benefits were associated with a 35 percent increase. Individual and demographic characteristics also were important determinants of earnings for agribusiness alumni. Advanced degrees such as MBA and JD increased earnings of about 16-36 percent compared to the graduates with a bachelors degree (the control group).

Gender was statistically a significant variable and results showed that women earned less than men, *ceteris paribus.* We explore the gender impact on wages in more detail later in the paper. Other factors, such as marital status and presence of children in the household also are expected to affect annual wages. Estimates show that on average married women earned about 19.3 percent less than married men. Being married increases earnings for men, as married men earned on average about 18 percent more than men that never married and 23 percent more than previously married men. Women that had never been married earned around 2 percent (19.3% - 17.4%) less than married men. Children did not affect significantly wages of male graduates. Literature suggests that a strong relationship exists between children, wages, and job experience of mothers, especially when children are young. Women with children are less likely to be employed and tend to prefer jobs that do not require overtime work or high work intensity. Indeed, regression results indicate that the presence of children under eighteen in the household was associated with a decrease in women's earnings of about 23 percent as compared to men's earnings. Estimated coefficients of the interaction variables such as gender*marital status and gender*children are statistically significant, indicating the relevance of family relationships in the annual earnings.

Gender Gap

Although the raw difference in annual wages between men and women offers an overall picture of the actual gender pay gap, identifying and measuring the components the wage gap between men and women is important for policy purposes. As mentioned, wage differentials between men and women are assumed to be due to at least two factors: differences in productivity characteristics and differences in market remuneration of these characteristics. Table 2 reports the mean values of the human capital characteristics separately for men and women included in the sample. Data show the differences between groups that exist in the human capital stock.

Table 2: Mean Values of Human Capital Characteristics for Men and Women

	MEN		WOMEN	
Variable	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
Ln (Current Salary)	11.3212	0.64131	10.8557	0.65141
Past Experience				
Experience	17.4525	10.36976	10.1452	6.92234
Experience Squared	411.969	404.42508	150.7229	191.0065
Extracurricular Activities				
Club Member	0.4775	049984	0.4848	0.50040
Club Officer	0.3070	0.46159	0.3990	0.49031
Foreign Programs				
Study Abroad	0.352	0.18444	0.0631	0.24351
Internship Abroad	0.0155	0.12359	0.0152	0.12231
Job Characteristics				
Ln (Starting Salary)	10.3625	0.40855	10.2213	0.36683
Type of Job				
Ag Sector	0.5254	0.49971	0.3662	0.48236
Related to Ag Sector	0.3479	0.47664	0.4091	0.49229
Job Status				
Lower Management	0.3211	0.46724	0.4217	0.49446
Upper Management	0.2479	0.43209	0.1187	0.32383
Proprietor	0.2930	0.45544	0.1591	0.36622
Job Specialty				
Accounting	0.1028	0.30393	0.1288	0.33539
Marketing	0.1944	0.39599	0.1439	0.35147
Greenhouse	0.1915	0.39380	0.0732	0.26085
All Other Ag	0.1254	0.33135	0.1389	0.34627
Non-ag Marketing	0.0859	0.28044	0.1323	0.42138
Non-ag Finance	0.0408	0.19807	0.0707	0.25666
Non-ag Services	0.0859	0.2844	0.1010	0.30172
Job Benefits				
Health	0.8310	0.37503	0.8359	0.37087
Retirement/Savings	0.7183	0.45014	0.7555	0.43356
Vacation	0.6423	0.47967	0.6869	0.46435
EquipmentUse/Discounts	0.8592	0.34811	0.8384	0.36856
Individual Characteristics				
Education				
MBA	0.0606	0.23870	0.0455	0.20856
MS	0.0577	0.23343	0.0758	0.26494
JD	0.0183	0.13416	0.0101	0.10012
Children				
Children under 18	0.4972	0.50034	0.4116	0.49275
Marital Status				
Never Married	0.1437	0.35099	0.2727	0.44593
Previously Married	0.0465	0.21067	0.0379	0.19114

The major difference evidently is in the category of work experience; men report almost twice as many years of experience on the job (17.5 years) as women (10

years). Another difference noticed in the productivity characteristics has to do with the fact that men tend to hold more upper management and proprietor positions than women which are concentrated in staff and non-supervisory positions.
To further investigate the wage gap separate regressions were run for men and women. The estimated coefficients express the remuneration of productivity characteristics for men and women in the labor market. Results are reported in Table 3 and 4.

Results show that the considered variables generally affect both groups in the same direction. Exceptions were marital status and presence of children variables. The presence of young children negatively affects the earnings of women, but does not turn to be a significant factor on the earnings of men (similar results to the overall regression). Married men earn 18 percent more than never married men and 21 percent more than previously married men. Women on the other hand, did not report any statistically significant differences with regard to marital status.

Next, the Oaxaca decomposition was applied and the results of the decomposition analysis are reported in Table 5[2]. The raw wage gap between men and women is estimated to be approximately 0.465. This reveals that on average, men earn a log wage 46.5 percent higher than women.

Results show that 55 percent (0.257) of the wage gap between men and women can be attributed to differences in productivity characteristics (explained component), while 45 percent (0.211) is due to the remuneration effects on these characteristics (unexplained component). The existence of the wage gap due to remuneration is some times interpreted as mainly caused by some sort of discriminating behavior in the labor market towards women. However, these results must be interpreted with some caution, given the difficulty of measuring important factors such as labor market experience (the difference between actual and potential experience), motivation and intelligence. In this model, the inclusion of potential experience variable approximates the real experience; however, it has been suggested that this variable overstates women's actual labor market experience (generally women spend less time in the labor market compared to men, especially in the presence of young children). As a result, the use of men's wage structure to experience overestimates the remuneration of women's experience, and inflates the unexplained part of the wage gap. Also, factors such as motivation and intelligence are likely to play an important role on earnings; however, variables representing them are missing in the model, leaving their effect to be captured in the error term.

[2]The decomposition is based on the assumption that men wage structure prevails in the market Results when the female wage prevails were also obtained and are available from the authors upon request.

Positive values in the decomposition columns of Table 5 indicate an earning advantage for men, while negative values indicate an advantage for women. Results show that men have a relative advantage in the human capital characteristics due essentially to work experience and job status (Figure 1). Women on the other hand have an advantage over men in the remuneration component attributable mainly to starting salary (Barkley, Stock and Sylvius found the opposite effect)[3], marital status and education. However, these advantages are offset by disadvantages due to the remunerations of variables related to the presence of children, extracurricular experience and the difference in the intercept of the regressions, which include the unmeasured effects not identified in the regressions[4]. These results agree with findings of other studies, such as Barkley, Stock and Sylvius.

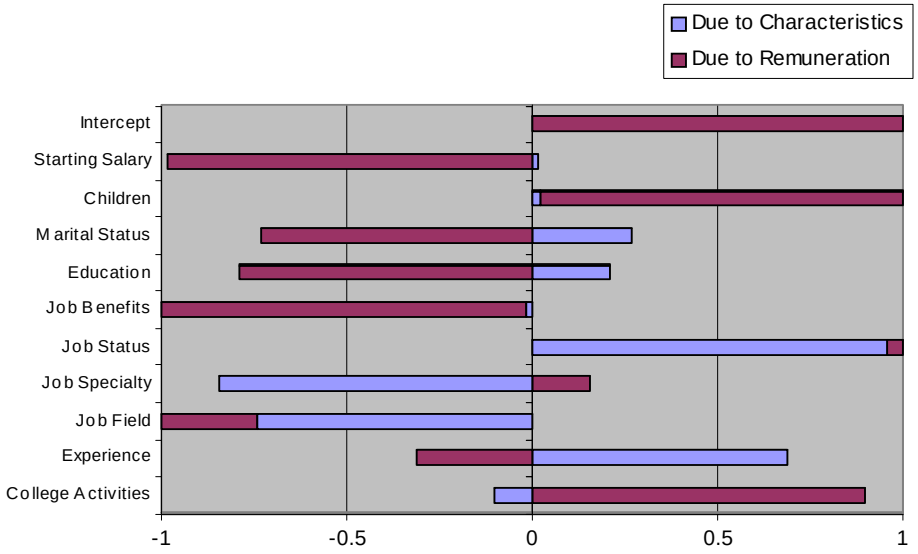

Figure1: Contributions of Characteristics and Remuneration to the Gender Wage Gap.

Conclusions

Various studies continue to debate the role and importance of gender in the process of wage determination. The objective of this study was to identify the main factors that influence the earnings of graduates and to provide new empirical evidence on

[3] This may be a result of a higher proportion of the female sample having starting salaries in later years.

[4] To illustrate the interpretation of the chart we focus on two variables: 'job status' and 'children'. Each variable contributes about a one percent point to the overall gender pay gap. However, the contribution of the differences due to characteristics and differences due to remuneration differs strongly for these two variables. In the case of the 'job status', the effect on the overall gap is mainly due to the fact that women are assigned to managerial positions less often than men, and not to differences in the remuneration between men and women in managerial functions. On the other hand, the effect of the 'children' variable on the wage gap, is almost entirely due to the fact that women seem to earn less than men with similar family situations, and not due to differences in the occurrence of these situations.

the status of gender wage gap in the agriculture industry. Based on survey data from agribusiness graduates of Cal Poly, San Luis Obispo, regression analysis was used to estimate the impact of various factors on the earnings. Findings indicate factors such as education beyond the bachelor degree, starting salaries, work experience, gender, job status and specialty, job sector, and marital status are all important determinants of earnings. In particular, characteristics such as, experience gained through a foreign internship during college, specialties such as marketing, accounting and finance and managerial positions are all factors that retain a relatively high market value. Results show that women are paid 81 percent of men's wage, indicating a wage gap of 19 percent. It is interesting to note the striking similarity of the gender wage gap in agriculture, this once male dominated sector, and the estimated gap from the other industries (GAO report estimated a 20 % pay gap in other industries). When comparing results from this study with those from earlier studies, it appears that the gender gap in agriculture has been slowly decreasing (Barkley, Stock and Sylvius found a 30 % wage differential for agricultural graduates).

Three key elements mark the findings of this study with respect to the gender wage gap: first, the importance of differences in men and women labor market participation rates; second, the differences in men and women wage structures; third, concentration of women in low paying positions and occupations. Differences in human capital characteristics explained to a large extent (55 percent) the gender wage gap; however, a large, unexplained differential remains between the earnings of men and women. Aside from labor market discrimination effect, literature has emphasized the role of preferences as important determinants of work-lifestyle choices and behavior as a possible justification of the unexplained component of the gender wage gap. It is suggested that though men and women do not differ in many of their underlying abilities, yet they do differ in their attitudes toward work, with a large share of them continuing to attach importance to traditional gender roles (Hakim). As a result, women make lifestyle choices that trade greater flexibility to manage work and family against potentially higher earnings.

Findings from this study have a number of implications. For academia, the integration of internships in the curriculum is becoming increasingly important. Industry feedback and circumstantial evidence indicate that graduates who participate in internships adjust faster on the job, need less on-the - job training and have a more open minded attitude. By actively partnering with the industry, universities might be able to enhance their curriculums to include more foreign internships and expand the set of opportunities that would expose students to real life problems in a globally competitive environment.

The presence of the gender wage gap in the industry has implications for agribusiness companies. Bureau of Labor Statistics projects that women's labor force participation rates are expected to keep rising, and the majority of expected

jobs to be created over the next decade will be filled by women. This implies that companies must actively compete to attract and retain workers from this group, by creating and expanding policies that facilitate the integration of work and family responsibilities. By implementing "family-friendly" programs (such as child care services, work-hours flexibility) not only will help women in the industry to successfully balance their work and family life, but will give businesses a competitive advantage to hire and retain the best-qualified employees, male or female. Further, to be successful, companies should try to find ways to help the advancement and promotion of the women employees to leadership and management positions.

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Appendix:

Table 1: Coefficient Estimates for the Overall Regression Model of Earnings

Variables	Mean	Estimated Coefficients	Standard Error	t-values
Dependent: **Ln (Current Salary)**	11.1546			
Independent:				
Intercept		8.053	0.438	18.398***
Past Experience				
Experience	14.8361	0.0330	0.0069	4.7878***
Experience Squared	318.4305	-0.0006	0.0002	-3.0598***
Extracurricular Activities				
[Did not Participate]				
Club Member	0.4801	0.0222	0.0444	0.5011
Club Officer	0.3400	0.0227	0.0474	0.4789
Foreign Programs				
[Did not participate]				
Study Abroad	0.0452	-0.0006	0.0784	-0.0079
Internship Abroad	0.0154	0.2581	0.1310	1.9698**
Job Characteristics				
Ln (Starting Salary)	10.3120	0.2023	0.4377	4.8919***
Type of Employment				
[Not in the Ag Sector]				
Ag Sector	0.4684	-0.1244	0.0569	-2.1848**
Related to Ag Sector	0.3698	-0.0986	0.0499	-1.9757**
Job Status				
[Entry Level Position]				
Lower Management	0.3571	0.1609	0.0462	3.4774***
Upper Management	0.2016	0.4772	0.0541	8.8219***
Proprietor	0.2450	0.6994	0.0574	12.1704***
Employment Specialty				
[Other Non-ag]				
Accounting	0.1121	0.2050	0.0639	3.2061***
Marketing	0.1763	0.2471	0.0599	4.1186***
Greenhouse	0.1492	-0.0707	0.0645	-1.0962
All Other Ag	0.1302	0.0156	0.0627	0.2487
Non-ag Marketing	0.1049	0.3766	0.0633	5.9509***
Non-ag Finance	0.0515	0.1606	0.0800	2.0068**
Non-ag Services	0.0913	0.0226	0.0660	0.3427
Benefits				
[Other]				
Health	0.8327	0.3525	0.0615	5.7318***
Retirement/Savings	0.7297	0.2057	0.0537	3.8273***
Vacation	0.6582	-0.0243	0.0399	-0.6080
Equip Use /Discounts	0.8517	0.0221	0.0692	0.3203
Individual and Family Characteristics				
Education				
[BS]				
MBA	0.0552	0.1625	0.0709	2.2884**
MS	0.0642	0.0204	0.0676	0.3019
JD	0.0154	0.3627	0.1351	2.6847**

Table: 1 (Continued)

Gender				
[Male]				
Female	0.3580	-0.1932	0.0641	-3.0109***
Children				
[No Children < 18]				
Children < 18	0.4665	0.0180	0.0505	0.3583
Marital Status				
[Married]				
Never Married	0.1899	-0.1759	0.0664	-2.6488***
Previously married	0.0434	-0.2248	0.0962	-2.3379**
Interaction Terms				
Fem & Never Married	0.0976	0.1737	0.0961	1.8084*
Fem & Prev Married	0.0136	0.3116	0.1714	1.8182*
Female & Children<18	0.1474	-0.2269	0.0785	-2.8925**
N = 1106	Adjusted R^2 = 0.424		F-value = 23.91	

For two-sided test: * indicates $\alpha = 0.10$ ** indicates $\alpha = 0.05$ *** indicates $\alpha = 0.01$

Table 3: Coefficient Estimates for Men's Regression Model of Earnings

Variable	Estimated Coefficient	Standard Error	t-value
Dependent Ln (Current Salary)			
Independent			
Intercept	8.60	0.537	15.981***
Past Experience			
Experience	0.03	0.0087	3.4896***
Experience Squared	-0.0004	0.0002	-2.307**
Extracurricular Activities			
[Did not participate]			
Club Member	0.03089	0.0520	0.5936
Club Officer	0.03699	0.0569	0.6485
Foreign Programs			
[Did not Participate]			
Study Abroad	0.01534	0.1118	0.1373
Internship Abroad	0.160	0.1637	0.9790
Job Characteristics			
Ln (Starting Salary)	0.15735	0.0502	3.1474***
Type of Employment			
[Not in the Ag Sector]			
Ag Sector	-0.1312	0.0774	-1.7042*
Related to Ag Sector	-0.108	0.0698	-1.5535
Job Status			
[Entry Level Position]			
Lower Management	0.15688	0.0663	2.3768**
Upper Management	0.51	0.0707	7.1848***
Proprietor	0.72758	0.0755	9.7011***
Employment Specialty			
[Other non-ag]			
Accounting	0.21364	0.0835	2.5738**
Marketing	0.227	0.0752	3.0290***
Greenhouse	-0.12	0.0771	-1.4828
All other ag	0.01004	0.0809	0.1237
Non-ag Marketing	0.3401	0.0847	4.0610***
Non-ag Finance	0.246	0.1106	2.2256**
Non-ag Services	0.09082	0.0857	1.0324
Benefits			
[Other]			
Health	0.298	0.0759	3.9252***
Retirement/Savings	0.1902	0.0629	3.0187***
Vacation	-0.08	0.0488	-1.1828
Equipment Use/Discounts	0.0503	0.0853	0.5896
Individual Characteristics			
Education			
[BS]			
MBA	0.10217	0.0863	1.1881
MS	-0.004	0.0895	-0.4339
JD	0.3374	0.1559	2.1627**
Children			
[No children under 18]			
Children under 18	0.02356	0.0525	0.4535
Marital Status			
[Married]			
Never Married	-0.185	0.0674	-2.7267***
Previously Married	-0.23	0.0971	-2.1757**
N = 710	Adjusted R^2 = 0.33	F-value = 12.867	

For two-sided test, * indicates $\alpha = 0.10$, ** indicates $\alpha = 0.05$ and *** indicates $\alpha = 0.01$.

Table 4: Coefficient Estimates for Women's Regression Model of Earnings

Variable	Estimated Coefficient	Standard Error	t-value
Dependent Ln (Current Salary)			
Independent			
Intercept	6.919	0.803	8.618***
Past Experience			
Experience	0.044	0.0147	2.9708***
Experience Squared	-0.001	0.0005	-1.7517*
Extracurricular Activities			
[Did not Participate]			
Club Member	-0.004	0.0889	-0.0439
Club Officer	-0.020	0.0914	-0.2239
Foreign Programs			
[Did not Participate]			
Study Abroad	-0.0131	0.1138	-0.1182
Internship Abroad	0.4151	0.2258	1.8392*
Job Characteristics			
Ln (Starting Salary)	0.284	0.0775	3.6668***
Job Field			
[Not in the Ag Sector]			
Ag Sector	-0.123	0.0889	-1.3861
Related to Ag Sector	-0.104	0.0738	-1.4133
Job Status			
[Entry Level Position]			
Lower Management	0.1831	0.0663	2.7617***
Upper Management	0.4413	0.0977	4.5187***
Proprietor	0.6392	0.0984	6.5005***
Job Specialty			
[Other non-ag]			
Accounting	0.188	0.1019	1.8439**
Marketing	0.2830	0.1030	2.7469***
Greenhouse	0.063	0.1355	0.4612
All other ag	0.002	0.1023	0.0157
Non-ag Marketing	0.372	0.0985	3.7767***
Non-ag Finance	0.0620	0.1197	0.5219
Non-ag Services	-0.101	0.1059	-0.9534
Job Benefits			
[Other]			
Health	0.436	0.1084	4.0171***
Retirement/Savings	0.260	0.1088	2.3873**
Vacation	0.033	0.0733	0.4531
Equipment Use/discounts	-0.062	0.1263	-0.4929
Individual Characteristics			
Education			
[BS]			
MBA	0.212	0.1322	1.6039
MS	0.124	0.1057	1.1754
JD	0.421	0.2801	1.5026
Children			
[No children under 18]			
Children under 18	-0.204	0.0699	-2.9117***
Marital Status			
[Married]			
Never Married	-0.009	0.0725	-0.1215
Previously Married	0.083	0.1473	0.5629
N = 396	Adjusted R^2 = 0.35	F-value = 8.164	

Table 5: Decomposition Results of Wage Gap by Components

Ln (Current Salary)	Men	11.3212	Women	10.8557	Effects Due to	Effects Due to
		Wage Gap = 0.4655			Characteristics	Remuneration
Variable	$\hat{\beta}_M$	$\bar{X}_M$	$\hat{\beta}_F$	$\bar{X}_F$	$\left(\bar{X}_M - \bar{X}_F\right)\hat{\beta}_M$	$\left(\hat{\beta}_M - \hat{\beta}_F\right)\bar{X}_F$
Intercept	8.581797		6.919			**1.662**
St Salary	0.15735	10.3625	0.284	10.2213	**0.0222**	**-1.3**
Past Experience					**0.1147**	**-0.0520**
Experience	0.03	17.4525	0.044	10.1452	0.2192	-0.1420
Exp Square	-0.0004	411.9689	-0.001	150.7229	-0.1044	0.09
Extracurricular Activities	0.03	17.4525	0.044	10.1452	0.2192	-0.1420
Club Member	-0.0004	411.9689	-0.001	150.7229	-0.1044	0.09
Club Officer	0.030888	0.4775	-0.004	0.4848	-0.000	0.0169
Foreign Programs	0.036993	0.307	-0.02	0.399	-0.003	0.022
Study abroad	0.015344	0.0352	-0.013	0.0631	-0.000	0.001
Internship abroad	0.16	0.0155	0.415	0.0152	0.000	-0.004
Job Characteristics						
Job Field					**-0.0143**	**-0.0050**
Ag Sector	-0.131208	0.5254	-0.123	0.3662	-0.0208	-0.0030
Related to Ag Sector	-0.108	0.3479	-0.104	0.4091	0.0066	-0.002
Job Status					**0.1475**	**0.0070**
Lower Management	0.156882	0.3211	0.183	0.4217	-0.0157	-0.0110
Upper Management	0.51	0.2479	0.441	0.1187	0.0659	0.008
Proprietor	0.727575	0.293	0.639	0.1591	0.0974	0.01
Job Specialty					**-0.0352**	**0.0065**
Accounting	0.213642	0.1028	0.188	0.1288	-0.0056	0.003
Marketing	0.227	0.1944	0.283	0.1439	0.0114	-0.0081
Greenhouse	-0.12	0.1915	0.063	0.0732	-0.0142	-0.0134
All other ag	0.010044	0.1254	0.002	0.1389	-0.0001	0.001
Non-ag Marketing	0.34	0.0859	0.372	0.1389	-0.0180	-0.005
Non-ag Finance	0.246	0.0408	0.062	0.0707	-0.0074	0.01
Non-ag Services	0.090816	0.0859	-0.101	0.101	-0.0014	0.019
Job Benefits					**-0.0029**	**-0.158**
Health	0.298	0.831	0.436	0.8359	-0.0015	-0.12
Retirement/Savings	0.190197	0.7183	0.26	0.75	-0.0060	-0.053
Vacation	-0.08	0.6423	0.033	0.6869	0.0036	-0.078
Equipment /Discounts	0.05	0.8592	-0.062	0.8384	0.0010	0.093

Table: 5 (Continued)

Variable	$\hat{\beta}_M$	$\bar{X}_M$	$\hat{\beta}_F$	$\bar{X}_F$	$\left(\bar{X}_M - \bar{X}_F\right)\hat{\beta}_M$	$\left(\hat{\beta}_M - \hat{\beta}_F\right)\bar{X}_F$
Individual Characteristics						
Education					**0.005033417**	**-0.018997356**
MBA	0.102168	0.0606	0.212	0.0455	0.001542737	-0.004997356
MS	-0.04	0.0577	0.124	0.0758	0.000724	-0.013
JD	0.3374	0.0183	0.421	0.0101	0.00276668	-0.001
Children					**0.002016394**	**0.09366205**
Children under 18	0.023556	0.4972	-0.204	0.4116	0.002016394	0.09366205
Marital Status					**0.021887**	**-0.06**
Never Married	-0.185	0.1437	-0.009	0.2727	0.023865	-0.048
Previously Married	-0.23	0.0465	0.083	0.0379	-0.001978	-0.012
SUM					**0.2570685**	**0.211016**

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The Joint Impact of Supply Chain Integration and Quality Management on the Performance of Pork Processing Firms in China

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Abstract

It is widely acknowledged that competition is no longer between individual firms, but between supply chains. A number of studies have indicated that supply chain integration and quality management have become essential to obtain competitive advantage. The present study tests the relationships among supply chain integration, quality management practices and firm performance in 229 Chinese pork slaughterhouses and processors using structural equation modeling. The most important results are that quality management is positively linked with firm performance. As managers put it "Quality is the life of the enterprise". Pork processing managers that wish to improve their performance are therefore advised to invest in quality management. Equally interesting is the indirect link of supply chain integration through quality management with firm performance. To improve quality of their products and reduce uncertainty in hog supply chains, companies are advised to develop more integrated relationships with their suppliers. However, in contrast to earlier studies, the direct link of supply chain integration and firm performance was not significant. This result may indicate that the Chinese pork processing industry is still in an early stage of SC integration.

Keywords: Supply chain management, quality management practices, pork supply chains, firm performance, China

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Introduction

Supply chain management (SCM) and total quality management (TQM) are two important tools that manufacturing companies use to achieve competitive advantage (Sila et al., 2006). These two concepts are discussed extensively in both theoretical and empirical contexts. Since competition is no longer between individual firms, but between supply chains, the understanding and practicing of SCM has become an essential prerequisite for staying competitive in the global race and for enhancing profitability (Power et al., 2001). The enhancement of organizational performance should be attained through closely integrating the internal functions within a company and effectively linking them with the external operations of suppliers, customers and other channel members (Kim, 2006).

Much like the recent emergence of SCM initiatives, the topic of quality management and improvement and the contribution of quality management practices to firm performance has dominated most manufacturing and service organizations. However, the number of studies interlinking SCM and quality management are still limited (Robinson and Malhotra, 2005). In the struggle for marketplace advantage, academic researchers and practitioners need to move from the traditional firm and product based mindset to an inter-organizational supply chain orientation involving customers, suppliers and other partners (Robinson and Malhotra, 2005). Traditional quality programs focus on quality management schemes, like total quality management, HACCP, and ISO 9001 (international quality management system standards). Nowadays, more and more companies apply a supply chain management philosophy to benefit from supply chain partnerships and quality improvement gains critical to customer satisfaction. In addition to addressing the relationship between quality management practices (QMP) and firm performance and SCM and firm performance, this study will also examine the interaction between SCM and quality management.

The study domain of this paper is the pork processing industry in China. Since the government removed state procurement quotas and price control in 1985, fundamental changes have taken place in the pork sector. It has become the largest pork production and consumption country in the world since the early 1990s. The total output of pork production reached 48.8 million tons in 2005, accounting for approximately 46.1% of the total pork production in the world. The Chinese people consume about half of the total amount of pork products in the world (China Statistics Yearbook, 2006). Although pork consumption has the tendency of decreasing in the last two decades, it is still the most popular meat in China, accounting for about 65% of the major meat products in 2005 (China Statistics Yearbook, 2006). Based on current pork consumption at various income levels, it is estimated that pork consumption will grow more than 7% in Chinese cities and 1.5% in the countryside over the next ten years. This generates an additional 12 million pounds of pork in 2011 (Pan and Kinsey, 2002). With the increasing income

and changing life styles generated by rapid economic and social development, the pork industry will be driven to emphasize safety, quality and convenience. However, the current pork industry is characterized by the dominant position of the 80% of small household hog producers and a large number of small slaughterhouses. Traditional spot market transactions are still the most popular market channel that farmers use in selling their hogs (Zhou and Dai, 2005). The organization of the pork processing industry induces problems in tracking and tracing pork from "field to table", and eventually results in potential quality and safety problems.

In recent years, some leading meat processing companies like Shineway and Yurun Co. Ltd. have established closer vertical coordination mechanism with their suppliers and retailers and invested heavily in developing cold chains to provide consumers with brand products. Will this kind of inter-organizational supply chain orientation and quality management improve firm performance? Will the level of supply chain integration facilitate the implementation of quality management in these companies? These are the main questions that this paper will address in order to identify critical success factors for competitiveness of pork processing firms in China. To the best of our knowledge, there has been no empirical study on this issue in the pork processing sector by using survey methodology in China. This paper attempts to fill in this gap by examining the relationship among supply chain integration, quality management practices and firm performance in the upstream pork supply chain in China.

In Section 2 we present the literature review on SCM, QMP and firm performance and describe a theoretical model that relates SCM and QMP to firm performance. Thereafter, the three constructs and the hypotheses are discussed. In Section 3 we present the instrument development and a description of the study sample. In Section 4 the methods to assess construct validity and reliability are first discussed. Once an acceptable measurement model is obtained, the hypothesized structural model will be tested using structural equation modeling techniques. In Section 5 our findings in the pork processing industry will be evaluated in the light of earlier studies, and the conclusions will be drawn. Finally, in Section 6, suggestions for further research and the implications for pork supply chain management are presented.

Theory and Research Hypotheses

This part will present the theory of SCM and quality management. The presentation will include the literature review on the relationships among supply chain integration (SCI), quality management practices and firm performance. Hypotheses will be developed and the section will end with a conceptual framework of the research.

Supply Chain Management and Firm Performance

Supply chain management (SCM) seeks to enhance competitiveness by closely integrating the internal functions within a company and effectively linking them with the external operations of suppliers, customers and other channel members. It has been credited as being helpful to cut costs (Mainardi et al. 1999), increase productivity (Gryna 2001) and reduce risk (Chase et al. 2000). Among the addressed benefits, improving profitability and strengthening organizational competitiveness are repeatedly mentioned (Fisher 1997, Christopher, 2000; Wisner and Choon, 2000; Kim, 2006). Industrial sectors, such as vehicle manufacturing and retail distribution, have made significant progress towards more efficient and closely integrated supply chains (Briscoe, 2005). The benefit of SCI can be attained through effectively linking various supply chain activities. This linkage should be subject to the effective construction and utilization of various supply chain practices. SCM practices have been defined as a set of activities undertaken in an organization to promote effective management of its supply chain (Li et al., 2006). Li et al. (2006) listed several studies on the dimensions of SCM practices. For example, Tan et al. (2002) identified six aspects of SCM practices through factor analysis: supply chain integration, information sharing, supply chain characteristics, customer service management, geographical proximity and JIT capability. Chen and Paulraj (2004) use supplier base reduction, long-term relationship, communication, cross-functional teams and supplier involvement to measure buyer-supplier relationships. When summarizing all these studies, we can notice that the literature portrays SCM practices from a variety of different perspectives with a common goal of ultimately improving organizational performance (Li et al., 2006). The performance of each supply chain practice should be evaluated depending on how the practice has a significant effect on the efficient integration of the supply chain (Kim, 2006). Bowersox (1989) asserts that the process of SCI should progress from the integration of internal logistics processes to external integration with suppliers and customers. This internal integration can be accomplished by automation and standardization of internal logistics functions, the introduction of new technology, and continuous performance control under a formalized and centralized organizational structure. External integration can be achieved by information sharing and strategic linkage with suppliers and customers, and the standardization of logistics processes between firms. Based on these discussions, our study will focus on the following five main SC integration activities of pork processors: internal integration, external integration, supplier-buyer relationship coordination, integrated information technology and integrated logistics management, and their relationships with firm performance.

SCI should engender superior performance (e.g. Tan et al., 1998; Frohlich and Westbrook, 2001). Vickery et al. (2003) also mentioned a growing body of literature that has suggested a positive relationship between the degree of integration across the supply chain and firm performance (e.g. Stevens, 1989, Lee et al., 1997; Frohlich

& Westbrook, 2001). Wood (1997) also indicated that integration of the supply chain could improve both profit potential and competitive position. Therefore it is hypothesized:

H1: There is a positive relationship between SCI and performance of pork processing firms in China.

Quality Management Practices and Firm Performance

To cope with the competitive environment, many companies have applied quality assurance systems. The importance of quality and its associated benefits such as improvements in customer satisfaction have been well acknowledged (e.g., Hendricks and Singal, 1997). Madu et al. (1995) studied QM practices in Taiwan's manufacturing firms. They found a significant causal relationship between quality dimensions (i.e., customer satisfaction, employment satisfaction, and employee service quality) and organizational performances. In their research on total quality management practices in the largest US firms, Mohrman et al. (1995) found that 83% of the surveyed companies had a "positive or very positive" experience with QM, and 79% planned to "increase or greatly increase" their QM initiatives in the next 3 years. Most of the TQM practices are related to one form of performance improvement or the other, e.g. productivity, quality of products, customer service, profitability and competitiveness. Kuei and Madu (2001) note that the focus of the quality-based paradigm has shifted from the traditional company-centered setting to complete supply chain systems. A number of articles offer insights on the critical success factors for achieving quality 'in-house' management and in a broader supply chain context. For example, Saraph et al. (1989) reported that eight critical factors could be used for QM assessment, namely the role of the quality department, training, product/service design, supplier quality management, process management, quality data and reporting, and employee involvement. However, a survey by A. T. Kearney of 100 British firms and a survey of the executives in US manufacturing and service firms revealed that only 20-30% believed that TQM made them more competitive (Economist, 1992, Mathews and Katel, 1992). Dooyoung et al. (1998) also reported estimates of QM failure rates as high as 60-67%. These mixed findings put forward the necessity to study the QM practices-performance link in companies of various size, not only big companies.

