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EDITOR'S NOTE

We have another full issue this quarter. It is an exciting time for us here at the IFAMR as submissions are way up and continue to rise. Kudos go out to our seven Managing Editors for shepherding these papers through the review process: Jacques Trienekens, Wageningen University (the Netherlands); David Van Fleet, Arizona State University (USA); Nicola Shadbolt, Massey University (New Zealand); Joao Martines, University of Sao Paulo (Brazil); Corrine Alexander, Purdue University (USA), David Sparling, University of Western Ontario (Canada), and Daniel Conforte, Massey University (New Zealand). This issue represents scholarship and scholars from four continents covering a wide range of topics, applied methods, and theory. The issue nicely reflects the scientific pluralism of agribusiness research.

Speaking of scientific pluralism, that term was coined in our upcoming **October 1, Special Issue** entitled, *"Scientific Pluralism of Agribusiness,"* by Editors, Desmond Ng and Wes Harrison. Be sure to watch for this important issue of the IFAMR that helps scholars explore the bounds of agribusiness thought and practice.

As this special issue comes to fruition, two new special issues are underway. Watch for the call for submissions for "*Multi-Stakeholder Interactions, Resources, and Value Creation,"* This call is aimed to attract research that addresses the "Wicked Problems" facing the Agribusiness sector and how managers deal with multi-stakeholders social and environmental expectations. The special issue will provide a deeper understanding of how firms effectively undertake multi-stakeholder interactions to develop new resources and ultimately create value. Domenico Dentoni, Wageningen University (the Netherlands) R. Brent Ross, and Christopher Peterson, Michigan State University (USA) will serve as editors of this special issue.

The second call soon to be announced is; *"Essays on Human Capital Development for the Global Agribusiness Community."* Aidan Connolly, Alltech, Inc., Mary Shelman, Harvard Business School and myself will serve as editors of this special issue. The IFAMR will publish the special issue on human capital development in conjunction with IFAMA's June 2012 Annual Symposium and Congress in Shanghai. There will be an open call for essays 1000-1500 words in length, on any topic or issue related to human capital development in agribusiness. Succinctness and clarity will be paramount.

We also inaugurate our first publication of undergraduate scholarship in our new undergrad section of the Review. Senior Alyse Reichard, from the University of Illinois explores the concept of tacit knowledge in agribusiness through a video case study about Valpolicella Wines. The new section in the IFAMR will use undergraduates and graduates as editors to publish undergraduate research and teaching case studies. Undergrads are welcome to submit articles, industry interviews, commentary, or teaching case studies.

The next issue due out **November 1** presents the best papers from our June 2011 Symposium in Frankfurt.

***Peter Goldsmith*, Executive Editor, IFAMR**

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Economic Feasibility of a Mobile Fast Pyrolysis System for Sustainable Bio-crude Oil Production

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Abstract

This paper analyzed the economic feasibility of a mobile bioenergy pyrolysis system using a Monte Carlo simulation model. Pyrolysis transforms any cellulosic materials into i) a bio-oil similar to crude oil ii) a synthesis gas similar to natural gas, and iii) a bio-charcoal substance. The pyrolyzer machine is currently being manufactured and tested with various types of feedstocks including corn stover and energy sorghum. The economic analysis focused on creating an automated process that integrates a transportation logistics cost optimization model with geographic information system (GIS) data. The geographic data provides possible paths for the mobile bioenergy pyrolysis unit as it moves to and from each harvest area, depending on stochastic availability of feedstock (determined by historical crop yields) and distance to oil refineries. The results indicated that there is a low probability of a positive Net Present Value (NPV) with current economic conditions. In general, the NPV was highest with a stationary scenario and it decreased with additional moving times. A sensitivity analysis is presented to assess the potential probability of success of a mobile pyrolysis system under alternative oil prices and feedstock costs scenarios.

Keywords: biofuels, pyrolysis, economic analysis

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Introduction

The concept of bioenergy is not new; wood and other plant material have been burned to produce power since man discovered fire. During the twentieth century, hydrocarbon fuels such as coal, natural gas, and diesel were the cheapest method of power generation, but recent global economic trends and rising fuel prices encouraged development of alternative biofuel from feed crops during the early twenty-first century. Biofuels, liquid fuels such as ethanol or bio-diesel derived from plant materials, developed from non-food sources, otherwise known as "second generation biofuels," are currently being researched by land grant universities, private industry, and government agencies around the world.

Pyrolysis (Figure 1) is a process that converts agricultural residues and any other carbon materials into bioenergy through intense heat in the absence of oxygen. Pyrolysis produces 1) a bio-oil similar to crude oil, though not as refined; additional processing is required to generate an equivalent crude oil product, 2) a synthesis gas (syngas) that can be used as fuel for heating or to produce electricity, and 3) a bio-charcoal substance that can be incorporated back into the soil to improve soil properties, or processed for other potential uses (Reed and Jantzen 2002). During pyrolysis the feedstocks are heated to temperatures of 400-600 degrees Celsius (pending initial moisture content of the feedstock) and converted to bio-oil, syngas, and bio-char. The syngas is fed back into the system as an energy source to continue to heat the unit. The bio-oil is the main source of revenue; however, the nutrient contents of the bio-char can be sold as a soil amendment. The pyrolysis process could also be used to offset carbon emissions if a clean energy bill with carbon credits were drafted.

The objective of this paper is to estimate the economic feasibility of a mobile vs. a stationary pyrolysis plant using alternative feedstocks. The feedstocks used for the analysis are corn stover in Illinois and Texas, and energy sorghum in Nebraska. A Monte Carlo financial simulation model will be used to analyze the probability of economic viability of a pyrolysis system for alternative feedstocks, locations, and frequency of plant relocation.

Most biofuel systems (and conventional fuel systems as well) utilize a centralized production facility, where large quantities of feedstock (or coal, for instance) are brought to one location to take advantage of economies of scale. However, in certain regions or at certain times, weather, availability of feedstock, or other economic factors may make biofuel production uneconomical. In the face of such constraints, a mobile production facility could prove advantageous. Roberts et al. (2010) showed that feedstock transportation distance presents a significant problem in proving economic viability of biochar-pyrolysis systems, suggesting that a mobile production facility may help improve profitability.

Mobile pyrolysis units, by definition, are portable and more versatile than conventional centralized biofuel production facilities. Their small size enables them to be transported quickly and easily on a tractor trailer to take advantage of seasonal feedstock availability at multiple locations. However, their size presents potential feedstock transportation issues, so the logistics must considered.

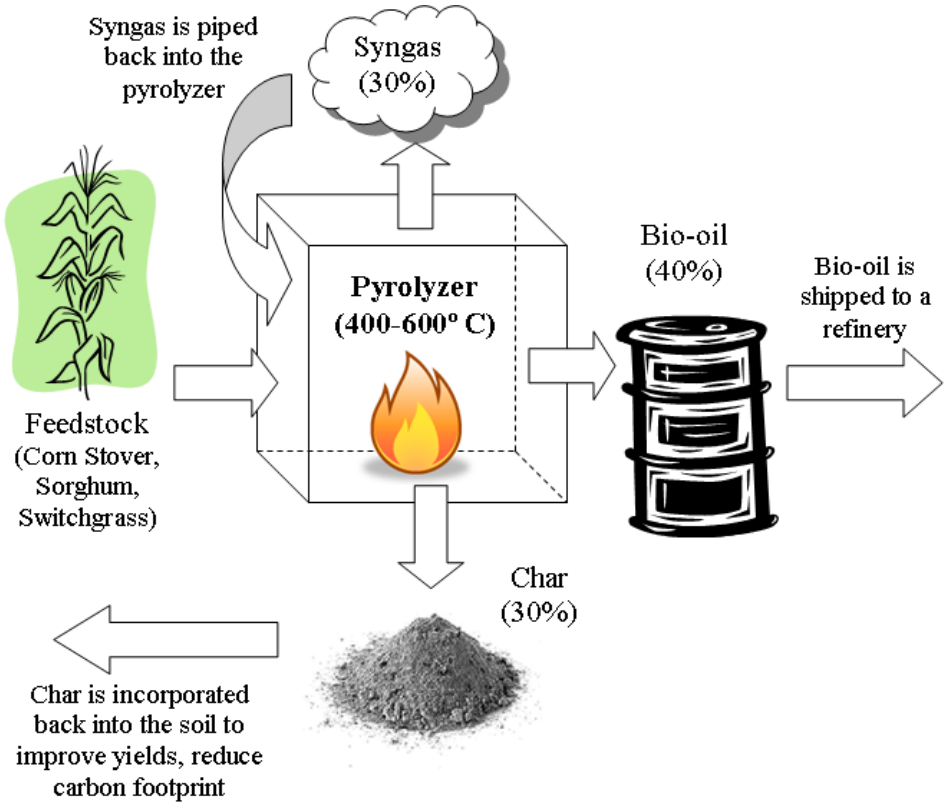

Figure 1. Pyrolysis Conversion Process and Associated Products.
Note: Actual conversion rates will vary by feedstock and initial moisture content. Percentages shown are by volume.

Data and Methods

The simulation model to analyze the mobile pyrolysis unit is an annual Monte Carlo financial statement model that incorporates multiple variables including historical prices and yields, estimated conversion ratios from feedstock inputs to bio-oil, bio-char, syngas outputs, and machine/labor/fuel costs. These variables, along with numerous other items that affect income and expense, are organized in an easy-to-understand format used by Cochran, Richardson and Nixon (1990); Outlaw et al. (2003); Richardson et al. (2007) and Outlaw et al. (2007). Monte Carlo simulation can be applied to econometric models by introducing stochastic components to each of the variables in the equation, then running the simulation model for a large number of iterations. The result is a distribution for each of the key output variables such as profit, yields, and net present value (NPV). The distributions of key output variables are crucial for analyzing feasibility of future business decisions under risk. The financial statement simulation model is programmed in Excel using the add-in SIMETAR©, a simulation and risk analysis software (Richardson, Schumann, and Feldman 2008).

The most critical output variable from the model for evaluating the economics of pyrolysis is the net present value (NPV). The model calculates NPV as follows:

$$(1)\quad NPV = -(BeginningNetWorth) + \sum_{j=1}^{10} \frac{Dividends_j}{(1+i)^j} + \frac{EndingNetWorth}{(1+i)^{10}}$$

Equation 1 calculates NPV (assuming a discount rate of i = 5%) of dividends paid to investors and net worth over the life of the investment (ten years), and compares that value to the net worth at the beginning of the investment. If the value of NPV is greater than zero, the business is considered an economic success (Richardson and Mapp 1976).

The major income-generating product is a bio-oil, equivalent to crude oil, which is transported to the nearest refinery, and sold at a 5% discount from the price of crude oil. The mean bio-oil price for 2011 was $78.54/barrel. The value for bio-char is determined based on the soil amendment value as a soil additive. According to Wise et al. (2011), char produced in 2011 can be sold for $24 per ton and it's value varies by feedstock. Syngas is assumed to be used as an energy source to sustain the pyrolysis unit and it is not generating revenue. Its production also varies with the level of moisture in the initial feedstock and by feedstock. Both the price of bio-oil (PO) and char (PC), along with the price of crude oil, are inflated annually and used to determine net income over the life of the business (Richardson et al., 2011). The model assumes a $1.00/gallon subsidy (S) for pyrolysis bio-oil offered as an incentive throughout the analysis period, as this is the current subsidy for second generation biofuels. Income is calculated as:

$$(2)\quad Income = (P_{Oil} + S)Q_{Oil} + (P_{Char}Q_{Char}) + (P_{Syngas}Q_{Syngas})$$

Income is stochastic because prices are drawn at random from probability distributions estimated from historical series. Other random variables include feedstock yield and prices, as well as the inputs and outputs. Syngas revenue is included for eventual analysis of excess syngas production but not included in this analysis.

An input to the financial simulation model was output from a transportation logistics cost optimization model with geographic information system (GIS). The analysis includes 15 alternative scenarios, including 3 stations/sources of feedstocks, and five frequencies for moving the mobile pyrolysis unit. The three sources of feedstock are corn stover in Illinois and Texas, and energy sorghum in Nebraska; the unit can be moved monthly, bi-monthly, quarterly, bi-annually, or it can be stationary. Table 1 summarizes the model scenarios for pyrolysis bio-oil production.

In addition to the transportation costs, there are also other set up costs associated with moving the pyrolysis unit. A hard surface movable pad and access road is needed around the pyrolysis unit, as this is a high traffic area. A portable military-grade "matting system" from GFI Inc., is used with interlocking mats measuring 6 feet by 6 feet with a unit cost of $450. A ¾ acre area is used requiring 908 mats for a total cost of $408,600. This pad area includes set up of machinery and storage of feedstock area. The access road is a 120 feet by 12 feet with a cost of $18,000. The labor cost to dismantle and assemble the movable mats in a new location each time the mobile pyrolysis unit is moved is $2,500.

Table 1. Model Scenarios for Bio-oil Production

Scenario	Name	Source	Frequency of Moving
1	IL 12M	Corn stover, IL	Monthly
2	IL 6M	Corn stover, IL	Bi-Monthly
3	IL 4M	Corn stover, IL	Quarterly
4	IL 2M	Corn stover, IL	Bi-Annual
5	IL 0M	Corn stover, IL	Stationary
6	TX 12M	Corn stover, TX	Monthly
7	TX 6M	Corn stover, TX	Bi-Monthly
8	TX 4M	Corn stover, TX	Quarterly
9	TX 2M	Corn stover, TX	Bi-Annual
10	TX 0M	Corn stover, TX	Stationary
11	NE 12M	Energy sorghum, NE	Monthly
12	NE 6M	Energy sorghum, NE	Bi-Monthly
13	NE 4M	Energy sorghum, NE	Quarterly
14	NE 2M	Energy sorghum, NE	Bi-Annual
15	NE 0M	Energy sorghum, NE	Stationary

Drying the feedstock presents a logistics issue. Moisture content of the feedstock can be anywhere from 25%-50% depending on field and weather conditions. The maximum optimal moisture content for feedstock at the pyrolyzer is 10% (Capunitan and Capareda 2010). The pyrolysis unit operating at 40 tons of feedstock as is per day generates enough BTUs to dry the feedstock to the 10% acceptable level for efficient operation of the machine (Capunitan and Capareda 2010). Energy start-up costs to initially power (heat up) the unit as well as replacement of bed sand amount to $2,000. Syngas generates sufficient heat to dry and process the feedstock once the unit has reached steady state.

The pyrolyzer can produce an average of 50 gallons of bio-oil per ton of corn stover and 45 gallons of bio-oil per ton of energy sorghum across expected moisture levels ranging from 10-40% wet basis (Capareda 2010). The pyrolysis unit has the capacity to process 40 tons of feedstock as is per day for 290 to 326 days per year, for the 12M vs 0M scenarios, respectively. On average, producers are paid a price of $67.5 per ton of feedstock delivered to the edge of the field, with a range from $60-$75 per ton depending on moisture content. The model assumes 11% of wasted feedstock during the logistics of transporting, storage and processing. The price for the feedstock includes the opportunity costs associated with additional fertilizer applications needed to replace nutrients. It is assumed that one pound of corn grain is equal to one pound of available corn stover (Pordesimo et al. 2004); however, only 25% of the available biomass in the fields will be harvested, leaving the remaining 75% on the fields for erosion control and soil sustainability purposes (Nelson 2002). The mobile pyrolysis business will own all handling, processing, and transportation equipment.

Total capital assets (beginning net worth) for the mobile pyrolysis unit are $2,169,516 and will be financed with 50% equity and 50% debt at a 7% interest rate over a 10 year period. If net cash income is positive, investors receive a dividend equal to 15% of net cash income each year. The initial capital investment in assets includes the pyrolysis machine, movable pads, access road,

storage and transportation of feedstock and bio-oil. Mobile pyrolysis model assumptions are presented in Table 2, and initial capital assets in Table 3.

Table 2. Mobile Pyrolysis Model Assumptions

Variable	Unit	Value
Corn stover cost	$/ton	GRKS(60,67.5,75)
Energy sorghum cost	$/ton	GRKS(60,67.5,75)
Corn stover to oil conversion	gal/ton	GRKS(40,50,60)
Energy sorghum to oil conversion	gal/ton	GRKS(35,45,55)
Corn stover to char conversion	ton/ton	0.237
Energy sorghum to char conversion	ton/ton	0.254
Operation processing	tons/day	GRKS(30,40,50)
Wasted feedstock per day	%	11.0
Processing bio-oil to crude equivalent	$/gal	GRKS(0.20,0.30,0.40)
Discount bio-oil from crude	%	5.0
Subsidy for bio-oil	$/gal	1.00
Costs of Mobile Unit		
Fraction of unit financed	fraction	0.5
Length of loan	years	10
Interest rate	%	5.0
Operating Loan Interest Rate	%	7.0
Dividend rate on equity borrowed	%	15.0

Stochastic variables which have limited historical data series are simulated using a GRKS distribution. Similar to a triangular distribution, the GRKS distribution is fully defined by a minimum, middle, and maximum value. In the GRKS, however, the minimum and maximum represent the 2.5% and 97.5% quintiles which allows the distribution to simulate low probability events that could be beyond the assured minimum and maximum (in contrast to the triangular, which does not allow values beyond the specified minimum and maximum). The GRKS distribution has been used by Richardson et al. (2007) for simulating uncertain distributions.

The GIS data provides feedstock hauling distances from the fields to a mobile unit station, optimal routes and distances to move the mobile unit from station to station, depending on availability of feedstock, optimal routes and distances of transporting the bio-oil to a refinery (Ha et al., 2010). Table 4 presents the results of the GIS transportation analysis. These distances are then used to calculate the associated costs of the following transportation components: 1) transporting the feedstock from the fields to the mobile pyrolysis unit; 2) transporting the char from the mobile unit back to the fields to be incorporated into the soil; 3) transporting the bio-oil to the refinery; and 4) transporting the mobile unit from station to station.

Table 3. Initial Capital Assets for a Mobile Pyrolysis Unit

Initial Capital Assets	**Value**
Road to and from the Site for Delivery	18,000
Cost of a Movable Pad Material	408,600
Cost to Dismantle and Assemble slab each time	2,500
Pyrolysis Unit	1,230,833
Purchase 2 Used Tractor/Truck to pull trailers	125,000
Purchase Oil Tanker Trailer (each) 2 of these	100,000
Purchase 40 ton capacity box trailer 2 of these	9,000
Flat Bed Trailer for Feedstock	2,000
Hopper for feedstock	2,000
Decanter/Centrifuge to Separate Oil/Water	10,000
Trailer mounted Feedstock Dryer Unit 5 of these	139,250
Equipment/Tool Storage + Office Building Trailer	22,333
Nitrogen Generator	20,000
Grinder	15,000
In loader -- 3 yard	30,000
Power Generator	30,000
Other	5,000
Total of Capital Assets	**2,169,516**

Results and Discussion

The projected mean values for the total cost of production per barrel of bio-oil from the mobile pyrolysis unit ranged from $142 to $167 depending on the production scenario. Costs were broken down by feedstock costs and other costs. Other costs include the transportation costs, processing costs and finance costs. Total revenue generated included receipts from selling the bio-oil (including the $1/gallon subsidy) and the char. Table 5 presents the mean values for the estimated production costs, revenues and net revenues for all 15 scenarios. In general the mean costs of production increased as the unit moved more frequently. The 3 scenarios with the lowest cost of production for each crop station are the stationary scenarios.

The summary statistics for the NPV across the 15 scenarios are presented in Table 6. The simulation results showed a negative mean NPV for all 15 scenarios. The NPV improves (less negative) as the number of moving times is decreased. For corn stover in Illinois, the mean NPVs go from -$2.2 million with a monthly moving schedule to -$1.4 million with a stationary pyrolysis unit. Corn stover in Texas had mean NPVs from -$2.1 million to -$1.4 million if the plant is moved monthly vs. a stationary pyrolyzer. For energy sorghum in Nebraska the NPV was -$7.7 million with monthly moves and -$4.9 million for a stationary machine. The stationary plants had higher NPVs due to the savings from not moving the plant that were higher than the extra cost of longer hauls for feedstock and biochar to and from the field.

Table 4. Results of GIS Transportation Analysis for a Mobile Pyrolysis Model.

Variable	Unit	IL	TX	NE
County		Lee	Dallam	Thayer
Feedstock		Corn stover	Corn stover	Energy sorghum
Biomass yield	tons/acre	4.7	5.4	6.7
Utilized Biomass	tons/acre	1.2	1.4	6.7
Monthly Move (290 operating days)*				
Hauling feedstock	miles/year	433	451	360
Hauling char back to field	miles/year	46	48	39
Hauling bio-oil to refinery	miles/year	6,318	4,011	23,750
Relocation of pyrolysis unit	miles/year	355	160	381
Bi-Monthly Move (308 operating days)*				
Hauling feedstock/char back to soil	miles/year	670	574	670
Hauling char back to field	miles/year	72	62	72
Hauling bio-oil to refinery	miles/year	7,776	3,537	36,577
Relocation of pyrolysis unit	miles/year	340	22	299
Quarterly Move (317 operating days)*				
Hauling feedstock/char back to soil	miles/year	887	985	985
Hauling char back to field	miles/year	95	106	106
Hauling bio-oil to refinery	miles/year	6,537	3,648	28,483
Relocation of pyrolysis unit	miles/year	52	34	300
Bi-Annual Move (320 operating days)*				
Hauling feedstock/char back to soil	miles/year	1,233	1,293	1,233
Hauling char back to field	miles/year	131	137	131
Hauling bio-oil to refinery	miles/year	8,321	3,365	31,306
Relocation of pyrolysis unit	miles/year	49	13	176
Stationary (326 operating days)*				
Hauling feedstock/char back to soil	miles/year	1,945	2,026	2,026
Hauling char back to field	miles/year	209	218	218
Hauling bio-oil to refinery	miles/year	6,183	4,733	38,526
Relocation of pyrolysis unit	miles/year	0	0	0

Note: * divide miles/year by number of operating days to arrive at average transport round trip distance for feedstock. Bio oil loads leave the plant every three days.

Table 5. Mean Values for Estimated Costs of Production and Revenue of Pyrolysis Bio-oil Production for 15 Scenarios

Scenario	Cost Feed	Total Cost	Revenue	Net Revenue
	$/barrel	$/barrel	$/barrel	$/barrel
Illinois				
12 moves	63	151	122	-30
6 moves	63	146	122	-25
4 moves	63	144	122	-23
2 moves	63	144	122	-22
stationary	63	142	122	-21
Texas				
12 moves	63	151	122	-29
6 moves	63	146	122	-25
4 moves	63	144	122	-23
2 moves	63	143	122	-22
stationary	63	143	122	-21
Nebraska				
12 moves	70	167	122	-45
6 moves	70	163	122	-41
4 moves	70	160	122	-38
2 moves	70	159	122	-37
stationary	70	158	122	-36

In addition to looking at the mean values of NPV, it is also important to look at their distributions to assess the risk component associated with each scenario. Richardson and Mapp (1976) used the probability of economic success, defined as the likelihood that NPV was greater than zero, to rank different risky alternatives. The results of the simulation, presented as cumulative distribution functions (CDF), indicated that there is a low chance of a positive net present value ranging from 0% to 15% (Figures 2, 3, and 4). In Illinois the probability of success increases as the number of moving times decreases, with a stationary unit having the highest probability of success (Table 6). In the case of corn stover from Texas and energy sorghum from Nebraska, the probabilities of success increased as the moving schedule is less frequent, except for a stationary unit. Even though the mean NPVs for the stationary scenarios in Texas and Nebraska were higher, their distributions were leptokurtic, and the positive tails of their distributions were smaller, and hence they both had lower probabilities of economic success (defined as positive NPV). For a stationary unit located in Texas and Nebraska, the CDFs are steeper exhibiting a smaller range in returns because a stationary unit has higher and more constant production with more working days per year, compared to mobile scenarios, hence, reducing downside risk and increasing net returns.

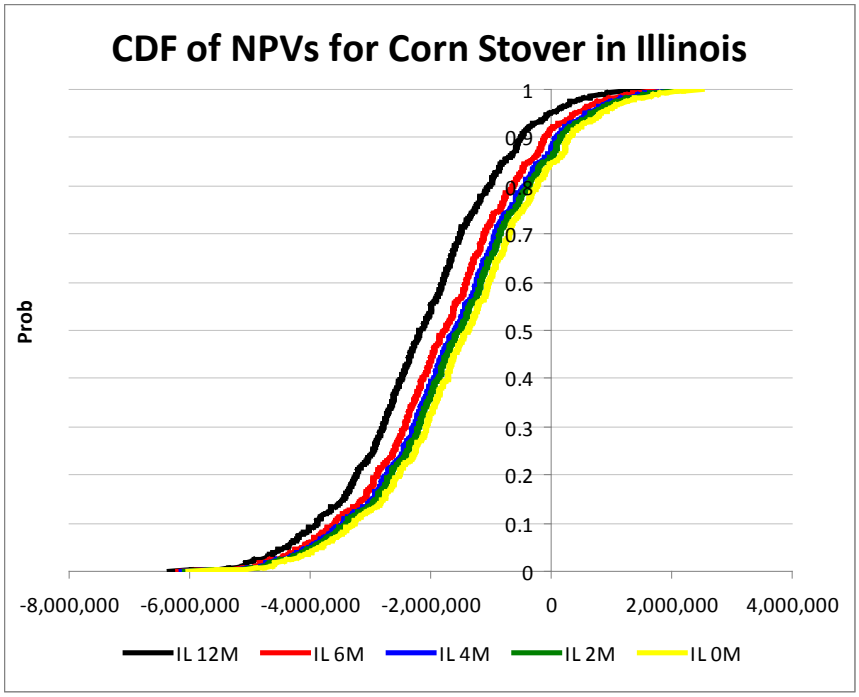

Figure 2. CDF of Net Present Values for Corn Stover in Illinois

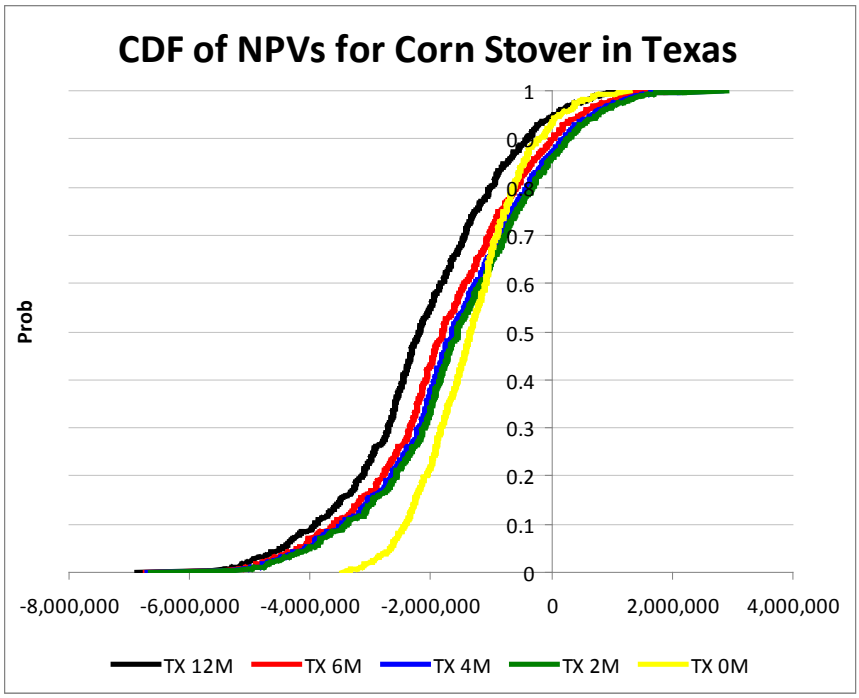

Figure 3. CDF of Net Present Values for Corn Stover in Texas

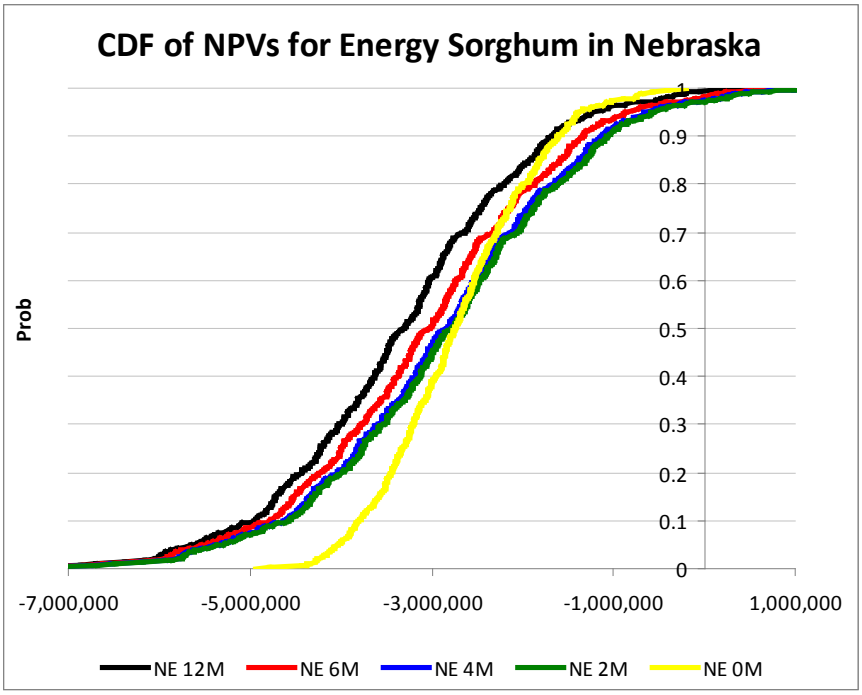

Figure 4. CDF of Net Present Values for Energy Sorghum in Nebraska

Sensitivity Analysis

This section presents a sensitivity analysis with changes in the level of crude oil prices, the costs of feedstock, and conversion efficiency of feedstock to bio-oil, and their impact on the economic feasibility of the mobile pyrolysis model. NPV would improve if feedstocks could be obtained at a lower cost than the current mean of $67.5/ton. Table 7 shows the impact of a reduction in the cost of feedstock of 10, 25, 50, and 75% on the probability of success. A 10% reduction of feedstock purchasing price, i.e. $60.8/ton would increase the probability of success from 16 to 29% for scenario IL 0M, from 15 to 27% for TX 2M and from 2 to 6% for NE 2M. In general, a probability of 90% or higher is typically regarded as a good chance of economic viability of a project as evaluated by investors. A 50% reduction in feedstock price, i.e. $33.8/ton, would increase the probability of success with 8 out of the 15 scenarios having a 90% or higher chance of success. With feedstock costs of about $16.9/ton all scenarios in all locations show a higher than 90% chance of economic success.

Recent Mid-East conflicts in Libya and Egypt, along with other market demand forces have pushed oil prices up above the $100/barrel threshold once again. As a consequence, a sensitivity analysis was conducted on the impact of an increase in oil prices (Table 8) on the probability of success for each scenario (Table 9). An average increase of 10% in oil prices over the ten-year horizon, from $79.4 to $87.3 per barrel in 2011 would increase the range of probability of success from 0-16% to 2-37%, respectively. An average increase of 50% in oil prices ($119.1 in 2011) would increase the probability of success ranges to 59-100%, with 9 scenarios with a 90% or higher probability of economic success. With mean oil prices of $139.0/barrel in 2011 all scenarios in all locations show a greater than 90% chance of economic success.

Table 6. Summary statistics of NPV for 15 scenarios

	12 Moves	6 Moves	4 Moves	2 Moves	No Moves
			Corn Stover Illinois		
Mean	(2,161,588)	(1,791,709)	(1,621,342)	(1,550,866)	(1,417,564)
StDev	1,320,525	1,364,024	1,383,891	1,390,243	1,400,731
CV	(61)	(76)	(85)	(90)	(99)
Min	(6,348,542)	(6,198,641)	(6,133,342)	(6,098,040)	(6,029,520)
Max	1,560,695	2,028,054	2,251,225	2,340,619	2,506,702
Prob(NPV<0)	95.3%	91.7%	87.7%	85.9%	84.7%
P(Success)	4.7%	8.3%	12.3%	14.1%	15.3%
			Corn Stover Texas		
Mean	(2,145,906.5)	(1,766,066.6)	(1,603,973.5)	(1,522,879.1)	(1,336,629.5)
StDev	1,344,715.1	1,390,240.8	1,413,757.2	1,419,220.7	863,696.8
CV	(62.7)	(78.7)	(88.1)	(93.2)	(64.6)
Min	(6,872,576.3)	(6,741,208.7)	(6,702,183.1)	(6,658,678.3)	(3,485,163.2)
Max	2,136,690.5	2,595,902.0	2,809,107.1	2,898,398.2	1,292,795.3
Prob(NPV<0)	94.6%	89.9%	87.0%	86.1%	93.6%
P(Success)	5.4%	10.1%	13.0%	13.9%	6.4%
			Energy Sorghum Nebraska		
Mean	(3,343,260.2)	(3,078,701.1)	(2,893,207.0)	(2,835,253.8)	(2,719,251.9)
StDev	1,355,402.9	1,423,568.7	1,444,986.8	1,455,261.1	838,796.8
CV	(40.5)	(46.2)	(49.9)	(51.3)	(30.8)
Min	(7,679,772.2)	(7,652,181.9)	(7,564,670.6)	(7,548,850.9)	(4,943,911.1)
Max	990,329.6	1,428,887.6	1,653,671.4	1,737,347.6	(196,753.6)
Prob(NPV<0)	99.5%	98.3%	97.4%	97.2%	100.0%
P(Success)	0.5%	1.7%	2.6%	2.8%	0.0%

Finally, preliminary work by Capareda et al. (2010) and Wise et al. (2011) show an increase in the conversion rates of corn stover to bio-oil. Reported conversion rates range from 70 to 90 gallons per ton of corn stover, a 60% increase in conversion efficiency from the conversion rate assumed in the simulation model. These results are yet to be replicated in a commercial scale pyrolizer. A sensitivity analysis with these higher conversion rates show a probability of success higher than 99% for all scenarios in all locations. Both syngas and biochar yields would be reduced in these scenarios but sufficient syngas would still be available for maintaining the heat in the pyrolizer and for drying the feedstock.

Table 7. Sensitivity Analysis of the Impact of Cost of Feedstock to the Probability of Success of each Scenario (NPV>0)

	Baseline	**10%**	**25%**	**50%**	**75%**
	$67.5/ton	$60.8/ton	$50.6/ton	$33.8/ton	$16.9/ton
Illinois					
12M	5%	12%	27%	74%	100%
6M	10%	18%	42%	88%	100%
4M	14%	23%	48%	92%	100%
2M	15%	25%	50%	93%	100%
0M	16%	29%	55%	95%	100%
Texas					
12M	4%	11%	29%	76%	100%
6M	11%	21%	42%	87%	100%
4M	14%	25%	49%	91%	100%
2M	15%	27%	52%	93%	100%
0M	5%	17%	59%	99%	100%
Nebraska					
12M	0%	1%	6%	36%	88%
6M	1%	3%	12%	50%	97%
4M	2%	5%	15%	61%	99%
2M	2%	6%	16%	63%	99%
0M	0%	1%	8%	75%	100%

Table 8. Oil Prices Assumed for the Ten-Year Planning Horizon.

	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Base	**79.4**	**93.3**	**97.5**	**101.0**	**103.9**	**107.7**	**111.6**	**113.7**	**115.3**	**115.3**
10%	87.3	102.6	107.3	111.0	114.3	118.4	122.8	125.0	126.9	126.8
25%	99.3	116.6	121.9	126.2	129.9	134.6	139.5	142.1	144.2	144.1
50%	119.1	139.9	146.3	151.4	155.9	161.5	167.4	170.5	173.0	172.9
75%	139.0	163.2	170.6	176.7	181.9	188.4	195.4	198.9	201.8	201.7

Table 9. Sensitivity Analysis on the Impact of Crude-oil prices ($/barrel) to the Probability of Success of each Scenario (NPV>0)

	Baseline	10%	25%	50%	75%
Illinois					
12M	5%	15%	46%	90%	99%
6M	10%	25%	58%	94%	100%
4M	14%	32%	63%	96%	100%
2M	15%	33%	66%	97%	100%
0M	16%	37%	70%	97%	100%
Texas					
12M	4%	17%	47%	90%	100%
6M	11%	27%	59%	94%	100%
4M	14%	32%	63%	96%	100%
2M	15%	33%	65%	96%	100%
0M	5%	30%	79%	100%	100%
Nebraska					
12M	0%	3%	15%	59%	92%
6M	1%	6%	23%	68%	95%
4M	2%	7%	28%	74%	97%
2M	2%	8%	29%	75%	98%
0M	0%	2%	24%	88%	100%

Summary and Conclusions

This paper analyzed the economic feasibility of a mobile bioenergy pyrolysis system. Pyrolysis transforms any cellulosic materials into 1) a bio-oil similar to crude oil 2) a synthetic gas similar to natural gas, and 3) a biocharcoal substance. The model integrates a Monte Carlo financial simulation model with a transportation logistics analysis based on geographic information system (GIS) data. The GIS data provides feedstock hauling distances from the fields to a mobile unit station, optimal routes and distances to move the mobile unit from station to station, depending on abundance of feedstock, and optimal routes and distances of transporting the bio-oil to a refinery. These distances are then used to calculate the associated costs of the following transportation components: 1) transporting the feedstock from the fields to the mobile pyrolysis unit; 2) transporting the char from the mobile unit back to the fields to be incorporated into the soil; 3) transporting the bio-oil to the refinery; and 4) transporting the mobile unit from station to station.

The analysis includes 15 alternative scenarios, including 3 stations/sources of feedstocks, and 5 frequencies for moving the mobile pyrolysis unit. The three sources of feedstocks are corn stover in Illinois and Texas, and energy sorghum in Nebraska. The unit can be moved monthly, bi-monthly, quarterly, bi-annually, or it can be stationary.

The results showed a low probability of economic success for all scenarios ranging from 0% to 16%. In Illinois, the probability of success increases as the number of moving times is decreased, with a stationary unit having the highest probability of success. In the case of corn stover from

Texas and energy sorghum from Nebraska, the probabilities of success increased as the moving schedule is less frequent, except for a stationary unit. For a stationary unit located in Texas and Nebraska, the maximum and minimum receipts are higher than for the mobile scenarios. A stationary unit has higher production compared to mobile scenarios, hence, reducing downside risk and increasing net returns.

A sensitivity analysis of changes in the cost of feedstock showed that if feedstock cost were reduced to $16.9/ton, all scenarios in all locations would have a 90% or higher probability of a positive NPV. Similarly, if mean crude oil prices are greater than of $139 per barrel in 2011 over the ten-year planning horizon all scenarios in all locations show a higher than 90% chance of economic success. If the conversion efficiency of feedstock to bio-oil is increased to 70-90 gallons of bio-oil per ton of feedstock (Capareda et al. 2010; Wise et al. 2011) then the probability of success is higher than 99% for all scenarios in all locations.

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Food Culture Distance: An Antecedent to Export Marketing Strategy Adaptation - An Empirical Examination of Swedish and Finnish Food Processing Companies

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Abstract

This study explores dissimilarity in food culture *(food culture distance)* as an antecedent to the adaptation of export marketing strategy for food products, and examines the impact of marketing program adaptation on export performance. Building on previous research, this paper introduces a model for operationalizing the construct *food culture distance*. Data were gathered via a mail survey of Swedish and Finnish food exporters. The results indicate a significant correlation between *food culture distance* and the extent of product adaptation. However, product adaptation does not affect export performance, implying that other factors, along with marketing strategy, may influence export performance.

Keywords: Culture, export, food, marketing, strategy

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Introduction

Due to economic globalization, goods, services, labor, information, and technology are flowing more freely across national borders (Pinstrup-Andersen 2002; Feenstra and Taylor 2008). Simultaneously, firms are developing and operating at a more international scale (Commander et al. 2008)

The European food industry, like many other European industrial sectors, has increasingly internationalized over the last decade (Eurostat 2009). This has been done mainly by exporting food products to international markets. However, food companies are also expanding internationally by establishing production facilities and retail outlets, and conducting mergers and acquisitions overseas (Benito and StrØm 2000).

Accordingly, from an international marketing perspective, a prominent challenge confronting food exporters in their internationalization decisions concerns applying a workable export marketing strategy in order to meet export venture objectives. Cavusgil and Zou (1994) define export marketing strategy as "the means by which a firm responds to the interplay of internal and external factors to meet the objectives of the export venture" (p. 4). Here, as Johnson et al. (2011) state, firms face a global–local dilemma. The question is whether they should standardize or adapt their export marketing strategy in order to meet the export venture objectives (Shoham 1995).

Levitt (1983), one of the most eminent advocates of standardization, argues in "The globalization of markets" that technology is a powerful force driving the world toward a converging commonality in which markets are homogenized and thus suited for standardized products. In contrast, proponents of the adaptation approach dispute this, claiming that the existence of significant dissimilarity in culture, legal and political systems, and customer values, etc., between markets, marketing programs must be adapted to the conditions of the target markets (Cavusgil et al. 1993; Cavusgil and Zou 1994; Calantone et al. 2004). Calantone et al. (2004) argue that, by adapting their marketing programs, firms are adapting the physical characteristics or attributes of products and their packages to the export market. Hence, by applying this strategy, exporting firms are trying to consider the major differences between nations and markets when making marketing decisions, in order to satisfy the needs of customers in each specific market. In contrast, when firms standardize their marketing programs, they are in fact ignoring the existence of dissimilarities between markets. Offering the same product in all markets may not satisfy all customers, so it is not always a feasible strategy (Calantone et al. 2004).

An export venture is usually initiated informed by economic (e.g., profits and sales) and/or strategic objectives (Cavusgil and Zou 1994). Therefore, the extent to which an export venture's economic and/or strategic objectives are attained would determine its performance (Cavusgil and Zou 1994). Therefore, export performance is defined as "the extent to which a firm's objectives, both economic and strategic, with respect to exporting a product into a foreign market, are achieved through planning and execution of export marketing strategy" (Cavusgil and Zou 1994, p. 4). The next question concerns whether adapting or standardizing the export marketing strategy will enhance a firm's export performance.

Achieving the economic or strategic objectives of an export venture requires adopting workable and effective long-term marketing strategies when exporting to international markets (Huliyeti et al. 2008). Hence, from both the managerial and theoretical perspectives, it is important to understand the antecedents to the adaptation of export marketing strategy and to examine the economic consequences of adopting a particular adaptation strategy.

The adaptation of export marketing strategy by adapting the products is a more obvious issue in "old-line" industries, i.e., industries with a low-technology orientation (Cavusgil et al. 1993), such as the food industry (Rama 2008). Accordingly, the extent of an industry's technology orientation negatively influences the degree to which it adapts its export marketing strategy. The argument is that products in lower-tech industries, such as the food industry, are more connected to customer tastes, habits, and customs, which differ from market to market (Cavusgil et al. 1993; Cavusgil and Zou 1994).

Furthermore, research reveals that products that cater closely to the needs of specific cultures or subcultures are likely to be adapted to the target markets. Accordingly, the cultural specificity of a product is one of the factors determining the degree to which its export marketing strategy will be adapted (Cavusgil et al. 1993; Cavusgil and Zou 1994). Cavusgil et al. (1993) define the cultural specificity of a product as "the extent to which the product caters to the needs of a specific culture or subculture" (p. 488). Therefore, the more specific a product is to a culture, the greater its degree of product adaptation. Food products traded in the food industry are highly culture specific (e.g., Lannon 1986; Fiddes 1995; Anderson 2005; Montanari 2006). According to Buisson (1995), due to the close integration of food with culture, it is difficult to promote the same food products in different markets, whereas other products can be promoted in different markets with only minor changes. Boddewyn and Grosse (1995) argue that dissimilarity in customer tastes is a key external obstacle to standardizing marketing practices for consumer non-durable products such as food. Hence, food exporters can be expected to adapt their export marketing strategies to a considerable degree when exporting to markets that differ substantially in terms of food culture, largely in order to satisfy customer tastes and preferences in the export markets.

Much research has examined the antecedents to export marketing strategy adaptation (Cavusgil et al. 1993; Cavusgil and Zou 1994; Evans and Mavondo 2002; O'Cass and Julian 2003; Ozsomer and Simonin 2004; Evans and Bridson 2005). Nonetheless, to the best of the author's knowledge, comparable research in the food sector, specifically examining the effect of customer food culture on the export marketing strategy adaptation, is limited. The current research attempts to examine the impact of dissimilarity in customer food culture—henceforth, food culture distance—as an antecedent to export marketing strategy adaptation by food exporters.

This study mainly seeks to examine the relationship between food culture distance and the degree to which food exporters adapt their export marketing strategy. The study also examines the relationship between export marketing strategy adaptation and export performance in the food sector. Building on previous research (Askegaard and Madsen 1998), this paper presents a model of the operationalization of food culture distance as a predictor of the degree to which food exporters adapt their export marketing strategy. This study focuses on the adaptation of export marketing strategy with regard to the product, being a key component of the international marketing mix that manifests a firm's characteristics in international markets (Calantone et al. 2004).

This is more appropriate in the current research setting, i.e., the food sector, in which, without a physical product, there is nothing to be traded in an exchange relationship (Grunert 2006).

The article is structured as follows: First, the conceptual framework is briefly outlined, then the proposed relationships are discussed and hypotheses developed. Next, the research design and methodology are described. Finally, the study's findings are discussed and conclusions about the theoretical and managerial implications of the study are drawn.

Conceptual Framework

Building on conceptual models proposed in previous international marketing research (Cavusgil et al. 1993; Cavusgil and Zou 1994; Ozsomer and Simonin 2004), the conceptual framework postulates that a food company's export performance is influenced by the extent to which its export marketing strategy has been adapted, which per se is influenced by the food culture distance between the firm's home and export markets (Figure 1).

Figure 1. The Conceptual Framework

Antecedents to Export Marketing Strategy Adaptation

Previous research identifies several factors that significantly affect the extent to which firms adapt their export marketing strategy (Table 1).

As Cavusgil and Zou (1994) point out, antecedents to export marketing strategy adaptation can be categorized as either internal or external forces. Factors related to firm or product characteristics are regarded as internal forces, whereas factors related to industry or export market characteristics are regarded as external forces.

Accordingly, a firm's international competence is among the internal forces that influence the degree to which it will adapt its export marketing strategy. Porter (2004) argues that the choice of marketing strategy is strongly influenced by a firm's capabilities and constraints. Cavusgil and Zou (1994) maintain that a firm's international competence is among the relevant capabilities in export marketing. Cavusgil et al. (1993) point out that direct involvement in international transactions (e.g., exports) and operating in international markets may increase the firm's international competence. Therefore, by achieving more international competence, firms proactively tend to adapt their products to the export market in order to reach customers in target markets (Cavusgil et al. 1993; O'Cass and Julian 2003; Calantone et al. 2004). Firm size is another internal factor whose effect on export marketing strategy is documented in the literature, large firms tending to apply a more customized marketing program. An adaptation strategy requires large resources (Whitelock and Pimblett 1997), so their access to more financial and management resources enables larger firms to invest more in adapting their products to target markets (Chung 2003).

Table 1. Antecedents to Export Marketing Strategy Adaptation

Selected Studies	Identified Factors
Cavusgil et al. (1993)	• Product and industry factors • Company factors • Export market factors
Cavusgil and Zou (1994)	• Internal forces (firm and product characteristics) • External forces (industry and export market characteristics)
O'Cass and Julian (2003)	• Firm specific characteristics • Environmental characteristics
Ozsomer and Simonin (2004)	• Customer similarity • Market infrastructure similarity
Evans and Bridson (2005) and Evans et al. (2008)	• Psychic distance

Dissimilarity in law and legal regulations, market structure, business practices, language, and customers between the firm's home and export markets exemplify the external forces that influence the extent of export marketing strategy adaptation (Cavusgil et al. 1993; O'Cass and Julian 2003; Calantone et al. 2004; Ozsomer and Simonin 2004; Evans and Bridson 2005). Evans and Bridson (2005) argue that significant differences, as mentioned above, between the firm's home and export markets make the firm adapt its product to the target market. The rationale is that these substantial differences oblige the firm to assume that its product in its current form will not satisfy prospective customers. Therefore, the product will be adapted to the export market. According to Calantone et al. (2004), by adapting its export marketing strategy, an exporting firm is trying to consider the major differences between its markets in its marketing decisions so as to satisfy the needs of customers in each market.

Psychic Distance as Antecedent to Export Marketing Strategy Adaptation

Psychic distance is among the most used and researched concepts in the international business and marketing field (Dikova 2009). Psychic distance has been cited to explain firms' internationalization decisions regarding the pattern of market entry (Johanson and Vahlne 1977; Kogut and Singh 1988; Tihanyi et al. 2005) and foreign market selection (Dow and Karunaratha 2006; Dow and Ferencikova 2010). Moreover, psychic distance has been used as a factor explaining the adaptation of export marketing strategy (Evans and Bridson 2005; Evans et al. 2008).

According to Evans and Mavondo (2002), psychic distance is defined as "the distance between the home market and a foreign market, resulting from the perception of both cultural and business[1] differences" (p. 517). Consequently, psychic distance is a subjective (perceived) rather than an objective (geographical) distance (Prime et al. 2009) that refers to similarity or difference in the degree of separation between the company's home market and a foreign export market (Evans and Mavondo 2002). Empirical studies reveal that a firm entering psychically more distant markets is likely to adapt its marketing strategies (products) to a greater extent than for psy-

[1] "Business differences" refer to differences in legal and political environment, market structure, economic environment, business practices, and language between the home market and a foreign market (Evans et al. 2008).

chically closer markets. This is because the perception of greater risk in target markets that differ considerably from the firm's home market may lead it to conduct more extensive market research, which may suggest that certain product attributes must be adapted to the export market (Evans and Bridson 2005; Evans et al. 2008).

Dissimilarity in culture (cultural distance) is a main component of psychic distance (Kogut and Singh 1988; O'Grady and Lane 1996; Evans and Bridson 2005). Previous research found that cultural distance is a key factor in export marketing strategy adaptation (Martenson 1987; Singh 1996; Calantone et al. 2004; Evans and Bridson 2005). Accordingly, firms are likely to adapt their marketing strategies when they perceive a substantial cultural distance in their target markets. Although Hofstede's index, based on five dimensions, i.e., power distance, individualism, masculinity, uncertainty avoidance, and long-term orientation (see Hofstede 2001), has been used as a dominant proxy for cultural distance in the past studies (Tihanyi et al. 2005), its use has been criticized in recent research.

Culture is defined as "the collective programming of mind that distinguishes the members of one group or category of people from another" (Hofstede 2001, p. 10). Accordingly, a nation's culture is visualized in symbols, rituals, and values. West and Graham (2004) argue that Hofstede's indices are value-based measures, and that values are not the only manifestation of a national culture that can [or should] be measured. In an empirical study of international retailers, Evans and Bridson (2005) find that cultural distance (measured using Hofstede's framework) does not significantly affect the adaptation of a retail offering. Other comparable studies either discard the significance of Hofstede's indices of cultural distance, for example, for foreign market selection in terms of exporting (Dow and Karunaratha 2006) and direct investment (Dow and Ferencikova 2010), or postulate an uncertain relationship (Brock et al. 2011). Dow and Ferencikova (2010) suggest that researchers need to move beyond simply inserting Hofstede's framework when operationalizing cultural distance. Other scholars refer to the importance and relevance of operationalizing cultural distance at the cognitive level of the decision-maker(s) instead of using macro-level indicators (Brock et al. 2011).

Food Culture Distance: A Psychic Distance

Food is described as a manifestation of a nation's culture (Lannon 1986; Fiddes 1995; Anderson 2005; Montanari 2006; Rozin 2006). Fiddes (1995) maintains that who we are is manifested in what we eat. Anderson (2005) points out that we consume food not only to meet our nutrient needs; humans also eat to communicate, cheer up, or "affirm religious faith." According to Anderson (2005), food is produced, prepared, and consumed inspired by human culture. Moreover, although humans are able to eat anything, they choose food based on their own preferences. Rozin (2006) describes food as a social marker that identifies one's group; food is an arena for making social contacts, expressing affection, and communicating. Taste is cited as one of the main factors determining consumer choice of food (Raats et al. 1995). Nonetheless, Montanari (2006) argues that, despite the common perception that the tongue is the organ of taste, the mind—which is shaped by culture—in fact plays the most important role in tasting food. Rozin (2006) maintains that culture is the predominant factor influencing human food choice, a statement confirmed by empirical research (see e.g., Schroeter et al. 2007). Food culture is defined as "a culinary order whose traits are prevalent among a certain group of people" (Askegaard and

Madsen 1998, p. 550). According to Swift (1999), dissimilarity in food culture (food culture distance) is one of the most important aspects of cultural distance between different markets/countries. Consequently, food culture distance is arguably a rigorous surrogate for cultural distance between markets. This is more applicable in the current research setting in which food exporter behavior in the internationalization process is under investigation.

Food culture distance is a subjective distance that refers to perceived similarity or difference in consumer food behavior between two markets. Following Evans and Mavondo (2002), it is proposed that food culture distance be defined as the distance between the home market and a foreign market, gauged by perceived differences in food culture.

From a marketing perspective, research indicates that products such as food that cater to the needs of a specific culture or subculture (Lannon 1986; Fiddes 1995; Anderson 2005; Montanari 2006; Rozin 2006) tend to be more adapted to the target markets (Cavusgil and Zou 1994; Cavusgil et al. 1993). This is due to dissimilarities in customer tastes, preferences, and customs among the markets (Boddewyn and Grosse 1995). By adapting their food products, firms strive to meet customer requirements in each specific market (Calantone et al. 2004).

Therefore, based on this review, it is anticipated that a food exporter will adapt its export marketing strategy when exporting to markets that differ significantly from its home market in terms of food culture. Accordingly, the following hypothesis is advanced:

H1: Food culture distance positively influences the degree to which a food exporter adapts its export marketing strategy.

Export Marketing Strategy Adaptation and Export Performance

Levitt (1983) maintains that standardizing their marketing programs allows firms to compete effectively in the global market. By standardizing their strategy and essentially exporting the same products to all markets, exporting firms achieve lower costs due to economies of scale, which positively influences firm performance. Moreover, Evans et al. (2008) argue that, by adapting their products to export markets, firms may face difficulties competing against local players, i.e., they "fail to capitalize on their uniqueness," which might result in poor performance. On the other hand, proponents of strategy adaptation claim that adapting the products will provide opportunities for differentiation to satisfy all customer requirements in an export market (Cavusgil and Zou 1994; Buckley and Ghauri 2004), which may enhance firm performance (Porter 2004).

Another group of scholars discards the linear relationship between the adaptation/standardization of export marketing strategy and export performance. Johnson et al. (2011) argue that, by adapting their export marketing strategy, firms are responding to customer requirements and may therefore enlarge their sales. However, in the long run, the cost of this strategy adaptation may exceed the benefits. Accordingly, Yip et al. (2006) suggest that export marketing strategy adaptation has a non-linear (inverted U-shaped) relationship with export performance, i.e., a certain extent of export marketing strategy adaptation may improve export performance, but exceeding that leads to declining performance. Accordingly, in terms of firm performance, whether to adapt or standardize the marketing strategy can be seen as a decision based on a tradeoff between the

cost advantages of standardization and revenue advantages of adaptation (Buckley and Ghauri 2004).

Empirical findings are also inconsistent as to the correlation between export marketing strategy adaptation and firm export performance. O'Cass and Julian (2003) find that the extent of export marketing strategy adaptation does not significantly influence export performance: either standardization or adaptation of export marketing strategy can yield comparable performance. Ozsomer and Simonin (2004) and Evans et al. (2008) find a negative relationship between export marketing strategy adaptation and firm performance. On the other hand, Cavusgil and Zou (1994) claim that adapting products to the export market produces better performance for firms. This statement is justified in the food sector context by an empirical study of Italian food exporters in the Chinese market in which Huliyeti et al. (2008) conclude that developing an effective marketing strategy by adapting products to consumers' consumption habits and taste is a key to a food exporter's long-term success.

Consequently, due to the integration of food and culture (Lannon 1986; Fiddes 1995; Anderson 2005; Montanari 2006; Rozin 2006), it is anticipated that adapting food products to satisfy consumer tastes and preferences in the export market will enhance food companies' export performance. Hence, the following hypothesis is advanced:

H2: Export marketing strategy adaptation is positively related to a food company's export performance.

Research Methodology

Population, Sample, and Data Collection

The sample for this study consisted of the total population of Swedish and Finnish food-processing companies, totaling 358 firms. An apparent trend toward a more internationalized structure is noticeable in both the Swedish and Finnish food industries. Accordingly, since 1998, Sweden's export value of food (including beverages) has increased by more than 130% (Statistics Sweden 2011). The corresponding number for Finland is approximately 200% (Eurostat 2008, 2010). This degree of growth calls for research specifically into internationalization issues in those countries.

Two registers of data on Swedish and Finnish food processing companies were acquired from Statistics Sweden and Statistics Finland, respectively. They were asked to provide the total population of food processing companies that satisfied the following criteria: (1) exported food products; (2) to at least three foreign markets; and (3) for at least three years. These criteria ensure that the respondents have adequate international competence and have been established in their target markets.

A formal structured questionnaire (see Appendix D) was used to collect the data from the respondents. In the case of Swedish companies, a cover letter explaining the purpose and importance of the study was sent to CEOs, who were asked to respond to a questionnaire that they would receive electronically shortly thereafter. After two reminders, the questionnaires were sent via mail to the CEOs who had not responded. In the case of Finnish companies, due to lack of

access to CEO e-mail addresses, the questionnaire, which was attached to a cover letter explaining the purpose and importance of the study, was sent directly via mail. Moreover, to reduce the risk of misinterpretation, questionnaires were professionally translated into Finnish.[2] A reminder was sent to the companies after two weeks. Dillman's (1991) total design method for mail surveys was applied in this study. A reply-paid envelope was enclosed with each questionnaire to minimize the cost of replying to the respondent. Furthermore, a summary of the results was promised as a reward to respondents who participated in the study. Finally, using the university letterhead for both the letter and the questionnaire helped establish the creditability of the survey.

A usable sample of 62 was obtained, yielding a raw response rate of 18% (i.e., 62 of 358). However, after taking into account the irrelevant cases (e.g., companies that exported animal feed, had gone bankrupt, or no longer exported), the effective rate was approximately 21% (i.e., 63 of 305). This amounted to a sample of 126 export ventures corresponding to 30 export markets (see Appendix A). This response rate was achieved because the respondents were asked to answer all questions twice, once with reference to an export venture in a psychically close market and once with reference to an export venture in a psychically distant market. After receiving a definition of psychic distance, the respondents were asked to nominate a psychically close foreign market and a psychically distant foreign market to which their firms had exported food products in the last three years. This method is in line with that used in previous research (Evans and Mavondo 2002; Evans et al. 2008). Consequently, the unit of analysis in the present study was the individual market export venture rather than the firm itself (Cavusgil and Zou 1994). The complete case approach (listwise deletion) was used to handle missing data (Hair Jr. et al. 2010).

In terms of the characteristics of the sample, 96 international operations in the sample were based in Sweden and 30 in Finland. The respondents came from a diverse range of business lines classified under the food processing industry, in which companies producing bakery and farinaceous products (23%), preserved meat and meat products (14%), and beverages (12%) were overrepresented (Table 2).

Table 2. Respondent characteristics in terms of line of business

Lines of business covered by the study
1. Bakery and farinaceous products
2. Preserved meat and meat products
3. Beverages
4. Processed and preserved fish, crustaceans, and mollusks
5. Dairy products
6. Grain mill products, starches, and starch products
7. Processed and preserved fruit and vegetables
8. Vegetable and animal oils and fats
9. Other food products

Method of Analysis

According to Fornell and Larcker (1981), due to its flexibility and ability to unite psychometric and econometric theory, structural equation modeling (SEM) is increasingly being applied in

[2] The original questionnaire was written in Swedish.

theory testing and empirical building in marketing research. SEM allows us to explain the relationships between unobservable variables (constructs) that are represented by observable or measurable variables (indicators). Applying constructs allows us to better represent theoretical concepts (e.g., food culture in this research) by using multiple measures of a concept to reduce the measurement error. Moreover, by accounting for the measurement error in the concepts, SEM improves the statistical estimation of the relationships between the concepts (Hair Jr. et al. 2010). The present research was designed using a two-step SEM process (Anderson and Gerbing 1988); first, the fit and construct validity of the proposed measurement models were assessed, after which the structural theories were tested. LISREL Version 8.8 (Jöreskog and Sörbom 2006) was used to estimate the measurement and structural models. Following Hair Jr. et al.'s (2010) recommendation, LISREL's maximum likelihood procedure was preferred for the estimation.

Construct Measures

To achieve valid and reliable measures of the variables, previously validated scales were used in this study. The structural model with corresponding indicators is presented in Figure 2. In accordance with LISREL conventions, indicators are shown in boxes and constructs in ovals (see Appendix B for a full list of all hypothesized constructs and indicators).

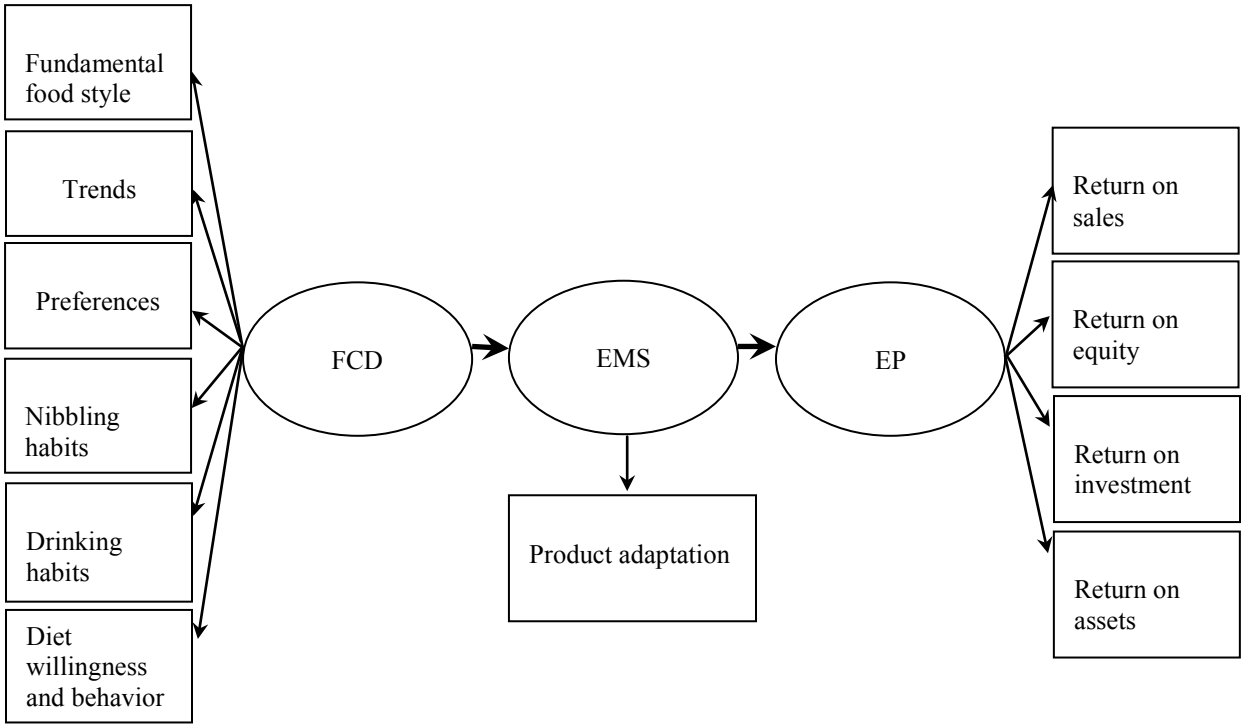

Figure 2. The structural model

Food Culture Distance

In a pilot study conducted as a part of the current research, 39 randomly selected respondents were asked to specify the extent to which customer food culture[3] in the export market was of im-

[3] Food culture was presented as a single accumulated variable.

portance in adapting the export marketing strategy; responses were given using a seven-point Likert scale ranging from 1 = "not important at all" to 7 = "very important." Almost 54% of the respondents answered 4 or higher to this question, giving a sign of the importance of food culture distance as an antecedent to export marketing strategy adaptation in the food sector.

The measures for operationalizing the construct food culture distance (coded as *FCD* in Figure 2) were adapted from Askegaard and Madsen (1998). When analyzing the data from a 1989 lifestyle survey, Askegaard and Madsen (1998) introduced the following dimensions for measuring the construct *food culture*: fundamental food style, trends, preferences, nibbling habits, drinking habits, and diet willingness and behavior. The first dimension, *fundamental food style*, refers to questions regarding general patterns of food consumption and interest in food products. *Trends* covers aspects of trends in daily food consumption (e.g., convenience food and fast food). *Preferences* concerns the desire for a variety of food products and attributes (e.g., liquid substances and freshness). *Nibbling habits* refers to food consumption patterns between meals (e.g., consumption of fruits and candies). *Drinking habits* refers to drinking patterns. Finally, *diet willingness and behavior* covers matters of health consciousness, controlled eating programs, etc. (Askegaard and Madsen 1998).

The original survey—used by Askegaard and Madsen (1998)—was carried out by the Centre de Communication Avancé (CCA), a marketing research agency in Paris, in cooperation with the Europanel network of opinion research institutes in 15 European countries. The primary purpose of the survey was to generate a pan-European lifestyle typology drawing on approximately 20,000 respondents from 15 European countries. Askegaard and Madsen (1998) focused only on the results of the 138 food-related questions that were part of the CCA survey and looked at the traits of homogeneity and heterogeneity in European food cultures.

Accordingly, since the respondents in the current research consisted of companies, rather than consumers as in the original study, an adapted form of Askegaard and Madsen's (1998) indicators and items was used to measure the construct food culture distance (see Appendix B). In the present study, the respondents were asked to specify the extent to which food culture was perceived to differ in two pre-nominated export markets versus the company's home market using a seven-point Likert scale ranging from 1 = "totally the same" to 7 = "totally different."

Export Marketing Strategy Adaptation

Regarding export marketing strategy adaptation (coded as *EMS* in Figure 2), this study focused on export marketing strategy with regard to the product rather than the other marketing "Ps" (i.e., price, promotion, and place) since, according to Calantone et al. (2004), the product is a key component of the international marketing mix that manifests the characteristics of a firm in international markets. Moreover, even though the concept of marketing mainly concerns satisfying consumer needs by introducing better products, research in international marketing has often focused more on advertising adaptation and product promotion than on the adaptation of the physical product. Specifically, in the food sector, without a physical product, there is nothing to trade in an exchange relationship (Grunert 2006). Therefore, we need empirical studies in marketing research that focus more on the physical product than on its surrounding elements.

Adapted from the previous research (Ozsomer et al. 1991; Cavusgil et al. 1993), the construct *export marketing strategy adaptation* (*EMS*) was measured using a single indicator, the extent of product adaptation. Largely due to the focus of the present research on general product adaptation, it was assumed that a single indicator for *EMS* would adequately represent the construct. Moreover, this approach was in line with that of previous research (see, e.g., Ozsomer et al. 1991; Cavusgil et al. 1993). The respondents were asked to specify the extent to which they adapted their products when exporting to two pre-nominated markets using a seven-point Likert scale ranging from 1 = "no adaptation at all" to 7 = "total adaptation."

Export Performance

In this study, export performance (coded as *EP* in Figure 2) was measured using only economic indicators. This was done because Cavusgil and Zou (1994) have pointed out that the performance measures most frequently used in previous research and by government agencies are economic in nature.

Accordingly, four economic indicators adapted from Evans et al. (2008) were used to operationalize the construct *export performance*: return on sales, return on equity, return on investment, and return on assets. Respondents were asked to indicate the extent to which the aforementioned indicators[4] had changed over the last three years in each pre-nominated export market using a seven-point Likert scale ranging from 1 = "decrease of more than 20%" to 7 = "increase of more than 20%."

The *FCD* and *EP* constructs were evaluated for validity and reliability.[5] The constructs, their indicators, standardized factor loadings, *t* values, R^2 values (Jöreskog and Sörbom 1993), and construct reliability indices (Cronbach's α) (Hair Jr. et al. 2010) are presented in Table 3.

Construct validity can be evaluated in terms of convergent and discriminant validity (Hair Jr. et al. 2010). Convergent validity indicates how well the indicators of a construct converge, having a high proportion of variance in common (Dunn et al. 1994). Table 3 indicates that all the factor loadings met the criteria[6] and the *t* values were also significant at the 0.05 level. Furthermore, the calculated average variance extracted (AVE) values for each construct exceeded 0.5 (AVE_{FCD} = 0.761, AVE_{EP} = 0.8724). This was also an indication of convergent validity (Hair Jr. et al. 2010, 709). To test for discriminant validity, the method suggested by Fornell and Larcker (1981) was used. Accordingly, the AVE for any two constructs (in this case, *FCD* and *EP*) was compared with the square of the estimated correlation between these two constructs. The variance extracted estimates were greater than the squared correlation estimates (0.761 and 0.8724 vs. 0.0049), indicating that discriminant validity was satisfied. Construct reliability indices (α) also met the criterion, i.e., were greater than 0.7 (Hair Jr. et al. 2010) (see Table 3). This suggests good construct reliability for both *FCD* and *EP*, meaning that all the measures consistently represent the same construct.

[4] The respondents were asked about the objective performance rather than their perceptions of the performance.
[5] I did not test EMS for validity or reliability since it was measured using only a single indicator.
[6] A robust condition of convergent validity is that the factor loadings are greater than 0.5 (Hair Jr. et al. 2010).

Table 3. Measurement models of the constructs, including *t* values and R^2 values

Indicators	Construct	Standardized factor loading	Standard Error	*t* value	R^2 value	α
Fundamental food style[f]	FCD	0.93	0.08	11.19	0.90	0.932
Trends[f]	FCD	0.90	0.09	9.95	0.79	
Preferences[f]	FCD	0.91	0.08	11.10	0.89	
Nibbling habits[f]	FCD	0.86	0.08	10.39	0.83	
Drinking habits[f]	FCD	0.88	0.08	10.75	0.86	
Diet willingness and behavior[f]	FCD	0.83	0.09	8.99	0.70	
Return on sales	EP	0.78	0.14	8.40	0.61	0.959
Return on equity	EP	0.98	0.10	12.21	0.95	
Return on investment	EP	0.98	0.09	12.36	0.96	
Return on assets	EP	0.98	0.09	12.30	0.97	

[f] The indicators of the construct *food culture distance* are factor scores computed in SPSS Version 17.0 based on the factor loadings of all items for each indicator. Factor scores were used due to the creation of a smaller set of variables to replace the original set (Hair Jr. et al. 2010) (see Appendix B for a complete list of indicators and corresponding items). This approach is consistent with that used in previous research (see, e.g., Dow and Karunaratha 2006).