The objective of quality management efforts should be focused on achieving customer satisfaction. Performance outcomes are driven by quality management practices (QMP), which in turn lead to customer satisfaction (Choi & Eboch, 1998). To identify the impact of quality management practices on firm performance, it is hypothesized:

H2: There is a positive relationship between QMP and performance of pork processing firms.

According to literature review, the quality management practices will consist of the following four sub-measurements: management leadership, supplier quality management, quality design and process management.

Supply Chain Integration and Quality Management Practices

Organizations world-wide recognize the requirement to improve product quality to succeed in the competitive international market place. They also realize that the involvement of suppliers is critical to improve quality and to meet customer specifications (Wong et al., 1999). Therefore it is imperative to study the dynamics of quality management in a supply chain context (e.g. Ellram, 1991; Bamford, 1994).

The integration of the upstream supply chain in the meat industry is particularly important since the outbreaks of animal diseases such as Foot and Mouth disease and BSE. Previous research (Fearne, 1998, 2000; Palmer, 1996) has highlighted the importance of greater vertical coordination within meat supply chains in order to reduce risk and uncertainty, improve quality and foster value creation (Taylor, 2006). However, the industry is dogged by adversarial relationships and a commodity culture that makes it hard for companies, particularly upstream, to reach a position of sustainable profitability (Simon et al., 2003). In other meat sectors studied, a stress on the relationship between close chain coordination and product quality has also been noticed. For example, Klein et al. (1996) asserted that one of the two primary steps that were regarded essential to ensure better Canadian pork quality was excellent communication and teamwork among all sector participants through the formation of strategic alliances or vertical integration. In the study of Hobbs (1998), a coordinated approach to production, processing and marketing was regarded as the driving force for the Danish pork industry to remain one of the most successful industries in the world. This approach was built on a thorough understanding of the requirements of different markets, a dedication to quality which includes the ability to provide a consistent and reliable supply of high quality products tailored to the needs of different markets. Co-operation between players at different stages of the supply chain enables information to be disseminated effectively and efficiently throughout the supply chain. In a study of 38 UK firms, Armistead and Mapes (1993) indicate that the level of SCI improves quality and operating performance. Thus, we formulate the following hypothesis:

H3: The level of SCI is positively related to quality management practices in pork processing firms in China.

Firm Performance Indicators

In literature much attention has been devoted to three main aspects of performance: financial, organizational and strategic performance. Organizational theory offers three approaches to measure organizational effectiveness or performance (Murphy, Trailer and Hill, 1996), namely the goal-based, systems and multiple constituency approach. After comparing different measures of performance, they suggest that multiple dimensions of performance should be considered where possible, including both financial and non-financial measures. Accounting-based indicators, with efficiency, sales growth rate and profitability (e.g. return on sales or on investments) are the financial indicators most commonly used (Murphy, Trailer and Hill, 1996). In addition, operational (non-financial) performance measures, such as product quality, customer satisfaction and market shares are often examined. Our research uses both financial and non-financial indicators to measure performance. The indicators we use to measure performance of pork processing firms are: growth rate, market share, profitability and customer satisfaction.

Research Methodology

The research framework of this study is shown in Figure 1. Supply chain integration and quality management initiatives and their relationships form the core of this research. The focus of the research is on the buying firms and their most important suppliers. The approach of surveying the buying firms' top purchasing and supply management executives to study buyer-supplier relationships has been widely practiced in the field of operations management (Carr and Pearson, 1999, Shin et al., 2000). Therefore the survey methodology was employed to set up the quantitative part of empirical research and to collect data to test the hypotheses developed in this research. To test the measurement model and the structural model of this research, structural equation modeling (SEM) was used. SEM is one of the most applied and consolidated means of testing relations and causality in the field of buyer-supplier relationships (Malhorta et al., 1999). The advantage of SEM over standard regression analysis (i.e. OLS) is its explicit consideration of the measurement error in the indicators and simultaneously estimation of a system of structural equations.

Moreover, SEM is a powerful method for testing causal models, because it enables the simultaneous evaluation of the individual paths constituting the model, total effects and the complete model's goodness-of-fit (Hair et al. 1998). In the next part, we will describe the process of scale development and determining the validity and reliability of the research constructs. Afterwards, the results of measurement model and structural model will be described.

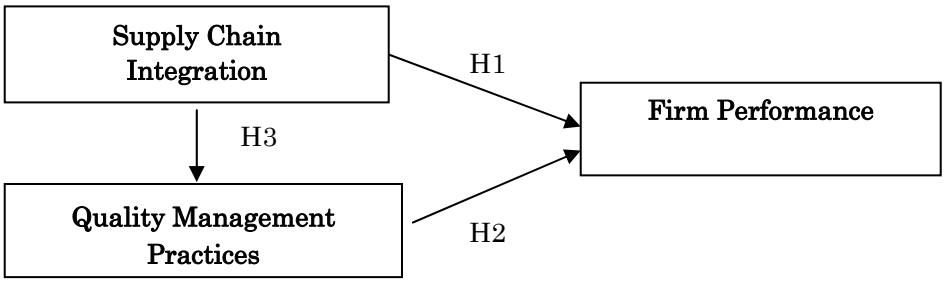

Figure 1: Research Framework.

Construct Measures

Figure 2 illustrates the analytical steps for scale development which incorporates aspects of both theoretical and statistical modeling to achieve construct validity and reliability as well as hypotheses testing. This paradigm is an amalgamation of similar frameworks of Segars (1996), Chen and Paulraj (2004), and Lu et al. (2007). A valid and reliable construct is very critical for research. Multiple scale items for each of the factors in the constructs are developed. As noted by Churchill (1979), many variables of interest are inherently complex in nature; therefore, they cannot be accurately measured with a single scale. Single measures typically contain considerable uniqueness and subsequently low correlation with the attribute being measured. Additionally, single items tend to frame concepts narrowly resulting in considerable measurement error. Multiple measures can overcome these difficulties. The specificity of individual items can be averaged out and more robust conceptualizations of complex variables can be developed thereby reducing measurement error (Segars, 1997). The scale development for the construct SCI was adapted from Chen and Paulraj (2004) and Segars (1997). It has five sub-constructs: internal integration, external integration, supplier-buyer relationship coordination, integrated information technology and integrated logistics management. Items on QMP were mainly derived from Saraph et al. (1989). We initially identified four sub-measurements to measure QMP: management leadership, supplier quality management, quality design and process management. Items on firm performance were mainly from Claro et al. (2004). Based on their studies and through interviews with practitioners, the items for the sub-measurements of the constructs were developed. Where appropriate, additional items were created to cover the domain of the constructs. Altogether 37 items were generated to measure the upstream pork SCI and QMP and 5 items for firm performance. A seven-point Likert scale was used where 1=not agree at all, 4=neutral and 7=totally agree. The scale was evaluated by practitioners and academicians in a formal pre-test study in order to establish construct validity. These were general managers from meat processing industries and professors from economics and management, food science and technology at Nanjing Agricultural University in China. In addition, the scales were pilot tested in 10 pork processing companies through structured interviews. Based

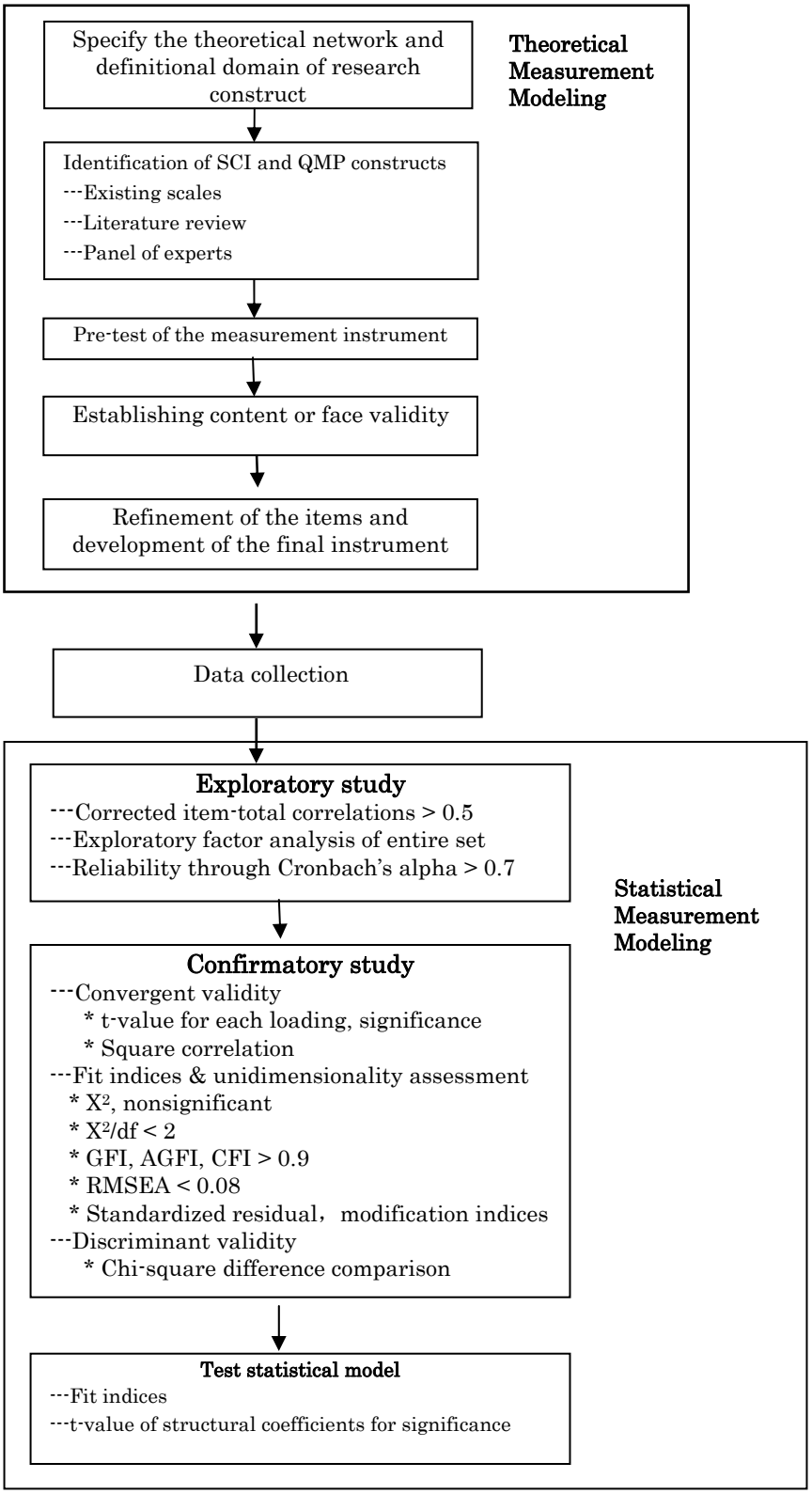

Figure 2: An Analytical Paradigm for Construct Development and Data Analysis

Adapted from Segar (1996), Chen and Paulraj (2004) and Lu et al. (2007)

revised instrument which contained 35 items for constructs SCI and QMP and 4 on suggestions by the managers, items were added, changed, or deleted to form a items for firm performance. The measurement items and indicators for this study are shown in Appendix A.

Data Collection

During the pre-test period, it turned out that it was difficult to get questionnaires back from the meat processing companies through post. The companies in China are still not used to answer mail questionnaires. Therefore the survey was carried out by students from Nanjing Agricultural University majoring in marketing, management and animal sciences, during the winter and summer vacations in 2005. As China is a big country, our research only focused on the eastern two provinces and one direct jurisdiction district of the central government of China, namely Jiangsu province, Shandong province and Shanghai. Four training sessions were organized for the students who were willing to do the survey. Each lasted for two hours. The students were divided into small groups to improve the effectiveness of the training. A written guideline on how to do the survey was distributed to the students. After explaining the research background and the questions to be asked, students were asked to work in pairs to practice the roles as respondent and interviewer.

A stratified sampling technique was deemed appropriate to collect the data after consultation of experts and professionals in the pretest. They provided valuable information on the distribution of the pork slaughtering and processing firms in the sampling areas. Cities include pork slaughtering and processing companies of various sizes, in the villages, small scale slaughterhouses prevail. Eighty eight cities were selected. A list of pork slaughtering and processing firms was provided by the meat associations of the Jiangsu and Shandong provinces. As the members of the meat association are usually large and medium size companies, students were asked to also pay attention to the small firms in the sector. The list of pork slaughtering houses, including small companies, could be obtained from the Designated Pork Slaughtering Administration Office in their cities. Students were taught to use the method of systematic sampling techniques for selection of slaughterhouses.

Two rounds of telephone contacts were conducted during the surveys. The first two rounds produced 202 questionnaires. Among these, twenty were not completed by the companies and therefore were useless. In the second round, another 56 questionnaires were returned. Among these, nine were useless. Therefore, the sample base for the empirical research was 229 questionnaires.

Table 1: Profile of the Respondent Companies (n=229)

Characteristics of the respondents	Number	Percentage
Job Title (n=229)		
General or Deputy General Managers	93	40.6
Quality Control Managers	49	21.4
Sales Managers	39	17.0
Head of the Office and Others	48	21.0
Organizational Status (n=229)		
State-owned	32	14.0
Collective	31	13.5
Private	70	30.6
Joint Venture	16	7.0
Private and Share Holding	80	34.9
Main Business (n=227)		
Slaughterhouses	94	41.0
Further Processing	60	26.2
Slaughtering/Processing	73	31.9
Employees (n=229)		
Below 50	48	21.0
51-100	48	21.0
101-499	93	40.6
More than 500	40	17.5
Level of Turnover (1,000 Euros) (n=229)		
Below 500	47	20.5
501-3,000	82	35.8
3,001-30,000	82	35.8
Greater than 30,000	18	7.9

Characteristics of Respondents

A comparison of the early and the late respondents was carried out to test for the non-response bias (Armstrong and Overton, 1977). T-tests were performed on the responses of the early and late respondents. At the 5% confidence level, there were no significant differences between the responses of these groups. This suggests that non-response was not a major problem in our sample.

The profiles of the respondents and their company characteristics are displayed in Table 1. The results show that 40.6% of the participants in the survey were general and deputy general managers, indicating a good quality of the respondents, who should have a clear understanding of what practices their firms use with regard to their relationships with their most important suppliers. As for the status of the organizations, private industry is developing very fast. Our survey also proved this, with 65.5% of the firms being privately owned or private share holding companies.

The survey on the business scope of the firms showed that 41% of the firms were slaughterhouses and 31.9% were integrated slaughtering and processing companies. Processors only accounted for 26.2% of the sample. The respondents were also asked to provide information about the number of employees and the level of turnover which indicate the scales of these companies. The results in Table 1 indicate that 40.6% of the companies had 100 to 500 employees. In China, companies are called "scaled companies" if their annual turnover is more than 500,000 euros. The number of companies with a turnover ranging from 500,000 euros to 30 million euros was 71.6%. In our sample, 7.9% of the companies had a yearly turnover of more than 30 million euros.

Data Analysis

Based on studies of Koufteros (1999), the following section will discuss statistical analysis used to determine the validity and reliability of each construct. The methods employed for the development of exploratory evaluation of the measurement scales for the two latent variables of SCI and QMP in this study is shown in Table 2. They included corrected item-total correlations, exploratory factor analysis and reliability estimation using Cronbach's alpha. The description of these methods will be given in combination with the data analysis of this research.

Exploratory Factor Analysis

As our constructs SC integration and QMP were based on previous research to enhance validity, we first conducted a principal component analysis with oblique rotation for these constructs to see whether the items fell under the defined constructs. The result for SCI construct turned out to be four factors for SC integration with integrated information technology and integrated logistics management into one factor. By looking at the questions, we found an interrelationship between these two sub-measurements. The result for QMP was also different. There were five factors. It was more appropriate to rename the first dimension as "incompany quality management" (coded as QMP1, QMP6 and QMP8) and the new factor into "employee involvement into quality management" (coded as QMP3, QMP4, QMP5 and PM2). The other three factors still had the same name, but with different items. Table 2 showed the result of the factor analysis. We then checked the item-total correlation which refers to a correlation of an item or indicator with the composite score of all the items forming the same set. We used the corrected item-total correlation that does not include the score of the particular item in question when calculating the composite score (Koufteros, 1999). The results of the analysis for the scales of SCI and QMP was also shown in Table 2. Each scale was purified by eliminating items if their corrected item-total correlation was less than 0.50 (Koufteros, 1999; Lu et al., 2007).

In the next step, we did an exploratory factor analysis to assess the dimensionality

of the remaining items using principal component analysis with oblique rotation. A factor loading can be used as an indicator in interpreting the role each item plays in defining each factor. Factor loadings are in essence the correlation of each item to their underlying construct (Lu et al. 2007). We use 0.40 as a cut-off for exploratory factor analysis. Items that are not pure (e.g. items with cross loadings) are eliminated. It is desired that the coefficient alpha is above 0.70 for established scales and 0.60 for new scales (Churchill, 1979). We didn't find any cross-loading

Table 2: Corrected-item Total Correlations, Factor Loadings and Cronbach's Alpha for SCM Construct (n=229)

Item code	Corrected--item total correlation	Factor loadings	Factor	Cronbach's alpha
Integ1	.640	-.788	Internal integration	.787
Integ2	.665	-.871		
Integ3	.610	-.606		
Exint1	.536	.819	External integration	.773
Exint2	.632	.869		
Exint3	.700	.760		
Exint4	.519	**.525**		
Coord1	.550	.907	Buyer-Supplier Relationship Coordination	.658
Coord2	.500	.652		
Coord3	.503	.750		
Coord4	**.263**			
Infoup	-	.920	Integrated IT & logistics management	.855
Logis1	.700	.815		
Logis2	.570	.928		
Logis3	.703	.686		
QMP1	.629	.713	Incompany quality management	.849
QMP6	.780	.904		
QMP8	.752	.800		
QMP3	.634	.813	Employee involvement	.750
QMP4	**.394**			
QMP5	.577	.747		
PM2	.542	.885		
SQM1	.658	.894	Supplier quality management	.778
SQM2	.569	.769		
SQM3	**.150**			
SQM4	.629	.689		
QMP2	**.454**		Product/service design	.714
QMP7	.522	.887		
Design1	.591	.753		
Design2	.502	.790		
QM1	.644	.861	Process management	.783
PM3	.644	.808		

factors. However, the factor loading of Exintup4 was below 0.60, and was subsequently eliminated. The percentage of variance explained of the four factors for SCM accounted for 69.35% of the variance, while the percentage of variance explained of the five factors for QMP accounted for 65.66% of the variance. This may indicate that our two constructs have a good unidimensionality.

Cronbach's alpha has several disadvantages, including the fact that it is inflated when a scale has a large number of items, and it assumes that all of the measured items have equal reliability (Gerbing and Anderson, 1988). Despite of these shortcomings, it is still one of the most widely used measures for evaluating reliability (Hair et al., 1998; Koufteros, 1999). Table 2 shows the Cronbach's alpha value for each factor. Except for the factor "buyer-supplier relationship coordination" which has a reliability value of 0.658, the reliability value for all the other factors was above 0.70, which is considered satisfactory (Hair et al., 1998).

According to Gerbing and Anderson (1988) and Segars and Grover (1993), exploratory factor analysis does not provide an explicit test of unidimensionality as each factor from an exploratory analysis is defined as a weighted sum of all observed variables in the analysis. In addition, O'Leary-Kelly and Vokurba (1998) point out that exploratory factor models do not provide any explicit test statistic for assessing convergent and disciminant validity. Therefore, we will discuss in the next part the assessment of unidimensionality and other properties related to construct validity and reliability through confirmatory factor analysis (CFA).

Results for the Measurement Model

Confirmatory Factor Analysis

CFA involves the specification and estimation of one or more hypothesized models of factor structure, each of which proposes a set of latent variables (factors) to account for covariances among a set of observed variables (Koufteros, 1999). The path diagram for the SCM construct with four latent variables is presented in Figure 3. A similar path diagram can be drawn for the QMP construct. To save space, this is not illustrated here.

According to the convention of AMOS analysis (Arbuckle, 1997), observed variables are represented by squares and latent variables by circles and labeled with the Greek lettersξ. The Greek letter$\delta$is seen as error in manifest or observed variables. A straight arrow pointing from a latent variable to an observed variable indicates the causal effect of the latent variable on the observed variable (Lu et al., 2007). It is worth to mention that on the estimation of the measurement model of constructs with more than one item (actually preferable in structural equation modeling), one of the loadings in each construct can be set to a fixed value of 1.0 in order to make the constructs comparable (Joreskog and Sorbom, 1996).

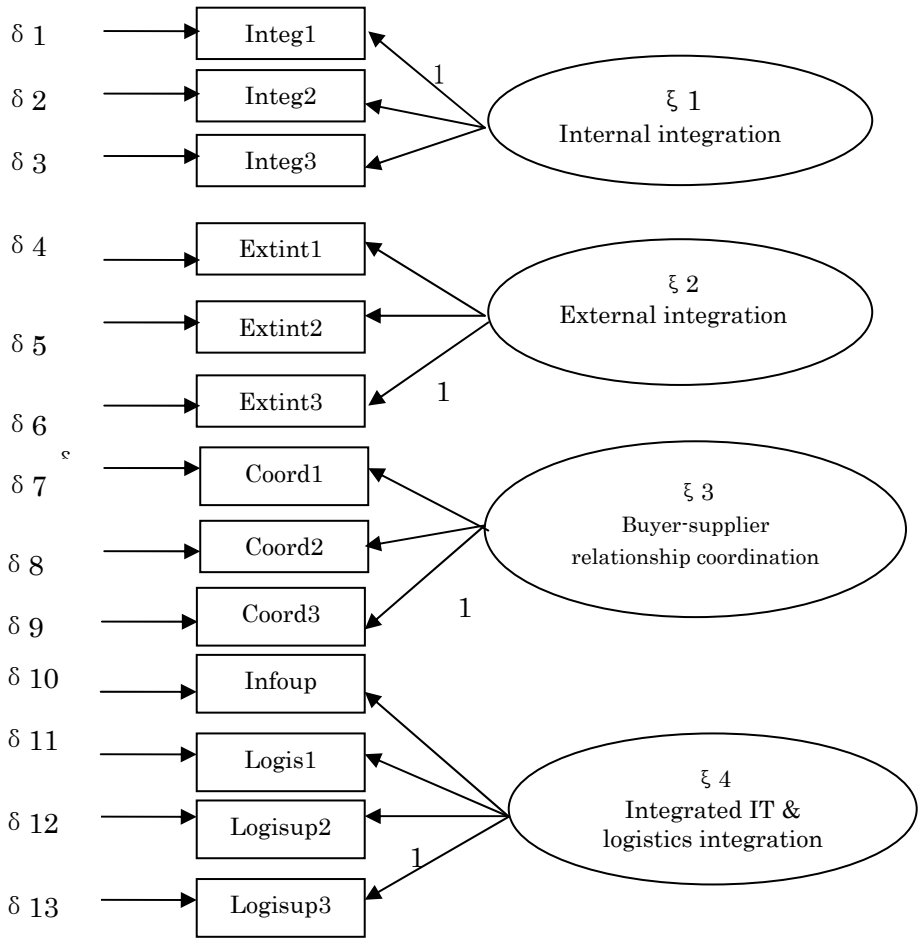

Figure 3: Path Diagram of the Measurement Model of SCI

Convergent Validity and Item Reliability

Convergent validity measures the similarity or convergence between the individual items measuring the same construct. It can be assessed by using EFA and CFA. In the exploratory factor analysis both constructs have achieved convergent validity. In CFA, convergent validity can be assessed by examining the loadings and their statistical significance through t-values (Dunn et al., 1994). In the AMOS text output file, the t-value is the critical ratio (C.R.), which represents the parameter estimates divided by its standard error. A t-value greater than 1.96 or smaller than -1.96 implies statistical significance (Byrne, 2001).

On the first-order level of measurement models, the proportion of variance (R^2) in the observed variables that is accounted for by the latent variables influencing them can be used to estimate the reliability of a particular observed variable (term). R^2

values above 0.50 provide evidence of acceptable reliability (Bollen, 1989). If any items exhibit R^2 less than this value, these can be dropped from the respective scale and parameter values can be re-estimated. Table 3 shows the result of parameter estimates, error terms, t-values and R^2 for the two main constructs in this study. An examination of the results reveals that 3 items (i.e., coord1, coord2, coord3 and QMP5) did not meet the 0.50 criterion of the R^2. Due to the fact that most of them reflected the coordination between the supplier and the buyers which was an important dimension in our study, they were kept for the forthcoming assessment of fit indices. Our analysis exhibited marginally acceptable R^2 and the critical ratios were all higher than 1.96, indicating a good convergent validity.

Assessment of the Fit and Unidimensionality

An evaluation of model fit, together with two diagnostics indicators modification indices, and standardized residuals will be used to assess unidimensionality. The overall fit of a hypothesized model can be tested by using the maximum likelihood X^2 statistic provided in the AMOS output. ThisX^2 is a function of both internal and external consistency. The p-value associated with thisX^2 is the probability of obtaining a X^2 value larger than the value actually obtained under the hypothesis that the model specified is a true reflection of reality (Koufteros, 1999). As the significance levels of X^2 are sensitive to sample size and departures from multivariate normality, this statistic must be interpreted with caution in most applications (Joreskog and Sorbom, 1989; Byrne, 2001). Therefore, we also use other measures of model fit in assessing model adequacy (Joreskog and Sorbom, 1989). Such indices include the ratio of X^2 to degrees of freedom, the goodness-of-fit index (GFI) and adjusted goodness-of-fit index (AGFI), Bentler and Bonnet normed fit index (NFI), the Tucker-Lewis indices (TLI), comparative fit index (CFI) and the root mean square error of approximation (RMSEA). Researchers have recommended usingX^2/df ratios of less than 5 to indicate a reasonable fit (Marsch and Hocevar, 1985). Most current research suggests the use of X^2/df ratios less than 2 as indication of a good fit (Koufteros, 1999). The recommended value for RMSEA should be less than 0.05 as an indication of a good fit while values between 0.08-0.1 indicate a reasonable fit (Hair et al., 1995). The result of our analysis in table 3 with regard to constructs SCI and QMP showed that all of our indices have met the criteria. Further analysis was made to the full measurement model of the two constructs together. Overall, the measurement model has a satisfactory fit with X^2=46.897 (with d.f.=26), X^2 /df=1.804, GFI=0.956, AGFI=0.925, NFI=0.951, TLI=0.969, CFI=0.977. The RMSEA is 0.059, which is also very good.

Diagnostic indicators such as modification indices (MI) and standardized residuals can be used to assess the model fit. The MI are measures of the predicted decrease in the Chi-square value that results if a single parameter (fixed or constrained) is free (relaxed) and the model re-estimated, with all other parameters maintaining their present values (Joreskog and Sorbom, 1996). Typically small modification

Table 3: Parameter Estimates, Error Terms, T-values, and R^2 for the Model

Latent Variable	Item	Unstandardized Factor Loading	Standardized Factor Loading	Error Term	t-values	R^2 (item reliability)
			SCI Construct			
ξ1	Integ1	1.000	0.757			0.757
	Integ2	1.082	0.777	0.102	10.611	0.604
	Integ3	1.278	0.732	0.126	10.116	0.536
ξ2	Extint1	1.105	0.581	0.141	7.859	0.508
	Extint2	1.144	0.724	0.125	9.170	0.524
	Extint3	1.000				0.748
ξ3	Coord1	0.928	0.645	0.136	6.818	**0.416**
	Coord2	0.811	0.692	0.116	6.988	**0.479**
	Coord3	1.000	0.640			**0.409**
ξ4	Info	0.725	0.809	0.053	13.614	0.655
	Logis1	0.897	0.809	0.066	13.613	0.655
	Logis2	1.000	0.845			0.715
	Logis3	0.713	0.656	0.068	10.425	0.503
			QMP Construct			
ξ1	QMP1	1.000	0.704			0.776
	QMP6	1.428	0.893	0.112	12.731	0.775
	QMP8	1.107	0.869	0.089	12.436	0.797
ξ2	SQM1	1.456	0.857	0.136	11.154	0.679
	SQM2	0.911	0.642	0.104	8.795	0.571
	SQM4	1.000	0.686			0.534
ξ3	QMP3	1.170	0.816	0.136	8.600	0.575
	QMP5	1.000	0.715			**0.357**
	PM2	1.047	0.613	0.134	7.794	0.666
ξ4	QMP7	1.256	0.607	0.183	6.878	0.502
	Design1	1.674	0.824	0.224	7.486	0.512
	Design2	1.000	0.598			0.512
ξ5	PM1	1.134	0.881	0.088	12.846	0.506
	PM3	1.000	0.791			0.515

Fit indices for SCI construct: X^2=105.148 (p=0.000), df=59, X^2/df=1.782, GFI=0.936, AGFI=0.901, NFI=0.913, TLI=0.946, CFI=0.959, RMSEA=0.059
Fit indices for QMP construct: X^2=132.887 (p=0.000), df=66, X^2/df=2.013, GFI=0.926, AGFI=0.882, NFI=0.924, TLI=0.944, CFI=0.960, RMSEA=0.067

indices (i.e., approximately 4.0, $p<0.05$) provide an insignificant improvement in model fit relative to the loss of one degree of freedom from estimating the additional parameter (Anderson, 1987). However, the judgment how small the MI should be is quite different in the book of Byrne (2001). Most of the values were well up above the recommended 4.0 by Anderson (1987). A careful check of other fit indices should be made before deleting the large MI. The standardized residuals (normalized) represent the differences between the observed correlation/covariance and the estimated correlation/covariance matrix. Residuals with values larger than 2.58 in

absolute terms are considered statistically significant at the 0.05 level (Hair et al., 1998). Significant residuals indicate the presence of a substantial error for a pair of indicators. Our analysis with regard to MI and standardized residuals shows the following results: the MI for items of constructs SCM and QMP ranged from 4.037 to 12.979 and 4.254 to 11.666 respectively. According to Byrne (2001), our model indicated a good fit and need not be re-estimated. The results also show that none of the standardized residual values exceeded 2.58 in absolute terms. Therefore, the check on the two diagnostic indicators MI and standardized residuals provides additional evidence of model fit and of no apparent misspecifications.

Discriminant Validity

Discriminant validity measures the extent to which items referring to the same construct distinguish from each other. In this study, discriminant validity is established by using CFA. Models were constructed for all possible pairs of latent variables (constructs) and run on each selected pair, (1) allowing for correlation between the two constructs, and (2) fixing the correlation between the two constructs at 1.0. A significant difference in chi-square values for the fixed and free solution indicates the distinctiveness of the two constructs (Bagozzi et al., 1991). A chi-square difference is above 3.84 at a significance level of 0.05 and above 6.63 at a significance level of 0.01, meaning that discriminant validity between two measurement variables exists (Anderson and Gerbing, 1988; Steenkamp and van Trijp, 1991). For the 9 constructs, a total of 64 different discriminant validity checks were conducted at the significance level of p=0.05. It was found out that all of the differences between the fixed and free solutions in chi-square were significant. This result provides a strong evidence of discriminant validity among the theoretical constructs.

Result of Structural Modeling

In accordance with the structural equation modeling analysis step, we can come to hypothesis testing once the measurement model was established. The structural equation model was tested by applying AMOS version 4.01. The theoretical framework illustrated in Figure 1 has three hypothesized relationships among the variables SCM practices, quality management practices and firm performance. The result of the structural equation modeling analysis based on the four performance indicators did not provide us with a satisfactory fit. Though these fit indices, e.g. GFI=0.863, AGFI=0.800, NFI=0.855, TLI=0.860 and CFI=0.889 were reasonable compared with results of some research, such as Li et al. (2007), the X^2/df value was 3.642. The RMSEA indicated a less than optimal recommended value of 0.05. When the market share indicator was deleted from the model, the re-estimated model showed an improvement of fit indices with GFI=0.903, AGFI=0.852, NFI=0.902, TLI=0.917 and CFI=0.936. The RMSEA and X^2/df were 0.085 and 2.646. The path diagram and the results of the structural equation model analysis are presented in

Figure 4. It should be noted that even though all the t-values of the measurements are significant at 0.05 level, their loadings to the corresponding second-order construct are different. Apart from the internal integration, the other three factors of supply chain integration have low factor loadings, indicating that they may not be strong indicators of supply chain management practices compared to internal integration. This can be true in accordance with the result of our in-depth multiple case studies. In quality management practices, indicators "employee involvement" and "quality design" have lower factor loadings as compared with the other three indicators in this construct.

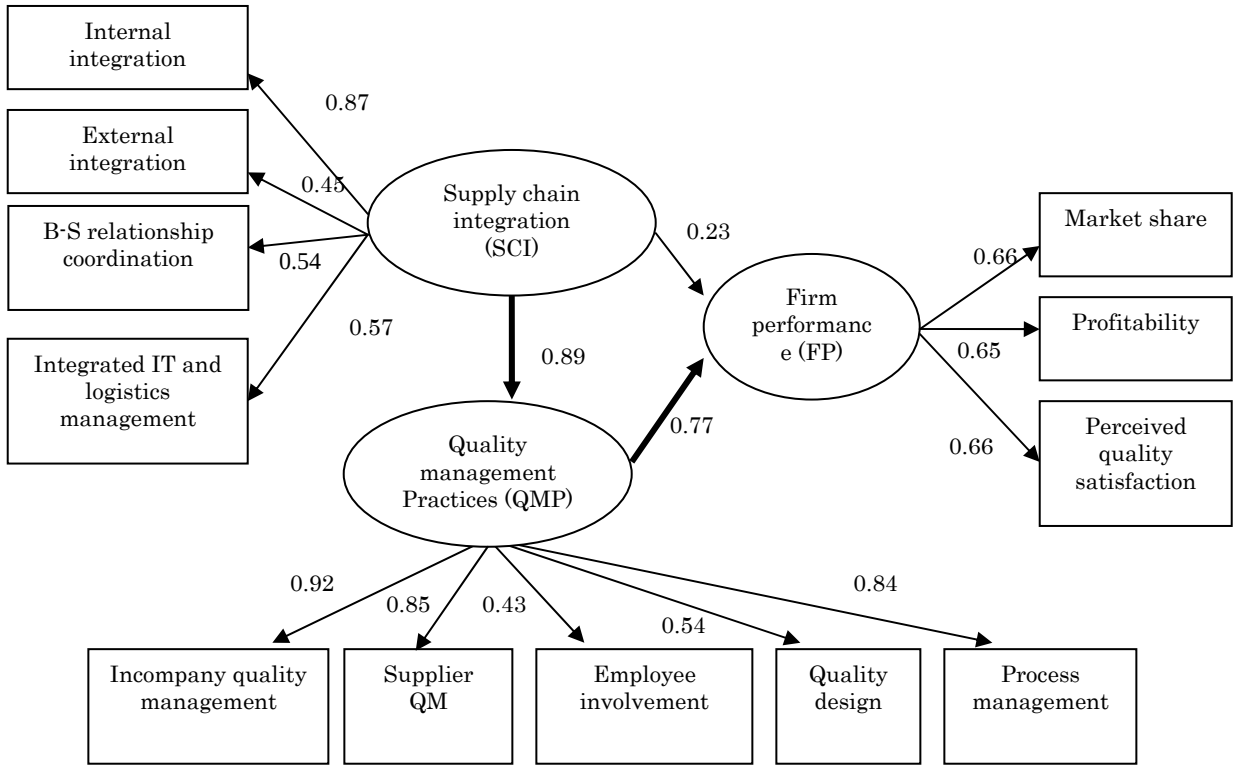

Figure 4: Path Diagram

Table 4: Results of Hypothesis Testing

Variables	Estimates	S.E.	C.R.	P	Hypothesis
SCI→FP	0.403	0.309	1.303	0.193	Not supported
QMP→FP	0.635	0.145	4.369	0.000**	Supported
SCI→QMP	1.904	0.236	8.056	0.000**	Supported

*P<0.05 **P<0.001

We also tested the hypotheses based on the model as shown in Figure 1. Table 4 summarizes the specified relationships among the variables supply chain integration, quality management practices and firm performance. Hypothesis 1 was not supported by the data, as indicated by a insignificant critical ratio (C.R.= 1.303), indicating that the positive relationship between supply chain integration and firm performance was not significant. However, supply chain integration had an indirect impact on firm performance through quality management practices. The indirect influence was 0.69. Our analysis showed strong evidence that the second and the third hypotheses were supported. Significant positive relationships have been found between quality management practices and firm performance (C.R.= 4.369, $p<0.001$) and between supply chain integration and quality management practices (C.R.= 8.056, $p<0.001$).

Discussion and Conclusions

Supply chain management represents one of the most significant paradigm shifts of modern business management by recognizing that individual businesses no longer compete as solely autonomous entities, but rather as whole supply chains (Lambert and Cooper, 2000). Although there are a number of interlocking ideas and propositions which constitute the theory and prescription of supply chain management, the central underpinning ideas relate to alignment and integration (Storey et al., 2006). Our research attempted to study the interrelationships among SC integration, quality management and performance on the basis of data collected from the pork processing sector in China. We will discuss our findings below.

The most important results of the present study are that quality management practices are directly linked with firm performance, while supply chain integration was indirectly linked to firm performance through quality management. The confirmed positive effect of quality management practices on firm performance is very encouraging for practitioners. It reaffirms the role of quality management in improving firm performance and provides impetus to managers on various levels in the pork processing industry to continue adopting quality management practices in their organizations. As many companies put it *"Quality is the life of the enterprise*". Firms that wish to improve their performance should therefore invest in quality management. Equally interesting is the indirect link of supply chain integration through quality management with firm performance. To improve quality of the products and reduce uncertainty in hog supply chains, companies should therefore develop more integrated chains with their suppliers. In the survey, we found (especially large) pork processors paying more attention to building strategic relationships with their most important suppliers in order to provide high quality pork products to the consumers.

However, the direct effect of SC integration on firm performance was not significant in our study. This is in contrast to some earlier studies. For example, Kim (2006)

studied the interrelationships among level of SC integration, implementation of SC practices and the organizational performance of 668 manufacturing corporations in Korea and Japan. He found that both the level of SC integration and SCM practices had a positive relation with firm performance. The results of Li et al. (2006) in 196 American manufacturing industries also supported the hypothesis that firms with high levels of SCM practices had high levels of organizational performances. Nevertheless, literature review also highlighted some opposite results. Handfield and Nichols (1998) indicated that there were in practice few examples of truly integrated supply chains while SCM has become popular. Few companies have succeeded simultaneously on strategic supplier-buyer partnerships, outsourcing non-core competencies and customer relations practices. Agricultural chains are still suffering from fragmentation, especially in developing countries (Boger, 2001). China is in a transitional period. Although its economy is in rapid development, its agri-food industry is still dominated by small companies with limited implementation of information technology and logistics integration (Chen, 2003). Chen suggested information centers to be established to facilitate SC integration. By taking a look at the result of our analysis, we found that factors "external integration", "buyer-supplier relationship coordination" and "integrated information technology and logistics management" contributed poorly to firm performance compared with the contribution of internal integration. This result may indicate that the Chinese pork processing industry is still in an early stage of SC integration.

Suggestions for Further Research and Management Implications

The present study focuses on the relationships between upstream parties of the pork supply chain. Since the unit of analysis in this study is the dyadic relationship between the pork processors (the buyers) and their suppliers, managers of purchasing, supply management and operations functions were considered to be the best candidates to answer the questions. Although difficulties arise when empirical research is based on data collected from both the buyer and the supplier side, validation can be ensured through cross checking. Further efforts can be made in gathering data from multiple respondents per company in order to increase the validity of the data. Furthermore, empirical research should be conducted to gain more insight into the relationship between processors and retailers. With regard to the relationship between SC integration and firm performance, it is suggested that further analysis should be done to compare the extent of SC integration between companies that have different strategies. For example, are companies that apply product differentiation strategy more integrated in SCM than those that apply cost leadership strategy? Are larger companies more integrated in SCM than smaller ones?

However, the present study has provided several important implications to both academics and pork supply chain managers in China.

This paper proposed to study the interrelationship among supply chain management, quality management practices and firm performance. The main theoretical contributions are as follows:

- The supportive effect of supply chain integration on firm performance through quality management practices contributes to supply chain management theory. This result also highlighted the assertion that supply chain management initiatives alone cannot improve profitability (Tan et al., 1999), which further confirms the necessity to combine supply chain management theory and quality management in doing research. Just as Robinson and Malhotra (2005) mentioned, the interlinking of supply chain management with the quality management perspective is often limited and tangential in nature even though much attention has been focused on supply chain management concepts in recent years. Academics need a more focused approach in evaluating quality management issues within the internal and external supply chain contexts. The significant impact of supply chain integration on quality management practices and the indirect relationship between supply chain integration and firm performance enriched the concept of supply chain quality management.

- The empirical evidence of the significant positive impact of quality management on the firm performance contributes to quality management theory. Our study indicated that quality management forms a second-order construct composed of the first-order constructs of imcompany quality management, supplier quality management, employee involvement in quality management, quality design and process management—the five major components of quality management practices. Noteworthy, the data analysis showed a profound impact of long term quality strategy, policy goals and quality assurance systems on firm performance on one hand, the contribution of supplier quality management on the other hand. Aligned with quality management practices, the same important perspectives are employee empowerment and quality design. Our empirical study showed that the employee involvement in quality management and quality design contributed less than other three dimensions. Further investigation is therefore needed.

The empirical evidence has several implications for practitioners in pork supply chain managers in transitional economy like China:

- The results show that there is a direct relationship between quality management and firm performance. The attention for quality management turns out to be critical to generate sales growth, improve customer satisfaction and provide profits for the company. In quality management practices, we found that in-company quality management, supplier quality management, employee involvement, quality design and quality process management all contributed to

overall firm performance. Quality management needs a clear vision from the management team and participation by all employees of the company.

- The indirect relationship of supply chain integration through quality management with firm performance indicates that pork processing companies not only need to be internally integrated, but also need to be externally integrated with their suppliers. The external integration enables a company to acquire technology and logistical capabilities to enhance customer service (Stevens, 1990).

- Therefore, pork processing firms in China should forge quality management practices and combine these with strategic supply chain partnerships so as to develop closer relationships with their suppliers.

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Appendix A: Items and Indicators for Constructs in this Study

Construct Supply Chain Integration

Internal Integration

- Integ1: We have a team involving different departments to jointly decide about company objectives.
- Integ2: We have a good team to jointly discuss and solve operational problems.
- Integ3: We have a good information management system covering different departments.

External Integration

- Exint1: Our company works with our most important suppliers to make production plans.
- Exint2: Our company participates in the sourcing decisions of our most important suppliers.
- Exint3: Our most important suppliers provide us with the inventory data of hogs (meat) they have.
- Exint4: We share risks with our most important suppliers.

Supplier-Buyer Relationship Coordination

- Coord1: Our most important suppliers are trustworthy.
- Coord2: Our most important suppliers and our company deal with problems that arise in the course of cooperation.
- Coord3: We have cooperated with our most important suppliers for a long time.
- Coord4: We frequently measure the performance of our most important suppliers.

Integrated Information Technology

- Infoup: For most of the times, we share information with our most important suppliers by using e-mail/fax.

Integrated Logistics Management

- Logis1: We can organize production in an efficient way according to market information
- Logis2: Our logistics activities are well integrated with those of our most important suppliers
- Logis3: We work together with our most important suppliers to reduce logistics costs instead of the internal cost of the company.

Construct Quality Management Practices

Management Leadership

- QMP1: The quality strategy of our company is based on long-term planning.
- QMP2: Our managers actively participate in quality improvement processes.
- QMP3: Our mid-managers are trained frequently in quality management practices.
- QMP4: Our employees are rewarded for quality improvement suggestions.

- QMP5: We train our employees how to implement quality practices frequently.
- QMP6: Our company has very good quality assurance systems (HACCP, ISO 9000 series or ISO14000).
- QMP7: We can trace and track products from field to table.
- QMP8: We make an effort in making quality goals and policies understood in the departments of our company.

Supplier Quality Management

- SQM1: Our most important suppliers are selected based more on quality than on price.
- SQM2: We pay our most important suppliers a premium for good quality pigs.
- SQM3: We provide our most important suppliers with feed and technology in order to get good quality hogs.
- SQM4: We check the quality of the pigs (meat) delivered by our most important suppliers frequently.

Product/Service Design

- Design1: We focus more on quality than on price in developing new products/services.
- Design2: The employees of our company know the procedures and operation standards.

Process Management

- PM1: Our company has a well-developed cold chain (from production to distribution and selling)
- PM2: Our mid-level managers inspect the work floor on a regular basis to check all operational processes.
- PM3: We pay great attention to in-process inspection, review or checking in pork production.

Construct Firm Performance

Sales Growth

- FP1: Total sales volume has grown faster than that of our main competitors in the last three years.

Market Share

- FP2: Market share has increased faster than that of our main competitors in the last three years.

Profitability

- FP3: We achieved better profitability than that of our main competitors in the last three years.

Customer Satisfaction

- FP4: We achieved better customer satisfaction on product quality than our most important competitors in the last three years.

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Discovering and Promoting Commodity Health Attributes: Programs and Issues

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Abstract

There is a growing consumer segment demanding healthy foods and diets, health and nutrition messages can expand food demand, and governments in the U.S. and EU, faced with increasing obesity and associated health outcomes, want consumers to have reliable information to choose healthy diets. California commodity organizations, charged with expanding the demand for almonds, avocados, strawberries and walnuts, are funding health and nutrition research as a means to discover a unique selling proposition for each product. Research and promotion effects are attracting interest by other commodity groups. Policy and regulatory issues abound.

Keywords: health, nutrition, food, marketing, promotion

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Introduction

Sharply increasing numbers of consumers who are selecting food based on health and nutritional attributes are an international phenomenon fueled by a number of factors. Included are increasing consumer incomes with a decreasing share spent on food, globalization of food supplies, worldwide health problems associated with diet (including obesity, heart disease, diabetes, and cancer), increased introductions of "new" processed food products, food safety incidents, and a proliferation of information and health claims by producers, processors, commodity organizations and other groups attempting to expand demand for their products. This increased emphasis on food attributes poses a series of issues and opportunities for food systems around the world.

Growing consumer concerns about the health attributes of food products, improving awareness about the possible impacts of diet on health, and growing demand for functional food products has been met with increased information and, sometimes misleading promotion concerning product attributes. In response, the U.S. Food and Drug Administration and the European Commission have issued and proposed new rules directed at inaccuracies, confusion, and false information related to the functional and disease risk reduction claims on food packaging and in commodity promotional materials. Several U.S. commodity groups are funding health and nutrition research programs to support health claims for their products. These actions raise policy questions regarding the appropriate bodies to be conducting health and nutrition research for food products, the nature of expected returns from health and nutrition research, and the dissemination of research results.

Objectives

This paper has three objectives. They are to:

1. Summarize the evolution of U.S. and EU rules for health claims on food.
2. Present case-study examples of health and nutrition research and promotion programs conducted by California commodity organizations.
3. Outline some policy issues related to health and nutrition research by commodity organizations.

Analytical Approach

Food production and marketing firms operate within a political environment that includes laws, regulations, government agencies and pressure groups that affect decision-making and profitability. Both the U.S. and the E.U. have laws and regulations covering issues such as competitive behavior, fair trade, truth in advertising, product standards, packaging and labeling and other important areas to protect consumers and prevent unfair competition. The political environment

changes over time in response to changes in economic, cultural and demographic forces. This study examines changes currently underway in laws and regulations affecting health and nutrition claims for food products in the U.S. and E.U. Widely used terms such as low fat, calorie free, and light have been defined and health claims must be based on sound scientific findings. Case studies of four California commodity organizations' health research and promotion programs, based on interviews with management, demonstrate actions taken to develop research data for promoting their commodities. These case studies document the research topics funded, the allocations of producer funds for health research, and the use of research results to obtain qualified health claims and promotion strategies based on health research results. Policy issues associated with the development of health and nutrition claims are outlined.

Government Rules

The U.S. Government and the European Commission have both found it necessary to develop and issue rules concerning health and nutritional claims for food products as an attempt to reduce the confusion facing a consumer attempting to select a "healthy diet" for his or her family. As pointed out by Michael Pollan in a New York Times article, "Once, food was all you could eat, but today there are lots of other edible food-like substances in the supermarket. These novel products of food science often come in packages festooned with health claims …. ". Prior to the issuance of rules and definitions, consumers faced an array of manufacturer product claims concerning fat, calories, cholesterol, sugar, sodium, and various nutrients using undefined terms such as "fat free," "90% fat free," "reduced fat," and "light/lite". Continued attempts by governments to reduce misinformation and confusion in the marketplace are often controversial with both consumer advocates and food manufacturers criticizing the rules. Following is a brief description of the evolution of U.S. Food and Drug Administration (FDA) and European Commission regulations regarding health and nutrition claims for food products.

U.S. Government Regulations

The FDA and the Federal Trade Commission (FTC) share authority to regulate the health information that food manufacturers and marketers place on labels and in their advertising. The FDA regulates health claims and authorizes nutrient content claims for food products while the FTC has authority over advertising messages and enforces "truth in advertising" for all business entities. Note that an advertising claim that satisfies applicable FDA requirements will typically satisfy FTC requirements.

Health Claims

The Nutrition Labeling and Education Act (NLEA) of 1990, gave the FDA specific authority to permit health claims in the labeling of foods, where health claims are always phrased in terms of "may reduce the risk of" some disease or health-related condition and not about treating, mitigating or curing diseases (Nickerson). Prior to Congressional action, foods that had certain science-backed claims about disease prevention in their labeling risked being regulated as drugs (defined as articles intended for use in the diagnosis, cure, mitigation, treatment or prevention of disease in man). There are two types of health claims, unqualified health claims and qualified health claims. Both require detailed FDA review of scientific evidence submitted in a health claim petition.

Unqualified health claims are also referred to as SSA health claims, where SSA stands for significant scientific agreement, and that comes from the Nutrition Labeling and Education Act's standard for FDA to authorize health claims by regulation. It is significant scientific agreement among qualified experts (Nickerson). For example, the unqualified health claim for low sodium foods and high blood pressure reads: "diets low in sodium may reduce the risk of high blood pressure, a disease associated with many factors."

Qualified health claims are health claims that are based on scientific evidence that is credible but that does not meet the significant scientific agreement standard. These health claims include a disclaimer or other qualifying language to prevent consumers from being misled about the level of support for the claim or other important facts, which could be, for example, conditions of use that are necessary to obtain the risk-reduction benefit. Qualified health claims are considered under FDA's exercise of enforcement discretion (Nickerson). The health claims secured through petition by California commodity organizations, to date, are qualified health claims.

Dietary Guidance

The FDA regards statements addressing dietary patterns or general categories of foods and health to be dietary guidance rather than health claims. Dietary guidance statements made on food labels must be truthful and not misleading, but do not require submission or notification to FDA. Claims about the effect of a food on the normal function or structure of the human body (structure-function claims) are also outside the FDA submission process. An example of a structure-function claim is that "calcium builds strong bones." These claims cannot link a specific substance to a disease or health-related condition or to disease prevention or cure.

Nutrient Content Claims

The Nutrition Labeling and Education Act also permits use of authorized "nutrient content claims," which characterize the level of a nutrient in a food. These claims, which must be in accordance with FDA's authorizing regulations, can describe the level of a nutrient or dietary substance quantitatively or by using terms relative to an absolute such as free, high, low, or a good source. For example, FDA regulations define "calorie free" as less than 5 calories per serving, "fat free/sugar free" as less than ½ gram fat or sugar per serving, "low calorie" as less than 40 calories per serving, and "light" as 1/3 fewer calories or ½ the fat of the usual food (Mehlberg).

European Commission Regulations

European and American consumers have experienced the same issues regarding health and nutrition claims for food products, but European regulators have been faced with the additional problems of dealing with diverse national rules. The European Commission put forward the proposal for the Health Claims Regulation on July 16, 2003 and on June 3, 2005 EU health ministers unanimously endorsed the Commission's proposal, including the provision for nutrient profiles and the authorization procedure, during a first reading vote at the Health Council. Then on May 17, 2006 the European Parliament gave its support to the Health and Nutrition Claims Regulation, in its 2nd reading. Final adoption of the Regulation on Health and Nutrition Claims by the Council of Ministers was on December 20, 2006.

Regulation on Health and Nutrition Claims

Health & Consumer Voice, the European Commission's newsletter (Jan. 2007) states: "The new legislation on health and nutrition claims will ensure that any claim made on a food label in the EU is clear, accurate and substantiated. Strict conditions are laid down for the use of nutritional claims such as "low fat", "a good source of protein" or "reduced sugar", and only foods that are consistent with agreed nutritional profiles will be allowed to carry such claims. For health claims, the Commission will draw up a positive list of well-established claims, such as "calcium is good for your bones", which may be used on a label as long as they are proven to apply to the food in question. New health claims or disease reduction claims, such as "reduces the risk of cardiovascular diseases" or "reduces the risk of osteoporosis", will have to undergo a specific authorization procedure before they can be used." Provisions in the Regulation are effective on July 1, 2007.

The European Food Safety Authority is charged with carrying out a scientific assessment of the evidence submitted to support health claims. The Regulation (2006) states that, "Health claims should only be authorized for use in the Community after a scientific assessment of the highest possible standard." It adds

that, "In order to ensure that health claims are truthful, clear, reliable and useful to the consumer in choosing a healthy diet, the wording and the presentation of health claims should be taken into account in the opinion of the European Food Safety Authority and in subsequent procedures." Note that disease reduction messages, currently prohibited by EU legislation, would be possible under new rules if they could meet the scientific standards for substantiation.

The Annex to the Regulation on Health and Nutrition Claims (2006) includes a rather extensive list of nutrition claims and conditions that must be satisfied to use them. These claims include, for example, low energy, low fat, low sugar, low saturated fat, low sodium-salt, fat-free, saturated fat-free, sugar-free, energy-free, sodium-free, salt-free, source of protein, source of [named vitamins or minerals], natural, light/lite, etc.

Given the similar goals for the U.S. and European regulations for health and nutrition claims for food products, it is not surprising to find similar terms, requirements, and procedures. The European Regulations, which include provisions for adjustments from existing national rules, are not fully effective for several years. In addition, the European Regulations may be more restrictive than U.S. rules in that they do not appear to allow for the qualified health claims approved by the FDA. This will depend on the standards for approval developed and used by the European Food Safety Authority.

Sources of Scientific Evidence

The relatively recent adoption of nutritional and health claims standards for food places new pressures on producer organizations and food manufacturers to conduct, fund, or lobby government for funding health research. The perceived value of a health and nutrition message for expanding product demand provides an economic incentive for firms and commodity groups to support health and nutrition research. Acquiring the research necessary for a health or nutrition claim, however, can be a long and expensive process. Following are case studies of health and nutrition research and promotion programs conducted by the Almond Board of California, the California Avocado Commission, the California Strawberry Commission, and the California Walnut Commission.[1] Each of these commodity groups is funding research to determine the health attributes of their products and then using research results in their public relations and promotional programs. The research and promotional programs for the four commodities will be compared and contrasted. The potential contributions of producer-funded research and promotion of healthy diets will be outlined. Successful programs for the case study

[1] The Almond Board is a Federal Marketing Order and the three State Commissions each have their own separate enabling legislation. All four programs were established by a 2/3 vote of covered producers and participation is mandatory for all California producers of each commodity.

commodities that have potential applications for other producer groups will be highlighted.

Research Focus

The California Walnut Commission (CWC) was one of the first commodity groups to fund health and nutrition research when it decided to counter diet recommendations urging consumers to reduce or constrain consumption of nuts because of their high oil content. The CWC funded their first project on the protective effect of nut consumption on the risk of coronary heart disease with researchers at Loma Linda University in 1990. The Almond Board of California (ABC) established a Nutrition Research Program and Nutrition Subcommittee in 1995 to review the scientific validity of proposals and recommend studies for funding. During 1997, the California Avocado Commission (CAC) made a strategic change to proactively communicate the nutritional benefits of avocados through national public relations/outreach efforts. The California Strawberry Commission (CSC) began funding nutrition research proposals in 2003. Results from this research are being used in the CSC advertising and promotion programs.

The four commodity groups each have analyses detailing their chemical and nutritional composition, including such things as amount and type of fat, calories, vitamins, phytochemicals, antioxidants, minerals, etc. The presence of particular components, already associated with favorable health outcomes, has helped focus research on important health topics. Health and nutrition research topics pursued by the four commodity groups have similarities as well as differences (Table 1). Each commodity group has or is seeking evidence on the value of consuming their product on reducing the risk of heart disease. Each group has evidence that product components may lower the risk of certain cancers and each of the commodities

Table 1: Current Health and Nutrition Areas of Interest Mentioned by Four California Commodity Groups

Research Area	Commodity			
	Almonds	Avocados	Strawberries	Walnuts
Cardiovascular Disease	X	X	X	X
Weight & Obesity	X	X		X
Cancer Prevention	X	X	X	X
Diabetes	X	X		X
Antioxidants	X	X	X	X
Aging	X	X	X	X
Prostate Health				X
Bone Health				X

contains antioxidants that are known to slow the aging process and protect against heart disease and various forms of cancer. Almonds, avocados and walnuts can be a component of diets to control weight gain and each can be part of a diet for managing and controlling diabetes.

Expenditures on health and nutrition research by almond, avocado, strawberry and walnut producers have been substantial. A review of budgets for the five-year period 2001/02 to 2005/06 indicates that these four commodity groups spent a total of over $9.08 million on health and nutrition research. The most recent budgets show annual expenditures on health and nutrition research of $1,000,000 by the ABC for almonds, $605,000 by the CSC for strawberries, and $1,468,857 by the CWC for walnuts. Each commodity group has formed a nutrition or scientific advisory committee that includes well-known and knowledgeable nutritionists and medical researchers to provide ideas and advice on research areas, nutrition based programs, and outreach efforts. Each commodity also maintains a website that provides detailed information on the nutrition/health benefits of consumption of the commodity and each has a nutritionist on staff or on retainer.

Results from commodity-group sponsored health and nutrition research is accumulating, as illustrated by a summary posted by the California Walnut Commission (CWC) for walnuts. The CWC began with studies on the relationships between walnut consumption and cholesterol levels and walnut consumption and the risk of coronary heart disease. The CWC funded epidemiological and clinical studies at universities in the U.S., France, New Zealand, Spain, Norway, and Japan. Results of these studies, published in medical, nutrition, and scientific journals, indicate that consumption of walnuts improves the function and reduces inflammation in arteries, reduces LDL cholesterol, reduces blood pressure and reduces heart disease risk. There is also evidence that melatonin in walnuts protects against cancer and heart disease, that walnuts can help in weight management, that consumption of walnuts are protective for people with type 2 diabetes, and that the form of vitamin E found in walnuts might halt the growth of lung and prostate cancer cells. Walnuts have high concentrations of antioxidants, which help the body ward off life-threatening maladies such as cancer, heart disease and diabetes, as well as debilitating ailments such as arthritis, osteoporosis and Alzheimer's disease (CWC, p. 6).

The Almond Board of California (ABC) initiated its nutrition research program in 1995, with funding of $300,000 for studies on cardiovascular disease, decreased cancer risk, glucose metabolism, and analysis of the nutrient content of almonds. Both funding and the number of studies increased rapidly. Now, with annual health research budgets of over $1 million, the ABC has ongoing research relationships with more than 20 scientific organizations and universities around the world. In terms of research support, the topic with the largest budget is cardiovascular research (24%), followed by research on the composition of almonds

(20%), research on antioxidants (19%), cancer research (14%), and research on weight (3%). The website www.almondsarein.com lists 11 ongoing almond nutrition research projects on topics in the above areas. Research topics include food allergy, Vitamin E content, analysis of the chemical composition of almond skins, colon cancer, cholesterol levels and reduction, the effect of almonds on glycemic control and insulin response, and the effects of almond consumption on appetite, energy and weight. The website lists references for 37 publications reporting nutritional characteristics and research results on potential health benefits of consuming almonds.

Qualified Health Claims

Both almonds and walnuts have secured FDA qualified health claims, the strawberry research program has a stated goal of obtaining a qualified health claim, and the CAC's Nutrition Advisory Committee is researching new and necessary information, timing and feasibility to submit a qualified health claim about avocados and heart health to the FDA (CAC, Oct. 2006). The CAC writes that they expect the process to take about three to five years (p. 58).

The International Tree Nut Council Nutrition Research and Education Foundation petitioned the FDA to authorize a health claim about the relationship between the consumption of nuts and reduced risk of coronary heart disease (CHD) on the label or in the labeling of whole or chopped nuts and certain nut-containing products.[2] The petition contained two model health claims (FDA, 2003):

1. Diets containing one ounce of nuts per day can reduce your risk of heart disease.
2. Eating a diet that includes one ounce of nuts daily can reduce your risk of heart disease.

The FDA concluded that there is not significant scientific agreement that consumption of nuts may reduce the risk of coronary heart disease and declined to authorize a health claim. The FDA did conclude, however, that that there is a sufficient basis for a qualified health claim about nuts and reduced risk of CHD, and approved the following qualified health claim and disclosure statement on July 14, 2003 (FDA, 2003):

> "Scientific evidence suggests but does not prove that eating 1.5 ounces per day of most nuts [, such as name of specific nut,] as part of a diet low

[2] The petition named peanuts and nine tree nuts, including almonds, Brazil nuts, cashew nuts, hazelnuts, macadamia nuts, pecans, pine nuts, pistachio nuts, and walnuts, as appropriate for the claim.

> in saturated fat and cholesterol may reduce the risk of heart disease. [See nutrition information for fat content.]"

The CWC submitted a separate petition to the FDA for a model health claim for walnuts stating, "Diets including walnuts can reduce the risk of heart disease." In a letter dated March 9, 2004, the FDA concluded that: "Based on FDA's reassessment of the scientific evidence subsequent to our initial July 14, 2003 qualified health claim enforcement discretion decision, the agency still concludes that there is not significant scientific agreement that the claim "Diets including walnuts can reduce the risk of heart disease" is supported by the totality of publicly available scientific evidence. Thus, FDA will consider exercising enforcement discretion for a qualified claim as presented below (FDA, 2004):

> "Supportive but not conclusive research shows that eating 1.5 ounces per day of walnuts, as part of a low saturated fat and low cholesterol diet and not resulting in increased caloric intake, may reduce the risk of coronary heart disease. See nutrition information for fat [and calorie] content."

The FDA ended its response to the walnut petition with the statement:

> "Please note that scientific information is subject to change, as are consumer consumption patterns. FDA intends to evaluate new information that becomes available to determine whether it necessitates a change in this decision. For example, scientific evidence may become available that will support significant scientific agreement or that will no longer support the use of a qualified claim, or that may raise safety concerns."

It is interesting to note that nutrition and health research budgets for the ABC and the CWC have increased since approval of qualified health claims for nuts and walnuts. Several factors support continued interest in nutrition and health research. Consumer interest in diet and health is growing and is impacting food choices. Each of the four California commodity groups has discovered that results from nutrition and health research can support a highly productive public relations effort. Media news reports and stories on these research results are low cost and have the additional benefit of being more believable than advertising to many people. Commodity group leadership and membership are confident that their research programs yield high returns through increased demand for their products. Anecdotal evidence lends support to these views. The walnut industry points to the positive impact on demand of McDonald's decision to add fruit and walnut salad as a menu item, a decision that was heavily influenced by results of CWC nutrition and health research. There is also solid evidence of increasing demand for avocados

and almonds attributable to advertising and promotion, some of which is based on health and nutrition topics.

Nutrition and Health Promotion Strategies

While the research thrusts for the four groups are similar, their advertising and promotion strategies differ. The ABC first emphasized public relations for their health message and then shifted almost all advertising and promotion to a health message after the FDA issued the qualified health claim for nuts. The ABC partnered with the American Heart Association and focused on promotion of California almonds as part of a heart-healthy diet. The CSC has focused all consumer communications on a health message for strawberries since initiation of their nutrition and health research program in 2003. The CAC continues to use only public relations for their health message to avocado consumers and targets health and nutritional professionals with promotional materials.

The CWC continues to emphasize public relations activities for the health benefits of walnuts after laboratory testing of advertising themes found that the message on the health benefits of walnuts is best communicated through a third party such as a magazine, newspaper, doctor, nutritionist or other credible source (CWC Summer Report, June 2001, p. 2). While advertising in Germany, Italy, Spain, Japan has included health as one of the messages, the advertising emphasis has been on quality, taste, and uses for walnuts in meal preparation, with public relations used for the health and nutrition message.[3]

Overall, consumer and media interest in diet and health issues appears to assure cost effectiveness for public relations programs. For example, the ABC increased public relations expenditures to $1 million during 1998-1999, but estimated that the advertising value equivalency of exposures related to the health benefits of consuming almonds increased to $7 million. The CWC estimates that publicity generated as a result of the FDA ruling on the qualified health claim for walnuts generated over 70 million impressions by the end of the 2003-04 crop year from news stories, magazine articles, and associated publicity on diet and health. Media impressions attributed to the CWC public relations program in the U.S. increased from a little over one billion in 2001-02 to over two billion in 2004-05 at a cost per million impressions that decreased from $0.59 in 2001-02 to $0.37 in 2004-05 (CWC, 2006).

Partnering by the ABC, the CAC, and the CWC with other organizations, such as the American Heart Association, the Spanish Heart Foundation and the American

[3] A review of CWC newsletter reports provides information on promotional activities in major export markets, including Canada, Germany, Italy, Spain, Israel, Japan, and Korea, http://www.walnuts.org/news/new_nletters.asp

Diabetes Association, provides product exposure in diets offering particular benefits such as heart healthy diets, healthy food choices for diabetics, or weight control diets. The funds allocated to nutrition research by each organization tend to add to total research rather than substitute for traditional research on production and post-harvest problems.