To assess overall model fit, the following goodness of fit (GOF) indices, together with *p* values,[7] were evaluated for both models: the root mean square error of approximation (RMSEA), the normalized chi-square (χ^2/df), the normalized fit index (NFI), the comparative fit index (CFI), and the adjusted goodness of fit index (AGFI) (Jöreskog and Sörbom 1993; Hair Jr. et al. 2010).

For *FCD*, $\chi^2 = 12.70$ ($p = 0.17684$), df = 9, χ^2/df = 1.41, CFI = 0.99, NFI = 0.98, AGFI = 0.88, and RMSEA = 0.073 and for *EP*, $\chi^2 = 1.06$ ($p = 0.58845$), df = 2, χ^2/df = 0.53, CFI = 1, NFI = 1, AGFI = 0.97, RMSEA = 0.000, indicating, first, that both estimated models have positive degrees of freedom and hence are identified (Diamantopoulus 1994) and, second, that the GOF indices have satisfied the criteria (see Appendix C for GOF criteria and acceptable levels).

Although the sample size in this study was relatively small, the high item (factor) loadings (>0.7) and the few constructs let us maintain the relationship between distinct parameters to be estimated to a sample size of 1:5, which is considered robust and desirable in SEM (Hair Jr. et al. 2010, p. 664).

The measures used here were obtained from the same respondent at the same time. Therefore, following Evans et al. (2008), it was necessary to establish whether common method variance (CMV) was a problem. To do this, the overall measurement model was modified to one in which all the measured items were indicators of only one construct. The new model was then tested and its fit was compared with that of the original two-construct model. Since the one-factor model's fit statistics[8] indicated that this model did not fit the data, CMV is not likely to threaten the findings (Olson et al. 2005).

[7] LISREL tests the hypothesis of bad model fit against the null hypothesis of good model fit; a *p* value above 0.05 is one indicator of good model fit (Hayduk 1987; Hansson and Ferguson 2011).
[8] $\chi^2 = 402.73$ ($p = 0.0$), df = 35, χ^2/df = 11.48, CFI = 0.50, NFI = 0.49, AGFI = 0.22, RMSEA = 0.358.

Regarding the construct *food culture distance*, the six indicators are manifestations of the latent variable rather than its defining characteristics, meaning that food culture is reflected in its indicators. Moreover, all the indicators share a theme (food consumption behavior), and it seems that omitting an indicator does not alter the conceptual domain of the construct. Finally, all the indicators have the same antecedents and consequences, suggesting that a reflective model[9] in which the direction of causality ran from the construct to the indicators was suited for operationalizing the construct *food culture distance*. Similarly, according to the definition of export performance (Cavusgil and Zou 1994, p. 4), a firm may enhance its export performance by applying a workable export marketing strategy (i.e., with a reasonable degree of product adaptation). Consequently, the extent of export marketing strategy adaptation is defined as a causal factor affecting the firm's export performance (see Figure 1). On the other hand, the degree to which a firm's economic objectives are achieved would be reflected in economic indicators. Furthermore, all the indicators share a theme: economic performance. Thus, these considerations suggested that a reflective model was also suitable for operationalizing the construct *export performance* in the current study. This approach has been used in previous research (Han et al. 2007).

Results of the Structural Model

Based on the conceptual framework postulated in Figures 1 and 2, the validity of the structural model and its corresponding hypothesized theoretical relationships (H1 and H2) was assessed.

Accordingly, it was hypothesized that food culture distance (*FCD*) positively influenced the extent of export market strategy adaptation (*EMS*). Furthermore, it was hypothesized that *EMS* was positively associated with export performance (*EP*).

The fit statistics, i.e., $\chi^2 = 56.15$ ($p = 0.08613$), df = 43, $\chi^2/df = 1.3$, CFI = 0.98, NFI = 0.95, AGFI = 0.82, and RMSEA = 0.063, all indicate that the data adequately fit the proposed model. Table 4 summarizes the results of the path model.

Table 4. Structural Parameter Estimates

Structural relationships	Standardized factor loadings	Standard error	*t* value	R^2 value
H1: FCD → EMS	0.82	0.23	2.38	0.67
H2: EMS → EP	0.08	0.22	0.55	0.006

As indicated by a significant structural path estimate at the 0.05 level (*t* value = 2.38) from *FCD* to *EMS* (see Table 4), hypothesis 1 was supported by the data, implying a positive and significant relationship between *FCD* and *EMS*. Moreover, the R^2 value indicates that *FCD* explains a significant proportion (67%) of *EMS*. The effect of EMS on EP is positive as predicted but not statistically significant (*t* value = 0.55), indicating that hypothesis 2 was not supported by the data.[10]

[9] See Jarvis et al. (2003) and Podsakoff et al. (2003) for a discussion of reflective/formative models.

[10] To test for a non-linear relationship between *EMS* and *EP*, models with transformed product adaptation values (squared and logarithmic) were estimated (Stolzenberg and Land 1983, pp. 640–646). In none of the models was a significant relationship obtained. The author is thankful to an anonymous reviewer for pointing out this issue.

Discussion

The study's results provide support for H1: Food culture distance positively influences the degree to which a food exporter adapts its export marketing strategy. This implies that when a food exporter recognizes that it is exporting to a foreign market that differs substantially in food culture from its home market, it adapts its products to that specific market. This conclusion is consistent with previous research findings. Calantone et al. (2004) argue that, to satisfy customer needs in specific markets, firms should adapt the physical characteristics or attributes of a product and its packaging to the target market. Furthermore, when firms perceive a substantial difference between the export markets and their home markets they should adapt their offerings (Evans and Bridson 2005). This relates to a firm's assumption that its products are not suitable for a given export market, leading them to adapt its products to that market. Evans et al. (2008) point out that the perception of greater risk in target markets that differ considerably from the firm's home market may lead an exporting firm to conduct more extensive market research. This research may suggest that certain product attributes must be adapted to the export market.

The present findings indicate that food, which is a highly culture-specific product (Lannon 1986; Fiddes 1995; Anderson 2005; Montanari 2006; Rozin 2006), is adapted when exported to markets where customers have a significantly different food culture. This conclusion is also consistent with the results of previous studies demonstrating that products that cater to the needs of specific cultures have been adapted to export markets (Cavusgil et al. 1993; Cavusgil and Zou 1994). Accordingly, food exporters adapt their products to suit consumers' varied consumption habits and tastes in their export markets (Huliyeti et al. 2008).

The findings do not support H2: Export marketing strategy adaptation is positively related to a food company's export performance. Accordingly, the non-significant *t* value (see Table 4) indicates that neither a linear nor non-linear relationship between export marketing strategy adaptation and export performance can be established. Essentially, previous research findings are contradictory regarding the relationship between adaptation strategy and export performance. Cavusgil and Zou (1994) find that firms may enhance their export performance by adapting their products to the export market, as this better meets customer requirements in the export market, leading to increasing sales and revenues. On the other hand, proponents of standardization state that, due to the cost advantages of economies of scale, firms perform better when standardizing their products (Levitt 1983; Ozsomer and Simonin 2004; Evans et al. 2008). Furthermore, other researchers suggest a non-linear (i.e., inverted U-shaped) relationship between export marketing strategy adaptation and firm export performance (Yip et al. 2006; Johnson et al. 2011), meaning that exceeding a certain level of adaptation results in the adaptation cost surpassing the additional revenue generated (Buckley and Ghauri 2004). The results of the current research are consistent with O'Cass and Julian's (2003) finding that the decision to adapt or standardize the export marketing strategy does not influence export performance *per se*, i.e., either standardization or adaptation is appropriate and yields comparable performance.

There are at least two possible explanations for the lack of support for H2: (i) a food company's export performance may depend not only on its export marketing strategy adaptation but also on other variables not examined in this study, e.g., firm's strategically relevant resources (Barney 1991). According to Barney (1991), conceiving and implementing strategies requires a firm's

strategically relevant resources[11] (e.g., assets, capabilities, organizational processes, firm attributes, information, and knowledge). (ii) Export marketing strategy adaptation may be related to a food company's strategic rather than economic performance. The latter was measured in this study. However, Evans et al. (2008) find that the extent of export marketing strategy adaptation does not significantly influence a firm's strategic performance.

Consequently, this study suggest that applying an appropriate export marketing strategy (e.g., product adaptation) along with acquiring strategically relevant resources such as international competence (Cavusgil and Zou 1994; Evans et al. 2008) may enhance a firm's export performance.

Conclusions

The findings of this study contribute to the literature on international marketing, more specifically, on international agribusiness management. First, the study builds on the work of Cavusgil and Zou (1994), Cavusgil et al. (1993), and Ozsomer and Simonin (2004) on the adaptation of export marketing strategy. Adapting ideas from Askegaard and Madsen (1998), the present research introduces the concept of *food culture distance*, and, to the best of the author's knowledge, this study is the first attempt to quantify the concept of food culture (distance) and empirically validate the explanatory power of food culture distance in relation to export marketing strategy adaptation. The findings indicate that food exporters are taking account of substantial differences in food culture in export markets when planning and executing their export marketing strategies. Second, consistent with previous research findings (e.g., Dow 2000; Brock et al. 2011), the present study justifies the importance and relevance of measuring *distance* indicators at the cognitive level of decision-makers. Third, the findings suggest that, in line with Subramanian and Lawrence (1999), despite the globalization of markets, national borders still matter. That is, differences between national cultures (including food culture) along with other differences, such as political and economic dissimilarities, contribute to the distinctiveness of national markets that provide business opportunities for firms to exploit. Finally, this study suggests that applying a workable export marketing strategy (e.g., product adaptation) may not enhance the firm's export performance *per se*. Achieving the economic objectives of an export venture may also require acquiring strategically relevant resources.

Managerial Implications

The present findings have several implications for international marketing managers in food companies. The findings indicate that, due to the integration of food with consumer culture, marketing managers are paying close attention to dissimilarities in food culture (i.e., *food culture distance*) when planning and executing their marketing strategies. This enables food exporters to reach customers in overseas markets.

Markets with substantially different food cultures can provide business opportunities for food exporters in terms of greater ability to differentiate. However, exploiting these opportunities re-

[11] Barney (1991, p. 102) distinguishes between a firm's resources and its strategically relevant resources. Accordingly, those attributes of a firm's resources that enable a firm to implement strategies that improve its performance are strategically relevant resources.

quires applying appropriate strategies in order to reach the customers in those markets. The study suggests that implementing a workable export marketing strategy, for example, by adapting the products, is a necessary, although not sufficient, condition for achieving the economic objectives of an export venture. Enhancing export venture performance also requires firm resources such as assets, capabilities, organizational processes, firm attributes, information, and knowledge, all of which enable a firm to implement its strategies. Therefore, acquiring international competence by operating in international markets would enable a firm to make better decisions regarding marketing strategies and hence enhance its performance.

Limitations and Future Research Directions

Although the findings of this study have theoretical and managerial implications, I should note several limitations and make suggestions for future research. First, a more comprehensive structural model that includes other influential marketing strategy variables (e.g., legal, political, economic, and market structure differences between the home and export markets) would provide broader-based information about the impact of those variables and about the interaction effects between food culture distance and those variables. This would require a larger set of data with which to estimate a model including further variables. Second, the study focused on Swedish and Finnish food exporters only, so the findings may be limited in terms of generalizability across other countries and regions: it must be acknowledged that the identified relationships may differ in other regional settings. However, the findings of the study are expected to be generalizable in the food sector as such. Third, in this study, I assumed that the perceptions and responses of a company's CEO were representative of the whole company. It could be argued that, depending on the respondent's position in an organization, we might obtain different perceptions and responses from respondents in different positions. Fourth, in this research, the customers in each market (country) are assumed to be homogeneous. It would be interesting to consider dissimilarity between segments/subcultures within an export market and examine its effect on the adaptation of export marketing strategy. Fifth, in this study, the construct *EMS* was measured using a single indicator: *extent of product adaptation*. It can be argued that including other measurement variables[12] would better represent the theoretical concepts and improve the statistical estimation of the relationship between the concepts. Sixth, although the integration of food with culture has been underscored by previous anthropological research, the importance and relevance of food culture in business studies has been rarely researched (Schroeter et al. 2007). Therefore, more research in this area from the business perspective would lead to the presentation of more comprehensive models applicable to various theoretical and practical matters. Finally, as food is a rigorous manifestation of national culture, this study proposes that *food culture distance* could be used as either a sole or a complementary measure of cultural distance in cross-cultural research.

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[12] For example, adaptation of brand name, packaging, signage, and care labels (Ozsomer and Simonin 2004; Evans et al. 2008).

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Appendix A

Table 5. The Export Markets Covered by the Study

Australia	France	Rumania
Austria	Germany	Russia
Bangladesh	Holland	Saudi Arabia
Belgium	Italy	Sweden
China	Japan	Switzerland
Denmark	Kuwait	Taiwan
Dubai	Monaco	Ukraine
El Salvador	New Zealand	USA
Estonia	Norway	Venezuela
Finland	Poland	Yemen

Appendix B

Table 6. Full description of the constructs and their indicators

Latent variable: *food culture distance*	
Fundamental food style	• The speed the meals are eaten on weekdays • Number of small meals eaten • Interest in food products • Interest in cooking • Interest in eating at home (1 = totally the same … 7 = totally different)
Trends	• Concern about health • Convenience food in daily meals • Fast food in daily meals • Nibbling between meals (1 = totally the same … 7 = totally different)
Preferences	• Preference for stimulating and challenging tastes • Preference for tasting and feeling the food • Preference for fresh fruit • Preference for delicious, unhealthy food • Preference for liquid substances • Preference for creamy food • Preference for something to cut up (1 = totally the same … 7 = totally different)
Nibbling habits	• Nibbling candies and pastry • Nibbling fruits • Nibbling ordinary chocolate bars • Nibbling salty snacks • Nibbling good-quality mini meals • Nibbling convenient and unhealthy small meals • Nibbling sophisticated chocolate bars • Nibbling small delicious candies (1 = totally the same … 7 = totally different)

Table 6. *Continued*

Drinking habits	• Drinking red wine • Drinking white wine • Drinking strong alcohol • Drinking something quick and convenient • Drinking something healthy • Drinking cola products • Drinking beer • Drinking something expensive and sophisticated (1 = totally the same … 7 = totally different)
Diet willingness and behavior	• Health consciousness • Watching the weight • Asceticism • Controlled eating program (1 = totally the same … 7 = totally different)

Latent variable: E*xport marketing strategy adaptation*
Extent of product adaptation
(1 = no adaptation at all … 7 = total adaptation)

Latent variable: *Export performance*
Return on sales
(1 = decrease of more than 20% … increase of more than 20%)
Return on equity
(1 = decrease of more than 20% … increase of more than 20%)
Return on investment
(1 = decrease of more than 20% … increase of more than 20%)
Return on assets
(1 = decrease of more than 20% … increase of more than 20%)

Appendix C

Table 7. Goodness of Fit Indices (adapted from Hair Jr. et al. 2010)

GOF index	Interpretation	Acceptable level
Root mean square error of approximation (RMSEA)	Measures how well the specified model reproduces the observed data	Values less than 0.08
Normalized χ^2 (χ^2/df)	Measures how well the specified model reproduces the observed data	Values less than 3
Normalized fit index (NFI)	Assesses how well the estimated model fits relative to an alternative baseline model	Values close to 0.9
Comparative fit index (CFI)	Assesses how well the estimated model fits relative to an alternative baseline model	Values close to 0.9
Adjusted goodness of fit index (AGFI)	Assesses which model of a group of models is best	Value close to 0.9

Appendix D

Survey

Swedish and Finnish food and drink industry's strategies for internationalization

Purpose

The purpose of this survey is to examine whether 1) the perceived distance in terms of food culture between the company's home market and the export market affect the degrees of adaptation of export marketing strategy and 2) the adaptation of export marketing strategy would affect the company's export performance.

Application

All questionnaires will be treated confidentially and used only for research purposes.

Introduction

Please answer the following question regarding your company.

*** 1.1 Line of business (sub-sector)**

- ○ Bakery and farinaceous products
- ○ Preserved meat and meat products
- ○ Beverages
- ○ Processed and preserved fish, crustaceans and mollusks
- ○ Dairy products
- ○ Grain mill products, starches and starch products
- ○ Processed and preserved fruit and vegetables
- ○ Vegetable and animal oils and fats
- ○ Other

Psychic distance

Psychic distance is a perceived distance between the company's home market and a foreign export market. This distance is resulting from the cultural and business differences between the markets. A market can be perceived as psychically close even though it is geographically far from the home market if the company has, for instance, prior experience from that market and vice versa.

*** 2.1 Please choose two markets (countries) where the company has exported food products to during the last three years. Which of these markets do YOU perceive as psychically close respectively distant to the company's home market?**

CLOSE MARKET

DISTANT MARKET

Food culture distance

*** 3.1 To what extent do you perceive that following aspects of food culture is different/the same in the nominated CLOSE market in relation to the company's home market?**

	Totally the same 1	2	3	4	5	6	7 *Totally different*
The speed the meals are eaten on weekdays	○	○	○	○	○	○	○
Number of eaten small meals	○	○	○	○	○	○	○
Interest in food products	○	○	○	○	○	○	○
Interest in cooking	○	○	○	○	○	○	○
Interest in eating at home	○	○	○	○	○	○	○
Concern about health	○	○	○	○	○	○	○
Convenience food in daily meals	○	○	○	○	○	○	○
Fast food in daily meals	○	○	○	○	○	○	○
Nibbling between meals	○	○	○	○	○	○	○
Preference for stimulating and challenging tastes	○	○	○	○	○	○	○
Preference for tasting and feeling the food	○	○	○	○	○	○	○
Preference for fresh fruit	○	○	○	○	○	○	○
Preference for delicious, unhealthy food	○	○	○	○	○	○	○
Preference for liquid substances	○	○	○	○	○	○	○
Preference for creamy food	○	○	○	○	○	○	○
Preference for something to cut up	○	○	○	○	○	○	○
Nibbling candies and pastry	○	○	○	○	○	○	○
Nibbling fruits	○	○	○	○	○	○	○
Nibbling ordinary chocolates bars	○	○	○	○	○	○	○
Nibbling salty snacks	○	○	○	○	○	○	○
Nibbling good quality mini meals	○	○	○	○	○	○	○
Nibbling convenient and unhealthy small meals	○	○	○	○	○	○	○
Nibbling sophisticated chocolate bars	○	○	○	○	○	○	○
Nibbling small delicious candies	○	○	○	○	○	○	○
Drinking red wine	○	○	○	○	○	○	○
Drinking white wine	○	○	○	○	○	○	○
Drinking strong alcohol	○	○	○	○	○	○	○
Drinking something quick and convenient	○	○	○	○	○	○	○
Drinking something healthy	○	○	○	○	○	○	○
Drinking cola products	○	○	○	○	○	○	○
Drinking beer	○	○	○	○	○	○	○
Drinking something expensive and sophisticated	○	○	○	○	○	○	○
Health consciousness	○	○	○	○	○	○	○

Watching the weight	○ ○ ○ ○ ○ ○ ○
Asceticism	○ ○ ○ ○ ○ ○ ○
Controlled eating program	○ ○ ○ ○ ○ ○ ○

*** 3.2 To what extent do you perceive that following aspects of food culture is different/the same in the nominated DISTANT market in relation to the company's home market?**

	Totally the same 1	2	3	4	5	6	7 *Totally different*
The speed the meals are eaten on weekdays	○	○	○	○	○	○	○
Number of eaten small meals	○	○	○	○	○	○	○
Interest in food products	○	○	○	○	○	○	○
Interest in cooking	○	○	○	○	○	○	○
Interest in eating at home	○	○	○	○	○	○	○
Concern about health	○	○	○	○	○	○	○
Convenience food in daily meals	○	○	○	○	○	○	○
Fast food in daily meals	○	○	○	○	○	○	○
Nibbling between meals	○	○	○	○	○	○	○
Preference for stimulating and challenging tastes	○	○	○	○	○	○	○
Preference for tasting and feeling the food	○	○	○	○	○	○	○
Preference for fresh fruit	○	○	○	○	○	○	○
Preference for delicious, unhealthy food	○	○	○	○	○	○	○
Preference for liquid substances	○	○	○	○	○	○	○
Preference for creamy food	○	○	○	○	○	○	○
Preference for something to cut up	○	○	○	○	○	○	○
Nibbling candies and pastry	○	○	○	○	○	○	○
Nibbling fruits	○	○	○	○	○	○	○
Nibbling ordinary chocolates bars	○	○	○	○	○	○	○
Nibbling salty snacks	○	○	○	○	○	○	○
Nibbling good quality mini meals	○	○	○	○	○	○	○
Nibbling convenient and unhealthy small meals	○	○	○	○	○	○	○
Nibbling sophisticated chocolate bars	○	○	○	○	○	○	○
Nibbling small delicious candies	○	○	○	○	○	○	○
Drinking red wine	○	○	○	○	○	○	○
Drinking white wine	○	○	○	○	○	○	○
Drinking strong alcohol	○	○	○	○	○	○	○
Drinking something quick and convenient	○	○	○	○	○	○	○
Drinking something healthy	○	○	○	○	○	○	○
Drinking cola products	○	○	○	○	○	○	○
Drinking beer	○	○	○	○	○	○	○
Drinking something expensive and sophisticated	○	○	○	○	○	○	○

Health consciousness	○ ○ ○ ○ ○ ○ ○
Watching the weight	○ ○ ○ ○ ○ ○ ○
Asceticism	○ ○ ○ ○ ○ ○ ○
Controlled eating program	○ ○ ○ ○ ○ ○ ○

Export marketing strategy adaptation

Product adaptation

*** 4.1 To what extent does the company adapt its products when exporting to the nominated CLOSE market?**

No adaptation at all 1 2 3 4 5 6 7 *Total adaptation*

*** 4.2 To what extent does the company adapt its products when exporting to the nominated DISTANT market?**

No adaptation at all 1 2 3 4 5 6 7 *Total adaptation*

Company's export performance development

Economic performance

*** 5.1 To what extent have the following economic indicators changed in the nominated CLOSE market during the last three years?**

	Decrease of more than 20 %	Decrease of between 10-20%	Decrease of less than 10%	Neither increased nor decreased	Increase of less than 10%	Increase of between 10-20%	Increase of more than 20 %
Return on sales	○	○	○	○	○	○	○
Return on equity	○	○	○	○	○	○	○
Return on investment	○	○	○	○	○	○	○
Return on assets	○	○	○	○	○	○	○

*** 5.2 To what extent have the following economic indicators changed in the nominated DISTANT market during the last three years?**

	Decrease of more than 20 %	Decrease of between 10-20%	Decrease of less than 10%	Neither increased nor decreased	Increase of less than 10%	Increase of between 10-20%	Increase of more than 20 %
Return on sales	○	○	○	○	○	○	○
Return on equity	○	○	○	○	○	○	○
Return on investment	○	○	○	○	○	○	○
Return on assets	○	○	○	○	○	○	○

Thank you for your participation in this survey.

*** 6.1 If you are interested in recieving a report of the results of this survey please enter your e-mail address here.**

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The U.S. Produce Traceability Initiative: Analysis, Evaluation, and Recommendations

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Abstract

The Produce Traceability Initiative (PTI) was created by a coalition of fresh produce industry leaders as a voluntary industry effort to improve supply chain traceability, expedite tracebacks and recalls, and isolate food safety problems when they occur. In this paper we assess the ability of the PTI to meet broad traceability goals and make recommendations for guidelines that should be followed for an effective traceback system. Our recommendations include principles for system-wide uniformity, standardization of product reference numbers, creation of a reporting mechanism, and open and transparent communication.

Keywords: Produce Traceability Initiative (PTI), fresh produce industry, food safety

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Introduction

In the U.S., foodborne illness accounts for approximately 76 million illnesses, 325,000 hospitalizations, and 5,000 deaths annually (Mead et al. 1999). Based upon the USDA Economic Research Service (ERS) and Centers for Disease Control (CDC) estimates of incidence, outcome severity, and medical, productivity, and disutility costs, outbreaks of Salmonella and E. coli O157:H7 alone are estimated to cost the U.S. $3,124,811,739 annually (USDA 2009b).

While there are more than 200 known diseases transmitted through food, a primary complicating factor in detecting foodborne illness is that many pathogens or agents are not readily identifiable or diagnosable. The CDC estimates that more than 75% of illnesses, hospitalizations, and deaths are caused by unknown agents and pathogens. Some of the most recognizable pathogens today (e.g., E. coli O157:H7) were not recognized as the cause of foodborne illness until the last twenty years (Mead et al. 1999). Considering the degree of difficulty in identifying certain strands of illness through simple testing (since so many illnesses, hospitalizations and deaths are attributed to unknown agents), it is imperative that other means be developed to narrow the investigative process and more quickly locate the source of an outbreak. An effective traceability program would go a long way toward making our food safety system safer.

A foodborne illness outbreak is defined as two or more cases of a similar illness resulting from ingestion of a common food (Mead et al. 1999). Advances in technology have made the detection of foodborne illness and foodborne illness outbreaks more rapid. One such technology is PulseNet, a system utilized by the CDC. Pulsenet, which uses standardized protocols, software, and nomenclature, was created after a major E. coli O157:H7 outbreak in 1993 that caused approximately 800 illnesses. In the 1993 E. coli outbreak, scientists used DNA "fingerprinting" to match the strain of E. coli found in sick patients with a strain found in hamburger patties that were served by a fast food chain. Investigators realized that had they been able to more rapidly identify the DNA match they would likely have been able to prevent many of the illnesses that occurred. PulseNet was designed as an on-demand electronic database of DNA "fingerprints" of disease-causing bacteria taken in a standardized manner from both sick humans and food suspected of being infected. The CDC conducts searches of the database in order to identify clusters of illnesses with the same DNA footprint. This rapid electronic detection of DNA "fingerprint" clusters across the U.S. enables the CDC to distinguish and react to outbreaks far more rapidly than was previously possible; outbreaks that once took days to discover can now be detected in hours (National Center for Infectious Diseases 2009).

While technological and communication advances, such as PulseNet, have aided in the *detection* of outbreaks, there is still considerable difficulty in investigating and tracing foodborne illness outbreaks back to the *source* of the problem. A recent study by the Alliance for Food & Farming illustrates the importance of being able to identify the source of a foodborne illness outbreak (Alliance for Food & Farming 2010). In those investigations in which there was a successful source implication, only 2% of outbreaks and 6% of illnesses were confirmed as problems associated with growing, packing, shipping, or processing fresh produce. According to the same study, 65% of the illness outbreaks associated with produce were attributed to restaurant mishandling, 14% to mishandling at community events, and 13% to mishandling in the home. These data are based upon confirmed cases, and do not account for those outbreaks and illnesses in

which a source was never implicated. Because the source of a contamination dictates the response (contamination from mishandling produce at a community event would be handled very differently from contamination originating at the grower level) it is extremely important to be able to trace a foodborne illness outbreak back to its source.

Once the source of contamination and the scope of products affected are identified, the FDA attempts to trace forward to each location in which the product was shipped in order to facilitate a recall. Any recordkeeping lapse can cause delays in this process, thereby extending the ultimate removal of other contaminated product from commerce.

As the U.S. population becomes more urban and more removed from any direct link to the food supply, consumer confidence in the safety of the food supply is critical. Despite an increase in government oversight and significant advances in the detection and investigation of foodborne illnesses and outbreaks, the number and severity of incidents has not decreased in recent years. In 2009, the Produce Traceability Initiative (PTI) was proposed by a coalition of fresh produce industry leaders as a voluntary industry effort to "enhance total supply chain traceability to better serve our customers, to expedite tracebacks and recalls, and more narrowly isolate potential recalls or other problems when they do occur," (PMA 2009a; PMA 2009b; PMA 2009c). The PTI was developed to help establish a common system of traceability across commodities in the produce industry.

Although it was proposed by industry leaders, industry support for the PTI is mixed at best. The cost of implementation has been a major hurdle for both suppliers and distributors of fresh produce due to the additional technological and labor expenses involved in adding a lot-specific barcode to each box and then reading and storing that data. Additionally, the use of a highly standardized approach to labeling a wide variety of commodities with different growing, packing, and handling processes creates additional burdens for users. For those firms that are already complying with one-up, one-down regulations under the U.S. Bioterrorism Act, doubt exists that the addition of a "barcode on a case" will be helpful to a traceback investigation performed by the FDA. Finally, critics are worried that the PTI makes it easier for regulators to use the grower as a scapegoat by providing a simpler mechanism to point straight back to the point of origin instead of the path through which food traveled on its way to consumers.

Proponents of the PTI cite the differences between *process* flow (the physical flow of the product through the supply chain) and *transactional* flow (the flow of money and paperwork in the sales and distribution through the supply chain) as a major benefit of the PTI. A more robust tracing system that identifies each physical location (the process flow) through which produce is handled instead of only transactional data (such as invoices) could shorten the time-consuming process required to trace the physical path of produce through the supply chain. The electronic footprint left by the PTI can provide a standardized link between each point in the supply chain through which the product moves and, subsequently, might be contaminated. As the flow of money and sales is very often different than the flow of physical produce, authorities will be able narrow the number of commodities, brands, and companies implicated in an outbreak by matching outbreak locations to specific lots of product sold through those locations. Accordingly, labels identifying the brand owner, commodity, product identification, and lot would not be used simply to identify the original supplier but rather to identify all relevant handlers along the supply chain.

Objectives

This research has three primary objectives:
1. Establish future goals for an ideal fresh produce traceability system;
2. Assess the extent to which the PTI meets the goals of an ideal fresh produce traceability system as well as the stated goal of enhancing the supply chain by expediting tracebacks and recalls, and more narrowly isolating potential recalls or other problems when they occur; and
3. Develop a set of recommendations or principles to guide future traceability systems.

Procedures

Our first objective was to develop a set of future goals for an effective traceability system. To that end, we started with a thorough review of existing local, state, and federal regulatory requirements to develop a complete picture of the current chain-wide traceability system as it applies to produce, as well as its strengths and shortcomings. Primary research was then conducted in the form of open-ended interviews with growers, shippers, brokers, retailers, foodservice providers, and distributors in the fresh produce supply chain. The objective of the interviews was to determine the strengths and shortcomings of the current system in order to formulate a set of future goals for a successful traceability system. This primary research was supplemented with publicly available comments and information from presentations by major firms in the produce supply chain. A total of 17 interviews were conducted with representatives of grower/shippers, brokers, processors, retail chains, technology vendors, and industry associations using an interview guide. The majority of these interviews were carried out in-person; a few interviews were conducted by telephone. Secondary research was then analyzed, focusing on the strengths and shortcomings of the existing system. The analysis was based on previous academic work in the field, government documents, public testimony of supply chain participants before Congress, the FDA, the CDC, the USDA, legislation, and documentation from various electronic sources regarding specific initiative data. We also examined two case studies for a deeper understanding of the food safety system, the 2006 E. coli contamination of fresh spinach and the 2008 salmonella contamination of peanut butter.

Second, we develop a set of future goals that would improve upon the effectiveness and timeliness of the current traceback system**.** A four stage iterative process was employed such that these goals encompassed, as accurately as possible, data accumulated through interviews as well as the analysis of secondary research. The first stage was to lay out each "shortcoming" in the current system as illustrated by primary and secondary research (interviews with supply chain members, FDA testimony and public releases, and an analysis of recent major outbreak and recall shortcomings). The second stage was to examine the shortcomings identified through various methods, looking for similarities such that they could be grouped into more cohesive categories. The third stage was to turn each category of "shortcomings" on its head and to develop "goals" for an effective traceability system. Finally, we compared the future goals to the original shortcomings from stage one to ensure that the synthesized final goals did not lose their original substance. This process was then repeated until the substance of the original shortcomings and the substance of the synthesized goals were one and the same.

The third step was to assess the PTI relative to the future goals. We laid out the PTI in detail and compared the system that the PTI would create in the supply chain to that of the future goals. This analysis allowed us to highlight what the PTI accomplishes conceptually and where it falls short. It is important to note that the PTI is described as a "living document" which is regularly updated. In order to maintain a consistent analysis, a single version of the PTI documentation as of May, 2010 was utilized.

Finally, based on the above analysis of the future traceability goals and the assessment of the PTI, we develop recommendations or principles that should be adopted in order to help ensure that future versions of the PTI will result in an effective, timely, and accurate traceability system for the produce industry.

Traceability Future Goal Development and PTI Assessment

In the following analysis we develop five future goals for a successful traceback system. We then use these goals as a means to assess the PTI's potential to increase the speed and accuracy of traceback and recall events.

Goal I. Standardization of Datasets

The FDA has indicated that a lack of uniqueness (or existence) of lot or code information makes any trace-back much wider in scope and therefore more complicated and time-consuming than would be the case with a unique lot identifier (USDA 2009a). The level of detail that should be captured is the primary issue. As evidenced through grower/shipper interviews discussing a wide variety of commodities, the growing, harvesting, handling, processing and distribution of each unique commodity can vary so dramatically, that there is no single level of detail (e.g. by field or by day) that most accurately and efficiently fits each process and accomplishes the goal at hand. To this end, interview data were used to examine the level of specificity that would allow the narrowest possible recall in which all possible contaminated products could be effectively identified. The ideal level of detail would minimize financial damage incurred throughout the supply chain and that provide the breadth necessary to remove all potential contaminated product from commerce. Determining this level of uniqueness in identification comes down to two primary categories of information: common nomenclature and common level of detail. Goal I is therefore broken down into two sub-goals reflecting these two categories. The first category, common nomenclature, is further broken into three sub-categories, company identification, discernable product characteristics, and lot or batch information.

Goal I.a. Common Nomenclature - Description

The application and use of a common language for fresh produce is necessary such that each member of the supply chain has a shared understanding of a traceability "language." The Harvard Business Tomato study concludes that the lack of consistency in the data presented causes major delays in rapidly following product through the supply chain (McEntire et al. 2009). Use of such a common nomenclature to describe individual products is essential to performing a rapid trace-back if technology is to be employed to be used with more rapid data mining techniques. A technology vendor put it most succinctly, indicating that when dealing with this nomenclature,

the specific means of delivery are irrelevant. Put another way, the utilization of a common technology or method of transfer across the supply chain is more important than the choice of the technology or method.

The choice of a common nomenclature is analogous in many ways to the use of different languages. If one member in the supply chain only speaks English, another only speaks Spanish and a third speaks only Chinese, then rapid communication is virtually impossible without the extensive use of a third party translator. It is imperative that any traceability nomenclature be uniform and consistently applied across the supply chain so that each member of the supply chain is able to read and understand the information. This nomenclature should be universal and allow for uniqueness on an international scale (especially considering the high degree of fresh produce imports into the U.S. food supply). This will allow the FDA to skip the step of "interpretation" from multiple "languages" and instead focus upon commonalities in source implication.

Interviews revealed that perhaps the most important part of a traceability system in terms of speed and accuracy is providing regulators with enough information such that they know both the right questions to ask as well as the right people to contact. A thorough analysis of our interviews and research on the current traceability process, indicate that there are three key components in to the nomenclature: unique company identification, discernable product characteristics, and lot or batch information. These are discussed below as Goals I.a.1., I.a.2., and I.a.3.

Goal I.a. Common Nomenclature - Assessment

The PTI directly addresses the concept of unique identifiers by utilizing the GS1 standard and the GS1 coding methodology as a means of creating a common nomenclature that is both universally recognized and unique in nature.