Published health and nutrition research results have been a positive factor in having almonds, avocados, strawberries and walnuts included in dietary recommendations by various organizations and agencies. As noted by the CWC, for example, a key recommendation of the 2005 Dietary Guidelines for Americans, announced in January 2005 by the USDA and U.S. Department of Health and Human Services is for consumers to consume more polyunsaturated fat (and less saturated and trans fat). Special emphasis was given to increasing intake of essential fatty acids, including omega-3 fatty acids, specifically noting plant sources of omega-3 fatty acids such as walnuts. This recommendation is consistent with recommendations of the American Heart Association, the U.S. Food and Drug Administration, and the National Academy of Sciences. This recommendation is expressed in the "MyPyramid Plan" announced by the USDA in April 2005.

Policy Questions

The significant expenditures on health and nutrition research by government sponsored commodity organizations and the approval of qualified health claims by the FDA have raised a number of questions. The EU's new Regulation on Health and Nutrition Claims is also a source of controversy. Following is a brief discussion of some of the issues being discussed.

Some agricultural producers argue that commodity organizations should not spend their mandatory assessments on health and nutrition research while others point to the positive impact of research results on product demand. Producers have a long history of supporting production research but very little experience with health and nutrition research. Government sponsorship of research through the agricultural experiment stations is well accepted and, while producers have developed an appreciation for the need to provide funding to help direct production research, the need or opportunities for health and nutrition research were not appreciated. As one might expect, producer opposition was much stronger before research results were available. Now several commodity groups are considering health and nutrition research programs as a possible way to expand product demand. Critics also point to the possible problem of a commodity organization not supporting research or suppressing research results that are unfavorable to their interests', a criticism that could apply to any privately sponsored research. Open and widely circulated requests for proposals (RFP's) and the execution of contracts with Universities, where faculty expect to publish their research results, helps to minimize the problem of suppressing results but not the selection of projects.

Supporters of commodity- organization-sponsored health and nutrition research have argued convincingly that the research is in their interest and if they do not provide financial support, it will not get done.

The question of "who benefits from health and nutrition research" is relevant. The producers funding the research obviously believe that the research is yielding positive benefits or they would reduce rather than increase expenditures. Commodity organizations funding health and nutrition research, however, face a potential free rider problem in a global economy. For example, the results of health and nutrition research funded by California almond and walnut producers will apply to almonds and walnuts regardless of where they might be produced. This may not be a serious problem for California almond producers, who account for the majority of world almond production but it may be important for producers of a commodity with a smaller market share that faces competition from other countries in both domestic and export markets. Firms that are able to obtain patent or trademark protection on products of their research programs may be able to capture the majority of benefits. Economic theory argues that improved information will benefit consumers and improve economic efficiency. Consumers can benefit from information that is used to make diet choices that lead to improved health outcomes. These benefits include "feeling better," reduced medical care, increased life spans, improved labor productivity, and all of the other personal and economy-wide payoffs accruing from a healthier population.

The FDA's approval of qualified health claims, which is the result of a legal ruling related to First Amendment rights, is controversial. Food manufacturers know that health claims can help product sales, even if the science supporting the claim is not strong. They argue that consumers should have access to emerging science. Critics believe that qualified health claims are confusing and not well understood by consumers. This view tends to be supported by FDA research. Derby and Levy (2005) asked people to look at a hypothetical product and an accompanying health claim that was similar to those carried by real products. Two of the four products included were a fake tuna product with a claim that the omega-3 fatty acids may help fight heart disease and a spaghetti sauce with a claim that lycopene could help fight cancer. An FDA "Questions and Answers" sheet on the findings of the Derby and Levy study summarizes the results as (Sept. 28, 2005):

> 1. "Qualifying statements that used only words to convey the strength of science underlying a claim were not understood by consumers."
> 2. "Qualifying statements that included a "report card grade" were understood by consumers to convey a rank order of the strength of science underlying a claim, but 'B' grades were understood to convey greater scientific certainty than unqualified health claims (i.e., claims that meet the significant scientific agreement standard). (In the FDA consumer research study, FDA did not use an "A" letter grade for the

> experimental conditions representing claims that met the significant scientific agreement standard, but simply stated the substance/disease relationship.)"
> 3. "Even when qualified health claims were understood as intended, qualifying statements had unexpected effects on consumers' judgments about the health benefits and overall healthfulness of the product bearing the claim. Sometimes, these qualified health claims led to more positive product perceptions."

After releasing the results of the Derby and Levy study, the FDA held a meeting on November 17, 2005 to assess consumer perceptions of health claims. A transcript of the meeting is available at http://www.cfsan.fda.gov/~dms/qhctran.html#qhc.

The EU Regulation on Health and Nutrition Claims was adopted by the Council of Ministers on December 20, 2006 and is effective July 1, 2007. The stated objectives of the Regulation are to achieve a high level of consumer protection, to improve the free movement of goods within the internal market, to increase legal security for economic operators, and to ensure fair competition in the food sector. The Regulation covers voluntary nutrition and health claims made on foods; labeling, presentation and advertising; trademarks and brand names. Provisions of the regulation will be phased in over time. Presently it appears that all health claims, which must be approved by the European Food Safety Authority (EFSA), will be based on and substantiated by generally accepted scientific evidence. There do not appear to be any provisions that allow for U.S. type "qualified health claims." An early task for the EFSA is to consult on establishing a Community positive list of permitted health claims. This list will be derived from the various lists of claims based on generally accepted evidence that are being compiled by member states. Companies wishing to use health claims not on the positive list are required to prepare applications that include evidence for a particular health claim.

The development and approval of the EU Regulation on Health and Nutrition Claims was controversial and its implementation is guaranteed to spark controversy. A news account in the Guardian Unlimited about issues involved when the regulation of food health claims was proposed helps to outline some points of contention (2003). The news story reported:

> "Heavy lobbying is expected from food manufacturers who have argued that new rules would hit consumer choice and hurt business. The European Breakfast Cereal Association described the proposed measures as overly restrictive and not proportionate to the objective pursued." On the other side, Sue Davies of the Consumers Association said: "There are vast numbers of products on the shelves promising health claims but it has always been impossible for consumers to distinguish between the real and the bogus. This is a great victory for

> consumers but it is only the first hurdle. We have a long way to go before we see these much-needed changes on the shelves."

The European Food Safety Authority will face political pressure from both sides of the table. Food manufacturers whose long-standing claims are not approved will protest, as will policy makers intent on combating obesity and improving diets. Manufacturers may face significant financial and time commitments to develop the scientific evidence needed for approval of a health claim. There is concern that small firms may be at a competitive disadvantage because of these requirements.

Concluding Comments

Health and nutrition claims for food products can be a very effective marketing tool. This has encouraged some firms to use misleading, dubious and just plain false claims in their labeling and promotion that has led to government action and regulation in many countries. The U.S. and EU now have rules in place requiring approval for health claims based on sound scientific evidence before such claims are used. In the U.S., the FDA is examining ways to clarify the meaning of qualifications to permitted health claims while in the EU, regulations are just becoming effective. The objective is to provide reliable information to guide consumers' healthy food choices.

Commodity groups are sponsoring nutrition/health research and promotion with the objective of increasing demand for their products. As part of this process they are adding to the research base on nutritional components of food products, beneficial effects of particular food components, and food component-disease interactions. They are also communicating the results to health and nutrition professionals and consumers in their outreach programs. Their programs appear to have a positive impact on product demand and there is increasing interest in discovering new health and nutrition benefits from consuming many commodities, including apples, blueberries, cranberries, kiwifruit, milk, and table grapes, to mention a few.

Actions taken regarding health research/promotion programs by the commodities listed above and others will be affected by the: (1) availability of research/promotion funds; and (2) the perceived returns for health research and promotion relative to other marketing program expenditures. There are potential developments that can have significant impacts on both funds and perceptions of returns. For example, according to Secretary of Agriculture Johanns, the USDA's 2007 farm bill proposals for specialty crops includes $5 billion in additional targeted funding to address market promotion, sanitary and phytosanitary issues, nutrition, and targeted research (May 7, 2007). If these proposed funds are included in the final 2007 Farm Bill, there will be additional funds available for health/nutrition research and promotion programs for specialty crops. Will they be spent for health/nutrition research?

Regarding use of funds, the following perceptions of commodity group fund allocation to alternative programs, based on a simple competitive markets model, are subject to research verification. They are: (a) production research reduces costs of production, thus increasing supply and decreasing price. For some supply and demand elasticities, this effect can reduce total returns and actually harm producers; (b) simple generic advertising programs increase demand, but the effect is not permanent. There may be lagged effects from generic advertising but the total effect appears transitory. Producers benefit when demand is higher but demand shifts back when the effect wears off; and (c) nutrition research plus promotion of nutrition benefits has a positive impact on product demand rather than supply and the discovery and promotion of health benefits may permanently shift demand and price to a higher level. If the above relationships hold, then (c) will be a better use of marketing program monies than (a) or (b). There are indications that a promotion message based on diet and health is more effective than the typical generic message on location of production, product availability, or flavor but this impact needs to be verified for individual commodities.

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Analysis of Farm Household Preferences in the Management of Invasive Species: The Case of *Miconia* in Hawaii

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Abstract

A major threat to Hawaii's ecosystem is the spread of invasive plant species. One such species is *Miconia calvescens*. Given that this plant was originally introduced to Hawaii by the horticulture industry and has negative effects on agricultural productivity, it is logical to find the farm households' preference for the control of *Miconia*. Using Conjoint Choice Experiment methodology, this study designed a survey to measure farm households' preferences for *Miconia calvescens* control program attributes. Results of the surveys indicate that the farm households are willing to support *Miconia* control programs if they prevent severe soil erosion and loss of biodiversity.

Keywords: *Miconia*, invasive species, Hawaii, farmers, Conjoint Choice Experiment, valuation

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Introduction

As the most isolated oceanic island in the world, Hawaii is naturally vulnerable to biological invasions of non-indigenous species. Due to the isolation, a unique balance has evolved that can easily be disturbed by the introduction of a non-native species. Non-native species can be introduced to Hawaii in two ways, accidental and deliberate. One deliberate introduction of new species to Hawaii is for horticultural purposes. This particular type of introduction accounts for approximately 70% of all documented invasive plant species in Hawaii (DLNR, 2007). The nature of the Hawaii floriculture and nursery industry is such that they are dependent on bringing in and cultivating new plants that are not found in Hawaii. Currently, the floriculture and nursery industry have one of the highest value of agricultural sales, contributing about $100 million to the Hawaiian economy in 2005 which is 20 percent of the revenues of the Hawaii agricultural industry (NASS, 2007). A plant that was introduced to Hawaii by the floriculture and nursery industry is *Miconia calvescens* also known as *Miconia*. *Miconia* was brought into Hawaii in the 1960s as an ornamental plant for its aesthetic value; it was continually cultivated in Hawaii and sold in garden centers and nurseries until 1992 when it was placed on the noxious weeds list of Hawaii (Loope, 1997). Currently, *Miconia* is on the list of the top ten invasive plants or animals of Hawaii. From its initial introduction to the islands as an ornamental plant, *Miconia* through the spread of its seeds made its way from home gardens to surrounding forests. By the time this was discovered the plant had established itself in forests on four Hawaiian Islands namely, Hawaii, Kauai, Oahu and Maui. The tree has proven itself to be highly invasive in Tahiti, which has a very similar environment to that of Hawaii increasing the possibility that what is happening in Tahiti can happen in Hawaii. Studies done in Tahiti have shown that *Miconia* causes soil erosion leading to landslides and directly threatens native species, which can lead to biodiversity loss.

Miconia not only affect the biodiversity of Hawaii, but it is also a direct threat to the productivity of the agricultural and agro-forestry industries. *Miconia* threatens these industries because it causes soil erosion with possibility of landslides. The loss due to soil erosion not only affects the land and watersheds, it has a broad range of effects on an island state from the mountain to the sea. Onsite effects of soil erosion include low soil fertility and reduced agricultural productivity. Studies have shown that loss of topsoil due to soil erosion causes three times the reduction of nutrients and 1.5 to 5 times the reduction of organic matter than the soil that remains behind (Sustainable Table, 2001). In addition, soil erosion causes approximately 3 to 31% decreases in the yield depending on the type of crops (USDA, 2000). As erosion occurs it causes the soil to have a shallower rooting zone, lower available water, and loss of nutrients and organic matter. This leads to farmers having to farm the subsoil, which has poorer tilth and is harder for the plant roots to penetrate which in turn will affect the productivity of the soil. Offsite

effects of soil erosion include the runoff from the watersheds. These additional run-offs from the watersheds end up in the streams and rivers (Loope, 1997). These streams and rivers are important to farmers as they depend on them for irrigating their crops. The irrigation ditches, which provide water to the farmers, obtain their water from a system of small streams in the areas where it is suitable for *Miconia* to grow. If the situation with *Miconia* worsens and major erosion occurs there is a possibility that the water in these streams will cease to flow. This will force the farmers to rely on state water supply to irrigate their crops, which will increase their costs considerably. Researchers have estimated that if *Miconia* were to take over the Koolau Mountain Range (one of Oahu's major source of water) it would cost the state between $4.6 billion and $8.5 billion because of the value of the lost recharge to aquifers (Kaiser and Roumasset, 2002).

Furthermore, with the ever-rising costs of energy prices, Hawaii cannot afford to import more inputs or food. As such, there is a need for Hawaii to be competitive to reduce imports and have greater food security. Most of the food Hawaii consumes is imported even though there are abundant arable lands due to the decline of the pineapple and sugar industries. One of the reasons for controlling invasive species is to maintain agricultural productivity and ensure the cost of production does not increase due to soil erosion. Unfortunately, there are not enough resources for complete eradication of all invasive species, despite the cataclysmic economic damages that are inevitable if their invasions are ignored. Current expenditures for control program are not sufficient enough for effective control as their strategy is mainly to destroy the plants. Furthermore, there are different impacts to farms based on the physical and hydrological profile of their locations. Therefore, recognizing the scarcity of resources for management, prioritization becomes an important decision for managers and with the limited resources, control programs have to be optimally designed to address the needs of the farmers. It boils down to a question of which and how many invasive species are chosen for stringent control and which are treated with less vigor. Since this problem will exist as long as there is a scarcity of resources, the best answer is to allocate sufficient resources to the projects where efforts will be answered with more positive results and public support.

Background Information of *Miconia*

Miconia is an invasive tree, which grows to approximately 15 meters tall. The particular species of *Miconia* found in Hawaii is native to Mexico, Guatemala, Belize and Costa Rica. It has tri-nerved leaves that are dark green on the top and purple on the bottom. Full-sized trees (>8 meters tall) can flower 2-3 times a year producing about 2-3 million seeds each time. Production of a large amount of seeds ensures the availability of seeds in the seed bank for re-sprouting when conditions are optimal. In addition, with the large amounts of seeds it sets a foundation for humans, birds and other animals to easily disperse the seeds (Loope, 1997).

Miconia thrives in tropical montane climate regimes. This makes it capable of establishing itself in areas that receive about 1,800-2,000 mm of rain per year. In Tahiti, which has a similar forest habitat to Hawaii, *Miconia* has taken over 65% of the island creating dense mono-specific stands over 25% of the island (Meyer, 1996). Moreover, in Tahiti, 70–100 native plant species, including 35–45 species endemic to French Polynesia, are directly threatened by invasion of *Miconia* into native forests (Medeiros et al, 1997).

Miconia is able to establish itself easily in Hawaii because of the invasive characteristics it has. These characteristics include rapid growth, early maturity, large quantities of fruits and seeds, effective seed dispersal and can reproduce by seed and vegetative growth. Once *Miconia* is established at a certain place it drastically changes the ecosystem and biodiversity of that environment. *Miconia* seeds in the soil seed bank will start to grow if overhead vegetation allows light to penetrate the forest floor. The plant will then continue to grow smothering native forest plants. In addition, *Miconia*'s dense foliage prevents the sunlight from reaching the forest floor causing the destruction of the forest ground cover. This in turns leads to soil erosion and since *Miconia* has a very shallow root system; it is not capable of holding the forest soil (Loope, 1997)

Objectives

The objective of this research is to evaluate the extent of farmers' preference for the control and management programs of *Miconia* so as to provide decision makers with the information to design more effective control programs. The analysis of farmers' preferences is crucial because the losses caused by *Miconia* have primary impact on the watershed, soil erosion and agricultural productivity which immediately affects the farmers. Specifically, this study examines what control program attributes are important to the farm households in Hawaii. This would be indicated by their choice on the different control programs presented to them using the Conjoint Choice Experiment (CCE) methodology. The beauty of CCE is it is able to describe the programs in terms of the program attributes. Then, the respondents would assess which attribute is more important. Based on the preferences of attributes it will be easier to design the programs of interventions. To accomplish this objective, the study performed several tasks, (1) develop a Conjoint Choice Experiment survey, (2) collect primary data from farm households from the four counties in Hawaii (3) analyze the data collected, and (4) interpret the results and make conclusions.

Method

In this study, Conjoint Choice Experiment (CCE) was used to study the farm household's preference for different *Miconia* control program attributes. The

following paragraphs summarize past studies using CCE and describe how the design of the CCE for this study took place.

Brief Introduction of Conjoint Choice Experiment (CCE)

The CCE technique was initially developed by Louviere and Woodworth (1983). As an empirical method, CCE originates in the market research and transportation literature (Hensher, 1994), and has only relatively recently been applied to other areas such as the environmental studies discipline. Since the mid-1990s, CCE has been increasingly applied to study various environmental problems. It has been used for valuating environmental amenities such as, recreational moose hunting in Canada (Boxall et. al, 1996, Adamowicz et. al., 1994), 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).

The CCE technique is based on the idea that any good or program can be described in terms of its attributes, or characteristics, and the levels that these attributes take. In this study's case, a control program for the invasive species *Miconia* can be described in terms of its adverse impacts and cost (which are called "attributes" in CCE context). The potential impacts of not having an effective invasive species control program include loss of biodiversity in terms of native species loss as defined in this study; soil erosion leading to possibility of landslides; and extent of spread which affects the aesthetic beauty of the natural and working landscapes. Using CCE can tell us which attributes are significant determinants of the values farmers' place on *Miconia* control program. This data collected also can be calculated to find out the extent of importance of each attributes given by the farmers.

Reasons for Choosing Conjoint Choice Experiment (CCE)

The study through a survey of farm households in Hawaii in the four counties used a stated preference method to elicit willingness to support *Miconia* control program. A stated preference method is one where the respondent is asked their preference for a good/service or willingness to pay for an environmental asset such as clean air within the context of a hypothetical market. There are generally three types of stated preference methods, 1) Conjoint Analysis, 2) Conjoint Choice Experiment and 3) Contingent Valuation. After extensive literature review on the three types of stated preference methods, Conjoint Choice Experiment was chosen as its advantages far outweighed its disadvantages.

A relatively new concept in environmental valuation, Conjoint Choice Experiment is an evolved form of the more traditional conjoint analysis introduced in the 1980's. It has been used for valuating environmental amenities (Adamowicz et. al., 1994), preferences for different forest landscapes in the UK (Hanley et. al., 2001). While

the traditional conjoint analysis presents all the product/program profile choices to respondents at one time, in choice-based conjoint models, respondents typically see a set of two or three profiles at a time which are constructed by varying two or more attribute levels. It then asks the respondent to pick the profile that they would most prefer from that set.

The advantages of using CCE far outweighed the disadvantages after reviewing the literature on the subject. There are two main disadvantages of the method with the first being that the respondents have to repeat similar tasks of choosing between each pair. After the first few repetitions of the task the respondent will "catch on" to what the researchers are trying to do and potentially can give biased answers. The researchers ensured that the problem with respondents "catching on" and giving biased answers was minimized by giving them a fewer number of choice sets to select from which in our study are 12, such that by the time the respondents "catch on" to what is being done the survey will be over. The second disadvantage is that there is no incentive to the respondents to provide accurate responses. Since *Miconia* is a serious and known problem in Hawaii, respondents will be likely to provide accurate responses even with minimal incentives.

The advantages of using CCE show the attractiveness of this particular method. The advantages of this method are: (1) the researchers are able to present program choices with different attribute levels allowing the respondents to answer questions about a sample of events from a universe of possible events; (2) the researchers can also design sets of attributes with different levels which allow for the measurement of tradeoffs that the respondent make in choosing one attribute over another mimicking real world decision making. (3) the survey design is such that the researchers are able to estimate economic values of each attribute by including cost as one of the attributes; (4) the survey tends to be more to the point and shorter in length due to the use of discrete choice answers, reducing the possibility of fatigue and boredom that is often faced with a long list of program profiles to rate in traditional conjoint analysis surveys; and (5) the method allows the researchers to quantify the relative importance of each programs attributes based on the choices the respondents made.

Experimental Design of CCE for *Miconia*

A CCE is designed to allow respondents to choose the program profiles based on their preferences. Each program profile presented to the respondents consists of a combination of different levels of program attribute outcomes such as level of program cost or additional tax burden on the taxpayer, extent of biodiversity loss and soil erosion, and impact on the aesthetic beauty of the natural landscape through the spreading of *Miconia*. Table 1 shows the design stages of a CCE (Green and Wind, 1975, Cattin and Wittink, 1982, Halbrendt et al., 1991).

Table 1: Design Stages for a Conjoint Choice Experiment

Stage	Description
1.Selection of attributes	Selection of relevant attributes of the *Miconia* control program. This is done through expert interviews and literature review. The interviews help to identify the possible environmental impacts (attribute outcomes) associated with the program, as well as the monetary cost of the program.
2.Assignment of attribute levels	After identifying the attributes, the range of each attribute is determined through literature review and expert interviews. The levels should be realistic and span the range over which we expect respondents to have preferences, and/or practically-achievable levels.
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 possible combinations of program profiles while allowing for efficient estimation of the effects of the individual attributes ('main effects').
4.Construction of choice sets	The profiles identified by the experimental design are then paired and grouped into choice sets to be presented to respondents.
5.Measurement of preferences	Choice of survey procedure either with face-to-face interviews or mail surveying and survey administration will take place.

The first stage of CCE design involves identifying the relevant attributes of the invasive species control programs. Studies (e.g. Travisi and Nijkam, 2004) have shown that attributes such as program costs, loss of biodiversity, productivity loss, soil and water pollution, effectiveness of control and human health are important factors in invasive species control. However, there is not any study on attributes that are specifically for a *Miconia* control program. In order to come up with the important attributes and their levels on *Miconia* control program, literature reviews heavily based on Tahiti where, *Miconia* is a major problem were conducted. Additionally a panel of *Miconia* experts was formed to solicit information on important control program attributes and information. The experts included scientists, local experts and policy and decision makers, who through their various perspectives helped identified relevant cost and program outcome attributes. Then for each attribute, the range of potential values or level of damage avoidance was identified based on scientific and economic feasibility. This assessment of possible attribute range is used in the second design stage of assigning the levels of each attribute. The four most important attributes selected for the study are (1) cost in terms of additional tax dollars, (2) soil erosion leading to landslides, (3) spread, and (4) loss of biodiversity in terms of native species loss.

Rationale for Choosing the Program Attributes and their Levels

Four attributes are identified as the most important for any *Miconia* control programs. There are three levels for each attribute. The rationale for choosing these attributes is as follows:

Cost

Obviously, program cost in terms of additional tax dollars is included as an attribute of any publicly funded control program. The range of $3-$7 annually per taxpayer is estimated based on expenditure information from Hawaii's Invasive Species Committees' management reports and personal interviews with the staff of the various Invasive Species Committees (Kaiser, 2006, Smith, 2006, Lee, 2006). The levels for program costs assigned for this study are $3, $5, and $7.

Spread

Miconia's characteristics of having rapid growth, producing large amount of seeds, and the dispersion of seeds by birds and other vectors enable it to spread rapidly (Chimera et al., 2000). Meyer and Florence (1996) state that since the introduction of *Miconia* to Tahiti in 1937, over 65% of the island (1,045km^2) has been dominated by *Miconia* in the late 1980s. Thus, preventing and controlling the spread of *Miconia* should be one of the major concerns in Hawaii. In this study, low spread, medium spread, and high spread have been identified as the levels of spread that cover the range of possibility of effectiveness of any control program.

Loss of Biodiversity

Hawaii is reputed by her unique biodiversity, but it is vulnerable to biological invasions of non-indigenous species being an island. In Tahiti, where the climate and ecosystem is very similar as Hawaii, 70-100 native plant species are directly endangered by *Miconia* (Meyer and Florence, 1996). In Society Islands, botanists believe that invasion of *Miconia* causes 60% of the endemic flora to be endangered (Florence, 1996). Using Tahiti case as the reference, the levels of biodiversity loss are 10, 45 and 100 native species loss.

Soil Erosion

Native species forests are being gradually replaced by *Miconia* due to its strong ability of having shade effects on native species growth. The root system of *Miconia* is too shallow to hold the soil. Soil erosion caused by the spread of *Miconia* not only leads to a loss of habitat for native birds and species, but affects the functioning of the watersheds, as well as low soil fertility and reduced agricultural productivity. Moreover, soil erosion affects the run-offs from the watershed which are important

irrigation sources to Hawaii farmers. Low soil erosion (no landslides), medium soil erosion (with possibility of landslides), and high soil erosion (severe landslides) are the three levels of soil erosion in the study. Table 2 shows the control program attributes and their levels.

Table 2: *Miconia* Control Program Attributes and Their Levels

Attributes	Levels		
Cost	$3 per year	$5 per year	$7 per year
Spread	Low	Medium	High
Loss of biodiversity	10 native species lost	45 native species lost	100 native species lost
Soil erosion	Low with no landslides	Medium with possibility of landslides	High level with severe landslides

The third and fourth stages of designing the CCE involve choosing and grouping different combinations of attributes and levels to be presented to survey respondents. CCE control program profiles are constructed by selecting one level from each attribute and combining across attributes. In this study, there are four attributes with three levels each, such that the number of possible profiles totaled 3 x 3 x 3 x 3 or 81. A complete factorial design would use all the 81 profiles for the surveying, which is undesirably difficult for respondents to evaluate and make decision from. So instead a fractional factorial design is proposed. 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. The most commonly used method of constructing fractional factorial design in conjoint measurement is the orthogonal array. Orthogonal arrays build on the 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). Orthogonal array designs are used because they have many desirable properties. First, they allow one to gather data from a large number of profile scenarios using a relatively small number of profile scenarios. Second, from a statistical perspective, orthogonal designs are most efficient. This study constructed 24 different profiles out of 81 based on degrees of freedom requirements to estimate all of the main effects within the orthogonal design (Louviere et. al., 2000). From the constructed 24 profiles, 24 pairs of profiles were randomly assigned and were grouped into 2 sets of 12 pairs. Having only 12 pairs for each respondent to evaluate from ensure the surveying exercise is short and manageable. At the final stage, the experiment is carried out. Each respondent is presented with one choice set of 12 pairs of

profiles to make their choices from. The experiment requires respondents to choose one program profile from each pair presented to them. Table 3 shows an example of a pair of program profile scenarios for respondents to choose from.

Table 3: Example of a Pair of Program Profile Scenarios

Attributes	Program A	Program B
Cost	$5 per year	$7 per year
Spread	High	Low
Loss of biodiversity	45 native species	10 native species
Soil erosion	Medium with possibility of landslides	Low with no landslides

Data Collection

Survey Location

Data were collected from four counties of Hawaii (Oahu, Hawaii, Maui and Kauai). Within the four counties, surveys were conducted in both urban and rural areas. A total of 10 locations, including five farmer's markets, one state fair, and four farmer's markets inside shopping centers were chosen for conducting the surveys. Six out of the ten survey locations are in the urban areas, and the rest are in the rural areas.

Sample Population

Respondents from farm households were surveyed from May 16 to August 6, 2006. To ensure having a representative sample, the size of the population sample was determined using sample size calculator (Creative Research Systems, 2003). Accordingly, the minimum sample size needed for statistical analysis at 5% error margin is 96. This study completed 107 surveys. Fourteen percent of the respondents were from Oahu, 32% from Hawaii County, 25% from Maui, and the remaining 29% from Kauai. The percentage of the respondents from Oahu County is lower because it is a big urban center with about 80% of Hawaii population living in this county. Also Oahu has larger and fewer farms. Hawaii County has a higher percentage of surveys completed because the majority of farms are located there. Table 4 shows the socio-demographic profile of the respondents and where Census data is available compared them to the Hawaiian farm population. The population of male farmers of Hawaii is 80% over 20% female farmers whereas in the study

about 46 % respondents were female versus 54 % male. The gender distribution of the respondents does not match the demographic characteristics of Hawaii farmers because the sample population was selected from adult members of farm households instead of only farmers. The average age of the respondents is somewhat similar with the average age of Hawaii farmers. Forty-four percent of the respondents have annual household income ranges from $10,000-$50,000. In comparison to other income categories, the percentage of respondents making more than $100,000 or less than $10,000 annual household income is much lower than the other income categories (16.7 % and 12.5% respectively). Majority of the respondents (56%) have high school or some college education.

Table 4: Socio-demographic Profile of Survey Respondents

	Descriptions	Hawaii Farmers * (%)	Survey Respondents (%)
Gender	Female	20.0	45.8
	Male	80.0	54.2
Average Age		56.5	49.0
Income	<$10k		12.5
	$10K to $50K		43.8
	$50K to $100K		27.0
	> $100K		16.7
Education	High School and less		28.8
	Some college		27.0
	College graduate and above		44.2

* NASS. 2002. *Census of Agriculture Hawaii State and County Profile*

Survey Instrument

The questionnaire consisted of two sections. Section one is the set of 12 pairs of program profiles for respondents to choose from. Section two consists of questions regarding the socio-demographic and economic background of the respondents such as age, income, education and other characteristics. Section one data provides the attribute-specific preferences. The data is analyzed using conditional logit regression model software developed by Sawtooth Software, Inc.

Survey Technique

Data were collected using a face-to-face survey technique. In our experiment, some attributes require relatively large amount of verbal and visual explanations. For example, the aesthetic value people attach to the landscape change due to the extent of the spread is better elicited with the aid of photographs. While conducting the survey, the interviewers showed pictures of the *Miconia* plant, landscape covered with *Miconia*, and landslides due to *Miconia.* Compared to other forms of survey technique, using face-to-face technique, the interviewer can motivate the respondent to keep going if her/his interest flags, thus, a face-to-face survey technique avoids the problem of self-selection bias. Brief description of *Miconia* and its potential impacts were read to every respondent regardless of their knowledge of *Miconia* to establish a minimal level of knowledge of *Miconia* prior to completing the survey. Then each respondent was given 12 pairs of programs profiles with differing levels of attributes and asked to choose one from each pair. The response rate of the survey is 70%.

Analysis of CCE Data

CCE is closely linked with random utility theory. Random utility theory derives from Luce (1959) and McFadden (1973), and is based around an alternative theory of choice that is used to derive conventional demand curves. Suppose that we can represent a person's preferences by the following utility function, U:

$$U = U(X_1 \ldots Xm; Z_1 \ldots Zn) \qquad (1)$$

where, utility for this individual depends on the levels of X_a , where a $\in\{1,\ldots m\}$, marketed goods and services consumed, and on Z_b, where b $\in\{1,\ldots n\}$, environmental goods. Now it may well be that some X_a and Z_b are unobservable to the researcher, or are observable only with an error. One way of representing this situation is to break down the conventional utility function U (.) into two parts: one deterministic and observable, V (.), and an error part, e (.). This means we can re-write equation (2) as:

$$U = U(X_1 \ldots Xm; Z_1 \ldots Zn) = V(\mathbf{X}) + e(\mathbf{X}, \mathbf{Z}) \qquad (2)$$

where, the bold letters represent vectors. This is the simplest representation of what lies behind random utility theory.

In choosing the most preferable programs in the choice set, the respondent is assumed to compare the maximum utility s/he could get with the pair of programs such as the example shown in Table 3, and then select the program that gives her/him the highest utility.

Given that there is an error part of the utility function, the analysis becomes one of probabilistic choice. The probability that any particular respondent (call them person *k*) prefers program *A* in the choices to any alternative program *B*, can be expressed as the probability that the utility associated with option *A* exceeds that associated with all other options, as stated in equation (3):

$$P[(V_{kA}+e_{kA})>(V_{kB}+e_{kB})]=P[(V_{kA}+V_{kB})>(e_{kB}-e_{kA})] \quad (3)$$

where, P(.) is the probability function.

This says that respondent k will choose program A over program B if the difference in the deterministic parts of their utilities exceeds the difference in the error parts.

In order to derive an explicit expression for this probability, it is necessary to know the distribution of the error terms (e). A typical assumption is that they are independently and identically distributed with an extreme-value (Gumbel) distribution. The Gumbel is similar to the normal distribution in shape, but the mathematics associated with it is much more tractable. Its distribution is given by:

$$P(e \le t) = F(t) = \exp(-\exp(-t)) \quad (4)$$

The above distribution of the error term implies that the probability of a particular program A being chosen can be expressed in terms of the logistic distribution (McFadden, 1973). This specification is known as the conditional logit model:

$$P(U_{kA}>U_{kB})=\frac{\exp(V_{kA})}{\sum_j \exp(V_{kj})} \quad (5)$$

where, j is all the program options.

This study will use the conditional logit model to estimate the attribute parameters and we use the conventional maximum likelihood procedures with the respective log-likelihood functions stated in equation (6) below, where y_{kj} is an indicator variable which takes an unity value if respondent *k* chose option *j* and zero otherwise.

$$\log L=\sum_{k=1}\sum_{j=1} y_{kj}\log[\frac{\exp(V_{kj})}{\sum_{j=1}\exp(V_{kj})}] \quad (6)$$

The empirical model is usually specified as being linear-in-parameters. If X is a vector of independent variables upon which utility is assumed to depend, and if β is a vector of parameters, this gives:

$$P(chooseA) = \frac{\exp(\beta' X_{kA})}{\sum_j \exp(\beta' X_{kj})} \qquad (7)$$

The estimated coefficients can be used to derive the relative importance or preference of the respondents toward each attribute.

Results

Conjoint Model Specification and Estimation

The conjoint preference model specified in equation 8 is used to estimate the importance of *Miconia* control program attributes from respondents' stated preferences through their choice of programs. Conjoint Choice Experiment assumes that each respondent makes one's choices to maximize utilities, which can be measured by their choice preference probability (P). This study assumes P is a function of program cost (C = \$3, 5, 7), extent of spread (S_L-Low, S_M-Medium and S_H-High), loss of biodiversity (B = 10, 45, 100 native species lost), and extent of soil erosion (E_L-Low, E_M-Medium, E_H- High). The model is specified in equation 8 below:

$$P(A) = f(C, S, B, E) \qquad (8)$$

where:

P (A) = Probability of choosing program A. Each program is represented by a combination of values taken in attributes of C, S, B, and E
C = Cost, taking values of \$3, \$5, or \$7
S = S_L-Low Spread, S_M-Medium Spread, or S_H-High Spread,
B = Biodiversity Loss in terms of native species, taking values of 10, 45 or 100,
E = E_L-Low Soil Erosion with no landslides,
E_M-Medium Soil Erosion with possible landslides,
or E_H-High Soil Erosion with severe landslides.

Qualitative attributes generally are presented by 'part-worth' or dummy variable specification in marketing studies (Halbrendt et al. 1995). In this case, the attributes that are qualitative (Spread and Soil Erosion), the study used effects-coding specification rather than dummy variable specification so as to better explain the attribute levels' influence on the probability of choosing a particular program. Cost and biodiversity attributes are treated as continuous variables.

Results of the model parameters estimated by logit regression using the Sawtooth Inc. software are reported in Table 5. The Chi-Square value (257.92) shows that the estimated model goodness of fit is significant. Estimated parameter for control program cost is not significant indicating the program costs which ranged from $3 to $7 per year are not a major determining factor in the choice of a particular *Miconia* control program. For the spread parameters, the signs of the parameters are as expected and significant at the 0.05, and 0.01 levels for medium and high spread, respectively. The signs of the low and medium spread variables came out to be positive as expected. Such positive signs can be interpreted that particularly for medium spreads being significant contribute to choice of control programs at those attribute levels. On the other hand, the significant and negative sign for the high spread variable indicates that farmers will be less likely to choose a program that does not mitigate the high level of spread. For the biodiversity parameter, biodiversity loss in terms of native species lost is significant at the 0.01 level and has the expected sign. The significant and negative sign for the biodiversity loss variable indicates that farmers will be less likely to choose programs with increasing native species loss. Finally, the estimated parameters for soil erosion have the expected signs and are significant at the 0.01 and .001 levels for low and high soil erosion, respectively. The significant and positive sign for the low soil erosion variable shows that farmers are more likely to choose control program that result in low soil erosion with no landslides. On the other hand, the significant and negative sign for the high soil erosion variable shows that farmers definitively will be less likely to accept programs that have high soil erosion with possibility of severe landslide. An analysis of interaction between soil erosion and biodiversity, soil erosion and spread, biodiversity loss and spread, and biodiversity loss and soil erosion variables was also conducted. Results indicated that interaction between these attributes was not significant.

Table 5: Conjoint Model Estimated Parameters

Variables	β Estimate	t Ratio
C	0.105	1.71
S_L	0.201	1.76
S_M	0.124	2.14*
S_H	-0.325	-2.80**
B	-0.008	-3.65**
E_L	0.354	2.98**
E_M	0.042	0.06
E_H	-0.397	-3.90***
Obs.=107		
Chi Sq. = 257.92		

*Significant at the 0.05 level
**Significant at the 0.01 level
***Significant at the 0.001 level

Relative Importance (RI) of Miconia Control Program Attributes

Program managers and decision makers have an interest to know which features of their control program are more important to farmers who might be affected by *Miconia*. Calculating the relative importance (RI) of different program attributes is a way to examine the farmer's preference. In this case, the RI of the four program attributes, cost, spread, biodiversity loss, and soil erosion, are examined. The formula for estimating the RI is detailed in the article by Halbrendt, Wang, Fraiz and O'Dierno (1995). Denote i as an attribute, and the relative importance of attribute (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 $\Sigma\ UR_i$:

$$RI_i = 100 \times \frac{UR_i}{\sum_{j=1}^{n} UR_j} \qquad (9)$$

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

The RI estimation results suggest that cost is least important in the respondent's choice of control programs (17.58%). The two equally important attributes to farmers are biodiversity loss (29.16%) and soil erosion (31.30%) followed by the extent of spread of *Miconia* (21.96%). Results show that farmers prefer control programs that emphasize more on protecting biodiversity loss and preventing soil erosion. According to previous studies, these two attributes, if realized have shown to have negative effects on environment and agricultural productivity. Based on this result, the researchers suggest that when designing program for the management of *Miconia* in Hawaii, decision makers and program managers need to place more weight on methods that control soil erosion followed by biodiversity loss. The results of the RIs of the control program attributes are presented in Table 6.

Table 6: Estimated Relative Importance (RI) of *Miconia* Control Program Attributes

Program Attributes	Relative Importance (Percent)
Cost	17.58
Spread	21.96
Biodiversity Loss	29.16
Soil Erosion	31.30

Most Preferred Control Program

Since budget priorities for each invasive species might change through time, it is important to know if there is a choice of economically feasible control programs what percent of the farmers will choose a particular program. This will help or guide the designing of the most desirable control program. In Table 7, four feasible control programs are presented. Of the four feasible programs within the price range of $0 to $7 per taxpayer, about 43% of the farmers preferred program 3 which is $5, medium spread, 45 native species lost and low soil erosion. Approximately 35% of the farmers chose program 4, 17% chose program 2 and hardly any acceptance of program 1 which is no cost and assuming no control measures taken. The results show that when there is a choice, farmers will choose a program with a lower cost which results in low soil erosion at the expense of some native species lost and some spread. Furthermore, the majority of the farmers do not accept doing nothing to control *Miconia*.

Table 7: Farmer's Preference for Hypothetical Control Programs

Control Program	Cost	Spread	Biodiversity Loss	Soil Erosion	Farmer Preference (Percent)
1	$0	High	100 species	High	4.98
2	$3	Medium	100 species	Medium	16.60
3	$5	Medium	45 species	Low	42.93
4	$7	Low	10 species	Low	35.49

Valuation of Program Attributes using Expenditure Equivalent Index (EEI)

Aside from the relative importance of program attributes, trade-offs between the attributes are examined. What is interesting to know is if the level of one control program attribute changes, then by how much would an average farmer be willing to pay to leave her/him indifferent between the before and after scenarios? For example, if biodiversity loss is changed from 10 species to 45 species, how much the farmer is willing and able to pay, keeping utility constant? Based on equation (10) and a set of assumptions of utility functions such as separability, Payson developed an expenditure-equivalent index (EEI) of quality change:

where, β_i is the estimated parameter for the ith attribute, dc_i is the change in the ith attribute level, γ is the estimated parameter for willingness to pay, and p is the base cost level.

$$EEI_j = 1 - \frac{\sum_{i=1}^{k} \beta_i dc_i}{\gamma p} \qquad (10)$$

EEI can be interpreted as the proportional change in willingness to pay with respect to the change in control program attribute level, which is necessary for the respondents to be indifferent with a reference or base control program profile.

Table 8: Estimated Expenditure Equivalent Index (EEI)

Cost	Spread	Biodiversity Loss	Soil Erosion	EEI
	High	0	High	2.09
	High	10	High	1.98
	High	45	High	1.60
$7	High	100	High	1.00
	Spread	**Biodiversity Loss**	**Soil Erosion**	**EEI**
	Low	100	High	1.72
	Medium	100	High	1.27
$7	High	100	High	1.00
	Spread	**Biodiversity Loss**	**Soil Erosion**	**EEI**
	High	100	Low	2.03
	High	100	Medium	1.60
$7	High	100	High	1.00

For the baseline control program profile, this study uses the profile with the possible lowest preference. For this study, the baseline profile of $7, high spread, 100 native species lost and high erosion is assumed to be the least preferred by the respondents. The EEI for the baseline profile is equal to one since the second term in equation (10) equals zero. To get an idea of farmers' willingness to pay for reducing biodiversity loss, erosion loss and spread using the stated baseline profile, the study uses equation (10) to estimate the EEIs for each of the program attributes while holding the remaining attributes and their levels constant. The results are presented in Table 8. The EEIs for biodiversity loss to avoid losing 100, 90, and 55 native species are 2.09, 1.98 and 1.60, respectively. In other words, farmers are willing to pay 2.09 times more than $7 which is equivalent to $14.63 so as not to lose 100 native species. Similarly, they are willing to pay 1.98 times more than $7 not to lose 90 species which is equivalent to $13.86 and 1.60 times more than $7 not to lose 55 species which is equivalent to $11.2. The EEI for spread to avoid medium and high spread of *Miconia* are 1.27 and 1.72 respectively. This implies that farmers are willing to pay 1.72 times more than $7 which is equal to $12.04 so as to avoid high spread. Similarly, they are willing to pay 1.27 times more than $7

which is about $8.89 to avoid medium spread. In addition, the EEI for soil erosion are 2.03 and 1.60 to avoid high and medium soil erosion respectively. The farmers are willing to pay about $14.21 and $11.20 for avoiding high and medium soil erosion. These monetary amounts are in addition to the current expenditure per capita on controlling *Miconia* as the survey asked the respondents to choose profiles with costs being stated as extra tax dollars.

Conclusion and Implications

This study sets out to examine what aspects of *Miconia* control program attributes that farmers would rate as important as stated by their choices of the different control programs using Conjoint Choice Experiment methodology. Results show that the cost of the control program (willing to pay the given range of costs) is not as important when compared with the rest of the program attributes. In terms of how respondents weigh in on the attributes' relative importance, two program outcome attributes stand out: soil erosion and loss of biodiversity. Together they added up to over 60% of the weights placed by respondents when choosing preferred control programs. This study sets a range of $3 to $7 for program cost of controlling *Miconia* after reviewing current expenditure information on *Miconia* in Hawaii. Obviously, from the farmers' stand point the range of the dollar amount used for this study alone has lesser significant influence on program choice.

More important attribute outcomes of significance to the farmers are preventing soil erosion and loss of native species. One can see why soil erosion causing landslides is particularly perceived as undesirable, as the Hawaiian Islands are made up of many mountains due to how the land mass was created with many farmers currently living or working on or near the mountains. It can also be interpreted that farmers are more concerned about the reduced soil fertility and low farm productivity caused by the soil erosion. Major crops grown near the slopes of the mountains in Hawaii are pineapple, coffee, avocado, banana, papaya, macadamia nut, ginger roots, taro, floriculture nursery, maize and sugarcane. These crops particularly would be impacted due to soil erosion caused by *Miconia.* Furthermore, these industries are primary contributors to the agricultural revenue of Hawaii which together contributed a substantial percentage of the total farm receipt of Hawaii (USDA, 2006). Studies have shown that soil erosion can reduce agricultural productivity by 3-31 percent in the U.S. depending on the location and crops. If *Miconia* is not controlled, one can deduce that there would be substantial economic loss due to soil erosion on the above mentioned crops in Hawaii.

Current management programs fall short of completely eradicating *Miconia* with the main management strategy of applying the chemical Garlon-4 and manually removing *Miconia*. There are some educational programs for enhancing public's awareness about the process of spread, its effect on biodiversity loss and soil erosion in addition to the existing chemical and manual control programs. The educational

programs will help the general public to recognize *Miconia* as an invasive plant and would therefore encourage the public to destroy it from their surroundings. Previously, *Miconia* was introduced as an ornamental plant by the floricultural industry and now has evolved as an invasive species. Therefore, to prevent this from happening again, targeted programs for nursery growers for not introducing potential species which will turn into invasive species should be developed. Progress has been made to minimize deliberate introduction and propagation of potentially invasive plants in recent years. The University of Hawaii has developed a Hawaii Weed Risk Assessment (H-WRA) program whose purpose is to assess the invasive potential of plant species. Furthermore, the nursery industry itself realizing that there are adverse effects from introducing invasive species has taken the initiative to develop a code of conduct for a list of invasive plant species that nursery growers should not be propagating and selling. This is a very positive step in the right direction to minimize nurseries from unknowingly propagating and selling invasive plants.

Recent expenditure shows that the state of Hawaii spends about $1.7 million dollars on three of the most *Miconia* infested islands (Hawaii County: $465,000 for 50,000 ha, Oahu: $286,117 for 411 ha, and Maui: $954,000 for 12,500 ha) which is equivalent to about $2 per person for controlling *Miconia* (based on the size of the Hawaii population above 18 years old). This study shows that most farmers are willing to support control program expenditures higher than current expenditures of $2 per taxpayer. This suggests that government agencies should spend more funds to effectively control or eradicate *Miconia* in Hawaii. The plan might include more educational programs and possibly research program on finding a biological control of *Miconia*. The important implication of this study is providing decision makers the information that the farmers are willing to support spending for *Miconia* control programs if they are effective in preventing severe landslides and huge loss of native species.

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On the Use of Valuation Mechanisms to Measure Consumers' Willingness to Pay for Novel Products: A Comparison of Hypothetical and Non-Hypothetical Values[1]

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Abstract

Willingness to pay (WTP) estimates for novel products are needed to assess consumers' valuation of these products as well as for product adoption and optimal pricing strategies. Using experiments in a retail setting, we compare hypothetical and non-hypothetical WTP values between a Becker-DeGroot-Marshak (BDM) auction mechanism and conjoint analysis. Our results suggest that the auction WTP values are higher than conjoint analysis WTP values. Moreover, the hypothetical WTP values are higher than the non-hypothetical WTP values in both elicitation mechanisms.

Keywords: Conjoint analysis, willingness-to-pay, auction, hypothetical, non-hypothetical

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Introduction

Every year thousands of new products are introduced into the marketplace with a low success rate. Due to the high failure rate, accurate marketing research procedures are critical to increasing the chance for a successful product (Lusk, Feldkamp, and Schroeder, 2004). Many of these novel products include new attributes or an innovative combination of preexisting attributes such as convenience, product form, new safety assurance levels, new technology or functional property. For any new product, food and agribusiness companies need to know how consumers would value these products and decide on an introductory price that reflects consumers' willingness to pay for the novel product. Commonly, the price is assessed based on a "relative" close substitute that has similar attributes. However, this strategy may not yield optimal pricing, since the initial price does not directly take into account how much consumers actually value the innovative product.

The objective of our study is to assess and compare consumers' willingness to pay (WTP) for novel products using two elicitation mechanisms: Becker-DeGroot-Marshak mechanism (BDM) auction and conjoint analysis. In addition, we also want to examine differences in WTP values from these two elicitation mechanisms using hypothetical and non-hypothetical experiments. Hypothetical experiments are normally used when the actual product to be evaluated is not yet available. A potential issue, however, that comes up when using hypothetical experiments is hypothetical bias in the WTP values. Consequently, non-hypothetical or incentive compatible mechanisms have been recently introduced in the marketing field as an alternative to traditional hypothetical valuation. Therefore, one of our goals is to specifically assess the sensitivity of experimental marketing results based on the following WTP elicitation mechanisms: hypothetical conjoint, hypothetical auction, incentive aligned/non-hypothetical conjoint and incentive compatible/non-hypothetical BDM auction. Food/agribusiness managers and researchers can use the results of our study to better understand how choice of WTP elicitation mechanisms can significantly influence WTP estimates, which can then be used to make informed product adoption and optimal pricing decisions. After discussion of the advantages/disadvantages of each technique, an illustrative example is given that compares the differences between the WTP elicitation techniques.

Methodology

Experimental Auction

In an effort to determine potential profitability of selling new goods or modifying existing products, economists and market researchers are increasingly using experimental auctions as opposed to other experimental mechanisms (Depositario, Nayga, and Wu, 2007; Lusk et al., 2006; Shaw, Nayga, and Silva, 2006; Corrigan

and Rousu, 2006; Umberger and Feuz, 2004; Wertenbroch and Skiera, 2002; Hoffman et al., 1993). Experimental auction procedures have especially become a popular method for eliciting WTP values for new product attributes, and for examining several aspects of economic theory (Shogren et al., 1994; Melton, Huffman, and Shogren, 1996). Hoffman et al. (1993) discusses in detail the advantages of including experimental auctions in a pretest market research program. Particularly in the last two decades, auctions have been widely used to test economic theory in a lab setting and less frequently in a retail setting (see Wertenbroch and Skiera, 2002).

In experimental auctions, subjects are normally assigned to a specific group (also called treatment) or a control group. The various treatments can be generated by using different types of subjects, settings, information, endowment levels, or elicitation mechanisms (e.g. Voelckner, 2006). In an experimental auction, subjects submit a bid (otherwise referred to as the subject's WTP) to get a product with the understanding that they may have to actually purchase the product at the conclusion of the study, and the market-clearing price is then determined. One of the most popular elicitation mechanisms is the sealed-second-price auction, in which the highest bidder is the winner and has to pay the second highest price from the group of participants. However, studies conducted in a retail environment typically entail a researcher asking a consumer a set of questions, which rules out the use of the sealed-second-price auction as an elicitation mechanism since there is no second highest bid. Consequently, we used the Becker-DeGroot-Marshak (BDM) mechanism. For a review of some advantages and disadvantages of auction procedures, check Lusk and Hudson (2004).

Commonly used experimental auction procedures are conducted in one of two ways: (i) subjects receive an endowed good (typically a pre-existing substitute) and then are asked to bid to exchange their endowed good for the good of interest, or (ii) subjects can bid directly on several competing goods and a random drawing can be used to determine which good is binding (must be purchased), so that demand for a single unit can be elicited. Experiments involving a transaction of goods or cash are non-hypothetical. In this study, we use the BDM mechanism to elicit our subjects' WTP values for a product.

Conjoint Analysis

Conjoint analysis has been widely applied to evaluate consumers' willingness to pay for various products. According to Green, Kreiger, and Wind (2001), conjoint analysis is "by far, the most used marketing research tool for analyzing consumer tradeoffs." This technique mimics a real buying decision by allowing subjects to choose between a set of product profiles with various combinations of predetermined attribute levels. By evaluating several products with various attribute combinations, it is possible to estimate the WTP for each attribute and its levels. A

key benefit of conjoint designs is their ease of use. However, conjoint designs have typically been hypothetical (i.e., no transaction takes place), in nature. Based on prior research, subjects facing a hypothetical buying decision tend to behave differently than subjects in a real buying situation, leading to biased WTP estimates.

Recently, some modified versions of conjoint analysis have been developed that maintain ease of use, while reducing hypothetical bias. Ding (2005) and Voelckner (2006) have published applications of incentive aligned conjoint analysis. This technique takes advantage of the incentive compatibility of experimental auctions and the availability of substitutes in conjoint analysis. In other words, conjoint designs are transformed from hypothetical transactions to "real life" transactions where the respondent may have to purchase a product that they are evaluating. By including the incentive modification to traditional conjoint analysis, the decision-making environment becomes even more realistic, while maintaining the ease of application that managers and researchers desire when conducting an experiment in a retail setting. Consequently, subjects may generate more accurate information and allow for improved applicability for agribusiness decision-making. However, introduction of a transaction into the experiment does come at a cost since the product chosen for purchase must be provided, which may cause problems if the product is only in the developmental or prototype stages. To our knowledge, prior work utilizing the incentive aligned conjoint approach has not been evaluated against auctions in a retail setting/field experiment.

Model

After conducting the study either through the auction or conjoint analysis format, calculation and comparison of WTP estimates is the next critical step. Calculation of the WTP of a product, for both the hypothetical and non-hypothetical auction experiments, usually involve running a regression to test the significance of both treatment effects and other explanatory variables, such as demographics. With regards to hypothetical and non-hypothetical conjoint analysis, when a rating scale is used, the ratings are regressed on the product profiles to obtain part worth estimates. Next, a transformation is needed to move from utility space to a monetary price space. Voelckner's (2006) transformation utilizes a limit-card to make the conversion from utility to price and is briefly described below. First, the part-worths are estimated for each attribute level for each respondent using ordinary least squares. Second the utility is calculated for each product using all part-worths except those associated with price. Third, the utility for those products the respondent is willing to buy and the minimum or limit utility are calculated. Fourth, the price that equates the limit utility with the utility value in step two is then the monetary WTP.

After obtaining all the WTP for every treatment, a random effects single limit (censored at 0) tobit model was used to assess both attribute and treatment effects on WTP. A random effects tobit model was used due to the panel like structure of our data when all treatments were merged together.

Application

We conducted a field experiment, utilizing both conjoint analysis and auction mechanisms, at selected grocery stores in College Station, Texas in February 2007. Adult shoppers (at least 18 years old) were intercepted while exiting the store and asked to participate in the study. The study was designed to last no longer than ten minutes to reduce respondent fatigue. Using grapefruit as the product of interest, our subjects completed both a demographic and consumption questionnaire about their fresh fruit purchasing. We used value-added products with attributes consisting of type of cut (segmented or cubed) and preservatives (with or without) in our WTP experiments. The attributes of interest (i.e., segment/cube and with/without preservatives) were identified during our pre-tests as the most important attributes that consumers consider in purchasing value-added grapefruit products. In addition to these attributes, the conjoint experiments also involved a price attribute ($0.5, $2.50, or $4.00 per half-pound). These price levels were also obtained from the pretest results of the survey. Our auction experiments did not have a specified price since respondents were required to give their own WTP. A total of 245 subjects participated in our experiments[2] which involved four treatments: hypothetical conjoint, incentive aligned/non-hypothetical conjoint, hypothetical auction, or incentive compatible/non-hypothetical BDM auction (see Table 1).

Table 1: Experimental Treatment Groups

Group	Subject Task	Sample Size
A-Nonhypothetical Auction	Write down WTP; product to purchase was randomly chosen.	44
B-Hypothetical Auction	Write down WTP on rating scale; no transaction occurred.	64
C-Nonhypothetical Conjoint	Rate pictures; Product to purchase was randomly chosen.	59
D-Hypothetical Conjoint	Rank pictures; no transaction occurred.	78

Subjects in the hypothetical conjoint treatment were asked to evaluate twelve pictures consisting of various combinations of product attributes and rate their intention to buy on a 1 to 7 scale. A transformation given by Voelckner (2006), discussed in the model section of this paper, was used to transform the rating scale values to monetary WTP estimates.

[2] The study script and questionnaires are available from the authors upon request.

In the hypothetical auction treatment, subjects were free to write down any number to express their WTP. Participants were explicitly told that they could assess a WTP of zero dollars if they did not want the product. The products were presented in a set of four pictures and every picture was titled with the attributes they represented. Since price was not given, as was the case with conjoint, only four pictures were needed, representing all combinations of the attributes presented above. Considering that this treatment was hypothetical, no transactions took place.

The only difference between the hypothetical and non-hypothetical treatments was that the respondents had the chance of purchasing one of the products in the non-hypothetical treatments. In the non-hypothetical auction treatment, a random product and price (i.e. market price) was chosen after giving their WTP for each picture. The subject had to purchase the randomly selected product if their stated price was equal to or higher than the market price. In the non-hypothetical conjoint treatment, a product was randomly chosen and the respondent had to purchase the product only if their rating was four or greater. If their rating was less than four then another product was randomly drawn. This procedure continued until a transaction occurred or three products had been drawn randomly. Up to three products were chosen so as to maintain the same chance of "winning" as the non-hypothetical BDM auction, given that the subject had a favorable rating for the product. Based on the incentive aligned literature, this can be thought of as a modified version of the work done by Ding (2005) and Voelckner (2006).
Our subjects each received $4 for participating in our experiments. This participation fee may be considered as an endowment that could be spent totally or partially in the study. If a subject purchased a product, then they received the product plus the $4 minus the price paid for the product. The giving of endowments may bias WTP estimates for the good in question (Harrison, 1989), which is called an endowment effect. Loureiro, Umberger, and Hine (2003) design an experiment to test if three levels of monetary endowments would cause significant different bids. The authors conclude that an endowment close to the value of the auctioned good should not have a significant impact in the experimental design. Consequently, since the four dollars was close to the expected WTP values based on a pretest of the survey, we do not expect a significant endowment effect in the WTP estimates.

Results and Discussion

The first step in the analysis was to calculate the WTP values for each treatment using the simple averages (see Table 2). Results show that the auction WTP means are higher than the conjoint WTP means, in both the hypothetical and non-hypothetical experiments. Also, in both auction and conjoint treatments, the hypothetical WTP mean is higher than the respective non-hypothetical treatment mean.

Table 2: Mean Willingness to Pay Values by Group*

Group	Cubes NoPreservatives	Cubes Preservatives	Segments No Preservatives	Segments Preservatives
A-Nonhypothetical Auction	$1.50 [C]	$1.35 [B,D]	$1.59 [B,C,D]	$1.32 [B]
B-Hypothetical Auction	$1.83 [D,C]	$1.56 [A,C,D]	$1.87 [A,C,D]	$1.67 [A,C,D]
C-Nonhypothetical Conjoint	$1.40 [A,B]	$0.73 [B]	$1.54 [A,B,D]	$0.84 [B,D]
D-Hypothetical Conjoint	$1.53 [B]	$0.79 [A,B]	$1.99 [A,B,C]	$1.18 [B,C]

(*) The simple averages represent the average WTP for that product.
Note: Significance is tested pair-wise using the Kolmogorov-Smirnov test. For example, a superscript of BD in Nonhypothetical auction means that Treatment A (non-hypothetical auction) is significantly different from treatments B (hypothetical auction) and D (hypothetical conjoint).

Table 3 formally shows the differences between the hypothetical and non-hypothetical BDM auction and the hypothetical and non-hypothetical conjoint. Statistical tests of the differences between treatments were calculated using the Kolmogorov-Smirnov test for equality of distribution functions since normality of the WTP distributions was rejected. Results generally indicate that, with the exception of two cases, the hypothetical WTP values are significantly higher than the non-hypothetical WTP values.

Table 3: Differences of Willingness to Pay Means

Group	Cubes NoPreservatives	Cubes Preservatives	Segments No Preservatives	Segments Preservatives
Auction (hypothetical – nonhypothetical)	$0.33**	$0.21*	$0.28*	$0.35*
Conjoint (hypothetical – nonhypothetical)	$0.13	$0.06	$0.45*	$0.34*

(*) Statistically significant at the 0.10 level using Kolmogorov-Smirnov test
(**) This difference has a p-value of 0.154

The descriptive statistics of all the variables in the model are presented in Table 4. The mean WTP results suggest that our subjects value segmented products without preservatives the most with average WTP of $1.78, followed by cubed products without preservatives, segmented products with preservatives, and then cubed products with preservatives.

Table 4: Descriptive Statistics of the Variables

	Median	Mean	Std. Dev.	Max	N.	Min
Willingness to Pay						
Cubes with preservatives	1.00	1.08	0.94	5.00	223	0
Cubes without preservatives	1.50	1.58	1.09	4.42	223	0
Segment with preservatives	1.08	1.25	1.03	5.67	223	0
Segments without preservatives	1.50	1.78	1.19	5.00	223	0
Treatment Indicators						
Treatment A (non-hypothetical auction)	0	0.18	0.39	1	223	0
Treatment B (hypothetical auction)	0	0.26	0.44	1	223	0
Treatment C (non-hypothetical conjoint)	0	0.22	0.42	1	223	0
Treatment D (hypothetical conjoint)	0	0.33	0.47	1	223	0
Income Indicators						
$19,000 or less	0	0.43	0.50	1	223	0
$20,000 - $39,999	0	0.22	0.42	1	223	0
$40,000 - $59,000	0	0.11	0.32	1	223	0
$60,000 - $79,999	0	0.08	0.27	1	223	0
$80,000 - $99,999	0	0.06	0.24	1	223	0
More than $100,000	0	0.09	0.29	1	223	0
Marital Status Indicators						
Single	1	0.51	0.50	1	223	0
Married	0	0.46	0.50	1	223	0
Other (widows and divorced)	0	0.04	0.19	1	223	0
Educational Indicators						
Less than 12 years	0	0.04	0.21	1	223	0
12 years (graduated from high school)	0	0.21	0.41	1	223	0
More than 12 and less than 16 years	0	0.29	0.46	1	223	0
16 years (graduated from college)	0	0.30	0.46	1	223	0
More than 16 years	0	0.16	0. 37	1	223	0
Situational Indicator						
Hungry and thirsty	0	0.28	0.45	1	223	0

To definitively assess the product and treatment effects on WTP, we ran a single limit random effects tobit model. The marginal effects and standard errors of the To definitively assess the product and treatment effects on WTP, we ran a single limit random effects tobit model. The marginal effects and standard errors of the random effects Tobit model are exhibited in Table 5, *see Appendix.* All the product and treatment effects are statistically significant at the 0.05 level. Specifically, consistent with the descriptive WTP means, our model results indicate that segmented products without preservatives are valued about $0.83 more than cubed products with preservatives (base product), *ceteris paribus*. Cubed products without

preservatives and segmented products with preservatives are valued about $0.61 and $0.23 more than cubed products with preservatives. In terms of the treatments, consistent with the descriptive analysis, results suggest that the auction treatments have generally higher estimates than the conjoint WTP values. Specifically, the results show that the non-hypothetical BDM auction ($0.43), the hypothetical auction ($0.76) and hypothetical conjoint ($0.37) treatments have significantly higher WTP values than the non-hypothetical conjoint[3]. The non-hypothetical conjoint treatment has the lowest WTP values while the hypothetical auction treatment has the highest WTP values. Also, as evidence of the expected existence of hypothetical bias in hypothetical valuation experiments, the hypothetical treatments have significantly higher WTP values than the non-hypothetical treatments. Specifically, the marginal effects suggest that the WTP values in hypothetical auction are $0.33 higher than the non-hypothetical BDM auction and the WTP values from the hypothetical conjoint are $0.37 higher than the non-hypothetical conjoint. In summary, we find that the non-hypothetical valuation mechanisms offered a significant reduction of the possible hypothetical bias. This finding is consistent with the findings of Lusk, Feldkamp, and Schroeder (2004). Using a sample of 104 subjects in a lab setting, they found that WTP for hypothetical treatments was 1.2 times the size of the non-hypothetical treatments. In contrast, Voelckner (2006) could not definitively find a significant reduction in hypothetical bias with the use of incentive aligned mechanisms. A key difference between our study and the Voelckner (2006) and Lusk, Feldkamp, and Schroeder (2004) studies is that their studies were conducted in a lab setting as opposed to a retail/field environment.

In terms of the other variables, marital status, education level and a situational variable (hungriness and thirstiness at the time of the experiments) are statistically significant. Specifically, single and married subjects have higher WTP values than other individuals (i.e., widows and divorced). As expected, subjects who indicated that they felt hungry and thirsty during the experiments have higher WTP values ($0.36 more) than those who were not hungry/thirsty. Ethnicity, household age composition, principal shopper condition, purchase location, frequency of purchasing and complexity of the task were originally included in the model but were excluded in the final model because they were not close to being statistically significant. Similarly, with respect to experimental design, we also did not find any significant store, time of the day, day of the week and interviewer effects.
To better understand the complexity of the treatment for each subject, a question was included asking each respondent to rate the degree of complication of the

[3] In addition, we compared groups A and C (non-hypothetical treatments) and B and D (hypothetical treatments). We found that the non-hypothetical conjoint was a significant $ 0.46 less than the non-hypothetical auction. Using the same procedure for the hypothetical groups, we found that hypothetical conjoint estimation was a significant $ 0.47 less than the hypothetical auction estimation. We do not include these outputs in the paper but are available from the authors upon request.

experiments (Table 6). As expected the hypothetical groups have a lower complexity index than the non-hypothetical groups. The hypothetical groups required little training to complete their task while the non-hypothetical groups required more respondent effort to understand the experimental and survey process. Further analysis reveals that the hypothetical conjoint (most popular approach) had the lowest complexity score, while the non-hypothetical or incentive aligned conjoint had the highest. In addition, the random effects model shows that the complexity variable was not significant. Considering the level of complexity expressed by the subjects overall and since it is not statistically significant, we do not believe that the complexity of the treatments played a significant role in their WTP estimates or can explain some of the WTP variation.