On a macro level, GS1 is an internationally recognized organization of common standards that provides a platform for unique codes. Standards for the individual codes that make up the PTI data scheme are all recommended based upon standards that are already in place and being used for other commercial purposes internationally. As a selection for nomenclature, the use of existing GS1 standards ensures that each member of the supply chain is speaking the same language to the degree that individual data elements are presented and utilized in a uniform manner across the supply chain. The selection of a uniform body of codes ensures that from a visual perspective (i.e. looking at the codes) and a system perspective (i.e. storing and accessing the codes) the individual elements are universally understood as the same data elements and designed for uniqueness in identification. GS1 does, indeed, offer the type of consistent nomenclature that is necessary as well as standards for the best-use and application of that language.

Goal I.a.1.Company Identification - Description

The ability to identify companies and their physical locations in a uniform and, most importantly, unique, fashion is paramount in any traceability nomenclature. Issues in identifying which company handled the product or grew the product drastically limit the scope of the investigation. As one interviewee pointed out, following the current one-up, one-down paper trail (as dictated by

the U.S. Bioterrorism Act) sometimes means following the financial flow of products rather than the physical flow.

By way of interpretation, this means that knowing the unique physical locations through which the product travels allows analysis of commonalities among multiple implicated products. The outcome of a limited investigation means that the speed and ability to implicate a specific product (and simultaneously exclude others from implication) is limited only by the specificity of the products identified through consumer outlets. In an industry where private labels are packed by multiple companies, identification of the specific company from which the fruit originated as well as those facilities through which the product passes is necessary.

Additionally, this interpretation suggests that the use of a unique identifier for each company is an effective method of following the physical product through the supply chain (i.e. the physical path the product takes as opposed to the monetary path in which dollars flow through the supply chain). Standardizing datasets throughout the supply chain requires that each member of the supply chain that handles product be identified uniquely and tracked uniformly throughout the process. In this way, the immediate previous source of the product (the prior firm that physically handled the product) may be recorded as well as the immediate subsequent recipient (the subsequent firm that physically handles the product).

Goal I.a.1.Company Identification – Assessment

The use of the GS1 Company Prefix numbers as the recommended code methodology within which to store and transmit the common nomenclature allows for the creation and use of datasets that ensure uniqueness of the source firm from which the product originated. Furthermore, both shippers and growers who maintain their own brand and processors who reconfigure or change the product in some fashion are required to apply labels with their company prefix.

While the PTI adequately handles the issue of determining the immediate prior firm that modified the product, it does not call for standardization of company codes at other levels of the supply chain, including some levels of distribution, retail, etc. This presents a situation in which regulators are presented with uniform company information at the application level (i.e. the medium selected for application of the dataset) that indicates the immediate prior modifier of the information but does not provide them with consistent information with which to trace the product fully through the supply chain. In other words, they will receive uniformly applied company codes that specify an original grower/shipper or brand owner in some parts of the investigation while needing to use other forms of identification for distribution centers, storage facilities and other locations that the product may pass through in other parts of the supply chain. This unevenly applied uniformity in the application of traceability presents a situation in which data reported are inconsistent and do not fully meet the goal of uniform company identification throughout the supply chain. By not utilizing a standard for each "stop" along the path of produce through the supply chain, investigations must rely upon multiple forms of information gathering in addition to the standardized data provided through the PTI. Utilization of standardized company codes across every member of the supply chain ensures that a dataset from one firm would indicate both the prior source and immediate destination and can be matched electronically with the datasets provided by the source company and destination company.

Additionally, the requirement that buyers with private labels utilize company prefixes as a standard part of the dataset (which indicates only the prior source of the product in which the product was modified or changed) does not accurately allow for the rapid traceability of physical product flow throughout the supply chain. Instead, regulators must first contact the buyer in order to even begin to identify the product. The PTI documentation on private labeling explains that the company prefix should be based upon the brand identified on the exterior of the box. Only if the exterior of the case is branded by the original grower or shipper (with private label packages inside the case) should the company prefix reflect the original source (PTI Steering Committee 2009). Again, it is important that company prefixes be used uniformly throughout the supply chain such that each firm that handles the product may be identified and that the combination of company and other unique data elements (product characteristics and lot/batch number) are able to be used uniformly nationwide. As many shippers who provide private label services for a buyer also either have a brand of their own (often sourced from the same lot) or provide private label services for multiple companies, the application of company codes is unnecessarily complicated in that it implicates multiple unique products, with different company or brand names, that all point back to the same original field.

As an example, following the goals established above, the dataset at each firm between a shipper, distributor, and retailer would include unique identifiers that show the flow of product from physical location to physical location. The shipper, distributor, and retailer's unique company codes are referenced, respectively, as the immediate prior and subsequent recipient of the product. The company identifier on each individual case identifies the last member of the supply chain to pack, reconfigure or process the product. Once reported correctly to investigators, the product flow can easily be determined because each unique location with each unique product creates a flow of product from location to location. As currently laid out in the PTI, this data flow is interrupted; the label indicates the brand owner (which, in the case of private labels is often a retailer and not a grower or processor) meaning further investigative work is required in many cases to trace back to the ultimate source. Additionally, because only brand owners are required to establish company identifiers, many links in the physical path of the product flow will not be identified without significant work tracing the product manually via documentation such as purchase orders, bills of lading, and invoices to determine each physical stop. As contamination may occur at locations in which the product physically passes through as opposed to locations in which it may simply be marketed (i.e. retail stores), identifying the brand owner doesn't necessarily assist in identifying possible contamination sources.

While the PTI does utilize a standardized company code, it does not use the company code uniformly across the supply chain. Company codes either represent the last organization to modify a package (as in a fresh-cut processor) or they do not (a private label owner that contracts the growing/packing/processing of products). Utilization of the same exact company code to indicate multiple physical points in the supply chain does not create a standardized data set. A standardized data set, when assembled with others across the supply chain in an investigation, should easily match the immediate prior handler with the immediate recipient. In other words, the dataset for the second location in a product's journey should indicate, in a uniform use of coding, that the first location was the immediate prior handler and vice versa. This would minimize or eliminate the need to fill in gaps for analysis of traceability data thus minimizing unnecessary and time-consuming extra steps in an investigation.

Goal I.a.2. Discernable Product Characteristics– Description

Discernable characteristics allow each level of the supply chain, including the end consumer, to identify and distinguish any given product from any other. This detail can include commodity, variety, brand, packaging, and post-harvest processing (e.g. cut or bagged). The important point is not the level of detail as much as the commonality of detail and understanding across the supply chain and by the consumer. This level of detail may or may not be referred to by each member of the supply chain or on individual paperwork used throughout the supply chain (i.e. bills of lading or invoices). While not every member of the supply chain has access to a visual portrayal of products still available for consumption (i.e. product that is still on grocery shelves but is no longer in pipeline inventory), it is also the case that not every member of the supply chain has access to existing electronic data (i.e. consumers at home or grocery clerks in remote areas without constant access to electronic means of communication). By matching the electronic identifier with the visual identification that makes the product discernable from another, implicated fresh produce may be communicated throughout the supply chain as well as with consumers and regulatory bodies in a uniform manner. This means that what the consumer physically "sees" when making a purchase is what the code "says" when used by members of the supply chain.

Goal I.a.2. Discernable Product Characteristics– Assessment

The PTI uses reference numbers to identify each of a company's products. The reference number utilizes GS1's product identification scheme for use in its standardized GTIN numbers. A GTIN, or Global Trade Item Number, is a standardized code devised by GS1 to globally identify any item that could be sold or appear on a price list (GS1 2009). In defining the methodology through which product reference numbers should be selected and identified, the PTI plan calls for product identification based upon the characteristics primarily used for selling. While this method makes sense from an e-commerce perspective, it is unclear how the standardization of primary product attributes based upon selling characteristics will directly enable trace-back investigations and recalls to occur in a more timely fashion. As shippers do have different selling processes (even with the same commodities, processes, and volumes), the identification of a product in a recall situation involves sifting through many product identification codes to interpret the range of codes that essentially mean the exact same thing. That is to say, regulators would again find themselves trying to connect the dots between unique points of data (disparate reference numbers) that all potentially mean the exact same thing in the context of a recall. While advanced analysis using analytics software can aid in this process, investigators must still ultimately take the time to determine whether or not one code is the equivalent of another. This added overhead and work required to tie things together is unnecessary for an accurate recall. For example, while two separate companies both ship bags of chopped romaine lettuce each will have a unique methodology for creating reference numbers and, thus, will have different reference numbers. While this differentiation is, to some degree, due to the nature of the differing methods by which individual companies buy and sell, some concrete methodology should be established such that multiple reference numbers don't exist to identify the same identical product (as with a bag of chopped romaine lettuce). If the differentiation between the two reference numbers is, indeed, brand, this should be spelled out. The characteristics necessary for an effective trace-back to link

to what a consumer actually eats are the characteristics that need to be identified in a reference number.

The sheer quantity of potential unique reference numbers has caused a major problem. There is great disparity in the understanding and application of reference numbers among shippers. Shippers with a similar number of commodities, processes, and relative volumes had differences in the number of GTIN's utilized for their products as large as 1,000 reference numbers. One shipper specifies that the lowest level of detail required is the commodity while others engaged in the same business identify GTIN's based upon every possible combination of variables in the selling process. The level of detail specified for reference numbers as laid out in the PTI is clearly ambiguous to those members of the supply chain charged with the creation of the reference numbers. In our interviews, not a single set of shippers had the same philosophy for assigning GTIN's. While the voluntary nature of the PTI means that some growers and shippers may not follow its guidance, sufficient guidance has clearly not been provided to assist those charged with the responsibility for implementing the PTI. As evidenced in interviews, spoken nomenclature used to refer to products tended to be very similar while the assignment of reference codes applied to these same products tended to vary greatly.

From an implementation perspective, the uneven use of reference numbers will create an added cost and burden to each member of the supply chain. Any time any single member of the supply chain adds or modifies a reference number, each other member that may potentially touch that product would potentially need to be contacted with updated GTIN's so that their method of receiving and recording the dataset retains its integrity. The tools suggested by the PTI for synchronization of GTIN's between supply chain members will largely minimize the difficulty in the data exchange portion of implementation. However, the data synchronization tools provided cannot match product received with an individual shipper's internal inventory system. That is to say, linking of GTIN numbers to an inventory system will, at a minimum, require either separate systems of identification (using internal product ID numbers) or a manual process of matching each synchronized GTIN and company prefix to a back office system by hand. For some members of the supply chain (such as distributors), this process will entail manually linking thousands upon thousands of unique codes to internal item numbers. The PTI documentation regarding external product substitutions for the PTI refers to "substitutes" as a product that can be substituted for another insomuch that it does not "compromise the specification or quality of the product" (PTI Steering Committee 2009). Considering that many of these thousands of items will fall into the category of substitutes, linking GTIN's to existing systems will be a tedious, expensive, and arduous task.

While the PTI has provided a common nomenclature and schema for product characteristics, it simply does not fully establish an approach for uniquely identifying products throughout the supply chain that will improve the speed of a recall. Utilizing a common nomenclature to establish standardization and then creating unique reference numbers for every type of product shipped from every company that ships the product is analogous to differing interpretations of language and slang terms across countries that speak the same language but with different dialects. If the goal of future product traceability is a more rapid and limited recall, simplicity and uniformity in differentiating individual products should be the goal of assigning reference numbers within a given commodity group. Allowing each company to individually determine the

level of detail to be used in assigning reference numbers for each product introduces a great deal of ambiguity and confusion into the system.

Goal I.a.3. Lot or Batch Information—Description

Lot or batch information should be unique to the degree that it segregates contaminated products to the maximum scope through which cross contamination could occur. For example, in some commodities this would constitute identifiers at the level of an individual field where contamination could be caused in a small portion of the field (e.g. droppings from wild pigs) or could be the caused by something that affects the entire field, such as a contaminated water source. The level of uniqueness for the lot should also represent the lowest common denominator of potential contamination (as in the case of water contamination). In many situations, the cause of contamination could be either a single field or multiple fields. However, the lowest common denominator is that which provides the narrowest scope. In other contexts, the lot or batch identification would be defined by a totally different set of parameters (for instance, cut and bagged mixed lettuce where the end product could consist of multiple varieties from multiple fields, farms, and/or growers).

The key point in utilization of the lot or batch number is to minimize the impact of a recall by narrowing the scope of the product that is implicated. Additionally, the lot or batch number becomes extremely important when products are processed (i.e. cut or comingled) such that a recall from a single distributor does not cause a much broader recall of processed products. If data on lots and batches is not consistent and does not follow the product, FDA's efforts to trace the product back through the supply chain may cause them to lose the trail of the product; the FDA may not know that they are still tracing the right product (USDA 2009a)

Additionally, it can be argued that simply following a product by its "product" characteristics may lead to a much wider recall than it would with a lot or batch number attached to it. For example, many trucks carry multiple commodities from multiple companies and many of the products are from multiple original lots. Thus, a trace-back for an apple that may have been caused by a problem on a single truck where temperature controls were not monitored could lead to a much broader recall of apples from one shipper or even for the entire apple industry. A similar situation occurred with spinach products in 2006 where an isolated problem was initially attributed to the entire spinach supply and resulted in a very broad recall of the entire spinach crop across the U.S.

Goal I.a.3. Lot or Batch Information—Assessment

Interviews with shippers showed a wide variety of philosophies in lot/batch number assignment. Some shippers have lot/batch number schemas that include very detailed information such as grower, field, date of harvest, crew and machine while others referred broadly to lots as windows of time (i.e. a single day of harvest) or a single ranch. The approach each shipper took in assigning lot or batch numbers was based largely upon their own processes and needs and not on any uniformity principle. Although the lot or batch identification is a key element to traceability, the PTI action plan has provided no guidance in establishing uniformity in lot/batch numbers. The resulting variety of detail and lack of consistency is the current outcome.

Goal I.b. Common Level of Detail—Description

In many ways, the level of detail is an integral part of the interpretation of traceability nomenclature. Depending on the commodity, post-harvest processes, and location in the supply chain (i.e. shipper's warehouse, processor's cutting line, or grocery store shelf), fresh produce has many levels of detail. In some cases, product is shipped and/or stored in bulk bins. In others, the product is stored in cases and palletized. Many commodities are placed on grocery shelves in bulk with no packaging (e.g. much tree fruit).

Interviewee's were relatively consistent in indicating that some method of implementing precise labeling and tracking at the unit level (i.e. on each individual potato or carrot) would allow investigators to minimize a recall if the consumer still had a sample available of a suspected food product. Of course, in practice this would rely on consumers possessing whatever portion of the product is remaining. Additionally, the reality is that labeling each individual type of produce by unit is neither feasible nor effective for a number of reasons, as both shippers and distributors pointed out. First, it is physically impossible to affix individual labels to many items such as bulk carrots or green beans. Second, traceability would not be improved through the supply chain by labeling individual items as they are shipped and moved through the supply chain in cases. Third, considering that a major problem for investigators is that consumers either don't remember what they ate in detail or have disposed of the product by the time regulators perform interviews, individual item labels don't do much to help narrow an investigation (USDA 2009a).

In the end, a trace-back that accurately identifies a source product that has been contaminated after the product has been consumed or disposed of (across the supply chain) does nothing to mitigate the spread of an outbreak. Trace-backs must occur with both accuracy and speed. In the world of perishable fresh produce, traceability yields little gain to consumers if product has already expired or been consumed by the time at which it is implicated. In order to implicate the specific source of an outbreak, an investigation must either match a strain of illness from patients to a particular food product, or investigators must find a statistically significant link between geographically dispersed clusters of the same strain of a pathogen in products consumed by those patients. In other words, narrowing the list of "possibilities" by having some idea what each patient consumed to find commonalities and then searching for common sources of those common products could drastically narrow the search. In order to establish this link, investigators must first have the ability to narrow the options. As customers often don't remember specifics of the products they have consumed, they are more likely to remember in general what they consumed (i.e. a bag of lettuce as opposed to a specific variety of lettuce) and where they shop (USDA 2009a). In this case, with the knowledge of what type of fresh produce (i.e. which specific types of romaine lettuce as well as which specific lots each of romaine lettuce) they have a heightened ability to statistically implicate a very narrow line of products and lots. Knowledge of what products could have been consumed at a narrow level of detail gives investigators an opportunity to not only exclude other products, but also to follow each product's path back through the supply chain for source commonality.

Therefore, the ideal level of detail for the for the application of nomenclature is that which is capable of both 1) narrowly identifying a specific company's lot-specific product (i.e. the lowest common denominator), and 2) being applied at a level of detail such that it is both identifiable

and visible to the largest number of supply chain members as any other form (i.e. pallet level of detail vs. case level of detail).

The use of data modeling to map commonalities between products has been tested and proven to be both successful and rapid, though the actual process of gathering and standardizing data (a necessary process) has caused long delays in data processing. Researchers working with Harvard University spent weeks "cleansing" data such that the reported information was fed to a computer modeler in a standard fashion. Once standardized, a visual trace-back and implication was possible in an incredibly rapid manner. Thus, the more data available in a pre-standardized format (such that investigators need not "cleanse" the data) the more rapidly one can expect statistical analysis to yield results for implicating an individual source product while also eliminating many others (McEntire J. C. et al. 2009).

Goal I.b. Common Level of Detail—Assessment

The PTI posits that, while item level traceability may occur in the future, the case level of identification makes the most sense at this time. The case level 1) may be implemented in a way that is not prohibitively costly or time consuming; 2) may be applied to all produce, including bulk produce that is too small or in some way cannot accommodate a unit-level sticker; and 3) is the lowest level of detail that is both feasible and handled by each member of the supply chain.

The debate over level of detail is one with fiercely differing views across the supply chain. Many individuals in the supply chain question the reliability of case-level traceability because produce that arrives at a retail store in a case is seldom purchased by consumers in that case. That is to say, there is still a degree of variability in the implication of a single product and/or lot because products from different companies and lots are comingled outside of the box for consumers to purchase. The argument is that case-level traceability does not allow regulators to implicate individual products in any narrower scope than they is currently available.

Based upon the methodology that is used in the epidemiological investigations that precede and accompany trace-back investigations, a broader outbreak of a specific illness provides many more points of data. For example, if (at a given time) there are twenty company prefixes in commerce for a given product and each of the twenty company prefixes are accompanied by five different lots that were received and placed into commerce at the store level, regulators are provided a great deal of data in which to build a confidence interval to statistically determine the likely culprit of contamination.

To illustrate, consider a nationwide outbreak in which several commodities are suspected. If data is readily available that allows investigators to view the potential products and associated lots for each of these commodities, then they can begin to establish commonalities. For example, an instant illumination of each product flow provides the possibility of finding a common point of contamination (a particular warehouse, truckload or origin lot). This allows investigators to limit the scope of an investigation by quickly focusing on the commonality and pulling only that product from commerce rather than causing a recall for an entire commodity or multiple commodities (as has happened in recent history).

Considering that the greatest damage to a commodity supply chain is the result of a massive outbreak (such as the 2006 E. coli outbreak in spinach), the case level as proposed in the PTI seems to adequately provide regulators with a great deal of uniform, readily available data that identifies product in 1) the narrowest feasible scope (i.e. each individual company's product by lot/batch) and 2) at the lowest level of detail utilized by each member of the supply chain (and which is subsequently recorded).

Goal II. Linking Data Elements—Description

The FDA has also noted that it is not only important that there be standardized data elements, but also linkages between those data elements from farm to fork. More specifically, the FDA has made the point that while standardized data elements are incredibly important to any traceability system moving forward, they "can't stand alone" simply because the existence of a data element does not create a link for the product across the supply chain (USDA 2009a).

Additionally, shippers with FDA investigation experience pointed out that it is imperative that fresh produce be traceable first by the *physical* path it traversed through the supply chain. That is to say, a trace-back motivated by existing documents such as invoices and bills of lading are suited to trace product back at the transactional and monetary level. As noted in a recent study (Alliance for Food & Farming 2010), contamination of food product can happen at any point in the supply chain in which the product is handled or moved (for example, a cooling failure or exposure to other harmful substances, etc.). Establishing a statistical link between individual lots of product to implicate as precisely as possible links between physical paths of multiple products/lots must be available and accurate.

As pointed out by the International Foodservice Distribution Association in their public response to the FDA's request for comments on traceability, the need for each link in the supply chain to maintain any list of ingredients for each product received is neither feasible nor helpful in the trace-back process (IFDA 2010). Rather, the organization in the supply chain that reconfigures or remanufactures the product should be responsible for establishing the link between each source product and the final lot/batch produced and shipped. As such, for an accurate and rapid recognition of each individual product's movement through the supply chain, there needs to be an electronic link between individual products used as ingredients and the lot/batch produced such that a trace-back can effectively locate product still in raw, bulk form or as part of a comingled or remanufactured product.

Goal II. Linking Data Elements—Assessment

The PTI provides recommendations for linking data elements (such as reference numbers) across the supply chain through the use of tools provided by GS1. GS1 can, through the use of standardized company codes and nomenclature, provide an electronic means to link identifiers to actual descriptions of the company and product. It is unclear at this stage to what extent this tool is being utilized through the supply chain and unclear that it is the methodology of choice for organizations across the supply chain. While it is reasonable to assume that the PTI itself should prescribe a specific means of linking data elements to the description of those data elements (i.e. a reference number linked to the description of that product), it must be the goal of any traceability

initiative to work across levels of the supply chain to establish commonality. A manual system (i.e. e-mailing spreadsheets with new reference numbers) of exchanging data elements that are intended to provide links between systems is cumbersome at best and, as evidenced through interviews, not currently effective. In most cases, there is confusion as to where reference numbers are to be sent and who needs to receive them.

The concept of linking data elements is also complicated by the of "brand owner" as the preferred methodology of company prefix. The utilization of company codes that clearly indicate the physical path (i.e. each warehouse through which the product flows) allows investigators to rapidly trace multiple products to establish commonality. However, the use of the brand owner as *the* company identifier creates a situation in which the datasets for some product will show the physical path by linking the company prefix of each location through which the product travels to the company prefix of the owner of that *location*. As currently implemented and recommended in the PTI, the use of company prefix simply provides a link back to the grower or prior processor of the produce and provides no unique company and/or location information for those locations in between the origin and ultimate consumption of the product. Considering that recent research suggests that a majority of outbreaks are caused by factors occurring after the product is grown, the use of currently proposed methodology appears to provide sufficient data on only a subset of locations (Alliance for Food & Farming 2010. Additionally, the use of "brand owner" in the case of private labeling will not go so far as to even provide that link. As currently written, the use of company identifiers is well employed to uniquely identify the individual product, but not extended to the degree that it provides a full product path dataset throughout the supply chain; the currently proposed labeling will not consistently lead investigators to a point in the supply chain (i.e. original grower or modifier) and will fail to uniquely provide linkage from location to location between farm and ultimate consumption.

In order to effectively trace product through the supply chain, it is imperative that the issue of tracing physical product flow versus the monetary flow of transactions be addressed.

Goal III. Standardization of Reporting Methodology —Description

In a major outbreak, regulators face multiple challenges in terms of information gathering for trace-backs. Among these are the window of time in which each organization has to report traceability data as well as the wide variety of both information formats and reporting formats. Thousands of pages received in differing reporting formats and mediums (i.e. fax, mail, photocopies, etc.) translate into more time assembling and interpreting the data. It is not only the access to and availability of uniform product information that is important, but also the uniformity in which the data are received. The Harvard Tomato study reinforced the need to establish commonality both in data and in reporting (McEntire J. C. et al. 2009). Common nomenclature on its own does not mean that the data reported is uniform (i.e. each individual back office system produces reports that have unique layouts, characteristics, descriptions, etc.) Additionally, recent outbreaks have proven that even a single day saved in the discovery and implication can make a difference in the outcome of an outbreak and, most importantly, in lives saved. Regulators must have rapid access to data that is not only collected in a uniform nomenclature but reported in a uniform manner as rapidly as possible. Electronic transmission is the fastest possible mechanism, assuming it is reported uniformly across the supply chain.

A major concern expressed by many of those interviewed is privacy. This was evident across the supply chain as many individuals expressed a concern for the privacy of proprietary trade data because of the potential that this proprietary data may be made public if the information were to become readily available to regulators in a "cloud-based" system. Shipments between supply-chain members constitute trade secrets and exposure of these "secrets" to competitors presents a major challenge in maintaining competitiveness. There is widespread fear that traceability data that is accumulated in a single location or available "on-demand" will be used for purposes other than tracing product by regulators and that shipment and product data may fall into the hands of a company's competitors. In an era of enhanced scrutiny and availability of data from regulators through means such as the Freedom of Information Act, organizations have a high level of concern that widely available data will not remain private and be used only as promised. While the use of electronic reporting in a standardized format for the traceability nomenclature is ultimately an important part of traceability, the issue of information privacy must be addressed. Based upon information from interviewees, a method for reporting in which regulators may receive rapid responses to standardized requests while simultaneously minimizing the chance of potential privacy violations for supply chain members through exposure of non-necessary data is ideal. A higher level of legal protection ensuring the protection of trade data will lead to a more cooperative industry and a greater likelihood that the necessary data will be provided.

Goal III. Standardization of Reporting Methodology — Assessment

The PTI does not, in any way, suggest or speak to a reporting methodology. The absence of standardized electronic reporting of data is an important method with which to ensure that data is "cleansed" so that regulators utilize it effectively. While the PTI suggests that data be recorded electronically, it provides no guidance whatsoever as to what additional information the dataset should include and no method or recommendation for the provision of data to regulators. Lack of universal company prefixes for each firm in the supply chain that handles the product adds additional ambiguity in the linkage of products from one supply chain member to the next.

The spinach recall of 2006 made clear that many hours were wasted simply sorting through the wide variety of data formats received (i.e. fax and mail) as well as differing formats and descriptions of data elements used in internal documentation (i.e. bills of lading and invoices). These wasted hours resulted in an investigation that proceeded much more slowly than would be the case with standardized data. The *storage* of standardized data as described by the PTI plan is only a first step toward improving the speed and accuracy with which a recall occur. The *presentation* of that data in relation to the data stored by other members in the supply chain is paramount in speeding up the process. It is critical that the data be both standardized *and* reported in a standardized manner.

Goal IV. Equal Recordkeeping Requirements across the Supply Chain — Description

The comingling of fresh food products at any level of the supply chain may be cause for worry when not properly documented. A 2008 outbreak of E. coli O157:H7 in ground beef was traced back to a common retailer who didn't keep records (called "grind logs") of which lots of beef were comingled into packages of ground beef. As a result, the Food Safety Inspection Service

(FSIS) was unable to trace the contaminated product back to its source to ensure that no additional contaminated beef from that lot was still being sold in other locations (USDA 2009a).

Grower/shippers indicated emphatically that they were very concerned that all organizations will not be expected to follow the same guidelines. Specifically, they expressed concern that small companies need to be held to the same standard as large companies. This concern was expressed not so much as a matter of fairness but rather with an eye towards effectiveness. In a supply chain with many links between the source and the ultimate consumer, a single broken link may cause the trail to be lost in a trace-back. If small farms, small distributors, and small retailers are allowed to bypass any requirements to track product and provide product source data that would make a trace-back and subsequent trace-forward more effective, the implementation across other members of the supply chain becomes compromised. In other words, a partial trace-back including only members of the supply chain deemed "large" will leave holes in the investigation and potentially cause inconclusive implication and more widespread recalls.

Pressure from industry partners and buyers may also serve to "raise the minimum bar." Shippers who do not comply with existing regulations may be forced to, at a minimum, increase the effectiveness of current traceability programs. However, it was noted by multiple supply chain members that large upstream supply chain members are the key to providing appropriate pressure to ensure widespread adoption of voluntary new data standards. While small buyers may not have the ability to influence a large distributor or shipper's operations, a very large buyer can exert such pressure. In this way, consistency on the part of upstream members is imperative if standardized data is expected to be broadly adopted. Almost without exception, it was noted in interviews that prior initiatives first endorsed by major downstream purchasers (such as the use of databar technology) were often cast aside in the instance of cheaper alternatives not meeting the requirements.

Similarly, each time a product is introduced into a new environment, data collection and retention requirements should also be applied in a uniform manner across each handler of the product, whether or not the product was reconfigured. Whether the product is packed, processed, distributed or simply handled and not reconfigured, each level of touch presents an opportunity for the introduction of contamination. In devising full-chain traceability for perishable produce items, it must be possible to track produce at any location where there is an opportunity for contamination.

Different members of the supply chain suffer in more or less dramatic ways depending on two factors: the quantity and quality of traceability data maintained as well as level in the supply chain. In defining appropriate quantity and quality, it can be noted that an effective trace-back procedure relies on a *quantity* of data sufficient to follow individual product lots from entry (source) to exit (recipient) in a given location while the *quality* of data would allow specific identification for minimal impact in a recall situation. Additionally, the level in the supply chain can dictate the stakes involved in a trace-back. To illustrate, we describe two fictitious examples related to us by several of our industry experts. In both examples, members of the supply chain who dutifully record and maintain trace-back information are harmed by those who do not.

1. Many growers/shippers comply with recordkeeping and labeling by application and maintenance of relevant traceability data by lot/batch. In the event of a recall, product is received from grower/shippers who have provided sufficient information as well as those who have not. Because there is only a partial dataset available for trace-back, a widespread recall on a commodity is initiated, harming all grower/shippers equally.

2. Trace-back information is provided and accurate at a grower/shipper level but maintained only partially at a distribution or retail level. In the event of an outbreak, there is not sufficient data to implicate a single source due to lack of traceability records between distribution centers and individual retail outlets such that all product must be recalled for a given commodity or commodities. While all members of the supply chain bear some cost in the recall, the ultimate burden is upon the grower/shipper who must refund the cost of the product through the supply chain in addition to performing a recall.

While these two examples are not intended to provide the full breadth of potential issues in which some players "follow the rules" while others do not, they are provided to support the idea that traceability, in order to be effective, must be implemented (without exception) chain-wide.

Goal IV. Equal Recordkeeping Requirements across the Supply Chain —Assessment

The future goals call for a full trace of product from one end of the supply chain to the next such that any link in the supply chain in which contamination is possible may be identified. However, the PTI allows certain supply chain members to forgo recordkeeping for the purpose of cross-docking. While product is handled by a third party, there is no requirement for recordkeeping. This physical "stop" along a fresh product's trip to the consumer presents an opportunity for contamination. To ignore record keeping requirements at any physical location is to reduce the transparency of traceability data and allow for a greater possibility of an untraceable contamination. This cannot be the case if the data provided by the PTI is to be complete for use in investigations.

Additionally, the PTI utilizes the Bioterrorism Act's definitions of exemptions from recordkeeping requirements; this means that small grocery stores, small farms, and direct-to-consumer restaurants have limited or no recordkeeping requirements. These consumer-facing companies are an important link between consumer illness and the source of food from which the contamination occurred and therefore must be included in any recordkeeping requirements for an effective trace-back system.

Goal V. Visibility —Description

A final and, perhaps most difficult, part of traceability is the concept of visibility to and the perception of consumers and regulators. If consumers and regulators do not trust the accuracy of a new traceability process, widespread recalls will continue to occur and consumers will continue to avoid the purchase of food not affected by a recall merely because it is the same commodity as the contaminated product. Consumers must ultimately have the perception that the traceability system in place across the supply chain will help ensure that contaminated product will be removed from commerce rapidly and accurately, thus minimizing reputational and financial dam-

age to industry. Additionally, consumers must have the *means* to know what food is affected in as detailed a manner as possible. If consumers only know that bagged spinach is affected but have no knowledge of brands, 'best-if-used-by' dates or other identification, they will likely cease to purchase bagged spinach products and the entire industry will suffer. Because of the experience with recent major outbreaks (such as the spinach recall of 2006), wariness by consumers and regulators, in terms of trusting traceability records, has continued to grow. If consumers don't trust the supply chain to accurately perform a recall such that contaminated food is pulled from commerce effectively, many consumers will cease to purchase that commodity for fear that they can still get sick and/or die. This concept of visibility and understanding of food safety on the part of the consumer was touched upon, in some way, in almost every interview conducted.

Goal V. Visibility —Assessment

The concept of providing visibility is a difficult one, probably the most difficult of the future goals. In this regard, it is also difficult to expect a plan such as the PTI to have visibility integrated into its outline. Visibility, in the case of the PTI, may be more in the form of recalls becoming less visible with its implementation. This is dependent upon regulators utilizing the system, narrowing trace-backs more rapidly, and outbreaks being minimized as quickly as product can be pulled from commerce. To this end, this goal will be met so far as the PTI is successful in reducing the publicity and damage from foodborne illness outbreaks.

Recommendations

In the previous section of this paper, we develop future goals for an ideal trace-back system for the fresh produce industry and assess to what extent the PTI has the potential to achieve these goals. In this section, we establish a set of principles as recommendations for moving forward. These principles are not intended to be individual steps towards meeting the future goals identified in this research. Rather, they are meant to be high level guidelines that will help meet the future goals and fill the gaps identified in the PTI.

Recommendation 1: Stick to Uniformity Principles

In order to effectively utilize data analysis techniques, it is important that investigators not waste valuable time "connecting the dots." If a principle is applied to one sector of the industry for recordkeeping, it should be uniformly applied to other sectors such that records are utilized in a consistent fashion. The point of traceability is to implicate the narrowest line of contaminated product(s) possible such that public health as well as financial damage may be limited throughout the industry to the maximum extent possible. A standard should be chosen, applied across the board, and used consistently. This includes identification of locations and companies that handle the product, identification of one product from another, and identification of source or origin of lots and batches. This uniformity needs to exist, without exception, between growing and ultimate consumption. Codes representing these elements should be universally recognizable and their meaning must be commonly understood across the supply chain.

Recommendation 2: Standardize Product Reference Number Elements

Related to uniformity but specific to one part of the nomenclature is the issue of assigning unique reference numbers. Unique reference numbers should identify the product uniformly. Otherwise the implementation of tracking systems will become monumental in scope and archaic in interpretation. A system that utilizes ten to twenty individual product codes for the same essential product for tens of thousands of products will undoubtedly lead to confusion on the part of regulators. The industry must settle on a common nomenclature for the sake of efficiency and the good of the industry. By reducing the ambiguity in defining products, the overall complexity of the system is reduced (both in implementation and ultimate use). Minimization of redundancy and interpretation should be a major goal in traceability data. Failure to clarify the interpretation of a product description simply because a standard level of detail was never agreed upon will exact a high price in terms of the speed and accuracy of an investigation.

Recommendation 3: Create a Reporting Mechanism for Investigative Purposes

Perhaps the most troubling aspect of the PTI is that there is not a single mention of reporting or recommendations or guidance for doing so. In reality, the FDA has recently made strides toward standardized technological reporting with the Reportable Food Registry. If the industry is working towards creating the dataset *for* the government, they should know that it will in fact be used *by* the government. If the industry implements the PTI and proceeds to print out volumes of reports (each in their own company-specific format) to mail and fax to the FDA, the industry has gained very little. In the case of a food-borne illness outbreak, time is of the essence. It is critical that a method for rapidly communicating information to the FDA be developed so as to speed up future investigations, and reduce human illnesses (and deaths) and industry losses. There must be a uniform method of rapid data delivery to the FDA from each point in the supply chain in order to successfully minimize traceability investigation timeframes.