Table 6: Level of Complexity of the Task

Group	Complexity Level
A-Nonhypothetical Auction	2.83
B-Hypothetical Auction	2.51
C-Nonhypothetical Conjoint	3.04
D-Hypothetical Conjoint	2.31

Note: The subject classifies the task from 1 (very easy) to 10 (very hard)

Concluding Remarks and Managerial Implications

Food and agribusiness managers continue to introduce novel products into the marketplace in the hope of increasing revenues, market share, and satisfy changing consumer and market needs. However, developing and introducing new products into the market can be expensive. In addition, thousands of new food products are introduced into the market every year with very low success rates. Thus, assessing consumers' valuation of these new products is critical. Secondary data are normally not available for new products. Hence, researchers need to use hypothetical or experimental markets to evaluate the market potential of novel products (Lusk and Hudson, 2004).

Over the last three decades, market researchers have been using conjoint analysis to measure consumer preferences and determine WTP. In addition, experimental economics have introduced some incentive compatible auctions to test economic theory and measure WTP. More recently, incentive aligned studies, taking advantage of both auction and conjoint analysis formats, have been proposed as the next step to measure WTP. We have reviewed the incentive aligned mechanism in an auction and conjoint analysis context. Using experiments in a retail setting, our results generally suggest that indeed, consumers' WTP values are influenced by the type of valuation or elicitation mechanism and by the hypothetical/non-hypothetical

nature of the valuation process. Interestingly, our findings suggest that auction WTP values are higher than conjoint analysis WTP. This result does not necessarily mean that one should be preferred over the other. On the contrary, the choice of a particular type of elicitation mechanism should be based, among others, on the objective and nature of the study. We also recommend that market researchers view these elicitation mechanisms as complementary to each other rather than substitutes. For example, experiences and values from a conjoint analysis study can be used to better design auction experiments and vice-versa. From our experiments, we also generally found that the hypothetical WTP values are higher than the non-hypothetical WTP values in both elicitation mechanisms. This result is expected due to the possible occurrence of hypothetical bias in hypothetical valuation studies. Evidence of this hypothetical bias in some contingent valuation studies is widespread (Cummings, Harrison and Rutstrom 1995; List and Gallet 2001; Loomis et al. 1997; Neill et al. 1994). Based on these results, our recommendation is for future valuation efforts to use nonhypothetical rather than hypothetical elicitation mechanisms especially when the new product of interest can be produced and available.

In conclusion, our results imply that the decision a researcher or manager makes with respect to the elicitation mechanism and their implementation can have a direct impact on estimates of the value of novel products. Since agribusinesses are continuously finding new ways of fulfilling a more demand and consumer-driven marketplace, this finding is of utmost importance due to cost of developing and launching novel products. Having appropriate estimates of consumers' valuation of these novel products can aid business managers decide which of these products should be adopted, market tested, or commercialized. It will also guide them in making optimal pricing decisions.

Future studies should attempt to design elicitation mechanisms that can provide consumer surplus and price elasticity of demand measures that can further aid business and managerial decision-making. For example, Corrigan (2006) and Depositario, Nayga, and Wu (2007) have examined the use of "reverse auction" mechanism. They argue that the reverse auction mechanism provides information that could enable the estimation of consumer surplus and price elasticities of demand. They also found that the reverse auction mechanism produces little bid affiliation and round effects in repeated auctions. Another promising tool that market researchers and managers can potentially use are virtual experiments (VE) (Nayga 2007). As Fiore et al. (2007) discussed, VE can bridge the gap between the controls of lab experiments and the naturalistic domain of field experiments, which can then provide tools that can assist managers make informed business decisions.

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Appendix:

Table 5: Marginal Effects and Standard Errors of the Random Effects Tobit Model

		4-Treatment Data Set
Groups		A, B,C,D
Sample Size		892
		Coefficient
	Intercept	-0.85*
		(0.44)
Product Indicators		
	Cubes with preservatives	Base
	Cubes without preservatives	0.61*
		(0.08)
	Segment with preservatives	0.23*
		(0.08)
	Segments without preservatives	0.83*
		(0.08)
Treatment Indicators		
	Treatment A (nonhypthetical auction)	Base
	Treatment B (hypothetical auction)	0.43*
		(0.20)
	Treatment C (nonhypothetical conjoint)	0.76*
		(0.18)
	Treatment D (hypothetical conjoint)	0.37*
		(0.17)
Income Indicators		
	$19,000 or less	0.39
		(0.27)
	$20,000-$39,999	0.18
		(0.26)
	$40,000-$59,000	0.08
		(0.29)
	$60,000-$79,999	0.63*
		(0.32)
	$80,000-$99,999	-0.04
		(0.33)
	More than $100,000	Base
Marital Status Indicators		
	Single	0.84*
		(0.35)
	Married	0.90*
		(0.36)
	Other (widow/divorced)	Base

Table 5: (Continued)

Educational Indicators		
	Less than 12 years	-0.50
		(0.35)
	12 years (graduated from high school)	0.31
		(0.21)
	More than 12 and less than 16 years	0.16
		(0.21)
	16 years (graduated from college)	0.22
		(0.19)
	More than 16 years	Base
Situational Indicator		
	Hungry and Thirsty	0.36*
		(0.14)
	Sigma_u	0.81*
		(0.05)
	Sigma_e	0.82*
		(0.02)
	Rho	0.49
		(0.04)

(*) Statistically significant at the 0.05 level.
Note: The values reported in parentheses are the standard error of the respective parameter.

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Bio-ethanol Production from Wheat in the Winter Rainfall Region of South Africa: A Quantitative Risk Analysis

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Abstract

Contrary to developments in other parts of the world, South Africa has not developed a bio-ethanol industry. The objective was to quantify the risks and economic viability of a wheat based bio-ethanol plant in the winter rainfall region of South Africa. Monte Carlo simulation of a bio-ethanol plant was used to quantify the risk that investors will likely face. Under the Base scenario a 103 million liter bio-ethanol plant would not offer a reasonable chance of being economically viable. Alternative price enhancing policies were analyzed to determine policy changes needed to make a bio-ethanol plant economically viable in the region.

Keywords: biofuels, ethanol, risk analysis, simulation, economic viability, Simetar, SERF

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Introduction

Contrary to developments in other parts of the world, South Africa has not developed a bio-ethanol industry. In spite of interest from government, financial institutions and investors, there are no grain based bio-ethanol plants operating in the country. Public and private role-players, involved with the bio-ethanol supply chain developments in South Africa, expect an official investment incentive dispensation from the national government for the successful introduction of bio-ethanol to the on-road fuels market. Furthermore, the provincial government and future supply chain members who consider promoting the production of bio-ethanol from wheat as a feedstock need a better understanding of the risks and prospects involved. While currently limited, increased knowledge on the risks and economic viability for the industry will enhance the ability of the national and provincial government to prepare investment incentives to finalize the draft bio-fuels industrial strategy.

The Western Cape Provincial Government see the possible developments of the bio-ethanol industry as an opportunity to address socio-economic development. An annual gross income and revenue stream from a bio-ethanol industry is expected to create employment throughout the province, thus addressing long-term unemployment in addition to the jobs created during construction. The introduction of a local bio-ethanol plant may create an economic spin off that will indirectly involve the creation of additional jobs in the economy. Benefits will accrue to all input sectors, particularly to wheat producers if the price of wheat is increased.

Wheat that is currently exported to other provinces could be used for bio-ethanol production and thus create new jobs at the provincial level and in rural areas. The provincial surplus of wheat produced in the Western Cape Province is sufficient to supply six percent of the total petroleum demanded. However, there are concerns about wheat bio-ethanol plants bidding up wheat price and thus food costs.

The current surge in feedstock prices, lack of incentives to encourage development, a general notion to evaluate the potential of the industry on point estimates (average, best-case, worst-case), and concerns about pressure on food prices reduces the confidence of investors. Agribusinesses in South Africa generally believe that the bio-ethanol industry is a break-even industry. Given the risks associated with feedstock price and availability, investors are cautious and they are demanding risk based economic feasibility analyses prior to investing.

New interest has been raised by the Draft National Bio-fuels Industrial Strategy. But, given the recommendations made in the Draft Strategy the bio-fuels industry would, according to the South African Biofuels Association (SABA), not be lucrative enough to attract investment. According to financial institutions investors require a real rate of return on investment of 19 percent (nominal 25 percent). At this point

a risk-based study of the economic feasibility for a wheat bio-ethanol plant in the Western Cape Province is needed to estimate the probability of success given the required return on investment.

The objective of this paper is to quantify the risks and economic prospects that influence the profitability of bio-ethanol production from wheat in the winter rainfall region of South Africa. Specific objectives are to: quantitatively assess risks that influence the income of potential bio-ethanol developments and identify possible public policy that could be used to enhance the economic viability of bio-ethanol developments.

Procedures

The objectives will be achieved by simulating the economic activity associated with a proposed wheat bio-ethanol plant in the Western Cape Province for 10 years under alternative policy assumptions. The alternative policy assumptions are based on the Draft Biofuels Industrial Strategy of the Republic of South Africa (2006) and comments submitted by SABA (2007), the Western Cape Task Team on Renewable Fuels (2007), as well as the latest corporate tax policy (South African Revenue Services (2006).

A Monte Carlo simulation model of a bio-ethanol plant was developed using the framework provided by Richardson, Herbst, Outlaw and Gill (2007). Data to describe the input and output relationships for the Western Cape plant will come from Lemmer (2006). Historical data (1989-2006) for defining the probability distributions of the stochastic variables affecting the plant will come from the Abstract of Agricultural Statistics (2006), Food and Agricultural Policy Research Institute (2007), Grain South Africa (2007a and b), South African Reserve Bank (2007), Statistics South Africa (2007), South African Revenue Services (2006), and The Bureau for Food and Agricultural Policy (2006).

A Monte Carlo simulation modelling approach is used because it is the best methodology for estimating the probability distribution of unknown variables such as rate of return on investment for a business. Monte Carlo simulation has been used extensively in agricultural economics to analyse riskiness of proposed investments (e.g., Richardson and Mapp (1976), Reutlinger (1970), Aven (2005), Hardaker, Huirne, Anderson and Lien (2004)) and to analyze the riskiness of ethanol plants (e.g., Richardson, Herbst, Outlaw and Gill (2007), Herbst (2003), Gill (2002), Lau (2004)). The methodology is flexible and can be applied to the analysis of ethanol plants in many different parts of the world.

The steps for developing a Monte Carlo simulation model are described by Richardson (2006). First, the objective of the model must be established -- in this case it is to determine the probability that the rate of return to investment is

greater than 25 percent and that the business will be an economic success. Second, one must define all of the equations necessary to calculate the key output variables (KOV) and then identify the stochastic variables necessary to simulate the equations.

Parameters to define the probability distributions for the random variables must be estimated and used to simulate the random variables. Before the model can be developed, the simulated values for each of the random variables must be validated. Standard statistical tests are used to validate that the stochastic variables statistically reproduce their assumed means and variability.

Once the stochastic component of the model is developed and validated, the equations necessary to simulate the variables used to calculate the KOVs are programmed. The equations for an agribusiness feasibility model are the equations in the pro-forma financial statements, namely: income statement, cash flow statement, and balance sheet statement. The equations for the Western Cape bio-ethanol agribusiness model are presented in the next section to provide an abstract description of how the model simulates the KOVs.

Simulation Model for Wheat Bio-ethanol

The stochastic variables for the model are: bio-ethanol price, wheat price, DDGS price, petroleum price, electricity price, prices paid inflation rate, and operating interest rate. These random variables are simulated in the model using the multivariate empirical (MVE) probability distribution suggested by Richardson, Klose and Gray (2000). A MVE distribution was used to insure that the random variables are correlated the same as they have been in the past. Parameters for the MVE distribution were estimated by detrending the data and expressing the residuals as fractions of trend (S_i) and cumulative probabilities ($F(S_i)$). The parameters for the stochastic variables were estimated, and the model was simulated, using the Simetar add-in for Excel (Richardson, Schumann and Feldman 2006). This method of estimating the parameters/simulation insures that the coefficient of variation (CV) for the simulated random variables equals the CV from the historical data even though the projected means may differ considerably from their historical counterparts. The equations for simulating the random variables are included in the Appendix. An independent stochastic variable was added to simulate the number of days the bio-ethanol plant is not operating due to repairs. The down time variable was defined as the number of days the plant is closed and was simulated as a GRKS (10, 20, 30) distribution[1].

[1]The parameters indicate that the minimum down time is 10 days, the middle is 20 and the maximum is 30 days. However, there is a 2.5 percent chance that the plant could be closed less than 10 days and the same chance it could be closed more than 30 days. The finite end points for the distribution are 5 and 35 days.

Following the steps for building a Monte Carlo simulation model, the stochastic variables were simulated for 500 iterations and the resulting sample was used to validate the simulation process. The Student-t tests failed to reject the null hypothesis that the MVE distribution appropriately correlated all of the random variables at the 95 percent level. The Box's M test indicated that at the 95 percent level of significance, the historical and simulated covariance matrices were statistically equal. Student–t tests were performed on the simulated means for the 10-year planning horizon and they were statistically equal to their assumed means.

Economic Feasibility Model

Equations to simulate the pro-forma financial statements using the stochastic variables as exogenous variables are described in the Appendix. The Appendix is separated into four sections, each pertaining to a pro-forma statement/function. The assumptions used for the economic analysis are described in this section.

The assumptions used to model a 103 million liter (ML) (27 million U.S. gallons) bio-ethanol plant are summarized in Table 1. This size of plant is consistent with average quantities of wheat that have been exported from the region for the past seven years. With the addition of a 5 percent petroleum denaturant total bio-ethanol production is 108.4 million liters of denatured ethanol. In a fermentation/distillation bio-ethanol plant, wheat produces 360 liters (95 U.S. gallons) of bio-ethanol, about 333 kg of DDGS per metric ton, and 333 kg of CO2 (Rueve 2005).

The cost of a 103 ML bio-ethanol plant was estimated at R404.7 million, based on an average 2006 exchange rate of R6.77 to $1 U.S. and a R3.93 per liter ($2.20/gallon) turn key construction cost in the United States. Half of the cost of the plant would be financed at the current long-term interest rate of 14.5 percent over 25 years. The remaining cost of the plant will be covered by a shared financing arrangement with a government agency. The agency will provide the funds in return for an annual return equal to the prime interest rate charged on long term debt plus 4 percentage points. Private investors require a return on bio-ethanol and infrastructure investment of 19 percent real interest rate and 25 percent nominal interest rate (SABA, 2007).

The petroleum pricing mechanism, known as the Basic Fuel Price (BFP) Formula represents the landed cost of petroleum. The formula links the domestic retail prices to international crude oil prices by using a benchmark based on spot prices published by Platts. In the simulation model the BFP is stochastic based on its historical variability and the stochastic bio-ethanol price is calculated using the appropriate pricing formula (Appendix equation 1). An alternative set of parameters for the pricing formula are tested in the results section.

Table 1. Input Assumptions for a Western Cape Wheat Base Ethanol Plant.

Total Annual Production of Alcohol (Liters)	102,973,680
Cost per Liter to Build a Plant (Rand/Liter)	3.93
Bio-Ethanol Production from Wheat (Liters/Ton)	360
Add: Denaturant (%)	.5
Cost of a Bio-Ethanol Marker (Rand/Liter)	0.01
DDGS per ton of Wheat	0.333
Extracted Liquid CO2 (Ton/Ton of Wheat)	0.333
Extracted Liquid CO2 (Rand/Ton)	109.20
Fraction Year Operating Loan Borrowed	0.3
Electricity (kW-Hours/Liter)	3.55
Enzymes (Rand/Liter)	0.0860
Yeasts (Rand/Liter)	0.0393
Other Processing Chemicals & Antibiotics (Rand/Liter)	0.0359
Boiler and Cooling Tower Chemicals (Rand/Liter)	0.0088
Annual Cost of Water (Rand/Liter)	0.0045
Maintenance & Repair (R/Liter)	0.0223
Labor WC - plant (Rand/Denatured Liter)	0.0806
Management and Qual. Control (Rand/Denatured Liter)	0.0244
Real Estate Taxes (Rand/Denatured Liter)	0.0034
Licenses, Fees and Insurance (Rand / den. Liter)	0.0074
Miscellaneous Expenses (Rand / den. Liter)	0.0244
Fraction of Plant Debt Financed	0.5
Length of Loan to Build Plant (Years)	25
Fixed Interest Rate %	14.5
Year Loan is Originated	2007
Annual Change in the Value of the Plant %	-5
Beginning Cash Reserves	0
Fixed Interest Rate for Cash Reserves %	8.7
Discount Rate for Net Present Value (NPV) %	25
Minimum Desired Return on Investment (ROI) for Investors %	25
Dividends as Fraction of Net Cash Income (NCI) %	25
Days the Bio-Ethanol Plant Does Not Produce	0
Minimum Days	10
Middle Days	20
Maximum Days	30

According to Akayezu, Linn, Harty and Cassady (1998) the crude protein content of DDGS from wheat is considerably higher than corn DDGS. Linn and Chase (1996) indicated that the nutrient content of distiller's grains is about three times more concentrated than the nutrients in the original feedstock before fermenting. As a result the price of DDGS is assumed to be 13 percent greater than the price of wheat on a ton basis.

Affordable energy is needed for the successful operation of dry mill ethanol plants. Energy generation in the Western Cape Province is however limited and industrial plants are powered by electricity from the national grid which is supplied by power lines from inland coalfields. Meredith, as cited in Jacques, Lyons & Kelsall (2003) indicate that wheat is virtually identical to corn (maize) in energy requirements for making bio-ethanol and requires 3.55 kW-Hours per liter. The average consumer cost of electricity is R0.24/kW-hour. The costs per liter for inputs in Table 1 such as enzymes, yeast, the processing chemicals and antibiotics is given by Tiffany and Eidman (2003) and translated into Rand by the current U.S.-dollar exchange rate. The price for the commercial use of water was R4.51 per kiloliter in 2005. The ethanol plant will use approximately 593.4 million liters of water annually. Annual maintenance and repair costs are estimated at 1 percent of the total capital cost. The labor, management and quality control cost as well as economic circumstances and real estate taxes and license, fees and insurance cost corresponds to the assumptions made by Tiffany and Eidman (2003) after conversion to rand.

Projected prices, interest rates and rates of inflation used for the 2007-2016 analysis are summarized in Table 2. These prices are the mean prices for the stochastic variables in the model. Linear trend was used to project mean annual prices for BFP, which were used to calculate the average prices for bio-ethanol and the price of petroleum denaturant. The annual percentage change in the BFP was

Table 2: Assumed Mean Prices, Interest Rates and Rates of Inflation for the Base Scenario.

	Price of Denaturant	Price of Wheat	Price of Bio-Ethanol	Price of DDGS	Price of Electricity	Annual Change PPI	Interest Rate
	(R/Liter)	(R/Ton)	(R/Liter)	(R/Ton)	(R/kWH)	(Fraction)	(Fraction)
2007	5.47	1223.49	2.55	1382.55	0.25	4.06	0.12
2008	5.70	1214.07	2.68	1371.89	0.27	4.91	0.11
2009	5.93	1223.96	2.81	1383.07	0.28	5.22	0.11
2010	6.15	1234.47	2.94	1394.95	0.29	5.46	0.10
2011	6.37	1239.04	3.08	1400.11	0.30	5.62	0.10
2012	6.59	1244.24	3.21	1405.99	0.32	5.65	0.09
2013	6.81	1241.55	3.34	1402.95	0.33	5.82	0.09
2014	7.04	1239.44	3.47	1400.57	0.34	6.09	0.08
2015	7.26	1241.71	3.61	1403.13	0.35	6.21	0.08
2016	7.48	1245.30	3.74	1407.19	0.36	6.02	0.07

used to calculate the mean electricity prices. Simple trend least square regression was used to project the mean annual rates of inflation and interest rates. FAPRI (2007) projections of world wheat prices were used to calculate the mean price for wheat, given adjustments for location and grade of wheat proposed for use in a bio-ethanol plant. As indicated earlier DDGS price is a linear function of wheat price.

Results

The Monte Carlo simulation model for a proposed wheat based bio-ethanol plant in the Western Cape Province of South Africa was simulated for 10 years, 2007-2016. The results of the Base scenario to quantify the risks inherent in bio-ethanol production in the study area are presented in detail. Alternative policy scenarios are presented to investigate the types of policy scenarios where bio-ethanol production in the study would be profitable.

The alternative scenarios analyzed are summarized as:

- Base scenario assumes an accelerated depreciation method, use of a bio-ethanol marker as a denaturant, 50 percent shared financing with a government agency, bio-ethanol price calculated using 95 percent of the BFP[2] and 31.5 percent reimbursement on the fuel levy.

- In the second scenario a price subsidy of R1.03/liter of denatured bio-ethanol is added to the Base scenario.

- In the third scenario a higher bio-ethanol price resulting from a policy change to price bio-ethanol at 100 percent of the BFP plus 100 percent reimbursement on the fuel levy is added to the Base scenario.

- The fourth scenario adds a price floor for bio-ethanol of R3.325/liter that is linked to the annual percentage change in the inflation rate for the Base scenario.

- The fifth scenario is the Base scenario plus a price floor of R3.325/liter and increasing the reimbursement on the fuel levy to 70 percent.

The five scenarios are compared in terms of the summary statistics for the proposed bio-ethanol plant's key output variables (KOVs): net present value (NPV), present value of ending net worth (PVENW), return on investment (ROI), annual net cash income (Net Inc), annual ending cash reserves (Cash Res), and annual dividends

[2] The shared financing requires an 18.5 percent annual return to the investor.

(Dividend). Probabilities are reported for the probability that NPV is negative, probability ROI is less than 25 percent, probability PVENW is less than zero, probability of annual net cash income being negative, probability of annual ending cash reserves being negative, probability of annual dividends equaling zero. Fan graphs of the annual net cash income and ending cash reserves are presented to show variability over time.

The results for the Base scenario are summarized in Table 3 and Figures 1 and 2. The firm's NPV averages –R88.5 million and ranges from –R230 to R64.6 million.

Table 3. Base Scenario for a Western Cape, South Africa Wheat Based Bio-Ethanol Plant, 2007-2016.

	NPV	PVENW	ROI		
	(M.Rand)	(M.Rand)	(Percent)		
Mean	-88.53	-92.24	-8.43%		
StDev	48.50	45.44	14.52%	**P(NPV<0)**	97%
CV	-54.79	-49.26	-172.20	**P(ROI<0.25)**	99%
Min	-230.65	-230.65	-56.57%	**P(PVENW<0)**	98%
Max	64.67	38.70	34.01%		

	Net Inc 2007	Net Inc 2008	Net Inc 2009	Net Inc 2010	Net Inc 2011	Net Inc 2012	Net Inc 2013	Net Inc 2014	Net Inc 2015	Net Inc 2016
	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)
Mean	-99.13	-100.81	-105.07	-106.49	-108.75	-109.03	-105.65	-99.76	-95.94	-91.54
StDev	77.22	82.17	84.91	93.88	100.64	98.65	102.26	117.32	120.13	121.58
CV	-77.89	-81.50	-80.81	-88.16	-92.55	-90.48	-96.79	-117.60	-125.21	-132.82
Min	-307.92	-281.33	-289.27	-378.13	-342.23	-342.67	-356.95	-437.40	-421.36	-391.43
Max	132.81	123.58	156.38	151.79	203.41	209.94	204.19	223.06	263.19	284.00
P(NCI<0)	87.5%	87.6%	87.6%	85.4%	83.8%	86.6%	84.1%	80.0%	79.0%	79.5%

	Cash Res 2007	Cash Res 2008	Cash Res 2009	Cash Res 2010	Cash Res 2011	Cash Res 2012	Cash Res 2013	Cash Res 2014	Cash Res 2015	Cash Res 2016
	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)
Mean	-100.87	-203.17	-310.13	-419.30	-531.78	-644.17	-754.01	-859.79	-962.21	-1,061.57
StDev	75.68	117.44	150.68	187.55	232.88	268.94	306.55	349.42	388.69	423.20
CV	-75.03	-57.80	-48.59	-44.73	-43.79	-41.75	-40.66	-40.64	-40.39	-39.87
Min	-308.95	-507.60	-644.32	-885.02	-1,141.54	-1,396.11	-1,589.35	-1,899.42	-2,111.54	-2,350.55
Max	115.18	182.98	119.87	218.81	282.03	161.36	120.45	124.12	150.21	157.95
P(EC<0)	87.7%	96.2%	98.0%	99.1%	99.1%	99.3%	99.2%	99.5%	99.7%	99.6%

	Dividend 2007	Dividend 2008	Dividend 2009	Dividend 2010	Dividend 2011	Dividend 2012	Dividend 2013	Dividend 2014	Dividend 2015	Dividend 2016
	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)
Mean	0.70	0.74	0.74	1.11	1.27	1.00	1.30	2.01	2.16	2.46
StDev	2.41	2.39	2.64	3.30	3.74	3.36	3.71	5.28	5.51	6.05
CV	342.94	325.29	359.04	297.46	293.48	334.05	284.97	262.64	255.28	246.13
Min	-	-	-	-	-	-	-	-	-	-
Max	16.60	15.45	19.55	18.97	25.43	26.24	25.52	27.88	32.90	35.50
P(Div=0)	87.4%	87.4%	87.6%	85.4%	83.6%	86.6%	84.0%	80.0%	78.8%	79.4%

Figure 1. Base Scenario Fan Graph for Annual Net Cash Income (M. R.)

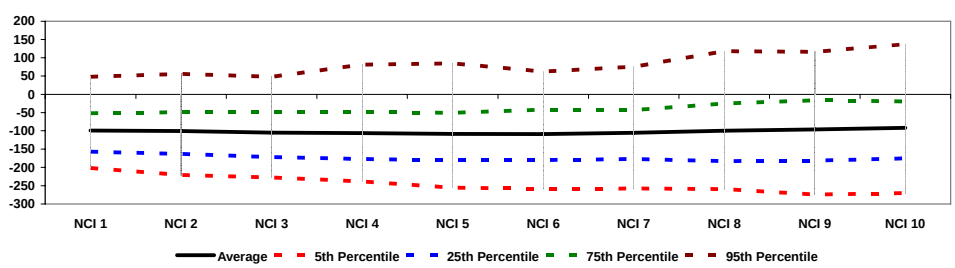
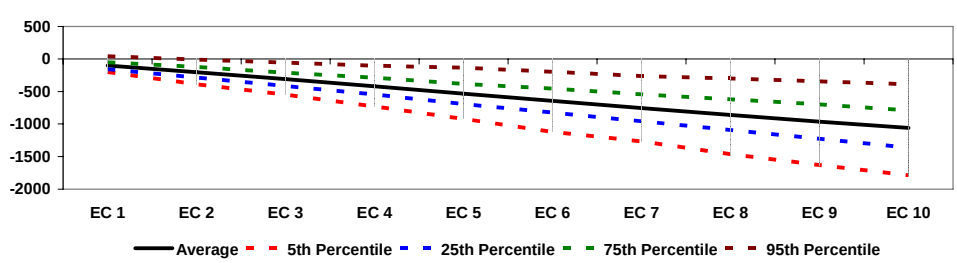


Figure 2. Base Scenario Fan Graph for Annual Ending Cash Reserves (M.R.)



The average ROI is -8.4 percent and there is a 99 percent chance that average ROI over the planning horizon will be less than the investor's minimum value of 25 percent. Average annual net cash income is negative every year ranging from –R99 million in 2007 to –R109 million in 2012. The variability around the average net cash income grows over time as evidenced by the coefficient of variation (CV) increasing from 77 percent in 2007 to 132 percent in 2016, due to higher interest expenses from refinancing cash flow deficits. The increased variability of net cash income is demonstrated in Figure 1, based on the widening of the 5 and 95 percentiles about the mean. Due to negative net cash income the firm's average ending cash reserve is negative and the risk of negative ending cash grows over the period. There is greater than an 87 percent chance of negative ending cash reserves each year. Average annual dividends are less than R3 million each year and the probability of a zero dividend is 79 to 87 percent over the planning horizon.

A subsidy of R1.03/liter of bio-ethanol was used for the second scenario. This level of subsidy was arrived at by experimentation to find the subsidy which provided a 90 percent chance that ROI is greater than 25 percent (Table 4 and Figures 3 and 4). The cumulative distribution function for ROI in Figure 4 shows the amount of variability in ROI and the relative position of the distribution to the investor's preferred minimum. The probability of a negative NPV is 5 percent so the business has a high probability of being an economic success, based on Richardson and Mapp's (1976) rule that economic success is a return greater than the discount rate, i.e., a positive NPV. Average annual net cash income ranges from R6 million in 2007 to R81 million in 2016. The probability of negative annual net cash income is 53.6 percent in 2007 and 27.5 percent in 2016. The fan graph shows that annual net cash income faces expanding variability over time, but has much less variability than under the Base scenario (Figures 1 and 3). The probability of negative ending cash reserves declines from 54.5 percent in 2007 to 18.7 percent in 2016. Average annual dividends ranges from R4.1 to R11.5 million, the probability of annual dividends equalling zero is 53.6 percent in 2007 and declines steadily to 27.4 percent in 2016.

In the third scenario the mean bio-ethanol price was increased by a favorable adjustment to allow 100 percent reimbursement in the fuel levy and allowing bio-ethanol to be valued at 100 percent of the BFP. Average ROI is 46.4 percent and average NPV is R80.7 million for this scenario, slightly higher than the price subsidy scenario (Table 5 and Figures 5 and 6). The probability of ROI less than the desired 25 percent level is 12.8 percent and the probability of a negative NPV is 9.2 percent. Average annual net cash income increases over the planning horizon from –R5.3 million in 2007 to R101.2 million in 2016. The probability of negative annual net cash income is more than 50 percent for 2007-2010, but improves to 30 percent in the last year. The average ending cash reserves is positive every year after 2010 and the probability of negative ending cash reserves decreases from 60

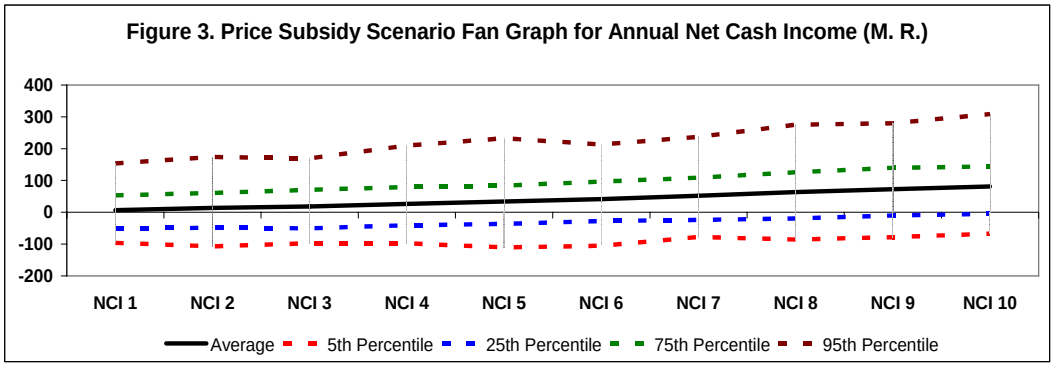
Table 4. Price Subsidy of R1.03/Liter for a Western Cape, South Africa Wheat Based Bio-Ethanol Plant, 2007-2016.