Recommendation 4: Create an Environment of Open and Transparent Communication

It will be critical that industry members within the supply chain and across commodities find an effective means of communication. It is clear, as discussed above, that issues of standardization and uniformity not directly met through the PTI must be addressed. However, it is also clear that it is not realistic for the representatives that form the steering committee to universally address these issues across all commodity groups. Industry members both within levels and across levels of the supply chain need to be in communication regarding the needs and uses of the datasets. Understanding the expectations and realities of the data that must be captured will go a long way towards collecting and reporting it. In this way, commodity specific associations should be involved in formulating a traceability plan for the future. If the common nomenclature to be utilized is that provided through GS1, leaders and representatives across commodity groups will be prepared to formulate methodologies for such items as reference numbers and universally applied levels of detail for each commodity. Without proper communication and cooperation, the industry will simply create another layer of complexity using a new nomenclature.

Concluding Remarks

The Produce Traceability Initiative establishes a necessary "first step" towards creating a common nomenclature and methodology for transferring that nomenclature throughout the supply chain. For this reason alone it will provide a valuable mechanism for traceability. It is evident that the committee that first created the PTI realized that it would not fully answer the call of a future traceability system from its first inception based on its recognition as a "living" document.

There are gaps in the PTI that need to be filled before it can effectively fulfill its lofty goals, goals that will not be met by implementation in its current form. One major issue that has arisen is that implementation is happening in isolated corners rather than as a commodity industry group. Until better communication is established between members of the supply chain, the implementation, understanding, and use of the PTI will be difficult. If this communication does not occur, gaps may never be filled and this may be yet another costly initiative that goes unused or underutilized. The utilization of data collection techniques to narrow the scope of recalls depends on both the quality and quantity of data. If the industry is not compelled to store and produce this data rapidly, the PTI will fall short of achieving its goals.

It also remains to be seen whether or not the information that is provided by the PTI will be communicated and/or used by the FDA for investigative purposes. Even if the data is created and stored industry wide, a methodology for reporting by industry and use by investigators must be established or the standardization called for by the PTI will fall short of accomplishing the PTI's objectives.

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Thinking Outside the Box: An Absorptive Capacity Approach to the Product Development Process

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Abstract

In high technology markets, the development of new products has received widespread interest among marketing and management scholars. Popular wisdom suggests that a consumer driven approach to the product development process is key to a firm's competitive success. Organizational learning research however has argued that a narrow focus on customer needs restricts a firm's ability to search for unconventional product market opportunities. Hence, a greater openness to external ideas that extend beyond the interests of the consumer has been called for. In drawing on concepts of absorptive capacity and strategic alliances, this study develops a conceptual model to examine a firm's product development process. This conceptual model is examined in the biotechnology industry. Regression analyses show a firm's absorptive capacity exhibits a positive yet diminishing effect on a firm's ability to introduce products to the market. Findings also indicate the type of knowledge possessed by a firm yields a distinct moderating effect to the product benefits of alliances.

Keywords: Organizational learning, absorptive capacity, alliances, and product innovation.

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In high technology markets, the development of new products has received widespread interest among marketing and management scholars (Eisenhardt and Martin 2000; Lane et al. 2006; Narver et al. 2004). This is because a firm's competitive advantage depends on its ability to continually develop product solutions that meet the changing needs of the consumer (Eisenhardt and Martin 2000; Jaworski and Kohli 1993; Slater and Narver 1995). This ability is widely attributed to a firm's "market orientation" which involves "…seek[ing] to understand customers' expressed and latent needs, and develop[ing] superior solutions to those needs" (Slater and Narver 1999, 1165). For instance, a firm who invests in its marketing expertise to assess the needs and preferences of its consumers will lead to more effective target marketing, product development and positioning (Benedetto 1999; Brown and Eisenhardt 1995). Various marketing studies have subsequently found that a firm's "market orientation" is positively associated with its performance (Han et al. 1998; Jaworski and Kohli 1993; Slater and Narver 1999; Zhou et al. 2005).

Yet, despite its general acceptance, there are nevertheless limits to this consumer driven approach (Christensen and Bower 1996; Hamel and Prahalad 1991 and 1994; Narver et al. 2004; Zhou et al. 2005). Christensen and Bower (1996) and Hamel and Prahalad (1991) argue that a narrow focus on customer needs restricts a firm's ability to search for unconventional product market opportunities. For instance, in Christensen and Bower's (1996) analysis of disruptive technologies, they found that "firms lose their position of industry leadership… [when]…they listen too carefully to their customers" (p.198). They argue a firm's exclusive focus on its customers' needs yields myopic behaviors that impede the development of innovative product solutions. Such arguments have been carried forth by Hamel and Prahalad (1991) as well as others (Narver and Slater 1990; Zhou et al. 2005) that contend "listening too closely to your customers" will lead to misguided product development efforts and discourage a firm from thinking outside the box. For instance, in Zhou et al.'s (2005) study of durable and non-durable consumer products in China, they found that a consumer driven focus negatively influences a firm's ability to innovate.

In response to these limitations in the market orientation approach, some marketing researchers have advocated an "organizational learning orientation" (Hurley and Hult 1998; Narver et al. 2004; Slater and Narver 1995; Zhou et al. 2005). Slater and Narver (1995) contend that firms need to develop a greater "openness" to "learning partners" that extend well beyond the needs and preferences of consumers. The learning organization needs to be open to "…other learning sources, such as suppliers, businesses in different industries, consultants…[in which]... the concept of "market" should be broadened to encompass all sources of relevant knowledge" (Slater and Narver 1995, 68). Such openness implicitly recognizes that the development of products is based on an innovative process in which the development of products are not limited to the technological confines of a firm, but such developments are built upon the technological achievements of connected others (e.g. Brown and Eisenhardt 1995; Scotchmer 1991). Such openness is particularly important in situations when consumers cannot fully comprehend the commercial value of emerging technologies (e.g. Atuahene-Gima and Ko 2001; Narver et al., 2004; Slater and Narver 1995; Zhou et al. 2005). This is because Slater and Narver (1995) argue that by gaining access to the experiences of technological partners, the learning organization is better positioned to assess the commercial value of technical advances and thus enabling the firm to develop products that consumers did not anticipate in needing (see also Hamel and Prahalad 1991).

Yet, although Slater and Narvers' (1995) organizational learning orientation has been an important extension to the market orientation concept (Hurley and Hult 1998; Zhou et al. 2005), the causal factors and processes that impact this "openness" is not well understood (Hurley and Halt 1998; Narver et al. 2004; Slater and Narver 1995). This is because a firm's openness to new ideas has been largely attributed to an "inside-out" learning process in which the focus has been on the "generation" and "dissemination" of market intelligence (e.g. Atuahene-Gima and Ko 2001; Hamel and Prahalad 1991; Jaworski and Kohli 1993; Narver et al. 2004; Slater and Narver 1995; Zhou et al. 2005). For instance, the "generation" of market intelligence stems from an "entrepreneurial" mindset that involves creating new product-markets through a firm's internal product experimentation and risk taking efforts (Slater and Narver 1995). Furthermore, given this internal generation of market intelligence, various marketing research has emphasized that the diffusion of information is another important aspect of a firm's "inside-out" learning process because it promotes the sharing and coordination of inter-departmental product development activities (e.g. Benedetto 1999; Dougherty 1992; Han et al. 1998; Jaworski and Kohli 1993; March and Stock 2003; Narver and Slater 1990).

Yet, as the creation of products involves sourcing technologies that are not held by any one firm (Powell *et al.* 1996; Rothaermel 2001; Rothaermel and Deeds 2004), this "inside-out" learning processes does not sufficiently account for a firm's "openness" to such "outside" influences. Namely, a firm's ability to assimilate and commercialize external ideas has not been a primary factor to "inside-out" learning explanations (e.g. Hurley and Hult 1998). As a result, in drawing on the "openness" ascribed by Slater and Narver (1995), there has been efforts to incorporate "outside-in" learning processes within an organizational learning approach (e.g. Hurley and Hult 1998; Zhou et al. 2005).With such an "outside in" learning process, the development of products stems from a firm's ability to internalize the external experiences of its "learning partners". Hurley and Hult (1998) describe "being oriented towards learning [also] indicates an appreciation for and desire to assimilate new ideas" (p. 44). Such openness has been supported in the new product development studies of Brown and Eisenhardt (1995) and Wind and Mahajan's (1997) who found that a firm's development of products is increasingly driven by its ability to adopt "outside" technological influences. However, in spite of this greater recognition that external or "outside" technologies can influence a firm's "internal" product development efforts, their remains limited understanding in marketing research of the factors that impact a firm's ability to assimilate such external influences (e.g. Narver et al. 2004).

Nevertheless, Cohen and Levinthal's (1989 and 1990) concept of absorptive capacity offers one approach to understanding this "outside-in" learning process. Absorptive capacity is based on a path dependent property in which a firm's ability to internalize external experiences is a self-reinforcing function of its past experiences (Cohen and Levinthal 1990). Specifically, by drawing on research on memory development, Cohen and Levinthal (1990) argue that firms with a greater depth and diversity of experiences are not only better able to internalize external experiences, but this internalization subsequently increases a firm's memory and thus experience to assimilate and commercialize external information in the next period (see also Bosch et al. 1999; Lane et al. 2006; Zahra and George 2002). As a consequence of this path dependent property, a distinctive feature of this absorptive capacity concept is that a firm's experiences positively influence its ability to innovate (e.g. Bosch et al. 1999; Lane et al. 2006; Zahra and George 2002). For instance, in the biotechnology industry, Nerkar and Roberts (2004) and Nixon and Woos' (2003)

studies respectively found that a biotechnology firm's cumulative and diversity of experiences positively influence a firm's product innovation.

Although the concept of absorptive capacity appeals to the openness of an "outside-in" learning process, this concept however faces two conceptual challenges. First, although a firm's experiences are generally recognized by absorptive capacity researchers to have a positive influence on its product innovation (e.g. Bosch et al. 1999; Lane et al. 2006; Zahra and George 2002), cognitive researchers find that a firm's cumulative experiences can however yield a selective interpretation of its outside environment. Such an interpretative bias can result in "competency trap" or "dominant logic" behaviors that reduce a firm's ability to assimilate outside innovations (Levinthal and March 1993; Prahalad and Bettis 1986; Tripsas and Gavetti 2000). Furthermore, although a greater diversity of experiences can overcome such dominant logic behaviors (Bosch et al. 1999; Cohen and Levinthal 1990; Lane et al. 2006; Zahra and George 2002), various marketing studies have found that increasing a firm's diversity of internal experiences limits a firm's product development process. This is because diversity places greater demands in coordinating inter-departmental activities (e.g. Dougherty 1992; Jaworski and Kohli 1993; Narver and Slater 1990). Second, as the concept of absorptive capacity is a firm level construct, researchers tend to focus on organizational experiences and mechanisms that promote the assimilation of externally relevant information (e.g. Lane et al. 2006; Todorova and Durisin 2007; Zahra and George 2002). This firm level focus is thereby emphasized at the expense of external or "outside" partnership experiences. Yet various studies have shown that alliance partnerships can positively influence a firm's product development process (Ng et al. 2006; Rothaermel 2001; Rothaermel and Deeds 2004). With the possible exception of Hess and Rothaermel (2011) and Rothaermel and Hess (2007)[1], the relationship between a firm's absorptive capacity and its ability to gain access to such "outside" experiences remains largely underdeveloped in mainstream absorptive capacity research.

Hence, to explain a firm's product development process, a conceptual framework that examines a firm's "outside in" learning process is developed to address these two challenges. Specifically, although increases in a firm's experiences have been found to positively influence its ability to assimilate external ideas, Lane et al. (2006) argue that with the exception of few scholars, few have challenged "the continued benefits of such expansion" (p. 847 see also Lei and Hitt 1995; Vermeulen and Barkema 2002). For instance, Vermeulen and Barkema (2002) argue that too rapid an expansion in a firm's knowledge may not provide enough time to absorb the new knowledge. Furthermore, Lei and Hitt (1995) argue that expansion in knowledge through acquisitions may affect absorptive capacity negatively because of a firm's failure to develop its own absorptive capacity. Although, both studies underscore the limits with expanding a firm's experiences, a firm's cumulative experiences are however also shaped by its unique interpretation of external events. Furthermore, the coordinative challenges associated with expansions in firm's diversity of knowledge can also limit a firm's absorptive capacity. Hence, the conceptual challenge facing absorptive capacity research is determining the nature of those constraints that are associated with these expansions in a firm's experiences. Another conceptual challenge facing absorptive capacity research is that since the development of products depends on sourcing technologies and resources from alliances partners, a firm's cumulative and diverse experiences not

[1] In these studies, their primary focus is not on the product development process. Their focus is on drawing on a dynamic capability approach to the absorptive capacity concept in which flexibility and responsiveness to changing environments were emphasized.

only need to account for potential constraints in their ability to assimilate external experiences, but these firm level experiences need to also account for the product benefits of their alliance partners. Yet, with the possible exception of Hess and Rothaermel (2011) and Rothaermel and Hess (2007), the role of a firm's experiences and their associated constraints in assimilating the experiences of its learning partners has not been a subject of focus of absorptive capacity studies. By addressing these two challenges, a conceptual framework is developed to extend the concept of absorptive capacity in two ways. First, this framework proposes and empirically shows that increasing a firm's cumulative and diverse experiences can eventually diminish a firm's ability to introduce products to the market. As a result, unlike the commonly accepted wisdom in absorptive capacity research (e.g. Bosch et al. 1999; Zahra and George 2002), continued investments in a firm's absorptive capacity are not optimal to sustaining a firm's competitive advantage. Second, the firm-level focus of the absorptive capacity concept is extended to account for the moderating role of alliances. A firm's cumulative and diverse experiences are not only subject to diminishing effects, but the nature of such experiences can distinctly moderate the product benefits of its alliance partners. To empirically examine these extensions, the biotechnology industry was used to examine the relationship between a biotechnology firm's absorptive capacity, alliances and their moderating effects on its product market introductions.

Conceptual Model

In developing this study's conceptual framework, its unit of analysis and definitions are first outlined. The innovating firm is the subject of focus in this study (e.g. Cohen and Levinthal 1990). Although there are various characterizations, an innovative firm is not strictly defined by a firm that introduces new and breakthrough products (e.g. Danneels and Kleinschmidt 2001). That is, in drawing on an organizational learning orientation, the innovative firm is defined by a learning process (e.g. Hurley and Hult 1998; Slater and Narver 1995; Rindfleisch and Moorman 2003) that involves the "generation" of new knowledge (see also Jaworski and Kohli 1993) from a firm's "openness" to new experiences. Such a characterization is not only consistent with Cohen and Levinthals' (1989 and 1990) concept of absorptive capacity, but it is also consistent with Slater and Narvers' (1995) organizational learning orientation. Slater and Narver (1995) argue innovation and learning are intimately related because innovation involves the "development of new knowledge or insights that have the potential to influence behavior" (p. 63).

Specifically, this "potential" is reflected by a firm's product performance or product introductions. Namely, a firm's product performance is the outcome of a firm's innovation process in which product introductions reflect underlying changes in a firm's knowledge (see also Hurley and Hult 1998). A firm's product performance is defined by the number of products introduced to the market (Nerkar and Roberts 2004; Tsai 2001; Wuyts et al. 2004; Zaheer and Bell 2005; Zahra and George 2002). As a result, products are innovative not necessarily because they constitute a breakthrough product (e.g. Danneels and Kleinschmidt 2001), but because they stem from an innovative process that involves changes in a firm's experiences from an openness to external ideas. Such a characterization of product performance follows the logic of an organizational learning orientation (e.g. Cohen and Levinthal 1990; Slater and Narver 1995).

Absorptive Capacity

To elaborate on this innovative process, Hurley and Hult (1998) and March and Stock (2003) argue Cohen and Levinthals' (1990) concept of absorptive capacity is suited to examining this aspect of a firm's learning process. Absorptive capacity refers to a firm's "ability to recognize the value of new information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal 1990, 128). This concept explicitly recognizes that the innovation process is built on a firm's ability to "borrow" the technical achievements of others (e.g. Cohen and Levinthal 1990; Scotchmer 1991). For instance, Cohen and Levinthal (1990) note "outside sources of knowledge are often critical to the innovation process… [in which]…March and Simon (1958, 188) suggested most innovations result from borrowing rather than invention" (p. 128). Cohen and Levinthal (1990) argue that this "borrowing" is highly dependent on a firm's experiences. This dependence on a firm's experiences stems from research on memory development in which Cohen and Levinthal (1990) describe, "research on memory development suggests that accumulated prior knowledge increases both the ability to put new knowledge into memory, what we would refer to as the acquisition of knowledge, and the ability to recall and use it" (Cohen and Levinthal 1990, 129).

Cohen and Levinthal (1990) argue that increasing a firm's experiences not only increases memory and thus absorptive capacity, but the greater ability to utilize the assimilated experiences subsequently increases a firm's ability to assimilate and commercialize external information in the next period (e.g. Bosch et al. 1999; Lane et al. 2006; Zahra and George 2002). Hence, due to such path dependence, a firm's ability to assimilate and commercialize external information is a "self-reinforcing" function of its past experiences (Bosch et al. 1999; Cohen and Levinthal 1989 and 1990; Lane et al. 2006; Zahra and George 2002).

Due to this path dependent property[2], various researchers have subsequently argued that a firm's cumulative knowledge positively influences its ability to introduce products to the market (e.g. Bosch et al. 1999; Lane et al. 2006; March and Stock 2003; Nerkar and Roberts 2004; Nicholls-Nixon and Woo 2003; Zahra and George 2002). Namely, as a firm's cumulative experiences increase its absorptive capacity to commercialize products from emerging technologies, the knowledge acquired from the development of such products increases a firm's ability to put more knowledge into memory. This increases a firm's ability to further assimilate technologies into the development of products in the next period. Hence, as a firm accumulates increasing experiences, it becomes increasingly "open" to new technological advances and thus increasing its ability to develop new products. In this fashion, continued expansions in a firm's cumulative experiences are a source of sustainable competitive advantage because it positively influences a firm's ability to bring products to market. For instance, studies by Nerkar and Roberts (2004), Nicholls-Nixon and Woo (2003), Sorenson and Stuart (2000), and Tsai (2001) find that increases in a firm's cumulative experiences positively influences a firm's product innovations.

Similarly, a firm's diverse knowledge is also positively related to a firm's product innovations (Ahuja and Katila 2001; Isobe et al. 2000; Lane et al. 2006; Ng 2007). That is, since prior learn-

[2] Readers should note that as this path dependent property is generally recognized by most absorptive capacity researchers, the focus of this study is not on the examination of this property but on examining the "effects" or consequences of this property on a firm's product development process.

ing facilitates new learning, a firm with diverse knowledge experiences increases its ability to relate to a greater breadth of external experiences (Cohen and Levinthal 1990). As Cohen and Levinthal (1990) describe, diverse knowledge experiences provide "…a more robust basis for learning because it increases the prospect that incoming information will relate to what is already known" (p.131). With such diversity, a firm is not only able to assimilate a broader set of experiences, but its assimilation increases a firm's "combinative abilities" to seek new resource linkages and configurations (Bosch et al. 1999; Cohen and Levinthal 1990; Zahra and George 2002). Such combinative abilities are important to the product development process because product innovations are driven by a process of novel resource and experience combinations (March and Stock 2003; Schumpeter 1934).

As a result, the concept of absorptive capacity suggests that increasing expansions in a firm's cumulative and diverse knowledge yield an increasing ability to introduce products to the market. This follows Cohen and Levinthals' (1989) earlier paper in which they argue a firm's absorptive capacity is a source of sustainable competitive advantage because increasing a firm's past – cumulative and diverse- experiences increasingly lowers the cost of assimilating and commercializing external information. By lowering the cost of assimilating this external information, it increases a firm's ability to develop new products (see also Bosch et al. 1999; Zahra and George 2002). Yet, in spite of this positive relationship, Simon (1957) and Cyert and March (1963) have long argued that firms are subject to basic cognitive limits in their ability to mentally process and coordinate externally assimilated information. Such cognitive limits suggest that the positive effects of a firm's absorptive capacity can be subject to diminishing returns.

Diminishing Effects to a Firm's Absorptive Capacity

Cumulative knowledge. Cognitive research suggests that firms with greater cumulative experiences are subject to systematic biases in their *interpretation* of external information (Daft and Weick 1984; Prahalad and Bettis 1986; Tripsas and Gavetti 2000; Walsh 1995; Weick 1969; Zahra and Chaples 1993). A firm with cumulative experiences attach increasing significance to its prior beliefs and thus interprets its information environment in ways consistent with these prior beliefs (e.g. Prahalad and Bettis 1986; Tripsas and Gavetti 2000; Walsh 1995). This selective interpretation has been widely attributed to a "confirmation bias" (Nickerson 1998; Russo and Schoemaker 1992; Walsh 1995). A confirmation bias is a robust feature of human judgment and has been empirically observed in a variety of management and organizational settings (e.g. Nickerson 1998; Russo and Schoemaker 1992). A confirmation bias reflects an affirmation of an individual's cumulative experiences in which an individual selectively interprets external information that is consistent with her established beliefs. For example, in the socio-cognitive development of Cochlear implant technology, Garud and Rappa (1994) show that an individual's cumulative experiences can increasingly "bracket" or limit an individual's interpretation of external information (see also Daft and Weick 1984; Weick 1969). They describe, "data inconsistent with an individual's evaluation routines are either ignored or appear as noise.... Given bounds to rationality, this bracketing of perception occurs because individuals may be more interested in confirming their beliefs than in actively trying to disprove them (Weick 1969)" (p. 347).

Such a confirmation bias can yield "dominant logic" or "competency trap" behaviors (Prahalad and Bettis 1986; Slater and Narver 1995) in which a firm reinforces the assimilation of infor-

mation and activities that reproduce past beliefs of success. Such behaviors inhibit a firm's ability to explore new product market opportunities (Prahalad and Bettis 1986; Tripsas and Gavetti 2000). Thus, as increases in a firm's cumulative experiences yield a confirmation bias, the resulting dominant logic diminishes a firm's ability to bring products to market.

A firm's cumulative experiences not only promotes this form of confirmation bias, but such a bias can subsequently yield the development of "organizational routines" (Cohen and Bacdayan 1994; Levitt and March 1988; Nelson and Winter 1982). Organizational routines are "patterned sequences of learning behaviors" involving "established patterns of organizational action" (Cohen and Bacdayan 1994, 555). Search routines are instrumental in economizing a firm's rationality because they confine a firm's search to information that is related to its past experiences (Levinthal and March 1993; Levitt and March 1988; Nerkar and Roberts 2004). Search routines are thereby mutually related to a firm's confirmation bias. That is, as a firm's cumulative knowledge yields the onset of a confirmation bias; such a bias promotes "search routines" in seeking information that reinforces a firm's prior experiences (Nerkar and Roberts 2004). These search routines deepen a firm's past experiences (Levitt and March 1988) which positively influences a firm's absorptive capacity to assimilate information that is consistent with these experiences. This yields a pattern of learning that not only reinforces the development and establishment of such search routines. But these routines subsequently generate myopic behaviors that blind the firm to external technological advances (e.g. Levitt and March 1988). As result, by increasing a firm's cumulative experiences, a firm's confirmation bias yields search routines that reduce a firm's absorptive capacity to assimilate external technological advances and thus diminishing a firm's ability to bring products to market. Such diminishing effects can thus also yield the "dominant logic" behaviors described by Slater and Narver (1995) and Prahalad and Bettis (1986).

Biotechnology firms are particularly vulnerable to such diminishing effects. Due to the high costs associated with the product development process ($800 million / product) (DiMasi 2001; DiMasi et al. 2003), there are strong incentives to leverage a biotechnology firm's cumulative experiences. By leveraging a biotechnology firm's cumulative experiences, the biotechnology firm is vulnerable to a confirmation bias. Such a bias promotes the development of search routines that drive out a biotechnology firm's ability to assimilate more distant biotechnological discoveries. This follows Nerkar and Roberts' (2004) study of the biotechnology industry in which they argue biotechnology firms tend to not only leverage their technical experiences, but in doing so favor a search of technologies that are in close proximity to their established expertise. This is also consistent with Rawlins' (2004) assessment of biotechnology companies where he argues biotechnology companies tend to "focus on improving approaches that have been clinically proven and financially successful, and [have] a disincentive to develop products for unmet medical needs" (p. 360). Yet, as the development of biotechnology products rests on a firm's ability to commercialize emerging advances in areas such as recombinant DNA or "rDNA", protein engineering, monoclonal antibody or "Mabs" technology (Liebeskind et al. 1996; Rader 2005), such myopic behaviors can thereby diminish a biotechnology firm's absorptive capacity in capitalizing on these advances. Hence, even though absorptive capacity researchers contend that a firm's cumulative experiences positively influences the development of product innovations (Bosch et al. 1999; Lane et al. 2006; March and Stock 2003; Nicholls-Nixon and Woo 2003), a firm's cumulative experiences can also yield a confirmation bias that promotes the development

of dominant logic behaviors that diminish the product performance benefits of a biotechnology firm's absorptive capacity.

Hypothesis 1a: Increasing a biotechnology firm's absorptive capacity – cumulative knowledge – exhibits a positive yet diminishing effect on its product performance.

Diverse knowledge. A firm's diverse knowledge is also subject to a diminishing return effect. However, unlike a firm's cumulative experiences, this diminishing effect is rooted in a "serial reproduction loss" problem (Markides 1995; Williamson 1967). A "serial reproduction loss" problem refers to the notion that as information is transmitted across increasingly diversified or specialized units, the quality of the transmitted information deteriorates (Markides 1995; Williamson 1967). This deterioration arises because as the assimilated information is transmitted across diversified sub units, the transmitted information becomes increasingly distorted by the experiences and perceptions of that unit (see also Brown and Eisenhardt 1995; Dougherty 1992). For instance, in Dougherty's (1992) study, she found departments or subunits of a firm were trapped in "departmental thought worlds" in which each subunit filtered information from their particular areas of specialization, while ignoring information that is not relevant to their tasks.
With continued expansions in a firm's diversity of experiences, this serial reproduction loss problem diminishes a firm's absorptive capacity because degradations in information quality reduce a firm's "coordinative capabilities" (Bosch et al. 1999). Bosch et al. (1999) describe that "coordination capabilities enhance knowledge absorption through relations between members of a group. They refer to lateral ways of coordination" (p. 556) that involve job rotations, intergroup communication activities, and cross functional interfaces. Such coordinative capabilities require that members from each coordinating unit have "overlapping" experiences with other members (Cohen and Levinthal 1990; Slater and Narver 1995). Yet, since the "serial reproduction loss problem" reduces the quality of the assimilated information, this reduces a firm ability to coordinate novel linkages amongst members of "overlapping" (Cohen and Levinthal 1990) subunits and thus mitigates the development of products. For instance, Han et al. (1998) describe, "if personnel in different departments do not open up to one another, they are more likely to conform to their routine mode of problem solving and less likely to be creative and take risks" (p. 34). This suggests that with increasing diversity, problems associated with a firm's serial reproduction loss problem will also increase and thus diminish a firm's coordinative capabilities. Hence, due to this serial reproduction loss problem, continued expansions in a firm's diversity will eventually overwhelm the benefits of a firm's absorptive capacity and thus diminish a firm's ability to bringing products to the market.

Biotechnology firms are particularly vulnerable to such diminishing effects. Studies find that the commercialization of biotechnology products depends on a firm's ability to combine knowledge from individuals in different units (Drew 2000; Hood 2003; Nerkar and Roberts 2004; Rader 2005). For instance, the development of new biotechnology products, such as the development of therapeutic drugs and / or agricultural / life science bio-engineered crops, draw on a variety of overlapping disciplines or specialty areas. This not only involves recombinant DNA or "rDNA", protein engineering, monoclonal antibody or "Mabs" technologies (Liebeskind et al. 1996; Rader 2005), but also advances in computing sciences, molecular biology, applied physics, protein chemistry, applied statistics, pharmacology and toxicology (Hood 2003). As each of these areas are based on distinct yet related disciplines (Drew 2000; Hood 2003), individuals in subunits that

reflect each of these respective areas will assimilate information that is relevant to their functional experiences (e.g. Dougherty 1992). Yet, as external information is assimilated through a firm's various subunits (Cohen and Levinthal 1990), a firm with an increasingly diverse array of such specialized expertise is increasingly vulnerable to the serial reproduction loss problem. This serial reproduction loss problem reduces the quality of the externally assimilated information and thus reduces a firm's ability to discover novel linkages among its diverse areas of specialized expertise. Hence, despite the assimilative benefits of diversity (Bosch et al. 1999; Cohen and Levinthal 1990), excessive diversity can yield a serial reproduction loss problem that diminishes a biotechnology firm's absorptive capacity in bringing products to market.

Hypothesis 1b: With increasing diversity, a biotechnology firm's absorptive capacity - knowledge diversity – exhibits a positive yet diminishing effect on its product performance.

Inter-Organizational Learning: Absorptive capacity and Strategic Alliances

A firm's product performance also depends on an "openness" to its "learning partnerships" (Rindfleisch and Moorman 2001 and 2003; Slater and Narver 1995). In the biotechnology industry, such "openness" involves forming strategic alliances (Chan et al. 1997; Powell et al. 1996; Rothaermel and Deeds 2004). Strategic alliances positively influence the commercialization of biotechnology products because biotechnology products are based on multiple technologies that are not held by any single firm (Chan et al. 1997; Deeds and Hill 1996; Powell et al. 1996; Rothaermel 2001). In fact, various empirical studies have found that biotechnology alliances involving licensing, R&D, commercializing, marketing and distribution alliances positively influence a biotechnology firm's product performance. This is because these alliances provide an assortment of resources and experiences that complement a firm's internal learning (Ng et al. 2006; Nerkar and Roberts 2004; Powell et al. 1996; Rothaermel, 2001; Rothaermel and Deeds 2004). In particular, Powell et al. (1996) argue alliances can complement or positively moderate a biotechnology firm's absorptive capacity because alliances provide a biotechnology firm access to external knowledge, while at the same time deepen a biotechnology firm's ability to assimilate and develop new innovations.

Such a positive moderating effect however requires greater scrutiny (see also Lane et al. 2006). Since a biotechnology firm's cumulated knowledge yields a confirmation bias, such a bias yields search routines that select alliances partners with similar experiences. This is consistent with Mowery et al.'s (1996) study of hi-technology industries where they found inter-firm knowledge transfers are more frequent with partners who share similar technological capabilities. This is also consistent with Lane and Lubatkins' (1998) study of student and instructor relationships where they found the assimilation and transfer of information are influenced by a common body of scientific knowledge. As a result, this suggests that as a firm's cumulative experiences yield a confirmation bias, a firm's search routines will favor exchanges with "redundant" partners (see also Rindfleisch and Moorman 2003). By assimilating such redundant experiences, a biotechnology firm is subject to "network myopic" (Gargiulo and Benassi 2000) behaviors whereby a firm's search for redundant alliance partners further deepens its cumulative experiences. This suggests that a biotechnology firm's cumulative experiences reduce a firm's ability to fully leverage the varied experiences of its network. As a result, despite the product benefits of alliances, a firm's cumulative experiences can have a negative interacting effect to the product benefits of its alliances.

Hypothesis 2a: the moderating effect of a biotechnology firm's absorptive capacity - cumulative knowledge - on its alliances is negatively related to its product performance.

On the other hand and consistent with Powell et al. (1996), a biotechnology firm's diverse knowledge can complement or positively moderate the product benefits of its alliances. Diverse knowledge experiences increase the likelihood that the biotechnology firm possesses technologies and experiences that complement the expertise of its alliance partners. As the innovation process stems from a recombination of diverse experiences and resources (Nerkar and Roberts 2004; Nichols-Nixon and Woo 2003; Schumpeter 1934), a firm's diverse knowledge increases the potential to form partnerships that more fully exploit the varied experiences of its network. This assimilation increases a firm's combinative abilities to seek new resource combinations and thus increases a firm's ability to develop new products. As a result, unlike a firm's cumulative experiences, a firm's diversity of experiences positively moderates the product benefits of its alliances.

Hypothesis 2b: The moderating effect of a biotechnology firm's absorptive capacity - diverse knowledge- on its alliances is positively related to its product performance.

Method

Data and Sample

To empirically examine this study's hypotheses, the biotechnology industry was chosen for two reasons. First, researchers find the development of biotechnology products often depends on a biotechnology firm's ability to assimilate basic advances in varied yet related disciplinary areas involving recombinant DNA or "rDNA", protein engineering and monoclonal antibody or "Mabs" technology (Liebeskind et al. 1996), computing sciences, molecular biology, applied physics, protein chemistry, applied statistics, pharmacology and toxicology (Hood 2003). Such advances in basic research have led to the rapid growth of human therapeutic and agricultural / life science based products and services (Liebeskind et al. 1996; Ng et al. 2006; Rader 2005). The assimilation of such basic advances in biotechnology and its subsequent commercialization is thereby suited to examining this study's extensions to the absorptive capacity concept. Second, since a biotechnology firm's product development process often requires forming multiple alliance partnerships (Chan et al. 1997; Deeds and Hill 1996; Liebeskind et al. 1996; Rothaermel and Deeds 2004), alliances underscore that the locus of learning in the biotechnology industry is not only influenced by a firm's absorptive capacity but it is also influenced by a firm's learning partners (e.g. Powell et al. 1996; Slater and Narver 1995). This yields a learning process that reflects the greater "openness" called for by Slater and Narver (1995).

Based on these motivations, a sample of 369 public biotechnology firms (Deeds and Hill 1996; George et al. 2002; Powell et al. 1996) was drawn from the 2004 "BioScan" database (American Health Consultants 2004). The BioScan database has been recognized as one of the most comprehensive and reliable databases in the biotechnology industry (Deeds and Hill 1996; Powell et al. 1996; Rothaermel 2001; Rothaermel and Deeds 2004) and has been used by a variety of alliance researchers (e.g. Deeds and Hill 1996; George et al. 2002; Powell et al. 1996; Rothaermel

2001; Rothaermel and Deeds 2004). As various industry analysts have argued that the distinction between biotechnology and pharmaceutical firms has become increasingly amorphous (Hopewell 2003; Rader 2005)[3], the BioScan database includes both life science and pharmaceutical companies. This study's data sample includes both types of companies (Rader 2005)[4].

Measures

Dependent variable. As product introductions reflect the outcome of a firm's innovation process, a biotechnology firm's product performance is measured by the cumulative number of commercialized biotechnology products or product introductions, since its founding. A similar definition of firm performance has also been used in prior product studies (Deeds and Hill 1996; Nerkar and Roberts 2004; Rothaermel 2001; Rothaermel and Deeds 2004) and is consistent with one of the absorptive capacity (output) measures (i.e. new product announcements) proposed by Zahra and George (2002).

Independent variables (absorptive capacity). Although the concept of absorptive capacity is well developed in management research, empirical measures for this concept remain a subject of much debate (Lane et al. 2006). For instance, although a firm's absorptive capacity has been commonly measured by a firm's R&D intensity (i.e. ratio of R&D expenditures to sales) (e.g. Cohen and Levinthal 1989 and 1990), the validity of this measure has been questioned (Lane et al., 2006). Namely, R&D intensity is often measured as a "stock of relevant knowledge" (Lane et al. 2006) to which it serves as an input to a firm's absorptive capacity. Yet, absorptive capacity is a multi-dimensional concept that consists of "an organizational learning ability" (Lane et al. 2006, 841). Since the objective of this study is to explain a firm's product development process through an organizational learning orientation (Narver and Slater 1990), R&D intensity is not suitable for this learning focus. In that, Mowery et al. (1996) argue that R&D intensity, as a stock of knowledge, does not account for a firm's learning process. Furthermore, as this organizational learning orientation involves an openness to alliances partners, Mowery et al. (1996) also found that R&D intensity was not a good predictor of inter-organizational learning.

From an econometric standpoint, the use of R&D intensity is problematic because it introduces a simultaneous causality problem or simultaneous bias (Wooldridge 2003; Stock and Watson 2007). The use of R&D intensity (R&D expenditures / sales) or even measures proposed by Zahra and George (2002), such as "amount of R&D investment" (Zahra and George 2002, 199) or "years of experience in the R&D department" (p. 199) are simultaneously related to the dependent variable, product introduction. This is because since product introductions are defined by the number of commercialized products, commercialized product are directly related to sales (Mowery et al. 1996), R&D expenditures and years experiences in R&D (Zahra and George 2002). With this simultaneous causality problem, measures based on R &D intensity or those proposed by Zahra and George (2002) would be correlated with the error term and thus resulting

[3] This is because pharmaceutical companies are no longer restricted to analytical chemistry in the development of drugs. Drug development has turned to genetic engineering to yield specific therapeutic properties (Hopewell, 2003; see also Rader, 2005).

[4] This study draws on an industry definition of the Biopharmaceutical firm that "includes all/everything from biotech like (smaller, entrepreneurial, R&D intensive) pharmaceutical and life science companies as being biopharmaceutical" (Rader, 2005, p 61). However, to avoid any unnecessary confusion with this term, we use biotechnology to include pharmaceutical and life science companies.

in a biased estimate (e.g. Wooldridge 2003; Stock and Watson 2007). One solution to this simultaneous causality problem is to choose proxies that exhibit a less direct relationship with the product introduction variable (e.g. Stock and Watson 2007; Wooldridge 2003). Specifically, the three following measures – age, employees, and diversity, were chosen as proxies to the absorptive capacity concept because relative to measures, such as R&D intensity (Cohen and Levinthal 1989 and 1990) and those measures proposed by Zahra and George (2002), these proxies not only have a less direct relationship to the product introduction variable, but they also serve to capture the learning aspects of the absorptive capacity concept (Lane et al. 2006).

Cumulative knowledge. Namely, to capture the learning capability aspects of the absorptive capacity concept, researchers have suggested a firm's "age" as a proxy measure for absorptive capacity (Hurley and Hult 1998; Lane et al. 2006; Rao and Drazin 2002; Sorenson and Stuart 2000). Studies have suggested that a firm's age can impact the extent to which a firm is receptive to new ideas (Hurley and Hult 1998; Lane et al. 2006; Sorensen and Stuart, 2000). In particular, Lane et al. (2006) argue that "proxies such as age and size have been used to argue that older and larger firms have higher absorptive capacity because they are likely to have accumulated knowledge and developed routines and processes [that] facilitate assimilation and innovation" (p. 944). Age is thus used to capture the routine aspects of a firm's cumulative learning. A biotechnology firm's Age is computed as the difference between the period of this data sampling (2004) and its founding date. As size is also another measure of cumulative knowledge (Lane et al 2006; Sorensen and Stuart, 2000), the number of employees is used as another measure because employees are also engaged in a firm's learning process (Graves and Langowitz 1993).

Diversity. Since the development of biotechnology products often draws on variety of specialized expertise (Hood 2003; Powell et al. 1996), knowledge diversity is measured by the cumulative number of unique subfields in which the firm has participated in. BioScan (2004) provides a description of the distinct areas of research application and focus pursued by each company. Diversity is measured as a count of a firm's total number of distinct technological and/or research areas of specialization (Rothaermel and Deeds 2004). Rothaermel and Deeds (2004) had used this measure for their study of the biotechnology industry. This diversity measure has also been used by Nicholls-Nixon and Woo (2003) and is consistent with Hurley and Hult (1998) who argue that a diversity of specialized skills can impact a firm's innovation process.

Strategic alliances. Alliance is a count of the cumulative alliances formed by the firm since its founding (Ahuja 2000). Alliance is the aggregation of Licensing, Research and Development (R&D), Marketing, Manufacturing, and Distribution agreements. The aggregation of these alliances is commonly used to measure a firm's connectedness in the biotechnology industry (Chan et al. 1997; Deeds and Hill 1996; Powell et al. 1996). Specifically, Slater and Narver (1995) describe the learning organization needs to be open to "…other learning sources, such as suppliers, businesses in different industries, consultants…[in which]... the concept of "market" should be broadened to encompass all sources of relevant knowledge" (p. 68). Hence, to capture this openness to learning partners, the aggregation of these alliances types was used.

Control Variables

To control for other factors that impact a firm's product introductions, a firm's Mergers and Acquisitions (M&A) was used. Since M&A are motivated to exploit scope economies through product line extensions, this control is included. Moreover, since larger firms have greater financial resources, they are more likely to undertake M&A. Such a measure is used to control for firm size effects that are separate from the age, employee and diversity measures of absorptive capacity. A firm's M&A is computed as the difference in the cumulative number of biotechnology mergers less divestitures, since its founding. Moreover, to account for any institutional differences, the site or location of the firm, noted as Location, is coded as a dummy variable (0= U.S. - based, 1= non-US based) (e.g., Rothaermel and Deeds 2004). The number of Subsidiaries held by a firm is included because they provide entrance into new product markets (Rothaermel and Deeds 2004). Lastly, as institutional investors provide sources of funding in bringing products to markets, the number of institutional shareholders, Investors (i.e., investors from major banks, fund agencies), is included.

Estimation Procedure

As the dependent variable, product performance, is count data, both negative binomial and Poisson regressions using Maximum Likelihood Estimation (MLE) methods were conducted. However, in the Poisson estimations, the Likelihood ratio test statistics of delta were all significant ($p < 0.01$). This indicates the presence of over dispersion (table 2) which violates the Poisson distributional assumption of mean-variance equivalence. Such a violation overstates the significance of the estimated variables (Long and Freese 2006). As a result, although the Poisson estimation results were generally consistent with the negative binomial estimations, only the negative binomial estimation results are reported.

When examining the interaction effects (hypotheses 2a and 2b), the main effects of a firm's absorptive capacity and alliance variables were mean-centered (i.e., observations less their mean values) to minimize problems of multi-collinearity (Aiken and West 1991). Interactions are subsequently based on these mean-centered values (Aiken and West 1991). Furthermore, Cortina (1993) contends that if the main effects of an interaction are highly correlated, significant estimates on the interaction term can be "artifactual". That is, if two main components X (i.e., absorptive capacity) and Z (i.e. alliances) are highly related (i.e., $\rho_{x,y} = 1$), then "a statistically significant interaction term is significant because of a nonlinear multiplicative effect (i.e., curvilinearity effect) and not because of a linear multiplicative effect (interaction effect)" (Cortina 1993, 917). A solution is to control for possible curvilinearity effects - before the interaction term - such that it rules out the alternative explanation that interactive effects are attributed to curvilinearity effects (Cortina1993). Since the concepts of absorptive capacity and alliances are theoretically and empirically correlated (see table 1), estimations of these interactions require controlling for such curvilinearity effects. The quadratic terms for the main effect variables are included to control for such effects. The inclusion of these additional variables is also theoretically consistent with hypothesis 1a and 1b. Moreover, as the estimated models consist of various interactions, the models were assessed for multi-collinearity. Multi-collinearity is moderate to strong when the Variance Inflation Factor (VIF) exceeds 10. Based on all the described variables, the mean VIF is 4.39. Model estimations were conducted with the Stata 9.1 econometrics software.

Results

The descriptive statistics for all co-variants and their correlations are shown in Table 1. The marginal effects for each variable in the negative binomial estimations are shown in Table 2.
From Table 2, Model 1 shows that with the exception of investors, all control variables are significant. The location dummy variable is negative which indicates U.S. based firms market fewer products than non U.S. based firms. The subsidiary coefficient is positive as expected. This is consistent with Rothaermel and Deeds' (2004) findings. The number of M&A is positive and significant, as expected.

Table 1. Descriptive Statistics and Correlations

Variables	MEAN	ST. DEV	1	2	3	4	5	6	7	8	9
1 Products	4.310	7.830	1.000								
2 Location	0.651	0.477	-0.101	1.000							
3 Investors	1.890	3.430	-0.113	0.143	1.000						
4 Subsidiaries	3.150	13.630	0.344	-0.032	-0.083	1.000					
5 Employees	3817.500	14362.900	0.439	-0.080	-0.129	0.494	1.000				
6 Age	21.220	23.600	0.341	-0.157	-0.139	0.259	0.417	1.000			
7 M&A	0.984	2.760	0.260	0.077	-0.013	0.183	0.253	0.052	1.000		
8 Diversity	3.500	3.290	0.335	-0.072	-0.062	0.074	0.221	0.173	0.258	1.000	
9 Alliances	9.150	11.700	0.577	0.088	0.050	0.245	0.444	0.171	0.322	0.342	1.000

Table 2.

Variables	**Model 1**	**Model 2a**	**Model 2b**	**Model 2c**	**Model 2d**	**Model 3**
Location	-1.233**	-0.358	-0.826***	-1.021*	-0.479	-0.624***
Investors	-0.123	-0.054	-0.045	-0.103	-0.024	-0.079
Subsidiaries	0.037*	0.030*	0.026*	0.040*	0.024*	0.018**
M&A	0.233*	0.196*	0.173*	0.161*	0.191*	0.103*
Age		0.093*			0.060*	0.056*
Age^2		-4.587E-4*			-4.264E-04*	-2.961E-04*
Employees			2.428E-04*		1.935E-04*	1.139E-04*
$Employees^2$			-2.45E-09*		-2.05E-09*	-1.39E-09*
Diversity				0.473*	0.302*	0.204*
$Diversity^2$				-0.020***	-0.025*	-0.022*
Alliances						0.119*
$Alliances^2$						-0.001**
Diversity.Alliances						0.003***
Employee.Alliances						2.680E-07
Age.Alliances						-7.455E-04*
Log likelihood	-889.5	-863.500	-853.700	-876.635	-836.170	-812.230
LR Test of Delta	1749.5*	1555.6*	1149*	1435.24*	1002.61*	773.41*
Delta	8.99	7.360	6.250	7.930	5.540	4.260

Note: *= p<1%, ** = p<5%, *** = p < 10%

Models 2a, 2b, and 2c respectively examine the positive yet diminishing effects for each of the three absorptive capacity measures: age, employees and diversity. In examining hypothesis 1a, model 2a shows the age coefficient and its quadratic counterpart are, respectively, positive and negative. A similar result is found with the employee variable in model 2b. These results are consistent with Slater and Narvers' (1995) argument that a firm's experiences can promote "dominant logic" behaviors that limit a firm's ability to innovate (see also Christensen and Bow-

er 1996; Hamel and Prahalad 1991). However, unlike these prior authors, a dominant logic does not stem from a myopic focus to the customer. Rather, model 2a and 2b results suggest that such a dominant logic can be attributed to limits with expansions in a firm's absorptive capacity. Namely, increases in a firm's cumulative experiences can yield a confirmation bias in which a firm's search routines diminish a firm's absorptive capacity to bringing products to market. In examining hypothesis 1b, model 2c shows the diversity coefficient and its quadratic counterparts are, respectively, positive and negative. This result is consistent with marketing studies that find a lack of coordination among inter-departmental units can significantly hinder a firm's product development process (e.g. Dougherty 1992; Han et al. 1998; Jaworski and Kohli 1993; March and Stock 2003; Slater and Narver 1995; Wind and Mahajan 1997). In particular, Model 2c's results suggest that excessive increases in a firm's diversity can yield a serial reproduction loss problem that can contribute to this lack of coordination.

As a firm's absorptive capacity can simultaneously consist of a firm's accumulated and diverse knowledge (Cohen and Levinthal 1990), model 2d includes all three absorptive capacity measures. Likelihood Ratio Tests were conducted between model 2d with each of the prior models, 2 a, b, and c. Likelihood Ratio tests reject ($p=0.000$) the null that all three measures of absorptive capacity –age, employees and diversity- are jointly equal to zero. Model 2d shows that a firm's absorptive capacity, age, employees and diversity jointly exhibit a positive yet diminishing effect and are highly significant ($p<1\%$). Hypotheses 1a and 1b cannot be rejected in this model.

To provide a further examination of these diminishing effects, this study draws on a procedure developed by Aiken and West (1991). In linear estimations, a diminishing effect – as reflected by the estimate of the quadratic variable, (i.e. X^2), - can be evaluated by computing its "simple slope" at one standard deviation above the mean value of its main effect, (i.e. X). In this study, simple slopes are reflected by the marginal estimates of the quadratic terms of the absorptive capacity variables. The marginal effects for each of these quadratic terms are then computed at one standard deviation above the mean values of their main effects. However, since negative binomial estimations are non-linear, their simple slopes are dependent on the values taken by all other predictor variables. Hence, to evaluate the diminishing effects for each of the quadratic terms of the absorptive capacity measures, their marginal effects are evaluated at one standard deviation above their mean values, while holding all other variables at their mean values (Graves and Langowitz 1993).

At one standard deviation above their mean values, the marginal effects for each of the quadratic terms, age, employees and diversity, are respectively, -0.00266, -1.28e-08, and -0.1592, and are significant ($p<5\%$). Hypotheses 1a and 1b are not rejected. In particular, as absorptive capacity researchers argue that a firm's experiences and innovation are positively related, this implies that a firm's absorptive capacity is not only positively related to its product performance, but that a firm can introduce products at an increasing rate. This is because since innovations are based on "borrowing" the technical achievements of the past (Cohen and Levinthal 1990), a firm's ability to innovate products in one period reduces the cost of innovating products in the next (Cohen and Levinthal 1989). This follows Anand and Khanna (2000) who note, "firms that have learnt to learn will continue to do so at an increasing rate" (p.298). This suggests a positive coefficient on both the main absorptive capacity variable and its quadratic counterpart. Yet models 2a-d shows

the quadratic estimates for these variables are consistently negative and statistically significant. As a result, even though the magnitude of the diminishing effects is very marginal, the signs on these coefficients reject the argument that continued investments in a firm's absorptive capacity is a source of sustainable competitive advantage (e.g. Bosch et al. 1999; Zahra and George 2002).

To include the role of strategic alliances, model 3 is the full model that includes the absorptive capacity and alliance variable interactions. Relative to model 2d, likelihood ratio tests do not reject the null that the additional alliance and interaction variables are equal to zero (*p=0.00*). In model 3, hypothesis 1a and 1b are not rejected at their mean values and are not rejected at one standard deviation above their means[5]. With regards to a firm's alliances, model 3 shows that a firm's alliances have a positive yet diminishing effect to a biotechnology firm's product performance. This is consistent with prior biotechnology studies (e.g. Deeds and Hill 1996).
To examine their interactions, the interaction effect between age and alliances is significant and negative. Hypothesis 2a cannot be rejected (*p< 1%*). With respect to the interaction effect between a firm's employees and alliances, this interaction was not significant. As age is correlated with employees (see table 1), a separate estimation was conducted that removes the correlated age variable. In this estimation, a significant negative moderating effect was observed. Hypothesis 2a cannot be rejected for this model[6]. This lack of significance is likely attributed to problems of multi-collinearity. These results complement findings reported by Rindfleisch and Moorman (2003) study. They argue that firms with "competitive dominant" alliances will tend to form "overlapping" network experiences that can limit a firm's absorptive capacity in developing innovative product solutions. In their empirical analysis, they find that a firm's alliances negatively moderate a firm's customer / market orientation. From an organizational learning orientation, model 3's findings complement this view by showing a firm's cumulative experiences can negatively moderate the product benefits of a firm's alliances.

With regards to the moderating influences of a firm's diversity, the interaction effect between a firm's diversity and alliances is positive and significant at the 10% level. At this level of significance, Hypothesis 2b is not rejected. This suggests that a firm's diversity of experiences is better suited to assimilating the product benefits of alliances. Although there are no studies that have directly examined such a moderating relationship, Perry-Smith and Shalley (2003) argue and find that a firm's product creation process can positively impact a firm's ability to utilize product alliance information.

Conclusions and Discussions

In high technology settings, innovation and the ability to introduce products to market are intertwined subject areas that have gained significant interest amongst marketing and management scholars (Brown and Eisenhardt 1995; Eisenhardt and Martin 2000; Nerkar and Roberts 2004; Wind and Mahajan 1997). Under hi-technology settings, a firm's "openness" to emerging technologies is instrumental to a firm's product development process because it yields innovative product solutions that are yet to be anticipated by consumers (e.g. Christensen and Bower 1996;

[5] At one standard deviation above their means, the marginal effects for the quadratic terms size, age and diversity, are respectively, -5.88e-09 (p <1%), -0.00125 (p <5%), -0.09149 (p <5%)
[6] Results are available on request.

Hamel and Prahalad 1991; Slater and Narver 1995). In drawing on the concept of absorptive capacity, an "outside-in" learning process was developed to explain this product development process. A key argument of this "outside in" learning process is that a firm's ability to bring products to market depend on not only its cumulative and diverse experiences but also on its ability to gain access to the experiences of its learning partners. Specifically, with this outside in learning process, these experiences are subjective to diminishing return effects and have distinct moderating effects to a firm's ability to internalizing the product benefits of its alliance. This study's empirical findings of the biotechnology industry provide support for this "outside-in" learning framework. This "outside-in" learning framework offers three contributions to product-marketing research and introduces applications / implications to agribusiness.

First, the concept of absorptive capacity offers "an outside in" learning process that complements the "insider-out" learning processes described in the organizational learning literature (Jaworski and Kohli 1993; Slater and Narver 1995). An "insider-out" learning process focuses on an "entrepreneurial" mindset in which the development of product innovations stems from a firm's greater risk taking and product experimentation efforts (Atuahene-Gima and Ko 2001; Jaworski and Kohli 1993; Slater and Narver 1995; Zhou et al. 2005). This study's "outside-in" learning process complements this "inside-out" process because a firm's absorptive capacity and its access to alliances promotes an "openness" to external ideas that can promote the risk taking and product experimentation efforts of this inside-out approach. The implication of this complementary relationship is that this greater openness to external ideas can cultivate a "culture" (Slater and Narver 1995) that focuses a firm to look outward rather than just inward in its product development efforts. Stated different, this "outside-in learning" process can promote an entrepreneurial and innovative cultural mindset to "think outside the box" and has been called for in Slater and Narvers' (1995) learning framework.

Second and building upon Slater and Narvers' (1995) organizational learning orientation, a firm's "outside-in" learning process further broadens the concept of market orientation (Jaworski and Kohli 1993). As this study's outside-in learning process emphasizes a firm's openness to learning partners, a firm's absorptive capacity and its access to alliance partnerships can mitigate the firm from being subject to the "tyranny of served market" (Hamel and Prahalad 1991). Namely, this "outside-in" learning framework broadens a firm's ability to identify its customer's "latent needs" (Slater and Narver 1995). Investments in a firm's technical expertise serves to not only leverage a firm's ability to relate to external technological advances, but in doing so identify commercial applications that are not known by the consumer. For instance, Eli Lilly (e.g. Hoang and Rothaermel 2005; Kale et al. 2002) have developed in house operations whose exclusive function is to assess the commercial value of external technologies and alliance partnerships. As a result, this study's outside-in learning framework can serve to bridge a firm's technology orientation with that of its market orientation. In that, although investments in marketing expertise (i.e. investments in focus groups, sales teams, market segmentation efforts) are important to addressing customers' immediate needs, a firm's investment in this "outside-in" learning process can address its customers' latent needs. The combination of these two processes can thereby improve a firm's long term product performance and has also been argued by Zhou et al. (2005).
Lastly, despite the positive merits from continued expansions in a firm's experiences, Lane et al. (2006) as well as others (Lei and Hitt 1995; Vermeulen and Barkema 2002) have challenged "the continued benefits of such expansions" (Lane et al. 2006; p. 847). That is, in addition to studies

by Lei and Hitt (1995) and Vermeulen and Barkema (2002), this study offers a further explanation as well as empirical evidence that challenge the merits of a continued expansion of a firm cumulative and diverse knowledge experiences. Specifically, unlike Bosch et al. (1999), Cohen and Levinthal (1990), and Zahra and George (2002), this study argues and shows that continued expansion in a firm's cumulative and diverse experiences yields diminishing returns to a firm's product performance. This is because a firm's confirmation bias and serial reproduction loss problem places limits in a firm's ability to assimilate external experiences. Thus, a firm's continued investment in their knowledge experiences is not optimal in sustaining a firm's competitive advantage. Furthermore, as various absorptive capacity researchers have called for a greater integration of the absorptive capacity concept with alliance level investigations (Tsai 2001; Wuyts et al. 2004; Zaheer and Bell 2005), this study contributes to this line of investigation in which a firm's ability to capitalize on the product benefits of its alliances is dependent on the cumulative or diverse nature of their knowledge experiences. That is, although alliances are widely recognized as source of inter-organizational rent (Powell et al. 1996; Rothaermel 2001), the ability to capitalize on such rents – such as through the development of products- is dependent upon the nature and constraints faced by a firm's experiences.

In terms of its applications, this study's proposed "outside-in" learning approach can be offered as one model to explaining potential changes in the product development process of the U.S. agricultural industry. Due to current fiscal realities, reductions in public funding from U.S.D.A. for basic and applied research are likely to induce a greater attention to organizational learning processes. This is because despite the historic contributions made to improvements in agricultural productivity, innovation and subsequent product developments in the agricultural industry have been facing diminished public support. For instance, U.S.D.A funding for research has fallen considerable since the 1990's[7]. More recently for the fiscal year 2010, the R&D budget was 2.61 billion and for fiscal year 2012 has been reduced to 2.373 billion[8]. Such declines will favor an increasing transfer of research responsibilities to the private interests of the agribusiness firm. This is not to say, that public-private innovations partnerships will cease to exist. For example, the recent opening of Dupont Danisco Cellulosic Ethanol plant was the result of a partnership with the University of Tennessee's Biofuels initiative[9]. Yet with current fiscal realities, a model of innovation and product development can no longer be restricted to the "assimilation" and "commercialization" of basic /applied agricultural productivity research, but will likely also require "organizational learning" activities involving private-private learning relationships. Since agribusinesses are distinguished by their interdependence to their value chain partners (Ng and Siebert 2009), the "outside in" learning approach described in this research may thus be one model to explaining this private-private learning relationship. Under such a model, the role of the agribusiness firm is no longer defined by its ability to assimilate and commercialize basic agricultural research (i.e. Dupont Danisco), but may also involve a more pro-active learning orientation in which product development processes depend on collaborations with learning partners of their value chain.

[7] http://www.aaas.org/spp/rd/agri09p.htm
[8] http://www.aaas.org/spp/rd/fy2012/AgricultureOnePageSummary.pdf
[9] http://www.biofuelsjournal.com/articles/DuPont_Danisco_Cellulosic_Ethanol__Genera_Energy__and_University_of_Tennessee_Hold_Grand_Opening_for_Cellulosic_Demonstration_Facility_in_Vonore-88955.html

Such an "outside in" learning approach also raises two implications to agribusinesses. First, agribusinesses involved in an "outside-in" learning approach are likely to engage multiple stakeholders in their product development process. That is, the development of agricultural products is not only intertwined with an agribusiness firm's value chain members, but as a result of this "openness" embeds the product development processes within a network of various stakeholder interests. For instance, the procurement of raw agricultural inputs in the production and packaging of products by multi-nationals, such as Coke (e.g. water stewardship initiative) and Nestle (e.g. creating shared value initiative), are increasingly driven by the interests of its various social and environmental stakeholder groups. Hence, one consequence or implication of this "outside-in" learning approach is a greater openness to these various stakeholder groups not only influences the procurement and development of their food products, but such openness can be one means to help reconcile an agribusiness' private interests with that of the public interests for environmental stewardship. A second and subsequent implication of this outside-in learning approach is the development of agricultural products need not be exclusively driven by the needs and preferences of the food consumer. Rather, such developments can also stem from the interests of the various members of the food supply chain to which enable the agribusiness firm to develop products that food consumers did not anticipate in needing (i.e. Hamel and Prahalad 1991). Hence, unlike a commonly accepted wisdom in agricultural marketing, the food consumer is not the pinnacle of the product development process but is one of many learning partners of an outside-in learning process.

Yet in light of this study's contributions and application / implications to agribusiness, these considerations should, however, tempered by limitations of this study. As this study does not directly tests a firm's confirmation bias and its serial reproduction loss problem, future research calls for a more direct testing of these constructs. In addition, because the concept of absorptive capacity is multi-dimensional, the development of a unified or standardized measure of absorptive capacity remains a subject of much debate (Lane et al. 2006). This study's proposed measures of absorptive capacity are thereby not only subject to limitations surrounding this debate, but the proposed measures reflect one of the many dimensions of this concept. Future research should thereby develop measures that capture others aspects of this concept. Furthermore, even though this study's empirical findings are generally consistent with this study's "outside-in" learning framework, the measures used for the absorptive capacity concept should be interpreted as a precursor for further empirical examinations. In particular, this study chose less direct measures for the absorptive capacity concept so as to minimize the simultaneous causality problem. Yet, in using such indirect measures, they are vulnerable to alternative explanations. For instance, a firm's experience, size and diversity may equally reflect the strength of firms' internal resources rather than just its ability to learn and exploit external knowledge[10]. Hence, future studies should examine more direct measures of the absorptive capacity construct. Such measures would however require developing an IV estimation technique within count data models. This is because although IV estimations have been offered as an alternative solution to correcting simultaneous causality problems, IV estimations are only applicable to linear estimations. Nevertheless, the work done by Mullahy (1997) offers a promising approach to developing an IV for count data model and thus this line of research is called for in future research.

[10] I'd like to thank an anonymous IFAMR reviewer for this point.

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Choice Experiments' Findings: A Tool for Fruit Agribusiness Managers' Decision Making

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Abstract

Choice experiment studies eliciting values for quality attributes provide relevant information to fruit agribusiness managers in various ways. First, it helps orchard managers to know if novel cultivars possess the attributes most valued by consumers. Second, it benefits warehouse and retail store managers to apply appropriate techniques to enhance fruit quality characteristics most appealing to consumers. Third, it is valuable for marketing managers to base their strategies on research-based information on consumers' preferences. Results from a choice experiment showed that consumers were willing to pay $0.19, $0.16, $0.16, and $0.06 for a one unit increase in Anjou pears' sweetness, texture, juiciness, and firmness liking scores, respectively.

Keywords: Anjou pears' quality, sensory test, choice experiment

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Introduction

To ensure the economic sustainability of the U.S. fruit industry, it is important to provide a consistent supply of fruit with optimal quality. This task needs to be carried out on multiple fronts, including improved genetics, postharvest handling, and marketing. In this context, choice experiments eliciting values for optimal quality attributes provide relevant information to agribusiness managers. First, these studies help reduce the uncertainties about commercial success of new varieties. Second, they guide warehouse and retail store managers on what postharvest methods to apply in order to maintain and enhance quality characteristics most preferred by consumers. Third, they guide marketing managers in formulating strategies based on research-based information on consumers' preferences.

This manuscript presents an empirical application on the relevance of choice experiment findings to the Anjou pear industry. Agribusiness managers understand that innovation is important for the long term viability of an enterprise. In the case of the pear industry, at the orchard level, innovation implies removing and replanting existing orchards with new systems that could be a different variety, training system, or some combination of these. Orchard managers need to take into consideration numerous risks including uncertainty if new variety would be commercially successful, ability to manage new horticultural systems, loss of cash income until new planting reaches mature yields, among others (White 2002, 2). Consequently, information on the potential commercial viability of new varieties alleviates some of the uncertainties managers face. That is, managers would faces less uncertainty if they know that the breeding program originating the new variety used a consumer feedback routine on preference and value. This adds to the concept of market driven horticulture, a strategy in which managerial decisions are based on information elicited from consumers rather than from the inside business only (Jaeger and Harker 2005, 2520).

Moreover, choice experiment studies can provide warehouse and retailer store managers, with information on the gains they could realize if postharvest methods aimed to enhance and maintain pear quality characteristics are applied appropriately. Typically, warehouse managers select fruit according to its quality condition when arriving at their facilities. The idea is to pack and store, in controlled or regular atmosphere, pears with optimal characteristics that are believed to preserve its quality attributes throughout the marketing season. However, pears do not always meet such requirements in a uniform fashion, and quality consistency of the fruit being packed is often jeopardized. To avoid losses when handling and guarantee an extended shelf-life, retailers are increasingly demanding pears immediately after harvest despite the fact that this fruit is not fully ripe. Unripe fruit does not possess the characteristics more appealing to consumers. One alternative is to treat pears with ethylene, a natural occurring hormone. Ethylene application or conditioning permits some control over ripening, making possible the supply of fruit with consistent quality.

The Pear Bureau Northwest reports that conditioning is becoming a popular practice across warehouses and retailers in the U.S. Indeed, about 38 percent of Anjou pears and 15 percent of Bartlett pears produced in the U.S. Pacific Northwest are being conditioned. Moreover, there is evidence indicating increased sales of about 25 to 50 percent for retailers starting a conditioning program in the first year (Moffitt 2011). Consequently, warehouse and retail store managers face

the decision whether or not to implement conditioning at their facilities. For warehouse managers, a piece of information to take into consideration is the estimated cost of conditioning. Zhang et al. (2004, 117) report that conditioning at the warehouse using a rented trailer costs about $0.004/lb. The benefit of conditioning pears at the warehouse is that process' parameters (temperature and time) are customized for pears only. Yet, there are some limitations, like less control when handling the fruit in transit. Nonetheless, anecdotal evidence suggests that benefits are greater than losses (or shrink) as pear damage at the retailer shelf is decreased because consumers do not over manipulate the fruit when checking for ripeness (the guess work). Also, selling ripe fruit implies an increase in the velocity of sales (Morgan, 2011, 62). Conditioning can also happen at the retailers' warehouses. Here, there is more control on handling fruit. However, typically, these warehouses ripe other fruits (e.g., bananas, tomatoes, avocados), and process' equipment and parameters are not necessarily tailored for pears (Moffitt, 2011). In sum, to minimize shrink when handling ripe fruit retailers shall find the right length of time to keep the fruit on display. This means balancing between selling the fruit too early when taste is not at its premium or too late when fruit is starting to soften and spoil. Retailers shall also find ways to increase consumers' awareness of ripe fruit (Morgan, 2011, 60).

Choice experiment studies are useful for fruit marketing managers, who are in constant search of consumers' feedback to guide their promotion and selling strategies. Relevant to marketing, choice experiment is one of the most popular marketing research tools, used in thousands of applications in both academia and business. Lusk and Schroeder (2004, 467) observe that such popularity is based on three factors. First, it allows the simultaneous valuation of numerous attributes. Second, it is consistent with consumer demand theory indicating that consumers derive utility from consuming a good from its attributes rather than from the good itself. Third, choice experiment frames questions in a way closely resembling a true purchase situation. However, the validity of choice experiment studies has recently been under scrutiny. Most concerns revolve around hypothetical biases or inconsistencies with situations involving experimental settings instead of actual settings and lack of monetary commitments instead of real money in line (List and Gallet 2001, 41, Lusk et al. 2008, 487, and Chang et al. 2009, 518). Carlsson and Martinsson (2001, 188) and Lusk and Schroeder (2004, 480) indicate no major differences in willingness-to-pay across hypothetical and non-hypothetical settings. Also supportive is Yue and Tong (2009, 370) who argue that the use of real products in a value elicitation experiment helps reduce hypothetical biases. Furthermore, McCluskey et al. (2007, 229) support the view that consumers' subjective evaluation of quality based on taste has a higher predictive ability than objective tests from instrumental measurements.

The purpose of this study is to enhance the understanding of how choice experiment studies' findings can be useful to fruit agribusiness managers. This manuscript is focused on WTP for Anjou pears targeted quality characteristics. Specific objectives include: (1) Eliciting consumers' WTP for Anjou pears' sweetness, juiciness, firmness, texture and ripeness (days to wait until fully ripe). (2) Estimate the potential effects of using different postharvest treatments (conditioning protocols) on Anjou pears' market share. It is hoped that these findings will induce industry actors and researchers in related disciplines to focus their efforts in enhancing sensory characteristics likely to increase Anjou pears' commercial viability.

A few WTP studies have been conducted to elicit values for pear quality characteristics (Gamble et al., 2006, 38; Combris et al., 2007, 465; Zhang et al. 2010, 105; and Gallardo et al. 2011, 452). Gamble et al. (2006, 38) conducted a conjoint analysis to evaluate consumers values for appearance of novel pears in Australia and New Zealand. Combris et al. (2007, 465) conducted an experimental auction to measure the effect of sanitary information, labels, and taste on the willingness-to-pay for Rocha pears in Portugal. They found that consumers were willing to pay 0.35 Euros/kg more for pears with 14 °Brix compared to pears with 11 °Brix; despite the fact that pears with 14 °Brix displayed no food safety guarantee. The present study is similar to Zhang et al. (2010, 105) who estimated WTP for ethylene-induced quality in Anjou pears. They found that consumers were willing to pay $0.25/lb more for pears with higher liking scores resulting from ethylene treatment applied to pears at the beginning of the marketing season. This study differs from Zhang et al. in the primary objective and the methodology used. In this study, the goal is to measure the WTP for each quality attribute, regardless of the postharvest treatments applied. In relation to the methodology, here a choice experiment approach is used instead of contingent valuation. Another similar study is Gallardo et al. (2011, 452). They also investigated the effects of ethylene treatments on consumers' WTP for Anjou pears. Here, treatments were applied to pears at the mid and end of the marketing season, hence the experimental design was different to the one used in this manuscript. Gallardo et al. found that consumers were willing to pay in between $0.20-$0.24/kg for a one unit increase in °Brix and willing to discount in between $0.15-$0.37/kg for a one unit increase in firmness measured in N. Again, this study differs on the experimental design and the primary objective (here we want to elicit values for quality characteristics regardless of the postharvest treatments applied).

Regarding the importance of studying Anjou pears, note that they are a popular pear variety grown in the U.S. Pacific Northwest. Between 2003 and 2008, Anjou pears represented, on average, 23 percent of all pears produced in the U.S. The average production is approximately 2.2 million metric tons per year with an estimated value of USD $185 million (Washington Growers Clearing House 2010 and United States Department of Agriculture National Agriculture Statistics Service 2010).

Methodology

Data

This study utilized data from a choice experiment questionnaire conducted during a sensory test at the Food Innovation Center in Portland, Oregon in October 2008. Recruitment of participants for each test consisted of sending an online screening questionnaire to about 5,000 consumers in the Portland metropolitan area. Individuals were asked about their willingness to participate in the pear taste test. Of those who completed the screening questionnaire, a sample of 120 consumers were recruited and offered a $25 incentive for their participation.

Prior to the sensory test, researchers provided individuals with a brief set of instructions on how to complete the test and questionnaire. Each participant was asked to taste four pear samples under different conditioning protocols. Pear samples used in the sensory test were harvested from a single orchard in mid-September 2008 and placed at room temperature (72°F) for 24 hours prior to cold storage (33°F). Then they were moved to a conditioning room and held at 65°F to 74°F, and one of conditioning treatments was applied to each test group: two, four, or six days with

ethylene or no ethylene exposure. Following the treatment, fruit was kept in cold storage (33°F) to simulate transit. Before the taste test, one half of each sample was tested for firmness by using a Fruit Texture Analyzer penetrometer and soluble solids concentration (a proxy measurement for sweetness) using a refractometer. After tasting each sample, participants were asked to respond a questionnaire. Questions included ratings for the pear samples tasted, respondents' demographics, fruit shopping habits, and the choice experiment questions. Out of the 120 completed questionnaires, 4 were ineligible yielding 116 usable questionnaires.