	NPV	PVENW	ROI		
	(M.Rand)	(M.Rand)	(Percent)		
Mean	77.35	55.12	43.67%		
StDev	46.35	36.27	14.53%	**P(NPV<0)**	5.01%
CV	59.92	65.80	33.28	**P(ROI<0.25)**	10.20%
Min	-70.12	-71.12	-4.92%	**P(PVENW<0)**	6.60%
Max	232.86	168.71	85.91%		

	Net Inc 2007	Net Inc 2008	Net Inc 2009	Net Inc 2010	Net Inc 2011	Net Inc 2012	Net Inc 2013	Net Inc 2014	Net Inc 2015	Net Inc 2016
	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)
Mean	6.28	13.38	18.22	26.29	33.37	41.28	52.36	63.55	72.18	81.12
StDev	77.31	81.55	84.07	91.77	96.60	95.37	97.55	108.51	108.70	111.87
CV	1,230.07	609.73	461.48	348.99	289.48	231.02	186.30	170.75	150.59	137.90
Min	-204.79	-164.50	-152.21	-232.62	-180.94	-179.36	-176.89	-197.60	-170.26	-148.32
Max	238.07	246.25	288.49	274.77	332.36	337.92	330.35	362.19	393.44	411.04
P(NCI<0)	53.6%	47.9%	46.3%	47.0%	40.6%	37.1%	35.2%	33.8%	28.3%	27.5%

	Cash Res 2007	Cash Res 2008	Cash Res 2009	Cash Res 2010	Cash Res 2011	Cash Res 2012	Cash Res 2013	Cash Res 2014	Cash Res 2015	Cash Res 2016
	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)
Mean	1.07	10.76	26.06	44.65	65.47	94.24	133.58	182.84	241.49	310.89
StDev	71.34	109.68	138.69	165.26	197.76	223.21	248.54	280.63	310.28	337.79
CV	6,690.24	1,018.92	532.10	370.11	302.06	236.85	186.05	153.48	128.49	108.65
Min	-205.82	-286.14	-292.51	-398.76	-458.10	-516.25	-648.77	-779.14	-794.20	-864.83
Max	205.55	364.31	422.74	600.20	760.87	785.08	893.43	1,032.67	1,202.17	1,368.74
P(EC<0)	54.5%	47.9%	43.2%	42.8%	39.2%	34.0%	29.2%	27.4%	22.4%	18.7%

	Dividend 2007	Dividend 2008	Dividend 2009	Dividend 2010	Dividend 2011	Dividend 2012	Dividend 2013	Dividend 2014	Dividend 2015	Dividend 2016
	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)
Mean	4.19	4.96	5.41	6.22	6.95	7.62	8.53	9.86	10.70	11.52
StDev	6.62	7.01	7.50	8.68	9.27	9.26	10.05	11.50	11.66	12.40
CV	158.04	141.38	138.58	139.64	133.35	121.45	117.79	116.64	108.98	107.62
Min	-	-	-	-	-	-	-	-	-	-
Max	29.76	30.78	36.06	34.35	41.55	42.24	41.29	45.27	49.18	51.38
P(Div=0)	53.6%	47.8%	46.2%	46.8%	40.6%	37.0%	35.0%	33.8%	28.2%	27.4%



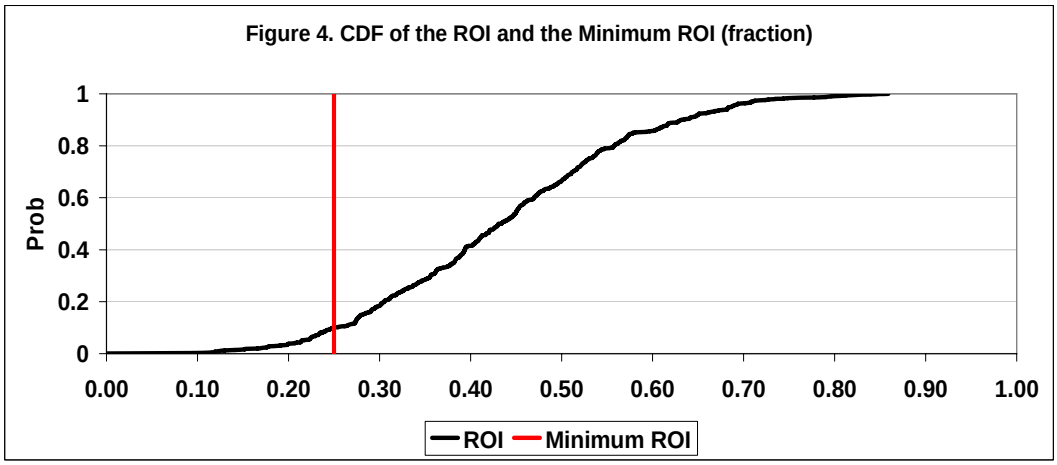


Table 5. More Favorable Bio-Ethanol Price Formula Scenario for a Western Cape, South Africa Wheat Based Bio-Ethanol Plant, 2007-2016.

	NPV	PVENW	ROI		
	(M.Rand)	(M.Rand)	(Percent)		
Mean	80.74	54.04	46.42%		
StDev	61.11	48.09	19.34%	**P(NPV<0)**	9.26%
CV	75.69	88.98	41.66	**P(ROI<0.25)**	12.82%
Min	-109.25	-109.77	-16.42%	**P(PVENW<0)**	13.56%
Max	290.08	207.96	102.25%		

	Net Inc 2007	Net Inc 2008	Net Inc 2009	Net Inc 2010	Net Inc 2011	Net Inc 2012	Net Inc 2013	Net Inc 2014	Net Inc 2015	Net Inc 2016
	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)
Mean	-5.34	3.68	11.47	22.94	32.90	44.24	59.55	75.27	87.83	101.22
StDev	103.12	108.03	111.64	121.82	127.30	126.64	129.64	144.44	143.81	147.93
CV	-1,930.39	2,931.72	973.62	531.11	386.91	286.23	217.71	191.88	163.73	146.14
Min	-259.87	-212.44	-211.83	-299.07	-239.70	-227.28	-215.56	-256.16	-216.53	-199.97
Max	293.59	304.46	351.86	350.57	415.56	426.31	419.13	464.38	504.45	526.04
P(NCI<0)	59.9%	50.8%	50.1%	50.3%	45.0%	42.0%	39.0%	37.5%	31.8%	30.4%

	Cash Res 2007	Cash Res 2008	Cash Res 2009	Cash Res 2010	Cash Res 2011	Cash Res 2012	Cash Res 2013	Cash Res 2014	Cash Res 2015	Cash Res 2016
	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)
Mean	-11.41	-11.89	-4.73	7.66	25.05	53.03	94.93	150.22	218.30	300.78
StDev	95.25	146.16	184.53	219.85	263.10	297.99	331.69	374.61	412.70	447.83
CV	-834.73	-1,229.36	-3,905.07	2,868.39	1,050.49	561.91	349.40	249.38	189.05	148.89
Min	-260.90	-390.43	-406.18	-603.27	-672.42	-759.43	-916.59	-1,075.68	-1,108.04	-1,224.82
Max	240.04	429.31	499.13	720.48	941.77	989.48	1,119.79	1,298.27	1,518.93	1,734.29
P(EC<0)	60.2%	54.8%	52.8%	50.5%	48.7%	42.8%	39.0%	35.1%	30.5%	27.0%

	Dividend 2007	Dividend 2008	Dividend 2009	Dividend 2010	Dividend 2011	Dividend 2012	Dividend 2013	Dividend 2014	Dividend 2015	Dividend 2016
	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)
Mean	4.86	5.70	6.39	7.49	8.35	9.29	10.54	12.32	13.46	14.62
StDev	8.34	8.77	9.47	11.13	11.89	11.99	13.04	15.06	15.24	16.31
CV	171.49	153.89	148.36	148.49	142.32	129.03	123.71	122.19	113.26	111.56
Min	-	-	-	-	-	-	-	-	-	-
Max	36.70	38.06	43.98	43.82	51.95	53.29	52.39	58.05	63.06	65.75
P(Div=0)	59.8%	50.6%	50.0%	50.2%	44.8%	42.0%	39.0%	37.4%	31.8%	30.2%

Figure 5. Use an Alternative Price Formula Scenario Fan Graph for Annual Net Cash Income (M. R.)

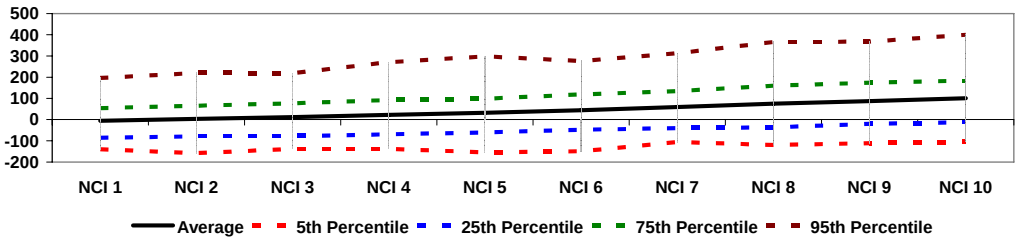
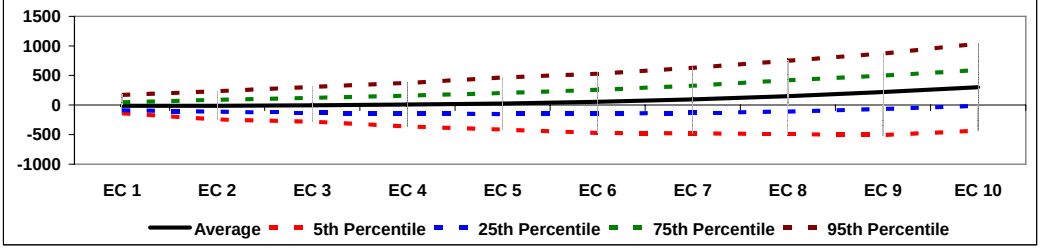


Figure 6. Use an Alternative Price Formula Scenario Fan Graph for Annual Ending Cash Reserves (M.R.)



percent in 2007 to 27 percent in 2016. The fan graph for ending cash reserves shows the improvement in the probability of positive cash reserves (Figure 6).

Instituting an inflation adjusted minimum price for bio-ethanol at R3.325/liter in the fourth scenario improves the economic viability of the proposed bio-ethanol plant over the Base scenario (Table 6 and Figures 7 and 8). Average ROI is 47 percent, a significant increase over the -8 percent for the Base scenario. The

probability that ROI will be less than 25 percent is less than one percent for the price floor scenario. Average annual net cash income is positive each year after 2008 and increases from –R14.0 million in 2007 to more than R140 million in 2016.

Table 6. Minimum Price Floor Scenario for a Western Cape, South Africa Wheat Based Bio-Ethanol Plant, 2007-2016.

	NPV (M.Rand)	PVENW (M.Rand)	ROI (Percent)		
Mean	72.74	57.53	47.38%		
StDev	27.66	22.05	10.65%	**P(NPV<0)**	0.57%
CV	38.02	38.33	22.49	**P(ROI<0.25)**	0.80%
Min	-23.71	-24.07	9.72%	**P(PVENW<0)**	0.63%
Max	166.55	131.58	85.59%		

	Net Inc 2007 (M.Rand)	Net Inc 2008 (M.Rand)	Net Inc 2009 (M.Rand)	Net Inc 2010 (M.Rand)	Net Inc 2011 (M.Rand)	Net Inc 2012 (M.Rand)	Net Inc 2013 (M.Rand)	Net Inc 2014 (M.Rand)	Net Inc 2015 (M.Rand)	Net Inc 2016 (M.Rand)
Mean	-14.05	-7.12	1.20	17.10	31.32	47.97	68.23	93.36	114.64	140.99
StDev	38.22	40.38	42.75	47.14	49.91	47.28	50.75	54.39	55.85	57.78
CV	-271.97	-566.99	3,555.22	275.67	159.37	98.56	74.38	58.26	48.71	40.98
Min	-125.56	-117.20	-119.40	-119.55	-104.23	-89.38	-107.89	-98.25	-35.66	0.53
Max	132.81	145.61	180.30	174.26	222.83	228.75	214.21	256.62	285.11	305.75
P(NCI<0)	66.4%	59.3%	49.6%	35.1%	25.7%	13.2%	8.0%	3.3%	2.3%	0.0%

	Cash Res 2007 (M.Rand)	Cash Res 2008 (M.Rand)	Cash Res 2009 (M.Rand)	Cash Res 2010 (M.Rand)	Cash Res 2011 (M.Rand)	Cash Res 2012 (M.Rand)	Cash Res 2013 (M.Rand)	Cash Res 2014 (M.Rand)	Cash Res 2015 (M.Rand)	Cash Res 2016 (M.Rand)
Mean	-16.19	-25.36	-26.60	-14.07	4.66	36.32	81.89	146.46	228.58	333.29
StDev	36.31	54.36	70.53	89.08	104.39	116.75	135.01	155.08	177.72	205.37
CV	-224.28	-214.35	-265.15	-632.95	2,239.96	321.43	164.88	105.89	77.75	61.62
Min	-126.59	-236.53	-241.46	-307.18	-337.87	-331.71	-336.41	-437.31	-434.58	-426.63
Max	115.18	182.98	185.31	251.20	317.21	325.05	437.24	572.55	783.06	1,022.98
P(EC<0)	67.2%	69.9%	67.5%	55.1%	48.4%	37.7%	27.6%	18.7%	10.0%	4.8%

	Dividend 2007 (M.Rand)	Dividend 2008 (M.Rand)	Dividend 2009 (M.Rand)	Dividend 2010 (M.Rand)	Dividend 2011 (M.Rand)	Dividend 2012 (M.Rand)	Dividend 2013 (M.Rand)	Dividend 2014 (M.Rand)	Dividend 2015 (M.Rand)	Dividend 2016 (M.Rand)
Mean	1.11	1.52	2.06	3.43	4.81	6.34	8.84	11.79	14.38	17.62
StDev	2.47	2.86	3.43	4.35	5.06	5.38	5.71	6.52	6.86	7.22
CV	223.26	188.37	166.56	126.69	105.09	84.85	64.54	55.25	47.73	40.98
Min	-	-	-	-	-	-	-	-	-	0.07
Max	16.60	18.20	22.54	21.78	27.85	28.59	26.78	32.08	35.64	38.22
P(Div=0)	66.2%	59.2%	49.6%	35.0%	25.6%	13.2%	8.0%	3.2%	2.2%	0.0%

Figure 7. Minimum Price Floor Scenario Fan Graph for Annual Net Cash Income (M. R.)

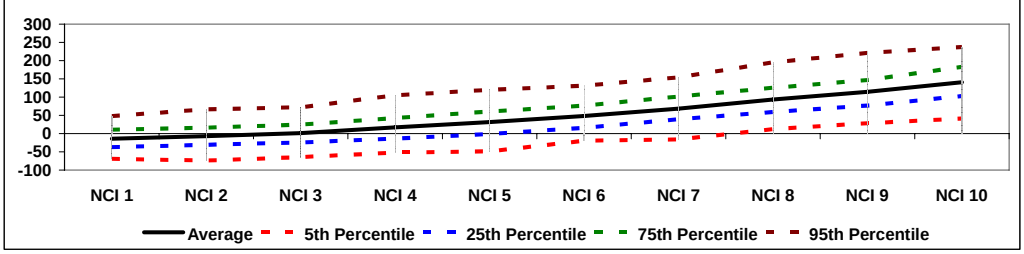
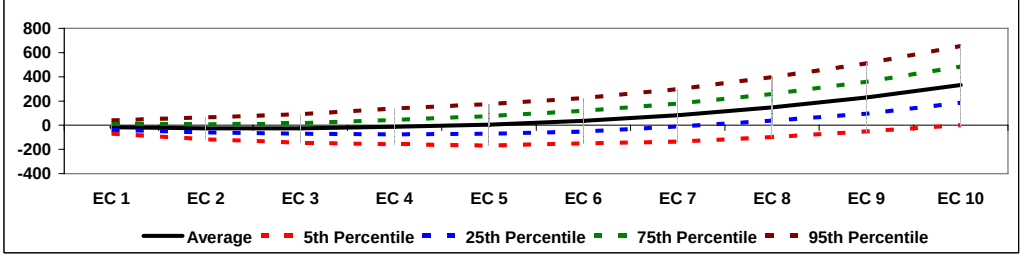


Figure 8. Minimum Price Floor Scenario Fan Graph for Annual Ending Cash Reserves (M.R.)



The probability of negative net cash income is 66 percent in 2007 and decreases to zero in the last year. The presence of a minimum price for bio-ethanol reduces the downside risk on net cash income. This result is best seen by comparing the fan graphs for net cash income between the Base (Figure 1) to the fan graph for the

minimum price scenario (Figure 7). Dividends average R7.1 million over the 10 years period and the probability of a zero dividend is less than 25 percent after 2011.

The last scenario combines a minimum price of R3.325/liter with a 70 percent reimbursement on the fuel levy (Table 7 and Figures 9 and 10). Average NPV is

Table 7. Combination of Scenario for a Western Cape, South Africa Wheat Based Bio-Ethanol Plant, 2007-2016.

	NPV (M.Rand)	PVENW (M.Rand)	ROI (Percent)		
Mean	100.59	78.36	56.18%		
StDev	34.88	26.58	11.86%	**P(NPV<0)**	0.43%
CV	34.68	33.92	21.12	**P(ROI<0.25)**	0.57%
Min	-21.29	-21.70	10.43%	**P(PVENW<0)**	0.45%
Max	207.86	158.42	93.94%		

	Net Inc 2007 (M.Rand)	Net Inc 2008 (M.Rand)	Net Inc 2009 (M.Rand)	Net Inc 2010 (M.Rand)	Net Inc 2011 (M.Rand)	Net Inc 2012 (M.Rand)	Net Inc 2013 (M.Rand)	Net Inc 2014 (M.Rand)	Net Inc 2015 (M.Rand)	Net Inc 2016 (M.Rand)
Mean	1.52	10.90	20.95	37.66	51.02	67.77	88.09	113.55	133.19	158.32
StDev	54.84	57.04	59.38	66.53	67.93	63.87	65.96	72.04	70.78	71.64
CV	3,596.70	523.18	283.42	176.67	133.13	94.25	74.88	63.45	53.14	45.25
Min	-125.56	-117.20	-119.40	-114.48	-103.61	-85.86	-73.86	-96.95	-35.66	5.00
Max	210.62	228.58	266.39	256.33	316.48	324.65	320.46	356.06	390.30	413.14
P(NCI<0)	57.6%	49.8%	39.8%	28.5%	18.7%	8.4%	5.3%	2.7%	1.7%	0.0%

	Cash Res 2007 (M.Rand)	Cash Res 2008 (M.Rand)	Cash Res 2009 (M.Rand)	Cash Res 2010 (M.Rand)	Cash Res 2011 (M.Rand)	Cash Res 2012 (M.Rand)	Cash Res 2013 (M.Rand)	Cash Res 2014 (M.Rand)	Cash Res 2015 (M.Rand)	Cash Res 2016 (M.Rand)
Mean	-2.09	5.92	24.14	54.61	90.70	140.43	205.79	292.33	397.73	527.33
StDev	50.27	75.58	95.92	117.46	137.26	152.12	171.21	195.87	220.58	247.59
CV	-2,405.34	1,276.34	397.36	215.10	151.33	108.32	83.20	67.00	55.46	46.95
Min	-126.59	-180.77	-188.76	-243.44	-291.33	-298.98	-318.29	-417.90	-414.08	-404.63
Max	183.27	319.92	323.33	490.35	632.17	639.31	730.42	843.27	1,062.92	1,272.87
P(EC<0)	58.0%	51.9%	44.7%	35.2%	28.3%	18.3%	10.4%	6.1%	2.9%	1.0%

	Dividend 2007 (M.Rand)	Dividend 2008 (M.Rand)	Dividend 2009 (M.Rand)	Dividend 2010 (M.Rand)	Dividend 2011 (M.Rand)	Dividend 2012 (M.Rand)	Dividend 2013 (M.Rand)	Dividend 2014 (M.Rand)	Dividend 2015 (M.Rand)	Dividend 2016 (M.Rand)
Mean	2.59	3.24	4.04	5.70	6.98	8.71	11.23	14.27	16.68	19.79
StDev	5.04	5.53	6.06	7.23	7.78	7.64	7.85	8.85	8.77	8.96
CV	194.75	170.45	150.11	126.96	111.55	87.66	69.88	61.98	52.60	45.25
Min	-	-	-	-	-	-	-	-	-	0.62
Max	26.33	28.57	33.30	32.04	39.56	40.58	40.06	44.51	48.79	51.64
P(Div=0)	57.4%	49.8%	39.8%	28.4%	18.6%	8.4%	5.2%	2.6%	1.6%	0.0%

Figure 9. Combination of Scenarios Fan Graph for Annual Net Cash Income (M. R.)

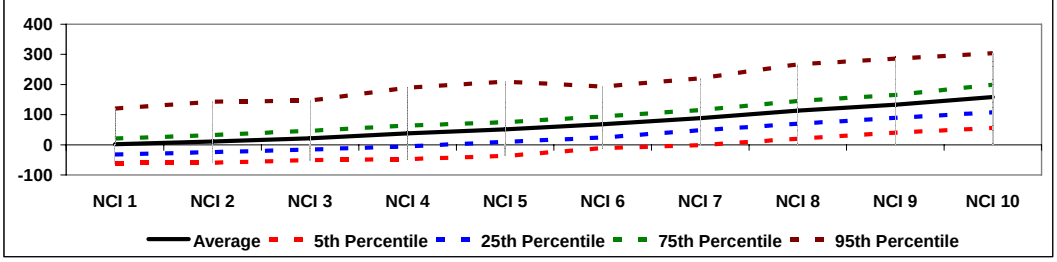
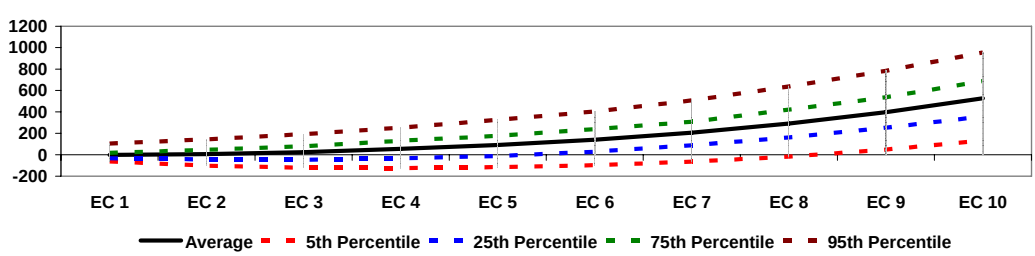


Figure 10. Combination of Scenarios Fan Graph for Annual Ending Cash Reserves (M.R.)



R100.5 million and there is almost a 100 percent chance of a positive NPV; the average ROI is 56.1 percent and there is a near zero chance that ROI will be less than the minimum desired level of 25 percent. Average annual net cash income increases over the period from R1.5 million at the outset to more than R158 million in 2016. The probability of net cash income being less than zero decreases from 57 percent to zero over the period (Figure 9).

A side-by-side comparison of the five scenarios is provided in Table 8. Based on the mean values for the KOVs, the most profitable scenario is the fifth scenario which provides a higher mean price and a price floor without a subsidy. The fifth scenario

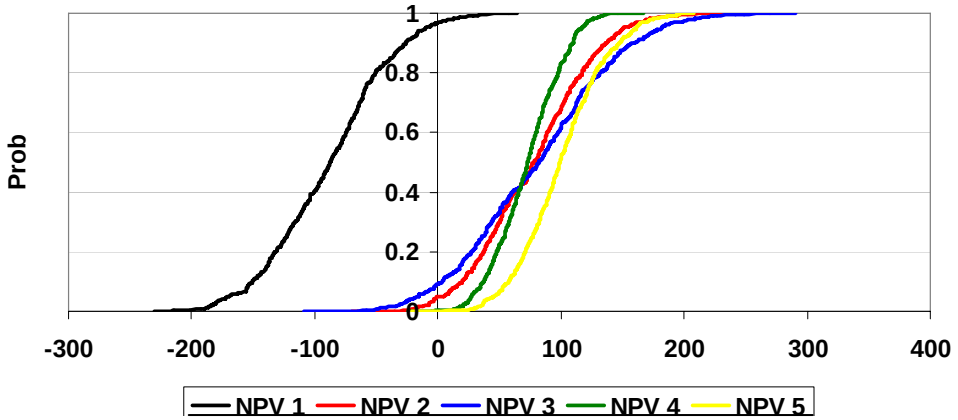
Table 8. Comparison of a Western Cape, South Africa Wheat Bio-Ethanol Plant's Economic Viability Across Scenarios.

	Base	R1.03/Liter Subsidy	More Favorable Price Formula	Minimum Price Floor	Higher Price and Price Floor
Net Present Value (NPV)					
	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)
Mean	-88.53	77.35	80.74	72.74	100.59
StDev	48.50	46.35	61.11	27.66	34.88
CV (fration)	-54.79	59.92	75.69	38.02	34.68
Min	-230.65	-70.12	-109.25	-23.71	-21.29
Max	64.67	232.86	290.08	166.55	207.86
P(NPV<0)	96.79%	5.01%	9.26%	0.57%	0.43%
Rate of Return on Investment (ROI)					
	(Percent)	(Percent)	(Percent)	(Percent)	(Percent)
Mean	-8.43%	43.67%	46.42%	47.38%	56.18%
StDev	14.52%	14.53%	19.34%	10.65%	11.86%
CV (fration)	-172.20	33.28	41.66	22.49	21.12
Min	-56.57%	-4.92%	-16.42%	9.72%	10.43%
Max	34.01%	85.91%	102.25%	85.59%	93.94%
P(ROI<0.25)	98.57%	10.20%	12.82%	0.80%	0.57%
Average Annual Net Cash Income					
	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)
Mean	-102.22	40.80	43.38	49.36	68.30
StDev	99.88	95.33	126.44	48.44	65.00
CV (fration)	-98.38	381.63	389.87	347.22	504.41
Min	-354.87	-180.75	-233.84	-91.66	-86.76
Max	195.23	321.49	405.64	214.62	308.30
Ending Cash Reserves in 2016					
	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)
Mean	-1061.57	310.89	300.78	333.29	527.33
StDev	423.20	337.79	447.83	205.37	247.59
CV (fration)	-39.87	108.65	148.89	61.62	46.95
Min	-2350.55	-864.83	-1224.82	-426.63	-404.63
Max	157.95	1368.74	1734.29	1022.98	1272.87
Average Annual Dividend					
	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)	(M.Rand)
Mean	1.35	7.60	9.30	7.19	9.32
StDev	3.84	9.39	12.12	4.98	7.37
CV (fration)	300.13	128.35	136.43	110.33	107.12
Min	0.00	0.00	0.00	0.01	0.06
Max	24.40	40.19	50.70	26.83	38.54

provides more than a 99 percent of economic success and of returning the investors a ROI greater than a 25 percent minimum. Based on the average ROI, NPV, net cash income, and dividends the second ranked scenario is scenario three, followed by the second scenario, a R1.03/liter bio-ethanol price subsidy.

Stochastic efficiency with respect to a function (SERF) [3] was used to rank the five estimated probability distributions for NPV (Figure 11)[4]. The five scenarios were analyzed across a wide spectrum of risk preferences, ranging from decision makers who are risk neutral to extremely risk averse (relative risk aversion coefficients of zero to 4.0. A Power utility function was assumed because the risky distributions represented both income and wealth changes over a multiple year planning horizon (Hardaker, Huirne, Anderson and Lien 2004). The SERF analysis showed that for decision makers representing all levels of risk aversion, the preferred is scenario five, followed by scenarios three, two, four and the least preferred scenario is the Base.

Figure 11. CDF of the Net Present Value (NPV) Probability Distributions for Alternative Scenarios.



Conclusions

Investors in South Africa have not ventured into the field of bio-ethanol production although sufficient wheat is available in the winter rainfall region. Uncertainty about government policies and rates of return that can be earned from investing in bio-ethanol plants has been used to justify the delay. The objective of this paper was to quantify the risks and economic prospects that influence the profitability of bio-ethanol production from wheat in the winter rainfall region of South Africa.

[3] SERF is a risk ranking procedure introduced by Hardaker, Richardson, Lien and Schumann (2004) and provides an innovative approach for quantitatively ranking risky alternatives utilizing certainty equivalents calculated at alternative risk aversion coefficients over the full range of decision makers' preference for income and risk.
[4] A CDF chart displays the probability of a risky variable, such as, NPV, being less than a particular value on the X axis. For example there is a 50 percent chance than NPV will be less than R100 million for scenario five.

Specific objectives were to: quantitatively assess risks that influence the income of potential bio-ethanol developments, and identify possible public policy that could be used to enhance the economic viability of bio-ethanol developments.

A Monte Carlo simulation model of the economic activity for a bio-ethanol plant in the region was developed and simulated for 10 years to quantify the risk that investors will likely face. Under the Base scenario a 103 million liter bio-ethanol plant would not offer a reasonable chance of being economically viable. Average NPV was –R88.5 million, average ROI was -8.4 percent, and there was more than a 97 percent chance that NPV would be negative. The risk for a bio-ethanol plant was considerably higher than most investors would be willing to accept given a CV of -54.8 percent and largely explains why agribusiness interests have not invested in the South African bio-ethanol industry.

Alternative pricing policies were analyzed to determine the type of policy changes that would be needed to make a bio-ethanol plant economically viable. Implementing a R1.03/liter subsidy for bio-ethanol would increase average NPV to R77.3 million and average ROI to 43.6 percent. With a subsidy there is significant reduction in the risk of a negative NPV, decreasing the chance from 97 percent for the Base to only 5 percent. A more favorable bio-ethanol price, due to pricing bio-ethanol at 100 percent of the BFP plus 100 percent reimbursement on the fuel levy, was analyzed. The more favorable pricing formula increased average NPV to more than R80 million and average ROI to 46 percent, and it reduced the risk of a negative NPV to 0.5 percent. Instituting an inflation adjusted price floor at R3.325/liter increased average NPV and ROI, but not as much as the subsidy. The last policy scenario, a price floor of R3.325/liter and increasing reimbursement on the fuel levy to 70 percent, it provided the greatest increase in average NPV, ROI, net cash income, dividends, and ending cash reserves, and the largest reduction in relative risk.

A stochastic efficiency ranking of the risky alternatives showed that the last policy scenario (price floor of R3.325/liter and an increase in the reimbursement on the fuel levy to 70 percent) would be preferred by all classes of risk averse decision makers. Ranked second was the more favorable formula for computing the bio-ethanol price.

The results of this analysis demonstrate that bio-ethanol production from wheat in the winter rainfall region of South Africa is not likely to be profitable without significant involvement by the government. Policy assistance to enhance price and reduce risk can take on many different forms as demonstrated by the analysis. Any policy option should be analyzed thoroughly prior to implementation to avoid unintended consequences. Although results from this study are not directly transferable to other countries, the methodology can easily be implemented to analyze the economic viability of ethanol production in other countries with alternative feedstocks.

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Appendix:

Economic Feasibility Model of a Bio-Ethanol Plant in South Africa

Stochastic Variables

1) **Bio-ethanol Price**[5]$_t$ = (0.95 * **BFP**$_t$[6] + 0.315 * Fuel Levy$_t$) * [1 + MVE (S_i , F(S_i), C_7)]

2) **DDGS Price**$_t$ = Mean Price$_t$ * [1 + MVE (S_i , F(S_i), C_6)]

3) **Wheat Price**$_t$ = Mean Price$_t$ * [1 + MVE (S_i , F(S_i), C_5)]

4) **Petroleum Price**$_t$ = Mean Price$_t$ * [1 + MVE (S_i , F(S_i), C_4)]

5) **Electricity Price**$_t$ = Mean Price$_t$ * [1 + MVE (S_i , F(S_i), C_3)]

6) **Inflation Rate**$_t$ = Mean Rate$_t$ * [1 + MVE (S_i , F(S_i), C_2)]

7) **OP Interest Rate**$_t$ = Mean Rate$_t$ * [1 + MVE (S_i , F(S_i), C_1)]

8) **Down Time**$_t$ = GRKS (minimum, middle, maximum)

[5] Names of stochastic variables are denoted in bold. Variables that are calculated as a function of stochastic variables become stochastic variables themselves and are denoted in bold.
[6] BFP stands for the Basic Fuel Price.

Where the C_i values in equations 1-7 represent the correlated uniform standard deviates that insure that random variables are appropriately correlated.

Income Statement

Annual receipts for the wheat bio-ethanol plant (14) are the sum of receipts for bio-ethanol, DDGS, and CO_2[7]. Bio-ethanol receipts (12) equal the product of stochastic bio-ethanol production and stochastic bio-ethanol price. Bio-ethanol production (9) is based on plant production capacity per day times the number of days the plant operates. Gross bio-ethanol sold (11) is equal to bio-ethanol production plus denaturant (5 percent petroleum) added. Receipts for DDGS (13) is the product of stochastic DDGS price and DDGS produced, which is a linear relationship to wheat used.

9) **Bio-ethanol Production**$_t$ = Maximum Production per Day$_t$ * (365 – **Down Time**$_t$)

10) **Bio-ethanol Denaturant**$_t$ = **Bio-ethanol Production**$_t$ * 0.05[8]

11) **Denatured Bio-ethanol Production**$_t$ = **Bio-ethanol Production**$_t$ + **Bio-ethanol Denaturant**$_t$

12) **Bio-ethanol Receipts**$_t$ = **Denatured Bio-ethanol Production**$_t$ * **Bio-ethanol Price**$_t$

13) **DDGS Receipts**$_t$ = **Wheat Used**$_t$ * DDGS per bu Wheat * **DDGS Price**$_t$

14) **Total Receipts**$_t$ = **Bio-ethanol Receipts**$_t$ + **DDGS Receipts**$_t$ + **Interest Earned**$_t$

Cash expenses for the plant are the sum of the cost for wheat, denaturant, electricity, interest, and other inputs (enzymes, labor, etc.). Wheat cost (16) is a function of the quantity of wheat used and the local price for wheat.

15) **Wheat Used**$_t$ = **Bio-ethanol Production**$_t$ / Conversion Rate

16) **Wheat Cost**$_t$ = **Wheat Used**$_t$ * (**Wheat Price**$_t$ + **Western Cape Province Price Wedge**$_t$)

Petroleum (17) cost for denaturant is a function of its stochastic price and the stochastic production of bio-ethanol. Electricity cost (18) equals electricity use times the price of electricity per kWH. Other production cost (19) equals the inflation adjusted cost of other inputs per liter times the total denatured bio-ethanol

[7] Receipts from CO_2 were calculated using a constant price to account for the product but uncertainty about the industry prevented modeling the byproduct further.