Compared with the demographics of Portland's population, the sample in this study overrepresented individuals aged 45-64, female, white, and with 4-year and advanced college degrees (United States Census Bureau 2000) (Table 1). This sample population is reasonably representative of the pear consumer profile described by the Pear Bureau Northwest: 75% to 80% female, white, 35-65 years of age, and post-secondary education (Moffitt, 2002).

Table 1. Comparison between Portland Population and Respondents Demographics - Summary Statistics

Demographics	**October 2008 N=120 %**	**US Census Portland Pop=529,121 %**
Age		
Under 24	6.0	31.4
25-34	27.2	18.3
35-44	19.5	16.4
45-54	23.8	14.8
55-64	19.3	7.6
Older than 65	4.3	11.5
Gender		
Male	22.1	49.4
Female	77.9	50.6
Ethnicity		
American Indian, Alaska Native	0.9	1.1
Asian, Asian American	3.4	6.3
Black, African American	0	6.6
Hispanic, Latin American	2.6	6.8
White	90.6	77.9
Other	0.9	1.3
Decline to respond	1.7	
Education		
High school graduate	0	22.2
2 year college or technical degree	31.3	30.8
4 year college	40.0	21.3
Advance college degree	28.7	11.4

Choice Experiment Design

The choice experiment included eight hypothetical purchasing scenarios, each mimicked a situation in which an individual would choose to buy one pound of Anjou pears from a set of two options (A and B) each with a different combination of given ratings for sweetness, juiciness, firm-

ness, texture, ripeness, and price. If neither of the options was of interest, respondents were given a third option to choose none of the alternatives presented. The experimental design for the questionnaire included three given rating levels: 2, 5, and 8 (based on a 9-point hedonic scale)[1] for the attributes sweetness, juiciness, firmness, and texture. Ripeness levels were categorized as one of three time periods needed to wait until fully ripe: ready to eat, wait 2-4 days to eat, or wait 7-10 days to eat. Each attribute combination was matched with two levels of prices ($1.09 /lb and $1.99 /lb). These prices were consistent with Portland grocery store prices for the first week of October 2008 (Figure 1).

Question #1

	Option A	**Option B**	**Option C**
Sweetness	Rate 2 Using a 1-9 Scale where 1= not sweet, 9=ideally sweet	Rated 8 Using a 1-9 Scale where 1= not sweet, 9=ideally sweet	Neither of them
Juiciness	Rate 2 Using a 1-9 Scale where 1= not juicy, 9=ideally juicy	Rated 2 Using a 1-9 Scale where 1= not juicy, 9=ideally juicy	
Firmness	Rate 2 Using a 1-9 Scale where 1= hard, 9=soft	Rated 8 Using a 1-9 Scale where 1= hard, 9=soft	
Texture	Rate 8 Using a 1-9 Scale where 1= mealy, 9=buttery	Rate 5 Using a 1-9 Scale where 1= mealy, 9=buttery	
Ripeness	Will take 1 to 2 days to become fully ripe	Ready to eat	
Price per pound ($/lb)	$1.09/lb	$1.99/lb	
I would BUY ✓ Check only one			

*If you chose Option C, please tell us why:*_____

Figure 1. Example of Choice Experiment Question

A factorial design was considered to create random combinations of given attributes, levels, and prices. This design is commonly used because it guarantees equal frequency of rating levels, no correlation between ratings and prices, minimization of invariant rating levels within a scenario, and balance in the probability of choosing an alternative within a scenario (Louviere et al. 2001, 85). There were five attributes each varied at three levels, and a price attribute varied at two

[1] Note that for sweetness we used the scale 1=not sweet, 9=ideally sweet, similar for juiciness. Our intention by using this scale was to get a "definition" of the ideal pear characteristics in terms of sweetness and juiciness, and later compare these values with refractometer measurements. However, comparisons were not to assess how well consumers predicted sweetness levels, rather, our intention was to observe what levels of SSC were considered as ideal. We noted that if we used an intensity scale (1=not sweet, 9=extremely sweet) and a like scale (1=extremely dislike, 9=extremely like) we could get a better correlation with the refractometer and a good idea of what consumers actually consider as ideally sweet or juicy. We acknowledge that the scale we used is not common in sensory analysis. Later in the manuscript, when we discuss the lack of correlation between refractometer measurement and sensory ratings, we hypothesize that the use of this scale could partially explain this lack of correlation.

levels. This means that there were 3^5 x 2= 486 possible descriptors that could be created, for individuals to respond. Obviously, this is not a reasonable option, thus a main effects fractional factorial design was used. The latter design yielded 32 scenarios. Yet, it was felt that 32 was too lengthy for respondents, so 4 questionnaire versions were created, each with 8 scenarios randomly assigned to participants.

Statistical Model

Choice experiments are based on the random utility theory stating that the utility derived from consuming a good has two components: a systematic component given by the good's attributes and a random component given by all factors not directly measurable. The random utility for individual *i* choosing alternative *j* is defined by,

$$(1) \quad U_{ij} = V_{ij} + \varepsilon_{ij}$$

where V_{ij} and ε_{ij} are the deterministic and random components, respectively. Moreover, ε_{ij} is distributed independently extreme value with variance $(\theta_j \pi)^2 / 6$. In this study, V_{ij} is represented by,

$$(2) \quad \begin{aligned} V_{ij} &= ASC_j + \alpha_1 Sweetness_{ij} + \alpha_2 Juiciness_{ij} + \alpha_3 Firmness_{ij} \\ &+ \alpha_4 Firmness_{ij}^2 + \alpha_5 Texture_{ij} + \alpha_6 Ripeness_{ij} + \beta \,\mathrm{Pr}\, ice_{ij} \end{aligned}$$

where ASC_j is the alternative specific constant representing the utility provided by option *j* not explained by rating variations (*j*=option A, option B); α_1 to α_6 represent the marginal utility of the ratings for sweetness, juiciness, firmness, firmness^2, texture, and ripeness, respectively; $Sweetness_{ij}$, $Juiciness_{ij}$, $Firmness_{ij}$, $Firmness^2_{ij}$, $Texture_{ij}$, $Ripeness_{ij}$, represent the ratings for sweetness, juiciness, firmness, firmness^2, texture, and ripeness as presented in option *j* to individual *i*; β is the marginal utility of price; and $Price_{ij}$ is the price presented in option *j* to individual *i*.

About the model specification, different from the other quality attributes, firmness is not treated as linear but as quadratic. This means that respondents' utility will not increase linearly as pears become softer. This specification is aligned with the rating setting in the choice experiment (i.e., firmness ratings were set at "one" if pear was found hard and "nine" if soft). In relation to ripeness, note that choice experiments allow an evaluation of both production and demand side effects. From a production perspective, quality attributes included in this specification are correlated with ripeness. In fact, ripe fruit is likely to be sweeter, softer, and have a more buttery texture when compared to unripe fruit. However, this experiment aims to measure a demand side effect. That is, investigate what consumers want. A consumer may want to have a ripe fruit that is not soft or not sweet, although theoretically impossible from a production perspective. An extreme example to illustrate this issue is when researchers investigate consumers' choices for high quality products offered at low prices. Typically, prices are higher when the quality is higher. However, it is always possible to evaluate consumers' choices in a situation where quality is high and the price is low, or vice versa.

To estimate the model coefficients, this study used the heteroskedastic extreme value (HEV) model. Typically, practitioners use the conditional logit model, because of its simplicity. Yet, it exhibits two main restrictive assumptions. First, it assumes independence of irrelevant alternatives (IIA), meaning that no matter what options are presented to the respondent his/her choice will remain invariant. The other restrictive assumption is that variance of unobserved factors are assumed to be constant across alternatives. Results from a Hausman specification test to check for IIA show that, in fact, this assumption holds for this particular setting (χ^2 =12.18 and p=0.143). However, a test for homoscedasticity shows that variance error terms differ across alternatives (χ^2 =11.83 and p=0.002). Hence, the HEV model was used. In this application, the variance of one alternative is normalized to 1, so that the variances for the other alternatives are estimated relative to the normalized one. Bhat (1995, 474) shows that the probability that individual *i* chooses option *j* is given by,

$$(3) \qquad P_{ij} = \int \left[\prod_{j \neq k} \exp\left(-\exp\left(-V_{ij} - V_{ik} + \theta_i w\right)/\theta_j\right) f\left(\varepsilon_{ij}\right) dw \right]$$

where $w = \varepsilon_j / \theta_j$, and θ_j is a scale parameter for the *jth* alternative. Coefficients are calculated in SAS® software using quadrature methods.

Results and Discussion

This section presents and discusses model estimates, WTP, market share and results' validation. About model estimates, the negative sign of the alternative specific constants[2] (option A and option B), indicates respondents' unwillingness to choose a pear purchase scenario unless it possesses certain quality characteristics. The marginal utility of price is statistically significant and negative, indicating that as price increases, an individual's utility decreases. Also, the marginal utility for the sweetness, juiciness, and texture ratings are all statistically significant and positive, meaning that individuals prefer sweet, juicy, and buttery pears. Firmness increases at a decreasing rate. Indeed, after reaching a maximum rating of 5.81 (in the 1-9 scale, 1=hard, 9=soft), preference for firmness decreases. Ripeness was not significant, indicating that individuals do not show great concern for the amount of time needed to wait for fully ripe pears as long as expectations for other quality characteristics included in this experiment are fulfilled. Not surprisingly coefficient estimates for the scale parameters for options A and B are statistically significant, indicating that error variances across alternatives are not constant.

[2] We included in the model ASCs for each option rather than one ASC for the "none" option. By doing this, the model provides more information about preferences for each option. Note that probability of choice for Option B is slightly larger than Option A. Although our fractional factorial experimental design aimed to keep the probabilities of choosing alternatives as similar as possible, we found differences across option A and option B. Results from a T-test show that Option B had statistically significant larger mean values for sweetness, firmness, and prices. Although having larger values for the latter two attributes will imply a lower probability of choice, respondents seem to prefer the option with higher values for sweetness.

Table 2. Parameter Estimates for Anjou Pear Quality Attributes – HEV Model

Variable	Parameter Estimate	Standard Error
ASC A[a]	-2.432*[b]	0.329
ASC B	-2.043*	0.355
Price	-0.990*	0.176
Sweetness	0.190*	0.024
Firmness	0.418*	0.111
Firmness squared	-0.036*	0.010
Juiciness	0.162*	0.028
Texture	0.157*	0.034
Ripeness	0.036	0.044
Scale parameter B	1.511*	0.280
Scale parameter C	2.081*	0.660

Number of Observations: 928, Log likelihood: -780.04, Akaike Information Criterion: 1582

[a] ASC means alternative specific constant

[b] * Significance at the 5% level

Validation of Results

We investigated the reliability of the choice experiment estimates by using a holdout sample test, following the methodology used by Haener et al. (2001, 636). First, the dataset was randomly divided into an estimation sample and a holdout sample. Parameters were estimated for the estimation sample. To assure reliability, the prediction test was repeated for the remaining models and holdout samples generated from 116 random draws from the dataset, or by deleting observations for one individual for each replication (there were 116 usable responses).

The percentage of correctly predicted choices was calculated by comparing each repetition outcome with actual respondents' choice. Results indicate that the model predicted correctly respondents' choice 56.8% of the time. Note that with the three options provided, to select A, B and none, a model of pure chance would correctly predict outcomes only 33% of the times. The holdout sample test thus reveals that our model results are reasonably robust.

Willingness-to-Pay

Willingness-to-pay (WTP) depicts the amount of money the individual would have to give up to be indifferent towards a one-unit increase in the quality attribute. This statistic is obtained by:

$$(4) \quad \text{WTP} = -\frac{\text{Attribute}_m}{\text{Price}}$$

where "Attribute" is the parameter estimate for the rating of attribute *m*, *m*=sweetness, juiciness, texture, firmness and ripeness, and "Price" is the parameter estimate for price.

WTP can also be calculated as the amount of money an individual would have to give up to be indifferent between two attribute levels, for example between rating 2 and rating 5. This time, the estimation follows:

$$(5) \quad WTP = -\frac{Attribute_m(Level_2 - Level_1)}{Price}$$

Table 3 lists results for WTP under three formats. First, there is the WTP for a one unit increase in the attribute rating, then the WTP for improving from attribute rating two to rating five, and from rating five to eight (in the 1-9 scale). Ripeness was evaluated differently, a one unit increase means one extra day to wait until fully ripe, going from rating two to five and from rating five to eight mean wait three more days to wait until fully ripe. Results imply that consumers are willing to pay more for a one unit increase in sweetness, juiciness, and texture when compared to firmness and ripeness or days to wait until fully ripe. Moreover, consumers seem to prefer softer pears, but this preference seems to decrease once reached a maximum point. Indeed, consumers express a willingness to pay 52 cents/lb when firmness varies from rating 2 to rating 5, however they are willing to discount 13 cents/lb if pears' firmness varies from a rating 5 to a rating 8 (i.e., softness increases). This information is particularly useful to agribusiness managers who are considering new orchard plantings, to select a cultivar with the highest scores for sweetness, texture, and juiciness, compared to other cultivars. Also, calls the attention to warehouses and retailers in that ripeness inducement shall be closely controlled for firmness. Having "too soft" pears might pose a challenge in handling and might not be aligned to consumers' preferences. Table 3 also exhibits the 95% confidence intervals estimated for WTP, via parametric bootstrapping (Krinsky and Robb, 1986, 715).

Table 3. Willingness-to-Pay (WTP) and Relative Importance Estimates for Anjou Pears Quality Attributes

Quality Attributes	WTP ($/lb) For a 1 unit increase in the attribute rating	WTP ($/lb) For going from attribute rating 2 to rating 5	WTP ($/lb) For going from attribute rating 5 to rating 8	Relative importance of attributes
Sweetness	0.19 (0.15-0.26)	0.58 (0.45-0.79)	0.58 (0.45-0.79)	32.46%
Firmness	0.06 (0.03-0.09)	0.52 (0.32-0.72)	-0.13 (-0.31-0.02)	6.87%
Juiciness	0.16 (0.13-0.21)	0.49 (0.38-0.62)	0.49 (0.38-0.62)	27.68%
Texture	0.16 (0.11-0.21)	0.48 (0.34-0.64)	0.48 (0.34-0.64)	26.85%
Ripeness[a]	0.04 (-0.03-0.12)	0.11 (-0.09-0.35)	0.11 (-0.09-0.35)	6.14%

[a] One unit increase in the rating of ripeness means one day extra to wait until fully ripe. Going from rating two to five and going from rating five to eight means wait three days extra to fully ripe.

Relative Importance of Quality Attributes

An important piece of information for agribusiness new product development or breeding programs is the relative importance of quality attributes to consumers. This information will help

set priorities when selecting attributes for a new cultivar. Relative importance is the change in an individual's utility relative to a change in the level of the attribute rating, which is calculated by,

$$(6) \quad \text{Relative importance} = \frac{\alpha_{ij}(\text{highest level} - \text{lowest level})}{\sum_{m=1}^{5} \alpha_{ij}(\text{highest level} - \text{lowest level})}$$

Results, reported in Table 3, indicate that sweetness, juiciness, and texture are the most important quality attributes for pear consumers, with a score of 32.46%, 27.68%, and 26.85%, respectively. Far behind is firmness and ripeness with scores of 6.87% and 6.14%, respectively.

Market Share Estimation

A useful feature of choice experiments is that it allows for the estimation of potential market share of the goods being analyzed. To illustrate the application of this statistic, we used the average rating scores from the sensory test of the pear samples under the four conditioning protocols described in the Methodology section and presented in Table 4. Market share is calculated by,

$$(7) \quad \text{Market share} = \frac{\exp(\overline{V_s})}{\sum_{s=1}^{S} \exp(\overline{V_s})}$$

where $\overline{V_s}$ represents the utility as depicted in expression (2), with the difference of having the average ratings for each attribute and treatment *s* multiplied by the parameter estimate for each attribute, and *S* represents the set of all pears that can be described with similar attribute ratings to those presented in this study. We assume that the samples, under the four treatments, represent all pears available in the market, and that price is the same across pears ($1.49 /lb). Market share estimates suggest that pears with sweetness rated as 7.11, firmness 6.97, juiciness 7.95, texture 7.26 and a no wait for full ripeness (pear sample 4, 6-day conditioning) will display a 54.68% share relative to pears with sensory characteristics as described in Table 4.

Table 4 also exhibits instrumental measurements for sweetness, expressed as soluble solids concentration, and firmness, expressed as lbf. About the lack of correlation between ratings for the ideal sweetness and refractometer measurements, note that the purpose of listing instrumental measurements was not to validate how well consumers predicted such values, but to have a close description of what level of sweetness is considered as ideal by consumers. This is the reason why we use the scale 1=not sweet and 9=ideally sweet. It is true that the use of this scale could introduce noise when comparing refractometer measurements and ratings for the ideal pear. However, to make direct comparisons between both measures was not the intention of the experiment. Moreover, it is relevant to consider that, often, the correlation between the perception of sweetness and soluble solids measured with a refractometer could be low, as explained by Kader (2008, 1864). Individuals' perception of sweetness is heavily influenced by fruit aromatic components that are mostly developed as fruit ripens. Thus, one observes higher scores for ideal sweetness in pears with more days of conditioning (pear samples 4 and 3). For firmness we used a different scale (1=hard, 9=soft) and not surprisingly there was a high correlation (-0.95) be-

tween the instrumental measurement (the higher the resistance in lbf, the firmer the pear) and individual's sensory ratings (scale 1-9, 1=hard, 9=soft).

These results have interesting implications for the industry. First, soluble solids as measured by a refractometer might not be as precise in measuring sweetness as it cannot measure other aromatic components more influential in consumers' perceptions. This underscores the importance of having consumer panels' feedback when evaluating quality characteristics. Second, ethylene treatments applied to pears within days of harvest seems to be a promising alternative to trigger ripening and enhance the quality attributes more valuable for consumers. Also, these results coincide with previous studies in that conditioning Anjou pears appears promising to positively affect consumers' preferences and WTP premiums (Zhang et al. 2010, 105; Gallardo et al. 2011, 452).

Table 4. Consumer Liking Scores, Instrumental Measurement for Soluble Solids and Firmness, and Market Share Estimates for Pears under Four Conditioning Protocols.

Quality Attributes	Pear 1 No conditioning	Pear 2 2-day conditioning	Pear 3 4-day conditioning	Pear 4 6-day conditioning
		Consumer Liking Scores		
Overall liking (1=dislike extremely, 9=like extremely)	4.33c (2.37)	4.49c (1.95)	6.33b (1.73)	7.48a (1.58)
Sweetness (1=not sweet, 9=ideally sweet)	3.73c (2.10)	3.93c (1.91)	5.71b (1.99)	7.11a (1.90)
Firmness (1=hard, 9=soft)	4.24c (2.44)	4.96b (2.03)	6.38a (1.93)	6.97a (1.78)
Juiciness (1=not juicy, 9=ideally juicy)	2.47d (1.59)	3.17c (1.97)	5.82b (2.07)	7.95a (1.41)
Texture (1=mealy, 9=buttery)	4.08c (2.30)	4.13c (2.03)	6.03b (1.99)	7.26a (1.59)
Ripeness (number of days to wait until fully ripe)	6.00	4.00	2.00	0.00
		Instrumental Measurement		
Soluble solids (°Brix)	14.94a (1.03)	14.61b (1.04)	14.57b (1.04)	14.52b (1.07)
Firmness (lbf)	11.13a (1.75)	6.11b (1.14)	3.47c (0.68)	2.23d (0.45)
		Market Share (%)		
	8.40 (4.93-14.15)	9.80 (6.56-14.26)	27.13 (24.77-28.19)	54.68 (43.48-63.77)

Lower case letters (a, b, c, and d) should be read by row for each attribute. Differing letters denote statistically significant differences; same letter denote no statistically significant differences.

Conclusions

Findings from this study demonstrate that choice experiments provide useful information for fruit agribusiness managers' decision making. This manuscript presents an empirical application of using a choice experiment to elicit WTP for targeted quality attributes of Anjou pears. There

is evidence that pear consumers in the Portland metropolitan area are willing to pay \$0.19, \$0.16, \$0.16, and \$0.06 for a one unit increase in pears' sweetness, texture, juiciness, and firmness liking scores, respectively. This information is useful to pear orchard managers who are planning to diversify their operations with new plantings and planning to select pear cultivars that emphasize sweetness, buttery texture, and juiciness. Second, for new product developers in fruit agribusinesses, fruit breeders, it helps in setting priorities when selecting for quality attributes. As such, the relative importance for pear quality attributes is 32.46% for sweetness, 27.68% for juiciness, 26.85% for texture, and 6.87% for firmness. Third, it benefits fruit marketing managers. Marketing strategies seeking to increase pear consumption should emphasize the dessert qualities highlighted by consumers' in this study.

Moreover, findings from this study suggest the potential benefits of conditioning pears or applying ethylene to trigger ripening. This is an important piece of information for warehouse and retail store managers who are contemplating whether or not to invest in conditioning pears. We found that pears two weeks after harvest and under a 6-day conditioning treatment developed an ideal sweetness score of 7.11 (soluble solid concentration 14.52%)[3], firmness 6.97 (2.23 lbf), juiciness 7.95, and texture 7.26. A pear with such characteristics will absorb a 54.68% market share when compared with pears receiving different conditioning treatments or no treatments. These results add to the anecdotal evidence suggesting that benefits could be greater than losses as pear shrink at retailer shelf could be decreased if fruit is conditioned. In sum, findings from this study underscore the potential benefits of conditioning to supply pears with optimal and consistent quality.

Finally, findings in this paper provide research-based information for agribusiness managers seeking to diversify their output with new cultivars and/or looking for methods to enhance the fruit attributes most preferred by consumers. Considering that preferences might not be consistent across time or individuals (consumers versus non-consumers), further research into the valuation of quality attributes across different population clusters is required to provide pear agribusiness managers with a more precise tool to forecast novel cultivars acceptance and the potential benefits of alternative postharvest methodologies.

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[3] Note that the use of the scale 1=not sweet, 9=ideally sweet could have influenced this lack of correlation. It would have enhanced our understanding of the interactions between consumers' ratings and instrumental measurements, if we used two scales, one that measure likeness (1=extremely dislike, 9=extremely like) and another that measures intensity (1=not sweet, 9=extremely sweet).

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Conjoint Analysis of Consumer Preferences for Lamb Meat in Central and Southwest Urban Albania

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Abstract

The objective of this study is to inform small ruminant sector stakeholders regarding consumer preferences for lamb meat attributes such as origin, price, weight and safety/certification. Conjoint Choice Experiment (CCE) was utilized to design the survey and latent class approach to analyze the data. Within the prices and weight constraints provided in the survey, origin is an important factor for all four identified consumer classes. All consumer classes prefer domestic lamb meat, and moreover, domestic highland lamb meat is strongly preferred over domestic plain/lowland meat. The identified consumer classes prefer smaller weight lamb to larger ones. This study also analyzed willingness to pay for the main product attributes for the largest consumer groups. The two largest consumer groups were willing to pay 101 and 276 ALL/kg for domestic plain/lowland meat as opposed to imported meat. This result can be used to producers' advantage if labeling and other marketing tools are available to inform consumers of the products' origin. Therefore, enforcement of origin identification should be a priority for the government and other stakeholders, while producers should consider introducing and promoting their own brands such as producer associations' brands.

Keywords: Conjoint Choice Experiment (CCE), latent class analysis, lamb meat, consumer preferences, Albania

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Introduction

Small ruminant (mainly sheep and to lesser extend goat) production is an important source of income for small Albanian agricultural holdings, especially in impoverished rural mountainous areas. In these areas, enhancing small ruminants' productivity is considered a priority by the Agriculture and Food Sector Strategy of Ministry of Agriculture, Food and Consumer Protection (MoACFP 2007). Meat and byproducts from small ruminants are used both for household consumption (most Albanian farms are subsistence and semi-subsistence farms) and sold on the market. Thus, government support for the development of this sector is important from rural economic development and poverty alleviation perspectives.

It is important that any support provided to this sector (as well as other agrifood sectors) be based on in-depth understanding of market characteristics and trends. In this context, understanding consumer preferences for lamb product attributes is instrumental in assisting policy makers, private investors, and individual farmers to design efficient and sustainable intervention activities. Specifically, the objectives of this study are to assess urban Albanian consumer preferences for different lamb meat attributes, to explore the market segments for the different lamb meat products, to estimate the relative importance of the different attributes and to assess willingness to pay for certain product attributes. This information is useful for marketing experts, policy-makers, producer associations and retailers. However, given both the production base and retail sector are highly fragmented with very limited capacities to design and implement marketing strategies, the findings of this paper are of particular interest for policy-makers and donor programs active in the sector. These entities play a crucial role in shaping the sector production in context of the market trends.

This study was commissioned by United Nations Development Program (UNDP) Project "Improving the Performance of the Livestock Sector in Albania" to provide inputs for their strategy to support the Albanian small ruminants sector. This UNDP project is assisting small ruminant farmers in Southwest Albania to enhance access to market and increase profitability. Therefore, understanding of consumer preferences and willingness to pay for certain lamb meat attributes was considered important to anticipate and serve as guideline for the support of the targeted farmers and farmer associations. Our study was developed in close cooperation with several stakeholders, including the grantor, and farmer associations. The preliminary results were presented and validated at a national workshop[1] in October 2010 with the main stakeholders of the sector, including Ministry of Agriculture, Food and Consumer Protection, donor community, farmer associations, and researchers. Workshop participants found this study useful for their future engagement in the sector, especially the aforementioned UNDP Project that used this study as a basis for its support strategy for small ruminant farmers in Southwest Albania

Background

The livestock industry is one of the fastest growing Albanian agricultural sectors in the past decade. Furthermore, since Albania has optimal conditions to breed sheep and goats as well as cows, the Albanian government considers the livestock sector a priority for development

[1] For more information on this workshop, please visit: http://www.undp.org.al/index.php?page=detail&id=155, last accessed on 15th August 2011

(MoAFCP 2007). Lamb meat production is considered to be a major opportunity for the development and growth of the Albanian agriculture sector (WB 2007), particularly because lamb meat is an important component of the traditional diet in Albania.

The estimated yearly per capita consumption in urban areas is 3.5 to 3.8 kg of lamb and mutton and 0.6 kg of kid goat meat, while consumption in rural areas is much higher, with an estimated consumption of more than 7 kg of lamb and mutton and 3 kg of kid goat meat (Leonetti and Kristo 2010). The yearly per capita lamb and mutton consumption rate is higher than other comparable countries in the region such as Serbia (2.2 Kg), Macedonia (1.9 Kg), Bosnia and Herzegovina (0.6 Kg) (FAO 2009) and Kosovo (0.4 Kg) (FAO 2009). Most consumers buy lamb meat from butchers, and some directly from farmers. Only about 5% of consumers in urban areas buy lamb meat at supermarkets or other types of retail shops (DSA 2010). Domestic lamb meat is typically bought fresh at the butchers whereas imported lamb meat is typically available frozen in supermarkets or minimarkets.

Albania possesses a considerable number of sheep – more than 1.7 million in 2009. The number of sheep increased in the 1990s, peaked in 2000 and subsequently declined and stabilized around 2005. However, increasing productivity has more than offset the reduction of number of animals (See Table 1). Overall, increased productivity and better access to market led to a net increase in this sector's output, though production still fails to meet the growing urban demand (WB 2007). At the same time, though imports remain insignificant compared to domestic production, they have almost doubled since 2000, and are expected to grow further due to income growth and trade liberalization.

Table 1. Number of sheep heads, sheep meat production and imports by year

Year	2000	2008	2009
Sheep (000 heads)	1,939	1,800	1,768
Meat production (ton)	12,300	14,900	15,600
Meat imports (ton)	342	599	616

Source: MoAFCP 2010 (Production figures), UNSTAT 2010 (Import figures)

Productivity and efficiency remain key challenges of this sector, contributing to relatively high production costs and prices. Product safety is also a major problem that has to be addressed by the producers and the government. Food-borne diseases caused by microbiological contamination are one of the major public health challenges in Albania, including frequently reported cases of brucellosis (WB, 2007).

While there have been several value chain studies of the small ruminant sector, there has not been an in-depth consumer preference survey on lamb meat in Albania. It is important that policy-makers, the donor community, and other stakeholders engaged in this sector take into consideration consumer "perception" for the main meat attributes when planning intervention strategies such as subsidy schemes and extension services. More specifically, this study provides useful inputs for strategies and actions implemented by the Ministry of Agriculture, Food and Consumer Protection, and several donor organizations/projects actively engaged in the Albanian small ruminant sector, including UNDP, SNV, EU projects.

Methodology

Research Design

The last two decades have brought major behavioral changes to European consumers. The increased awareness of food safety, as well as changes in dietary and consumption patterns have attracted interest in studying fresh meat consumption preferences (Grunert 2005; Bernabeu and Tendero 2005). Various studies have focused on consumer behaviors related to lamb meat. Past studies have found that attributes such as quality and safety perceptions, health concerns (Rimal 2005; McEachern and Willock 2004; Schupp et al. 1998), tenderness (Dransfield 2005), packaging, production systems and origin (Roosen et al. 2003; Grunert 1997) influence consumer choices. Other scholars (such as Basiotis et al. 1993; Misra et al. 1993; Schutz et al. 1989; Adu-Nyako et al. 1999; Jimin et al. 2004; Becker et al. 1998 and Grunert 2005) emphasized that demographic factors such as age, gender, education, place of residence, household size, and income influence the choice and frequency of lamb meat consumption.

In this study, Conjoint Choice Experiment (CCE) and Latent Class Analysis (LCA) were used to develop efficient survey product profile designs and estimate consumer preference for lamb meat respectively. CCE was developed by Louviere and Woodworth (1983) and is based on the idea that a good can be described by its product attributes and their levels. The lamb meat attribute selection is based on extensive literature review on consumer's preference indication in regards to both extrinsic elements (labeling, place of purchase, price, origin, etc.) and intrinsic elements (color, texture, fat content, aroma, tenderness, freshness, etc.) of the product itself.

Few studies have used clustering methods or conjoint experiments to analyze fresh lamb meat consumption behavior; however there have been several studies for other types of meat. Various scholars such as (Lusk and Parker 2009; Lusk and Cevallos 2004; Lusk et al. 2001; and Ward et al. 2008), look into various aspects/attributes of beef meat, whereas Nilson et al. (2006) looks into pork meat. Regarding lamb meat, Bernabeu and Tendero (2005) interviewed 400 consumers in Spain focusing on the relative importance of different attributes such as price, certification, origin and commercial type; and Cunhal-Sendim et al. (1999) applied conjoint analysis to a butcher shop survey and found that the most important criteria for consumers were pricing and grading.

There are several advantages in using CCE over traditional conjoint analysis. First, the design of product attribute sets can mimic products with vary attribute levels, allowing measurements of the tradeoffs respondents make by choosing one attribute over another. Second, CCE uses discrete choices for choosing among pairs or sets of product profiles, rather than rating or ranking ten or twelve product profiles at one time. Thus, the design reduces the possibility of respondent fatigue often seen with traditional conjoint analysis. CCE also has two disadvantages. The first is that respondents repetitively choose a profile from a choice set. The respondent may "catch on" and give strategically biased answers. To minimize that possibility, the number of choice sets was reduced to about 12 per respondent. The second disadvantage is that there are no incentives for people to want to do the more complex conjoint choice survey. However, lamb meat is a traditional component in the Albanian diet and respondents are familiar with the attributes and more likely to participate if they know the product and the purpose of the survey. Overall, the advantages of CCE far outweigh its disadvantages (Chan-Halbrendt et al. 2010, a). A complete

CCE includes several steps such as attributes selection and determination level, choice set construction, data collection, and analysis.

Various studies have used several techniques for determining the most relevant product attributes. These include focus group interviews, in-depth interviews or means-end chain analysis (Krystallis and Ness 2005; Cunhal-Sendim et al. 1999). In this study, we chose the attributes based on extensive literature review of consumer preferences for lamb products (based on studies of Cunhal-Sendim et al. 1999; Bernabeu and Tendero 2005; Basiotis et al. 1993; Misra et al. 1993; Schutz et al. 1989; Adu-Nyako et al. 1999; Jimin et al. 2004, Becker et al. 1998; Corcoran et al. 2002; Bonne and Verbeke 2006) and other type of food basket products (Siskos et al. 2001; Sandalidou et al. 2002; Goering 1985; Gazquez-Abad and Sanchez-Perez 2009). We also organized two focus groups with consumers and experts (in agrifood marketing specialists, veterinarians, farmer association representatives, etc.) to determine the most important lamb meat purchasing attributes, their levels and other aspects related to the survey. As a result, four attributes were chosen for studying lamb meat preference: weight, origin, certification, and price. A summary of attributes and levels is shown in Table 2.

Table 2. Lamb Meat Attributes and Levels

Attributes	**Levels**			
Carcass Weight (Kg)	7	10	13	16
Origin	Import	Domestic Highland	Domestic Plain	
Safety Certification	VS*	NVS**		
Price ALL***/Kg	700	800	900	1,000

Source: Literature review and focus groups
*: Veterinarian Stamp Any Butcher/Seller
**: No Veterinarian Stamp Known Butcher/Seller
***: ALL is the Albanian currency, 1USD ≈ 100 ALL

Product Attributes and their Levels:

1. *Weight.* Lambs are mostly sold by farmers when the lambs are small as there is higher demand for young lamb meat. In addition, since sheep milk is often more profitable than meat, farmers tend to "get rid" of lambs as quickly as possible in order save the ewes' milk for sale and sell young lamb meat at a premium price. Thus, lambs that weigh between 7 – 16 kg dominate the market (Leonetti and Kristo 2010). For this attribute there were four levels: 7, 10, 13 and 16 kg (slaughtered/butchered weight).

2. *Origin.* Lamb meat origin is a very important consumer purchasing factor. Bernabeo and Tendero (2005) found that origin was an important purchasing attribute for various areas in Spain. Consumers and butchers participating in the focus groups confirmed a strong preference for domestic lamb meat as compared to imported. In addition, lamb grown in highland pastures is perceived to be of higher quality than lambs grown in the flatland. Thus, for this attribute, three levels were included: import, domestic highland, and domestic plain/lowland.

3. *Certification.* This is an essential attribute especially in the case of a developing country like Albania, which faces serious problems with food safety enforcement. The only

sources of lamb meat safety insurance in Albania are governmental veterinary inspection and certification on one hand, and personal trust in the local butcher on the other hand. According to Albanian law, butchered lambs (and carcasses of other types of animals such as calves) should be inspected by an authorized veterinarian who stamps the carcass if it met government standards of safety and quality. Imports, on the other hand, are subject to more regular control via customs inspection. In practice, the public veterinarian certification system is not found to be very reliable according to the focus groups. Alternative mechanisms of safety and quality certifications are practically non-existent in this sector in Albania, as also there are no production or retail brands applied to lamb meat. Thus, for this attribute the levels were: lamb meat with veterinarian stamp (VS) from any butcher/seller, or lamb meat without veterinarian stamp (NVS) from a trusted (local) butcher/seller.

4. *Price.* Price consisted of four levels: 700 ALL[2]/kg, 800 ALL/kg, 900 ALL/kg, and 1,000 ALL/kg. These prices are generally found in the market place and were confirmed by the focus group.