[8] Petroleum is generally used to denature alcohol and when used it expands the volume of bio-ethanol about 5 percent. An option to be evaluated in South Africa is the use of a marker instead of using petroleum as a denaturant. The cost is R0.01/liter and is assumed to add no volume to total bio-ethanol produced.

production. Similar formulas are used to simulate electricity (18) and other (19) production costs. Total variable costs (20) is the sum of all these cash costs.

17) **Petroleum Cost$_t$** = **Petroleum Denaturant$_t$** * **Petroleum Price$_t$**

18) **Electricity Cost$_t$** = **Denatured Bio-ethanol Production$_t$** * 3.553 * **Electricity Price$_t$**

19) **Other Costs$_t$** = VC/liter$_{t-1}$ * **(1 + Inflation Rate$_t$)** * **Denatured Bio-ethanol Production$_t$**

20) **Total Variable Cost$_t$** = **Wheat Cost$_t$** + **Petroleum Cost$_t$** + **Natural Gas Cost$_t$** + **Electricity Cost$_t$** + **Other Costs$_t$**

The cost of operating interest expense (21) is simulated using the stochastic interest rate, total variable costs, and the fraction of the year operating capital is borrowed.

21) **Operating Interest$_t$** = **Total Variable Cost$_t$** * **OP Interest Rate$_t$** * Fract. of year

The interest cost to finance the proposed plant (22) is a deterministic value based on the amount financed (principal owed$_t$), the interest rate, and the number of years financed.

22) Plant Debt Interest$_t$ = Principal Owed$_t$ * Fixed Interest Rate$_t$

In the event the business has a cash flow deficit an equation is included to calculate the interest for a one-year loan to cover the cash flow deficit.

23) **Carryover Loan Interest$_t$** = **Cashflow Deficits$_{t-1}$** * **OP Interest Rate$_t$**

Total interest expenses (24) for the business is the sum of interest expenses in 21-23.

24) **Total Interest Expense$_t$** = Plant Debt Interest$_t$ + **Operating Interest$_t$** **Carryover Loan Interest$_t$**

Depreciation (25) was calculated assuming an accelerated depreciation schedule that recapture the original capital cost in 3 years (50, 30, and 20 percent) for the original investment plus the depreciation for annual capital expenses for improvements.

25) Depreciation$_t$ = Plant Cost * fraction$_t$ + Capital Replacement$_t$ * fraction$_t$

Total expenses (26) is the sum of total variable expenses, interest expense, and depreciation. Net returns (27) to the plant equals total receipts minus total

expenses and net cash income (28) is total receipts minus variable costs and interest expenses.

26) **Total Expenses$_t$ = Total Variable Cost$_t$ + Total Interest Expense$_t$ +** Depreciation$_t$

27) **Net Returns$_t$ = Total Receipts$_t$ – Total Expenses$_t$**

28) **Net Cash Income$_t$ = Total Receipts$_t$ – Total Variable Costs$_t$ – Total Interest Expense$_t$**

Cash Flow Statement

Cash flows of an investment are often more critical to the success or failure than the return on investment (Richardson and Mapp 1976). Annual cash flows for the proposed plant are calculated using equations 29-35. The cash flow calculations start with interest earned on cash reserves from the previous year (29). Total cash inflows (30) is the sum of net cash income generated during the year plus positive cash reserves on January 1st and interest earned.

29) **Interest Earned$_t$ = Positive Cash Reserves$_{t-1}$ *** CD Interest Rate$_t$

30) **Cash Inflows$_t$ = Net Cash Income$_t$ + Positive Cash Reserves$_{t-1}$ + Interest Earned$_t$**

Cash outflow (34) is the sum of several expenditure categories, namely: dividends (31), principal payments (32) for the original plant loan, scheduled capital replacements, repayment of cash flow deficit loans, and income taxes (33).

31) **Dividends$_t$** = Maximum [0.0, **Net Returns$_t$** * 0.25]

32) Principal Payment$_t$ = Fixed Annual Payment – Plant Debt Interest$_t$

33) **Income Taxes$_t$ = Positive Net Cash Income$_t$** * Income Tax Rate

34) **Cash Outflows$_t$** = Principal Payment$_t$ + **Repay Cashflow Deficit$_{t-1}$** + Capital Replacement$_t$ + **Dividends$_t$ + Federal Income Taxes$_t$**

Annual ending cash reserve (35) is the difference between cash inflows and cash outflows.

35) **Ending Cash$_t$ = Cash Inflows$_t$ – Cash Outflows$_t$**

Ending cash balances can be positive or negative due to the variability of production, input costs and product prices. If ending cash is positive, it is an asset, and if it is negative a one-year cash flow deficit loan is obtained.

Balance Sheet Statement

The balance sheet for the wheat bio-ethanol model contains three equations: assets (36), liabilities (37), and net worth (38).

36) **$Assets_t$** = Land Value + Book Value $Plant_t$ + **Positive Ending $Cash_t$**

37) **$Liabilities_t$** = Plant $Debt_{t-1}$ – Principal $Payments_t$ + **Negative Ending $Cash_t$**

38) **Net $Worth_t$ = $Assets_t$ – $Liabilities_t$**

Financial Ratios

The financial ratios and KOVs to summarize the economic viability of the bio-ethanol plant are calculated in the last part of the model. Net present value or NPV (39) is calculated as the difference between beginning net worth on the present value of retained earnings and dividends which leave the business.

39) **NPV** = – Beginning Net Worth + $\sum$ **($Dividends_i$ + ΔNet $Worth_i$) /** $(1+0.25)^i$

The present value of ending net worth or PVENW (40) is calculated using a 25 percent discount rate to reflect the investor's specified minimum rate of return on investment.

40) **PVENW = Net $Worth_{10}$ /** $(1+0.25)^{10}$

Return on investment or ROI (41) is calculated each year as the sum of net returns plus interest cost divided by the initial investment in the plant.

41) **ROI_t** = (**Net $Returns_t$** + **Total Interest $Cost_t$) /** Initial Plant Cost

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An Overview of the Global Economy: Markets, Competitiveness and Trade Facilitation

Executive Interview: The Honorable Carole L. Brookins, U.S. Executive Director to the World Bank, 2001 – 2005

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Abstract

The global economy is growing increasingly more integrated. The dawn of the 21st century was marked with cutting edge technologies creating the platform for greater connectivity and competition among global markets. The evolving economic paradigm is re-defining the way products are moving across markets, regions and continents. The combined effect of technological advances, global political economy and seasonal weather variability has called for dynamism in the way businesses are run. The potential benefit of this development is that it could culminate into increased productivity through the involvement of more people in economic activities across the globe, and the development of new efficiencies and new technologies to better manage our environment and create the right economic blocs. This synopsis is an interview conducted with the Honorable Carole L. Brookins, former Executive Director to the World Bank, 2001-2005. The objective was to relate current and evolving global economic trends to their importance on markets, competitiveness and trade facilitation across the globe. This interview was conducted at the 16th Annual World Forum, Symposium and Case Conference in Buenos Aires, Argentina in June, 2006.

Keywords: Global economy, emerging markets, competitiveness, trade facilitation.

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Introduction

In today's global market, competitiveness seems to be dependent on a lot of factors – a mix of which gives a trading country an edge over competitors. Although market size plays an important role in attracting foreign direct investment to a country, it has been established that trade facilitation depends to a much larger extent on some key internal factors - port efficiency, customs environment, regulatory harmonization and the level of service sector infrastructure (Wilson, Mann & Otsuki, 2004).

The evolving economic paradigm is re-defining the way products are moved across markets, regions and continents. In addition, the combined effect of technological advances, global political economy and seasonal weather variability has called for dynamism in the way in which businesses are run all over the world. Most of the challenges in the evolving global markets have enormous potential to culminate into increased productivity through the involvement of more people in economic activities across the globe, and the development of new efficiencies and new technologies to better manage our environment and create the right economic blocs.

In this report, Honourable Carole L. Brookins, an international consultant known for her work as a policy and trade strategist shares from her wealth of experience on issues of global political economy and its effects on the food and agricultural sector. A graduate of the University of Oklahoma, Carole started her career in 1967 as a municipal bond under-writer in Chicago, before moving into commodities with the Chicago Board of Trade and then with E.F. Hutton in New York City. In 1980 she founded World Perspectives, Inc. and held the position of Chairman and CEO of the company. In 2001, she was nominated by President George Bush to the position of the U.S. Executive Director to the World Bank and was confirmed by the U.S senate. Ms. Brookins played a leading role in developing collaborative programs between the World Bank's International Development Agency (IDA) and the International Finance Corporation (IFC), providing critical support to small enterprise development in sub-Saharan Africa. She helped President Bush achieve initiatives to deliver IDA assistance in the form of grants instead of loans and adopt result based measurement program. Carole was a consistent advocate for partnering public and private sectors to develop infrastructures in the poorest countries.

Executive Interview

What are the major factors driving the global economy?

I think that the major factors are related to the integration of new technologies in the world market. Now we know everywhere in the world, what is happening

everywhere else in the world instantly and our reaction time is much shorter than in the past. Whether an event is in the markets or a geo-political development, its impact is magnified and driven by instant communication. Then the question is: How do you translate that knowledge into policies and business decisions that will permit the inclusion of all people into the benefits of participating in world markets? That's where most of the focus is going to be: "real" global integration, not just in terms of "virtual" communications. A good example is the logistics supply chain that we know and talk about. Like our colleague here at the IAMA conference from Brazil said: you still have to have the road, the water supply, power supply. Otherwise IT doesn't make things/products move from here to there. In other words, you still have to have the supporting physical and institutional infrastructure. So I believe that a hallmark of this century is going to be integration. If we have a financial crisis, it's going to be global because we are all related to each other. The other major factor integrating us is energy and environmental management. The cost of energy is going to be increasing, as more and more people raise their living standards, demand goods and services and join the economic mainstream. Energy use and climate change are driving integrated strategies for global environmental management along with economic integration. They are linked and going to shape our future common economy and society.

How do these factors impact the agricultural markets?

There are going to be a lot of new efficiencies and new technologies to better use land—including and in addition to biotechnology--and to better use water resources which will be increasingly scarce. We must (which I think we will do) learn to take salt water and desalinate it, and to do this cost effectively/efficiently. I'm still of the "old" school which believes that necessity is the mother of invention; because we have problems to solve, someone will innovate to solve that problem. I think it will force agriculture to become more technology intensive and at the same time to become much more of a stakeholder in the energy pipeline, in the energy machine—both through biofuels and environmental management.

In your opinion, what are the opportunities and threats to the evolving global markets?

In my view, it is fear and protectionism which can stop global integration. If we have an economic slow-down in the world or recession, people will be trying to put up protectionist barriers to serve their own markets, and I think that's very dangerous. For the emerging markets specifically, I think it's critical to open up the South-South trade which I talked about yesterday. Most of the duties today are paid from Nigeria to South Africa (within the South-South market). Most of the duties of developing countries everywhere are paid to each other. Every major study that has been done has found that trade liberalization does not create poverty but really does create opportunities for people. The model for developing countries to follow

should not be: because I am poor, I should not let in any product; it should be: because I am poor I need help in becoming a better market. I need to let in products in order to become competitive, because through investments and trade you not only transfer goods, you transfer knowledge, services, and skills. Through trade, you build the integration and connection for people to become part of the world.

In short unilateral liberalization is better than no liberalization?

There have been some important successes in unilateral liberalization, like New Zealand in agriculture. The key to successful liberalization is to focus on strengthening the capacities and competitiveness of the domestic market, as you open up that market to foreign investment and imports. Additionally, where there are very sensitive commodities, the tradition has long been to apply appropriate safeguards according to WTO/GATT rules, which permit trade to develop over time and protection against a flood of imports which could destroy internal markets overnight. But, the main point I want to make is to make the domestic production platform a priority along with trade strategies. For example, if you have no roads going to the ports from your own internal producers and you open the import door, then before long foreign products can come into major cities and compete at lower prices than local producers. If your local industries can't grow because they don't have the same opportunity to compete in domestic and international markets because of logistics impediments from the interior, you've got to improve your domestic platform. Creating a competitive interior market goes hand in hand with being a global competitor and building a level playing field.

So the key to trade facilitation is working on your internal structure.

Behind the border! That is absolutely key: You must analyze and then reduce your behind the border constraints at the same time as you begin to open up to trade. And you must also look at the time frame because there could be mismatches; where it may take 20 years to get the power supply internally, but immediately products could ship in. I don't mean to imply that trade shouldn't begin—even with internal supply chain deficits. In fact, I believe that it is trade incentives which will focus official attention and resources on necessary infrastructure (physical and institutional) gaps that are limiting the productivity and competitiveness of domestic producers. So you really have to balance your market strategies, get the investment you need, identify export drivers and improve the domestic supply chains. Otherwise, the WTO could eliminate all barriers to developing country exports, but producers in those countries still won't be able to export their products competitively.

Since the level of progress among developing economies vary, how would you classify or describe emerging markets?

I classify emerging markets as emerged, emerging, yet-to-emerge and sub-merged—based on GDP growth levels, per capita income and the number of people who have "emerged" into the consuming/middle class. So, while China is an "emerged" market based on macroeconomic measures, it is still an emerging" market because a large number of people are still living in poverty. For example, there are geographic areas of China and India, which are not yet part of the consumer market. Similarly is a country like South Africa. These are countries that are traders, that have capacities, growing wealth (particularly in major urban centers) and that are deeply involved and already integrated into the world trading system. They have good institutions in place, encourage private investment and economic development, but still face serious challenges in bringing the benefits of globalization to all their people—particularly those in rural areas.

Considering the fact that some emerged economies based on macroeconomic variables – like China (but who are still emerging in terms of welfare measures) and some fully emerging countries are dominating the global market in some products, do you think these countries have potentials for sustaining this growth trend?

All you have to do is to look at the demographics. In a number of years, the industrial countries will have less than 10% of the world consumers. So to me, it's a race against time to get the physical and institutional infrastructures in place. The large markets are going to have the real potentials to be competitive in the global economy; there is no question about it. China is the leading producer and competitor in a lot of products today (both industrial and agricultural). China has very dynamic growth centers on the coast and yet-to-emerge/emerging parts in the interior. So how do you bring more and more of those people into globalization? In South Africa you also have a dynamic middle/consumer class; through their wealth creation, the government and private sector have more resources to invest in business and in supporting infrastructure and social services that create the base for job creation that will bring the next group of people out of poverty. In India, you have more than 250 million emerged middle-class consumers but a lot of people in India are still trying to live on under a dollar per day. As you expand economic activity, this process advances. And, remember that much of growth is driven through trade, because trade-led growth pays higher wages, and ultimately creates the production and marketing of more goods, and services. Whether it is bringing more competition to the financial services market, lowering the costs of borrowing and providing more trade finance or physical, or improved IT logistics, the result is to add increased opportunity. Moreover, you need to be focusing not only on measuring macroeconomic growth/wealth/GDP at the national level. A country can have a high level of GDP, but 70 or 80% of that may be generated in one or two large cities. So you may want to be looking at the spatial issues within countries—their economic geographies and the impediments to wealth creation outside of major urban centers. Like I said, China is emerged but there are huge regions of China

that are yet-to-emerge; but China is working to link together interior and marginal regions with the wealth and opportunities of coastal markets. The challenge of this is very big financially; the Chinese finance minister mentioned a few years ago that it cost the government a certain amount of money to bring 300 million people out of poverty. Then he said that to bring the next million out of poverty, it will cost as much because these people do not live in concentrated major cities; they live in rural areas and are more remote. It's pretty obvious. A highway around a major city is one thing, but to extend that hundreds of kilometres, or thousands; or power lines and sanitation systems when distances are great and population density does not make supplying these services commercially viable. So it's a challenge to get services to them because they are not congregated in five or ten cities. This is the big challenge of the "information economy;" information can flow virtually if you have some form of power and telecommunication links. But if you don't have basic physical infrastructure, you can't produce and market goods.

This is a very interesting challenge which will impact everyone in the world, because the emerging countries are going to be 'the world' force in this century. The industrial countries are going to be serving the emerging markets and not vice-versa—even though this is happening in a gradual transition. Emerging countries are demanding greater shares of commodities and other resources for growing populations and productive industries. Every day more potential consumers in these countries are becoming effective consumers as they gain purchasing power. Behind the border policies are either accelerating or impeding that trend. Large countries are going to have an easier time achieving results, because they are magnets for investment. They will attract more investment if they are well run, and investors will forgive some of their impediments because they are such potentially large internal markets and production platforms. But, in short, they don't have to be as well run as small countries. Small and land-locked countries face bigger challenges attracting investment—even when their institutions and policies are sound. Examples are countries in Africa like Mauritius or Uganda or Ghana. Uganda and Ghana have made major policy strides. Mauritius has been a star in economic management and performance. But they don't attract the bulk of the investment that Nigeria attracts because of Nigeria's big market potential and oil resources—even though Nigeria has had major problems in government management. So resource rich countries or countries that are large in terms of a domestic demand base are always going to find it easier to attract capital and trade flows.

If you have a big domestic market you leverage down your per unit cost of production, because you are producing for a big domestic market and exports. For instance if you want to build a production plant in either Brazil or Paraguay you'll probably build it in Brazil, not only because it is a platform for the world but also because it's a platform for the domestic market. So these are real choices that need to be considered by countries in developing their strategies for globalization. I think that the smaller emerging markets will have to be more competitive and creative in

their strategies, but there are significant examples of extraordinary economic achievement by smaller countries—just look at the outstanding global trade positions of The Netherlands or South Korea. Or unique platforms like Singapore and Hong Kong. It's important to study how smaller countries with smaller consumer bases and not a lot of resources have created very dynamic trading platforms. If you can identify some industries that are capital intensive, where you can have higher skilled workers – like Singapore, Hong-Kong or The Netherlands--which excel in supply chain management. So it's always a matter of thinking global and acting local. What are your strengths and weaknesses? Do you have a competitive port or are you land-locked? Are you resource rich or resource short? Where are you located in the world or in a region? Who are your major potential big trading partners and what do they need that you can do? Emerging markets are going to be the name of the game; linkages South/South and North/South through trade will determine who supplies the demands of 90%of the world consumers. The question today is who will emerge as the strongest economies to dominate trade flows, build sustainable environmental and economic platforms and command the new "heights" of global economic power?

I see a number of variables coming in here, there's population and spatial demographics, purchasing power and where resources are located. Some are even exogenous and others internal. Do you think enough resources are being channeled towards managing investments and also maximizing the benefits?

The world is awash with more than enough capital looking for places to go. Where is it flowing? Emerging markets are capturing more investment, especially China and India. Investment climate is critical for countries to attract both public and private capital and this means viable institutions, sound macro economics and predictability. The test always is growth, what is happening to productivity? I visited projects in Indonesia where communities competed for grant funds, put in their own money and together financed a clean water supply or feeder roads that were all-weather road. And you look at what it did in less than 6 months—the result of just one feeder road (1 kilometre) between two secondary highways. All the shops along the road I stopped at, probably ten of them, every one of the shops that I visited their turn-over had gone up by between 300-400 per cent since the road was constructed. Some of these small entrepreneurs are now able to send their children to school. So, one action that took six months, has had an enormous impact on expanding the market and increasing productivity. So it's not always the big things, but real success in small things.

What about regional trade influences?

If the US economy is performing badly, it will hurt China or many other countries who depend on exports/trade with the US, but particularly neighbors on the border--Canada and Mexico. And I believe the major tragedy for Africa is that Nigeria has

not been a major growth pole for West Africa, and Kenya for East Africa due to weak institutions, poor governance and inadequate regional infrastructure linkages. South Africa is a major growth pole in Southern Africa and many of its companies are key investors throughout Sub Saharan Africa. The problem and tragedy for the Southern Cone really is Zimbabwe—which is holding back the dynamic growth and integration of the region, and creating instability as well as terrible suffering of its people. Many African countries do not have large internal markets and are not well integrated in real terms. There are a lot of agreements between countries on paper for cooperation, but the real advances need to happen. What is needed is for the largest economy in each part of Africa to be a strong and open market and "anchor" , with a good system integrating their economies into regional growth poles with smaller neighboring countries. It's crucial to create these regional free trade markets and economies of scale for both internal demand and investment/trade competitiveness. This is especially the case when you have land-locked countries that are dependent on the bigger "anchor". Kenya, for example, has serious governance and business climate problems; this is unfortunate because Kenya is so rich in agricultural resources, industrial production and human capacities as well as major ports. Uganda, Rwanda and Tanzania are not going to do well economically if Kenya isn't doing well. For example, Uganda has to ship through Kenya. It costs 300 per cent more to ship a container from Mombassa (Kenya) to Kampala (Uganda) than it costs to ship a container from Europe to Mombassa. So even if Uganda's government has solid policies and a business friendly institutional climate, its growth will be held back due to lack of cost effective and efficient transit through Kenya. So, when we look at Africa particularly, countries like Nigeria, Kenya and South Africa have critical important responsibilities to be good regional neighbours, to take very seriously their role in building competitive regional economic and trade platforms. That will strengthen Africa's competitiveness and economic opportunities both intra-regionally and globally.

For a continent like Africa, will it be right to say that the major challenges are the institutions, creating the right hubs and the real free trade agreements?

Africa needs to strengthen national and regional institutions to build a continent-wide market, because most African countries are too small to be major diversified economic powers. Many countries are resource rich, but oil and mineral revenues must be used effectively for improving the social capacities and business climate—and not looted or wasted. Countries in Africa must find ways to cooperate in real ways. They have to come together in creating regional power pools, water districts, port access, road networks. Cross-border power grids are already developing in Southern and East Africa, along with the developing of the West Africa gas pipeline. This is good news for Africa in reducing the cost of providing power building efficiencies and bringing services and connectivity. Look at what has happened to build the economic and trade integration on the European Continent through steps

from the original European Coal and Steel Community to the current European Union (EU)—from trade and investment to a common currency.

Of course, trade agreements are important. They set the legal framework and rules for a level playing field. But these agreements on paper, as I've said repeatedly, are only as successful in bringing trade benefits as the real capacity on ground; the legal agreement is an important policy beginning but it's just words. You have to be able to clear customs; you've got to have roads, rail gauges that work. And while you're negotiating trade agreements, you would be smart to get to work on your interior market. Policy and institutions matter. In the 1970s when Ghana had a cocoa marketing board and Cote d'Ivoire did not (or rather had a different system), prices being paid to farmers in Ghana were much lower than those of Cote d'Ivoire. And Ghanaian cocoa ended up being smuggled to export markets through Cote d'Ivoire, so all of a sudden Ghana's trade figures went down. Farmers and other entrepreneurs are smart; they want to maximize their returns and when institutions are corrupt or policies are harmful to their business, they will find ways to get around them. Sometimes it's not a straight line, sometimes it is steeper way but they'll find ways to enhance their ability to sell or to gain imports.

Talking about trade negotiations, you find that the positions taken by the developed countries do not support economic growth in the developing and under-developed countries. For instance the Doha Round of the WTO is deadlocked just because the developed countries do not want to reduce domestic support and farm subsidies substantially (or even eliminate them). Don't you think it would be fair if the rich countries could at least allow a level-playing field?

Everybody knows that we need to get rid of farm subsidies but there are some countries who are used to importing cheaper food, so we have to also understand the impact this would have on food importers and their standard of living as well. Our goal must be to reduce and eliminate all unfair trade practices. A lot of the tariff escalation (which is putting higher tariffs on more processed products) needs to come down; it needs to happen, but it's not going to happen over-night. Remember that many countries are very successful despite subsidies and protection. New Zealand is the leading dairy producer in the world; leading exporter in the world as well, despite the fact that the US, EU and other dairy producers have very protective dairy regimes. So I think you're absolutely right, Doha needs to create a more level playing field, but many of the problems of developing countries are behind the border impediments. Look at one simple competitive issue: money or finance. How much does it cost you to finance your farm production? What is the interest rate if you want to finance your business? Can you get long term finance, or trade finance? What's the rate? Are there competitive banks? Yes, Doha needs to move in that direction of further opening markets and reducing subsidies, but we must remember that this is a "Global" market. Liberalization won't work if developing countries say: "Trade is only good one way. We shouldn't let in imports."

It's got to be a win-win situation for everybody. There could be (and will be) longer time to allow developing and poor countries to meet commitments, and lower targets. That was the way that commitments were made under the Uruguay round—with special treatment for developing countries through a longer period for phasing in their commitments and lower commitment targets than industrial countries. But you must also remember that success isn't going to be achieved by developing countries by keeping their markets closed—either to each other or developed countries. They need to be open to create competition. Competition is good; we've just heard two presentations for services during this conference—from John Deere and Oracle who are both selling IT services. They are competing! Lack of competition creates monopoly rents, then services go down and costs go up.

To me, trade negotiations are not about beating up on people; trade negotiations are about making something positive and meaningful happen. There's always going to be a war of "words", lobbying for one position or another. But negotiators need to always understand that they are not there doing their job for the rhetoric…but to get enough consensus for real trade deals to be done that provide the maximum benefit. Look at the war of words over Africa cotton. Do you know who was leading the whole charge on cotton – the French; because French companies control the mills in those countries. Most are monopolies in those countries. So they led an effective charge to beat up on the US. The US will have to change its cotton support regime and comply with the WTO dispute settlement ruling. Yes, African cotton farmers are being hurt in part by U.S. subsidies. But it is a much bigger picture that most people don't understand. Take a look at the cotton supply chain in those countries, and you tell me if the biggest problem for producers is the U.S. subsidy or their own internal infrastructure impediments, governance problems, financial costs and a range of other problems behind the border which keep producers from higher achievement and market potential.

Honourable Brookins, do you mean some of the agitations of the developing countries are not real or genuine?

Some of them are real; some of them are very true. Cotton subsidies should be reduced in industrial countries, subsidies should be eliminated. But if you do not do what you need to do behind the borders, in sanitary regulations and enforcement, in building your supply chains and giving people access to power, in having clean water to wash your fruits and vegetables, in having IT to know the markets and manage chains/trade/finance, then you cannot compete. You could open all the markets tomorrow; for instance Chad has AGOA, businesses in Chad could be shipping cotton products to the US but they don't have any power in the South of Chad for textile plants to operate. Power costs more in Chad than virtually anywhere in the world, it is very high. So how are you going to participate even if there is trade liberalization? You have to really look at it and say: "If I'm not being competitive why am I not being competitive?" My advice would be to be an effective

negotiator and participant in the WTO process. This means: BE a tough negotiator; but you can't be effective if you haven't carefully analyzed your economy, your key industries and issues—and then set meaningful priorities. Integrate your approach to trade and aid/development programs. Trade ministers may yell about cotton, but are finance ministers seeking loans from development banks/or grants from development partners to support the cotton economy development? Talk to your private sector in setting your priorities. KNOW your investment climate and your limitations/impediments.

So, each country needs to do some self assessment and evaluation in terms of drivers of its competitiveness?

Right, you need to look at what is competitive, what is not competitive and/or what you hope to achieve. And what's that going to cost; what are the steps that will take to get you there. It's a practical exercise; for example, some of these components are obvious when you do models. Look at John Wilson's work on global trade facilitation (the things that I talked about in my presentation yesterday). Just four simple components in trade facilitation and what they could do to increase trade revenues; he studied these factors – electronic documentation, trade processing for efficiency, customs environment and regulatory harmonization i.e. getting improved regulation so that your regulations conform to everything. He looked at 75 developing countries and assessed what would happen if they improved and moved up half-way to the average of the world in performance. The result is that it increased trade for those countries by nearly 400 billion dollars! This growth in their trade had nothing to do with lower subsidies or import barriers. So, while I share the concern of developing countries with unfair subsidies, this is only one factor in their competitiveness. In fact, many countries are very successful traders today, even in highly subsidized industries. That's why I used New Zealand as an example. They met all the requirements of the Uruguay round and even went further because the Uruguay round agreement permits a lot of subsidies. But New Zealand's government basically got rid of all the supports—not only to agriculture but industry; it transformed the country's domestic business culture. Just be fair. Look at where problems lie—behind and across borders. And then work to overcome them through negotiations, investments, pro-trade and investment policies and institutions that work.

Remember as well that many developing countries tax agriculture; many put high tariffs and barriers on inputs which add to very high internal production cost. They tax agriculture through the whole supply chain deficit and in other ways. And that is why you have to look at the trade environment in a more holistic way, particularly for agriculture. How much does fertilizer cost, what about the road networks, how much IT do they have, what kind of seed varieties, how much does seed cost, what is the distribution cost to get the seeds, are they monopolies, are they competitive? Those are questions to be asked. So you have to be honest, you

have to call what is true, true and call what is untrue, untrue. You must be willing to point fingers at problems wherever they are and you must say what can we do to solve them?

In short, competitiveness has to be re-defined in real terms. How then do you define competitiveness?

I think competitiveness is having the tools to raise productivity on a continuing basis, both through the internal production processes and both physical and financial infrastructures, human infrastructure (health/eduation), institutions that work in providing the regulatory and policy environment that enable an individual to be productive. That is what I view as being productive. I had a company that was first to do something in 1980. It did very well and pretty soon other people saw what I was doing and they started doing it too. So the value of my business went down because other people were in the business. So I had to look for a different thing to do because you can't just always keep doing the same thing. That is innovation!

In conclusion, what are your projections with regards to the global economy in the medium and long-term?

Well there is no choice, the global economy is going to grow and become more integrated. I think we are going to go through recessions and slow-down as we adjust to it. And I think there will be two major adjustments. One will be increased variability in weather and natural disasters due to climate change/global warming which is going to add more shocks and costs; these will be real challenges for the industry and for policy leaders to manage. We are going to put a lot of capital into responding to those problems as we seek to improve our environment and maximize our renewable agricultural resources as part of the solution. Second, I think we will have greater integration of capital and technology flows; much more innovation and much faster response times. It will be costly and fast moving. How will technologies be applied? Which cutting edge (like biotechnology) technological integration will be the key driver of bringing more people (say about another one billion people) out of poverty in the next decade? There are going to be tremendous opportunities for feeding people better and increasing productivity. In short, we will have many more choices due to fast paced innovation coming out of laboratories; and we will have to collectively be very wise in the choices we make because of the costs involved—even choices in what we use our cropland to produce (food, feed, fuel).

At the same time, we are going to learn to use our resources more effectively and I think technology will help us—in agriculture, for example, drought resistant crops, for example; or a greater ability to improve the consistency of plant output through bioengineering. As to the general economic outlook globally, I think right now, we've got a little bit of a slow-down. We've got inflation from energy. I was surprised it didn't happen sooner. Inflation is going to be passed through. China can't keep

production costs down; they've got wage pressures too, along with raw material input costs from their industrial suppliers, so they will be passing this through in the price of steel and other major inputs to global industries/consumer. If the world's central bankers decide to take a firm control on inflation targets, then we will see higher interest rates which will slow down growth. Even China will likely see some slow down as it tries to keep the economy from overheating and manage its financial system.

Conclusion

Based on Carole's comments, it is evident that there is great capacity for growth in the global economy, provided countries (particularly the emerging economies) learn to manage their internal economic environment appropriately. It is instructive to note that trade agreements alone do not move products but a mix of internal and external factors. A recent empirical study by Pustovit and Schmitz (2003) supports the general notion that there is potential for some developing economies to change their trade positions provided rich countries – specifically the OECD countries – reduce their domestic support and farm subsidies substantially. In most cases however, competitiveness is driven by how well the internal structures of a country are capable of providing the right platform and leverage, as well as gaining the trust of investors.

The emerging markets have 90% of the world's consumers. However, there is a huge disparity when it comes to the purchasing power as compared to industrialized countries. Factors such as spatial demographics, level of infrastructure development, availability of energy, as well as supply chain management portend a challenge to the drive towards integrating more of the world's population into the economic system. Therefore, the emerging economies must learn to manage their logistics supply chains effectively in order to better position themselves for increased participation in global economic system, which has enormous growth potentials.

The imminent challenges to the global markets, such as climatic variability, energy shortages and inflation will be surmounted. For instance, the Chicago climate exchange (www.chicagoclimateexchange.com) provides an important model for managing climate change in an economically efficient way, with appropriate offsets that involve both the industrial and agricultural sectors. Also, the involvement of biotechnology (with Brazil leading the way) in energy production is a step forward in reducing the global energy challenge. It was projected that by the end of 2006, Brazil ethanol export capacity would have increased to 5.6 billion litres (Bravo & Mae-Wan, 2006) and this is expected to double by 2010 (Luhnow & Samor, 2006). Brazil's leadership in competitive ethanol production and it's potential for production capacity expansion will ensure that economies in high demand for energy - for instance the U.S. which is the largest importer of Brazil's ethanol - are

able to increase their use of bio-fuels to reduce greenhouse gas emissions and meet the Kyoto Treaty commitments (for countries which have ratified the Kyoto protocol). Although there are speculations that Brazil may face over-production risks if the U.S. and E.U. increase their tariffs on ethanol, the recent pronouncement by the U.S. president that his country plans to reduce its use of gasoline by 20% by the year 2017 (Kenfield, 2007) suggests the contrary.

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