Statistical Design and Analysis

Statistical design is used to combine the levels of the attributes into a number of alternative product profiles to be presented to respondents. Depending on how many choice sets and profiles are included in the experiment, one can have either complete or fractional factorial designs. A fractional factorial design is used to reduce the number of attribute level combinations while allowing for the efficient estimation of the effects of the individual attributes ('main effects'). In this study, there are four attributes, of which two have four levels (price and weight), one has three levels and one has two levels. Thus, the number of possible profiles totaled 4*4*3*2 or 96. A complete factorial design would use all the 96 profiles, which is impossible for respondents to evaluate. The most commonly used method of constructing fractional factorial design in conjoint measurement is using orthogonal array. Orthogonal arrays build on Greco-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). From all possible profiles, sets of profiles were randomly developed and separated into 7 versions. The survey consists of two parts. The first part consisted of choosing the 12 choice sets and the second part was additional questions that included the socio-demographic details of each respondent. A sample choice set is given in Table 3. The software used to design the surveys was Sawtooth Software SSI web version 6.0. Since imports and uncertified lamb meat cannot occur together as all imports are subject to more rigorous international and custom safety standards and certification, the occurrence of this combination as a potential profile was prohibited.

[2] ALL is the Albanian currency: 1 USD ≈ 100 ALL.

Table 3. Examples of a Choice Set

Attributes	Choice A	Choice B	Choice C	Choice D
Carcass Weight (Kg)	10	13	16	7
Origin	Domestic Highland	Import	Domestic Plain	Domestic Plain
Safety Certification	NVS	VS	NVS	VS
Price ALL/Kg	800	900	1,000	900

Source: Current study

Interviews were conducted with 378 randomly selected people from Tirana, Vlora, Saranda and Durres during July-August 2010. These four towns are situated in central and southwest Albania and together make up more than 65% of Albania's population with a high concentration of purchasing power. Geographical coverage, interview locations and the number interviewed were based on the aforementioned focus groups and expert assessment, constraints of the budget and the UNDP project's geographical coverage area. According to Johnson and Orme's (2003) formula for sample size with four attributes, the sample of 378 respondents is sufficient for the number of attributes and levels in this study.

Mail-based surveys are not possible in Albania given that the system of addresses is chaotic and information is often missing[3]. To the authors' best knowledge, a mail-based household survey has never been administered in Albania. In-person interviews have been widely applied to similar consumer surveys in other countries (Lusk et al. 2002; Burton et al. 2001) and also to Albanian consumer research (Chan-Halbrendt et al. 2010, b). Therefore, this study was designed be be conducted through face-to-face interviews. The interviews were carried out by trained students at various sites within the targeted towns suggested by the focus groups. Interviews took place close to meat markets, butcher shops and supermarkets – people were approached randomly and after completing each face-to-face interview, interviewers would approach the next closest person who walked by.

In CCE (Conjoint Choice Experiment), which is applied for this study, the assumption is that a respondent will choose the product or profile that would give them the maximum utility. According to random utility model, a respondent's utility can be written as equation (1) (Magidson and Vermunt 2003; McFadden 1974):

$$(1) \quad U_j = V_j + e_j$$

Where *Uj* represents total utility derived from the product and *Vj*, the systematic component of the utility and *ej* denotes a stochastic error. The probability *(P)* of choosing alternative *Aj* from a set of alternatives *A'* which is a subset of the alternatives union is given by equation (2) (Magidson and Vermunt 2003):

$$(2) \quad P_j = \exp(V_j) / \sum_{k \in A'} \exp(V_k)$$

[3] http://uk.reuters.com/article/2010/05/14/us-albania-addresses-idUKTRE64D3HK20100514, (accessed June, 2011)

As to Latent Class Model, Magidson and Vermunt (2003) also provides an equation for probability of respondents in class *t* choosing choice *j*. The population is divided into t classes, and *t* =1, 2,..., T:

$$(3) \quad P_{j.t} = \exp(V_{j.t}) / \sum_{k \in A'} \exp(V_{k.t})$$

Table 4 (below) shows the gender and age structure of the Tirana survey respondents. Tirana is the capital and largest city in Albania, and half of the interviews were conducted there. Most of the study sample matched the Tirana population except there were more male respondents. Men are slightly overrepresented in this study, and in Albania it is more common for men to do the food shopping, particularly for older generations.

Table 4: Demographic structure of the sample and population in Albania

		Survey Respondents	**Albania Population**
		(%)	(%)
Gender	Female	41.62%	50.82%
	Male	58.38%	49.18%
Age	20-24	14.26%	6.46%
	25-29	11.98%	10.39%
	30-34	9.87%	11.52%
	35-39	9.42%	8.71%
	40-44	9.52%	9.83%
	45-49	10.01%	12.08%
	50-54	8.80%	13.20%
	55-59	6.86%	8.15%
	60-64	5.29%	8.15%
	65 and up	5.10%	11.52%

Data sources: Institution of Statistics, Republic of Tirana. Available at: http://www.instat.gov.al/ and survey data

Results

The software used to analyze the data was Latent Gold Choice TM, Version 4.0 developed by Statistical Innovations. The first part of the Latent Class Analysis is to determine the number of classes for the model. Bayesian Information Criterion (BIC) is commonly used to assess model fitness in Latent Class Analysis (Magidson and Vermunt 2003). The lowest BIC value implies the best fit. In this case, we tested from one to 8 classes. In addition to using BIC, we used a bootstrap test to analyze the R-squares among the class models that have very close BICs. The bootstrap test was used to test between 4-class and 5-class models. The test showed that the 4-class model had the best results in terms of having a low BIC and insignificant bootstrap test between the 4-class and the 5-class model. As such, the 4-class model results were used to interpret the data. Price in the model was a continuous variable and other attributes were dummy variables using effects coding scheme to represent the levels. Table 5 below shows the estimated parameters and their statistical significance. In the 4-class choice model, Classes 1, 2, 3, and 4 represented 37%, 30%, 19% and 15%, respectively, of the interviewed sample. No socio-demographic

variables (such as age, education etc.) differ significantly between these classes. Details of the four classes' estimated parameters are described below.

Table 5. Parameter Estimates

Attribute	Class1	z-value	Class2	z-value	Class3	z-value	Class4	z-value
Price	-0.005**	-10.269	-0.004**	-13.965	-0.001	-1.437	-0.001	-0.778
Origin								
DH	3.111**	20.411	0.404**	6.741	1.673**	13.206	1.785**	13.035
DP	-1.303**	-6.689	0.351**	6.200	0.357**	2.913	1.389**	10.746
I	-1.808**	-7.895	-0.754**	-8.653	-2.029**	-10.371	-3.175**	-16.524
Weight (Kg)								
7	0.071	0.938	0.039	0.598	1.634**	12.523	-0.343*	-2.340
10	0.299**	4.032	0.155**	2.857	0.419**	4.721	0.377**	2.890
13	0.221**	2.539	0.225**	4.114	-0.357**	-3.164	0.046	0.308
16	-0.592**	-5.907	-0.419**	-6.017	-1.696**	-9.907	-0.080	-0.491
Certification								
VS	-0.243**	-3.244	-0.451**	-9.440	-0.268**	-3.006	1.877**	16.660
NVS	0.243**	3.244	0.451**	9.440	0.268**	3.006	-1.877**	-16.660

Source: Study's analysis
** Significant at 0.01 level

Most estimated parameters were significant at the 0.01 level, with the exception of some of the price and lamb weights of 13 and 16 kilos. All price variables were negative as expected. All the classes preferred meat from domestic highland origins followed by domestic plain/lowland and lastly imports. There was variability in the preferences for carcass weight and certification by classes.

Respondents in Class 1 strongly preferred lamb meat from domestic highlands, but not domestic plain/lowland and imported lamb meat. For butchered weight, respondents were more likely to buy 10-13 kg lamb meat and less likely to buy the heavier lamb meat. In addition, respondents in Class 1 were more likely to buy lamb meat from a known butcher even if they did not have veterinary stamps. The price coefficient is negative (as expected) and significant.

Respondents in Class 2 significantly preferred domestic highland and domestic plain/lowland lamb meat but were less likely to buy imported lamb meat. Like Class 1 respondents, they were more likely to buy the medium size lamb meat and less likely to buy the higher weight lamb meat. The certification preference also paralleled Class 1 in that respondents were likely to buy from known butchers without certification. Also for this class, the price coefficient is negative (as expected) and significant.

Respondents in Class 3 were more likely to buy domestic lamb meat, but strongly preferred highland meat to that from the plain/lowland; their lowest origin preference was for imported meat. Class 3 was likely to buy the lowest weight lamb meat, and was more likely to buy meat from known butchers without government quality and safety certification. Price was not significant in this class.

Respondents in Class 4 were most likely to buy domestic highland lamb meat, followed by domestic plain/lowland meat and least likely to buy imported lamb meat. Respondents were more likely to buy medium weight lamb meat and less likely to buy the lower weight lamb meat. Attitude toward certification differed for this class in that Class 4 respondents were more likely to buy lamb meat with approved government certification. Price was not significant in Class 4 too.
The results of the parameters above showed the significant attributes and the relative preference directions of the attribute levels for each of the classes. However, using relative importance analysis can show which attribute among all the significant attributes is the most important for each of the classes. Table 6 summarizes the relative importance for the four classes. Origin was the most important attribute for most of the classes, but particularly for Classes 1, 3 and 4 in which the importance was close to or over 50%. For Class 2, price and origin were equally important in purchasing decisions. For Class 3, origin and weight were equally important to consumers' preferences, while the group placed very little importance on price and certification. For Class 4, origin was very important followed by certification, however, price and weight are not important to this class.

Table 6. Relative Importance and Size of Each Class

Share of each class	**Class1**	**Class2**	**Class3**	**Class4**
	37%	30%	19%	15%
Attributes				
Price	19%	33%	33%	2%
Origin	63%	29%	29%	52%
Weight	11%	16%	16%	7%
Certification	6%	22%	22%	39%

Source: Study's Analysis

Another aspect analyzed was willingness to pay, which is represented by implicit prices, showing the maximum amount of money consumers are willing to pay in exchange for a different attribute level for the good. Implicit prices can be determined using the ratio of the price attribute coefficient to the difference of the coefficients of the attribute levels of interest (Colombo, 2008). In this study, the compensating surplus equation was used to estimate the implicit prices as shown in equation (4):

$$4) \quad CV = -\frac{1}{\beta_m}(V^1 - V^0)$$

Where, βm is the parameter estimate of price, and V^0 and V^1 are the initial utility and the desired utility, respectively. As the willingness to pay involves the estimated parameter of the attribute price, it makes sense to only discuss Class 1 and Class 2 because the price parameter in Class 3 and Class 4 was not significant. Table 7 gives a summary of WTP for Class 1 and Class 2.

Table 7. Willingness to Pay for Origin Changes in Attribute Levels (ALL/kg)

Origin	**Class 1**	**Class 2**
Import to Domestic Plain/Lowland	101	276
Domestic Plain/Lowland to Domestic Highland	883	13

Source: Study's Analysis

As previously discussed, origin is very important for all classes. For Class 1 and Class 2, domestic highland lamb meat is the preferred lamb meat. Respondents in Class 1 and 2 are willing to pay an additional 882 and 13 ALL/kg, respectively, for domestic highland meat as opposed to domestic plain/lowland meat, and an additional 101 and 276 ALL/kg for domestic plain/lowland meat as opposed to imported meat (See Table 7). These two classes would switch to veterinary certified (stamped) meat only if it were about 100 or 200 ALL/kg less expensive than meat without formal certification but recommended by the butcher.

Conclusions

This study illustrates important aspects of Albanian urban consumer preferences for lamb meat attributes including origin, price, weight and food safety (certification). Within the given range of prices, origin, certification and weight of the survey, origin is by far the most important factor for consumers when choosing to buy lamb meat (similar to studies by Bernabeo and Tendero 2005; Grunert 1997). The attribute preferences are followed by weight and certification. However, the importance of weight, as well as price and certification seem to vary significantly across the four identified consumer classes.

All identified consumer groups prefer lower (10 Kg) carcass weight, while only class 3 prefers even lower (7 Kg) carcass weight. The three largest classes show statistically significant dislike for the 16 Kg carcass weight compared to lighter weights. These findings are partially in line with a similar study on consumer preferences for lamb meat in the Mediterranean in which Bernabeo and Tendero (2005) found that Spanish consumers generally preferred suckling lamb (butchered between 25-30 days with a dead weight carcass of less than 7 kg) as compared to ''ternasco'' (lamb butchered between 60 and 90 days, with a carcass weighing between 10 and 14 kg). The lower weight preferences may be translated into different cost – benefit ratios for breeders when taking into consideration feeding costs, insemination schedule and transportation costs.

As long as proper labeling is in place to avoid cheating from butchers or retailers, it appears that competition from import lamb meat is not a major issue for the Albanian lamb meat industry. Domestic highland lamb meat is strongly preferred to plain/lowland meat, which can be used as an advantage if labeling or other marketing tools are available to inform and convince consumers of the origin. Therefore promotion of origin of the lamb meat should be a priority for the government and other stakeholders, while producers should consider introducing and promoting their own brands (i.e. producer associations' brands).

There is obvious distrust in the government food safety enforcement system as most consumer groups do not prefer to buy veterinarian stamped meat. This has strong implications for policy-makers. Strengthening the implementation capacities and improving the image of the government veterinarians and food safety regulation system should be considered a priority in the context of the ongoing institutional and legal reforms. On the other hand, there is a relatively strong trust among most consumer groups in the local butchers. It should be noted that trusted local butchers may be perceived to have the capacity not only to guarantee meat safety but also other aspects such as quality and origin. This exceeds the scope of the current veterinarian

certification provision, in which safety is the primary concern[4]. Therefore, it may be concluded that currently all marketing, promotion and communication strategies of different stakeholders should largely rely on butchers to reach consumers.

The information provided by this study is useful for marketing experts, policy-makers, producer associations and retailers. Farmers can use this information to decide which would be the most profitable and preferred lamb carcass weight to sell, whereas farmer associations or production groups may consider introducing their own brands, particularly in the case of breeders of high-land-bred lamb. Retailers and intermediaries (wholesalers) can brand/label the product to promote preferred origin. Finally, the study findings are of interest to policy-makers and donor programs active in the sector, which play a crucial role in shaping the sector production in context of the market trends.

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Farm and Retail Prices in the South African Poultry Industry: Do the Twain Meet?

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Abstract

The study intended to determine the producer (farm)-retail price transmission behavior in the South African poultry industry. At the heart of the study was to desire to establish whether there was symmetry or asymmetry in the price transmission. Using price data from 2000 to 2010 and employing both the Houck and Error Correction Model (ECM) approaches the study found that there was symmetry in the farm-retail price transmission of poultry in South Africa, where a change in farm price of chicken was observed to lead to a similar change in the retail price in South Africa. The price setting system in the poultry industry was further defined by estimating elasticities of price transmission and it was found that retail price is very sensitive to change in farm price, particularly falling prices.

Keywords: poultry, price transmission, farm and retail prices, time series

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Introduction

The recent food price crises, coupled with numerous allegations of price-fixing and other non-competitive practices by some role players in the food value chain in South Africa, have rekindled interest in how prices are transmitted along the value chain of agro-food products. There is widespread evidence to support that price transmission in agro-food products is asymmetrical (Lechanová, 2006; Piesse and Thirtle, 2010; von Braun, 2008). Peltzman (2000), for example, argues that asymmetric price transmission is the rule, rather than the exception and thus concludes that asymmetric price transmission is prevalent in the majority of producer markets and conventional economic theory that does account for this situation must be incorrect. Recently the price of food has seen unprecedented increases on the back of rising input costs and South Africa has not been spared (Altman 2009; NAMC 2007).

Price transmission studies have been used to understand the function of agricultural markets and how food prices are determined and transmitted along the entire value chain, particularly during times of food price crises. For example, Cutts and Kirsten (2006) study of price transmission and market concentration in four South African agro-food sectors was sparked by the high food prices of 2002 and 2003 in South Africa. The Cutts and Kirsten (2006) study found that, by and large, there was asymmetric price transmission in the South African agro-food industry sectors studies and this led to the identification of market concentration and possible abuse of this market dominance thus underscoring the importance of price transmission studies in unearthing uncompetitive behaviour in the market.

The price for inputs such as fertilizer more than doubled as a result of increasing fossil fuel (petroleum) price and this led to the price of commodities such as maize increasing accordingly (von Braun, 2008). The price of maize has a direct bearing on the poultry industry as it is the main ingredient in the formulation of animal feed. Another factor that has a bearing on the price of food is the growing population demanding more food, coupled with the recent economic growth which has pushed up consumers' purchasing power thus generating demand for high-value protein food such meat and dairy products.

The objective of this study is to uncover the producer (farm)-to-retail price transmission behaviour in the South African poultry industry. This was solely aimed at establishing whether there is symmetry or asymmetry in the price transmission. To achieve the above stated objective the paper is structured as follows: section two is the overview of the poultry industry in South Africa, section three presents a brief literature review on price transmission, section four presents the analytical approach used, section five presents the results and section six are the conclusions and recommendations.

Overview of the South African Poultry Industry

The poultry industry in South Africa accounts for more than 17% of the agricultural gross domestic product (GDP), making it the biggest agricultural sector with the gross value of R23 billion in 2009 (FAS 2010) thus making it an important sector in the South African quest to reduce unemployment and food insecurity. However, Joubert (2009) argues that the gross value of the poultry industry was more than R24 billion, in 2009. Furthermore, Joubert (2009) indicates that

the value of the industry at the retail level was more than R36 billion in 2009. Broiler meat is by far the main contributor to the poultry industry accounting for more than 70% of the industry.

Furthermore, poultry meat remains the most affordable source of animal protein relative to other meat protein sources (SAPA, 2009). In this regard, SAPA (2009) argued that the average producer price of pork (which is slightly lower than beef), for all classes, was R15.65/kg in 2009 while the producer price of broiler was R13.66/kg in the same period. The broilers and eggs subsectors are among those agricultural sub-sectors with high direct and indirect labor multipliers thus employing a higher number of people compared to other agricultural sub-sectors (Departments of Agriculture & Land Affairs 2006). In terms of direct labor multiplier, poultry meat and eggs are ranked at number ten and eleven while in terms of indirect labor multiplier they ranked number one and two, respectively. Poultry meat was estimated to rank number three while eggs ranked number ten in terms of number of people employed per agricultural sector. It is also interesting to note that the egg industry was even classified as attractive and competitive while the poultry meat was classified as attractive. The attractive and competitive classifications were done by the South African government and they are in the context of industries' abilities to create jobs thus their attractiveness to meeting government goals of creating more jobs. The poultry industry in South Africa employs an estimated 77, 000 (SAPA 2011).

In addition to its importance as a source of food and its contribution to the nation's Gross Domestic Product, the SA poultry industry remains an important contributor to job creation and employment opportunities, both in the formal and informal sector, with in excess of 80% of the industry consisting of SMMEs (Small, Medium and Micro Enterprises). Approximately 10% of all agricultural sector workers are employed in the poultry sector.

The South African poultry industry is broadly made up of 404 commercial broiler producers, of which 199 are independent individual producers and 205 are contract growers for the larger chicken producing companies (SAPA 2011). There are 267 known commercial egg producing farmers. It is worth reiterating that the South African poultry industry is an interesting in that it consists of a few large scale producers and a plethora of small scale farmers of which there are 1,554 small scale farmers comprised of previously disadvantaged individuals (blacks) and these have been established with the assistance of the South African government (SAPA 2011).

The performance of the poultry industry since 2006 has been impressive (SAPA 2009; 2011). However, the high input costs, high inflation, the global economic recession and a subsequent slowdown in consumer demand and job losses during 2007 to 2009, negatively impacted the broiler industry performance in South Africa (FAS 2010). The annual growth in average broilers produced/week decreased in 2009 to only 1.1%. During the period from 2007 to 2008 the number of broilers slaughtered/ week increased at an average annual rate of 6% (SAPA 2009).

As envisaged, the broiler meat demand started growing again in 2010 as the domestic economy recovered from the global recession. The two most important factors that drive demand for broiler meat are economic growth and competitive broiler meat prices. Economic growth is the main driver for increased demand for broiler meat as rising living standards are expected to push large numbers of consumers towards protein-rich diets, increase health awareness and desire for convenience. Other reasons for the expected increase in the consumption of broiler meat include in-

creased marketing by broiler producers, price competitiveness relative to other proteins on the market. There is still scope for growth in the South African poultry industry, given the still relatively low per-capita consumption of chicken meat in South Africa compared with other economies in the world (Sovereign Foods 2010).

It is also observed that there is growing trend towards processed chicken meat and more sophisticated value-added products will create further market opportunities. South Africa is a net importer of broiler meat, further underlying the argument that there is still room for the domestic poultry industry to grow and demand outstrips supply. The domestic per capita annual consumption of poultry meat in South Africa for 2009 was 32 kg compared to 15.77 kg for beef, 4.17 kg for pork and 3.21 kg for mutton and goat meat combined, and 8.6 kg for eggs (FAS 2010; Joubert 2009; SAPA 2009). Sovereign Foods (2010) argue that more consumers will demand chicken as the world continues to face higher food prices. The local poultry industry has a major role to play in ensuring that all South Africans have continued access to high quality, affordable protein. Given the foregoing overview, it is important to investigate the issue of price transmission in the poultry value chain.

Literature Review

Interest in marketing margins and price transmission has been around for some time now but has recently gained remarkable momentum and the amount of studies on this subject is rapidly growing (Vavra and Goodwin, 2005). There is a myriad of questions about prices and margins investigated by these studies, yet new questions are surfacing as markets and business practices change with an impressive speed. In South Africa, recent finding by the Competition Commission of collusion and price fixing by a number of agribusinesses has added impetus to the interest in the price transmission analysis. Wohlgenant (2001), who conducted a survey on marketing margins, identified a number of issued intriguing researchers and policy makers alike and these included issues such as: Are marketing margins too large? Why are margins different among products? How have margins changed over time? What is the incidence of marketing costs on retail prices and farm prices? How quickly are farm prices transmitted to the retail level and vice versa? What is the relationship between concentration and market power? Is increased concentration detrimental or beneficial to producers?

With quickly changing market structures, growing concentration of processing and retail firms and the recent evidence of collusion and price fixing in the food industry in South Africa and elsewhere, these types of questions are attracting greater public scrutiny. Against the background presented thus far, it becomes imperative to be able to answer the question of how quickly and to what extent are changes in farm prices transmitted to the retail level and vice versa.

Vavra and Godwin (2005) stress the importance of distinguishing between the analyses of evolution of margins over time and price transmission as these topics are closely related but are not identical. Conclusions about price transmission that are drawn from the evolution of marketing margins over time, but that do not incorporate other information such as the changes in the costs of other inputs, such as cost related to processing, packaging, transportation, advertising and storage, may well be misleading as such conclusions would have been made based on limited

information. This paper limits itself to an analysis of vertical price transmission within the South African poultry industry.

The adjustment to price shocks along the chain from producer to wholesale and to retail levels (price transmission), and vice versa, is an important characteristic of the functioning of markets. As such, the process of price transmission through the supply chain has long attracted the attention of agribusiness practitioners (managers and agricultural entrepreneurs), agricultural economists, and policy makers. Recently, the subject of price transmission internationally and particularly in South Africa, has been increasingly linked to the discussion about benefits from agricultural reform including the competitiveness of the food industry. Policy makers have been interested in whether it is true or not that due to imperfect price transmission, often ascribed to be market power and oligopolistic behavior, a price reduction at the farm level is only slowly, and possibly not fully, transmitted through the supply chain. In contrast, price increases at the farm level are thought to be passed more quickly on to the final consumer. The afore-mentioned scenario is known as asymmetric price transmission.

An implication of asymmetry in price transmission, where it exists, is that an analysis of growth and development in a particular sector is likely over-estimates the benefits to the primary producer and consumers because the reduction in farm prices might not be immediately or fully transmitted to final consumers. Consequently, there would be smaller positive effects on primary producer and consumer welfare and a possible increase in rents for the firms in the downstream sector. Thus, it is important to understand the processes related to transmission (pass-through) of price changes as price transmission assumptions along the supply chain play an important role in determining the size and distribution of welfare effects of marketing policy.

Cognizance should be given to fact that market power might be an important explanation for any evidence of asymmetries in price transmission, but it may not be the only causal factor. That is, incomplete or asymmetric price transmission may take place for a number of other reasons. In support of this assertion, Peltzman (2002) argues that asymmetric price transmission may be characteristic of competitive, as well as oligopolistic market structures, and it cannot simply be concluded that presence of asymmetric price transmission automatically implies market power. It is worth reiterating that the aim of this paper to provide empirical evidence of the farm-to-retail price transmission behavior in the South African poultry industry.

Analytical Approach

There are a number of approaches that can be used to study price transmission from farm-to-retail and vice versa. For example, the mark-up pricing model has been used in several studies over the years (e.g. Heien1980; Kinnucan and Forker 1987; and Ferris 1988). Another approach is the relative price spread specification model which has been purported to be superior in performance compared to the mark-up price (Gardner 1975; Wohlgenant and Mullen 1987). The superiority of the price spread specification over the mark-up pricing model emanates from the fact that farm-to-retail price spread changes with shifting retail food demand, changing farm product supply or the changes in marketing services.

Given the complexity of policy applications, Wohlgenant and Mullen (1987) suggested that the relative price is more ideal to the measurement of price symmetry in the food industry. However,

other workers who compared the mark-up pricing and relative price models (see Dickerson 2003 and Tey,2009 for examples) found that the mark-up pricing performed better than the relative price model in that the former model gave more plausible elasticities of price transmission. The mark-up pricing model can be written as:

$$(1)\quad MM_t = c + \beta_1 P_{rt-1}$$

where MM_t is the retail price (P_{rt}) less farm price (P_{ft}) in month t (R/kg), and P_{rt} is retail and P_{ft} is farm prices of chicken (R/kg).

The expression in equation (1) can be estimated using generalized least squares or ordinary least squares. As a rule of thumb, generalized least squares are used if serial correlation is evident and ordinary least squares if serial correlation not evident. The ultimate benefit of the mark-up price model is its ability to produce elasticity of price transmission and in this the elasticity of price transmission for poultry in South Africa for the time series is of particular interest. The formula for calculating the elasticity of price transmission is given as:

$$(2)\quad EPT_t = \frac{1}{(1-\beta_1)} * \frac{P_{ft}}{P_{rt}}$$

A number of studies have assumed symmetry in price transmission when calculating price transmission elasticities (e.g. Heien, 1980; Kinnucan and Forker, 1987) implying that retail prices behave similarly to farm prices in terms their direction of movement (both decreases and increases). However, there have also been a similar number of studies that have found the relationship, in terms of price transmission, between retail and farm prices to be asymmetrical. For example, von Cramon-Traubadel and Meyer (2000) found asymmetry in price transmission and purported that such asymmetry can be construed as evidence of market failure or the abuse of market power (dominance). It has also been reported that, generally, price transmission elasticities associated with rising farm prices are larger than corresponding elasticities associated with falling farm prices (Kinnucan and Forker, 1987; Hahn, 1990; Bernard and Willett, 1996; and Capps and Sherwell, 2007). Interestingly, this preceding view has been contradicted by other researchers who argue that the relationship should be vice versa (Ward, 1982; Punyawadee *et al*., 1991).

Given the recent food price crises (von Braun, 2008; Piesse and Thirtle, 2010) and the assertions of von Cramon-Traubadel and Meyer (2000), it is imperative to investigate if there has been market failure or the abuse of market power in the South Africa poultry market. This is particularly interesting given that the South African poultry industry has never been regulated in South Africa thus not directly affected by the deregulation of agricultural markets that took place in the mid 1990s in South Africa. It is prudent and proper to first investigate whether price transmission in the poultry industry in South Africa is symmetric or asymmetric before delving into the analysis of farm-to-retail price spread for the poultry industry. Following Capps and Sherwell (2007), the Houck (1977) model was chosen as the most appropriate model as backed by compelling empirical evidence (e.g. Boyd and Brorsen, 1998; Kinnucan and Forker, 1987; Bailey and Brorsen, 1989; Zhang *et al*., 1995; Mohanty *et al*., 1995; Bernard and Willett, 1996; Willett *et al*., 1997; Peltzman, 2000; Aguiar and Santana, 2002). The Houck model is premised on idea that

retail prices are a function of farm prices and farm prices being a function of retail prices and it can be expressed as:

$$(3)\quad \Delta P_{rt} = \alpha_0 + \alpha_1 \Delta P_{ft}^{+} + \alpha_2 \Delta P_{ft}^{-} + \in_t$$

Where P_{ft} is farm price of poultry (R/kg), $t = 1,2,...,$ Δ is the first difference operator, ΔP_{ft}^{+} is the cumulative of $P_{ft} - P_{ft-1}$, if $P_{ft} > P_{ft-1}$ and 0 otherwise, and ΔP_{ft}^{-} is cumulative of $P_{ft} - P_{ft-1}$, if $P_{ft} < P_{ft-1}$ and 0 otherwise.

However, in reality, perfect efficiency in price transmission[1] as depicted in Equation (3) is hard to come by. While the poultry industry in South Africa is completely unregulated it is still dominated by a few large producers strategically placed throughout the country. These few large poultry producers involve a number of relatively smaller producers through contract farming which may be viewed simultaneously as providing market outlets to these smaller producers while reducing competition (the few large producers). Most of the smaller producers are, bound by contract to larger producers, relatively uneducated and rely on their larger counterparts and word-of-mouth for price information which normally takes a long time to filter through. Thus, Equation (3) can be modified by incorporating a time lag which can be estimated through generalized or ordinary least squares and thus be written as:

$$(4)\quad \Delta P_{rt} = \alpha_0 + \sum_{i=0}^{M1} \alpha_1 \Delta P_{ft}^{+} + \sum_{i=0}^{M2} \Delta P_{ft}^{-} + \in_t$$

Where *M1* and *M2* are the length of the lags, and other variables are as described in Equation (3). It is necessary to determine if the price transmission in the South African poultry industry is asymmetric, as already discussed. A formal test on the asymmetry hypothesis (Equation 5) can be conducted using a *t*- or *F*-test, following the specification of Gardner (1975).

$$(5)\quad H_0 : \sum_{i=0}^{M1} \alpha_{1i} = \sum_{i=0}^{M2} \alpha_{2i}$$

Failure to reject the null hypothesis would mean that the price transmission is symmetrical. Conversely, a rejection of the null hypothesis suffice as proof there is asymmetry and the implication would be that Equation (5) can be estimated by using error correction model (ECM).

The ECM approach is based on the assumption of cointegration between retail price and farm price, and if that is the case the residuals of the ECM can be incorporated in the Engle-Granger Theorem expression of the price transmission process as:

$$(6)\quad \Delta P_{rt} = \alpha_0 + \alpha_1 \Delta P_{ft} + \alpha_2 ECT_{t-1} + \sum_{i=1}^{M1} \alpha_{3i} \Delta P_{rt-i}^{+} + \sum_{i=1}^{M2} \alpha_{4i} \Delta P_{ft-1} + \in_t$$

where ECT is the residuals from the cointegrating relationship between P_{rt} and P_{ft} and other variables are as defined already.

[1] Perfect efficiency in price transmission refers to a situation where there is complete symmetry between the farm (producer) price and retail price of a particular product in a particular market.

The model represented by equation (6) was improved upon by Granger and Lee (1989) who modified it by segmenting the ECT into positive and negative components. Further improvements were made by von Cramon-Taubadel and Loy (1999) to allow the incorporation of ΔP_{ft} results in the asymmetric error correction model being expressed as:

$$(7)\quad \Delta P_{rt} = \alpha_0 + \sum_{i=1}^{M1} \alpha_{1i} \Delta P_{rt-i} + \sum_{i=0}^{M2} \alpha_{2i}^{-} \Delta P_{ft-i}^{-} + \alpha_3^{+} ECT_{t-1}^{+} + \alpha_3^{-} ECT_{t-1}^{-} \in_t$$

The expression in Equation (7) yields long-run or cumulative effect of rising and falling farm-retail price transmission. However, in the interest of providing a well-rounded view, this study also looks at the short-run effect of rising and falling farm-retail price transmission thus the final model can be given as:

$$(8)\quad \begin{aligned} \Delta P_{rt} = {} & \alpha_0 + \sum_{i=1}^{M1} \alpha_{1i} \Delta P_{rt-i} + \alpha_{2i} \Delta P_{ft-i}^{+} \sum_{i=0}^{M2} \alpha_{3i}^{+} \Delta P_{ft-i}^{+} + \alpha_{4i}^{-} \Delta P_{ft-i}^{-} + \sum_{i=0}^{M3} \alpha_{5i}^{-} \Delta P_{ft-i}^{-} \\ & + \alpha_6^{+} ECT_{t-1}^{+} + \alpha_7^{-} ECT_{t-1}^{-} \in_t \end{aligned}$$

The ECM approach is better than the Houck approach if any of the coefficients, α_{1i}, α_6^{+}, and α_7^{-} are statistically different from zero when Equation (8) is estimated via generalized or ordinary least square estimation. To further ascertain if the poultry price transmission is asymmetrical, the F-test or t-test can be performed on the hypothesis:

$$(9)\quad H_0 : \alpha_{2i}^{+} = \alpha_{4i}^{-} \text{ or } \sum_{i=0}^{M2} \alpha_{3i}^{+} = \sum_{i=0}^{M3} \alpha_{5i}^{-} .$$

Finally, short-run and long-run elasticities of price transmission can be derived from Equation (8) and the formulae are as follows:

Short-run elasticity of price transmission for raising farm prices:

$$(10)\qquad \varepsilon_{sr}^{+} = \alpha_{2i}^{+} * P_{ft} / P_{rt}$$

Short-run elasticity of price transmission for falling farm prices:

$$(11)\qquad \varepsilon_{sr}^{-} = \alpha_{4i}^{-} * P_{ft} / P_{rt}$$

Long-run elasticity of price transmission for rising farm prices:

$$(12)\qquad \varepsilon_{LR}^{+} = \sum_{i=0}^{M2} \alpha_{3i}^{+} * P_{ft} / P_{rt}$$

Long-run elasticity of price transmission for falling farm prices:

$$(13)\qquad \varepsilon_{LR}^{-} = \sum_{i=0}^{M3} \alpha_{5i}^{-} * P_{ft} / P_{rt}$$

Data and Preliminary Results

Monthly data from January 1994 to December 2010 for farm and retail prices of chicken and relevant macroeconomic variables such as rand/dollar exchange rate, interest rate, prices of substi-

tutes (pork, beef and mutton), import and export values of chicken meat, etc. were obtained from various sources. The price data were deflated by the price index for meat to make them temporally compatible (in real terms). The mark-up price was calculated as the difference between farm (producer) and retail prices and this will be discussed further under the results section that follows.

Table 1 shows summary statistics of the data. The mean farm price was R9.64/kg and the retail price was R22.51/kg over the studied period. Looking at the cumulative values, it can be clearly seen that the prices for chicken meat rose (11.41) more than they fell (-7.18) between 1994 and 2009, which hardly surprising as food prices are not known to fall at regular intervals. Another insight that can be gleaned from the descriptive statistics is that retail price, on average, was more than double the producer price indicating some possible asymmetry in price transmission in the South African poultry industry, although this should not be taken at face value. This point will be further discussed in the discussion section of the paper.

Table . Descriptive statistics, 1993 - 2010

Mean price (R/kg)		**Cumulative**	
Farm	Retail	Rising	Falling
9.64	22.51	11.41	-7.18

Further information on the spread of farm and retail prices of chicken is presented graphically in Figure 1.

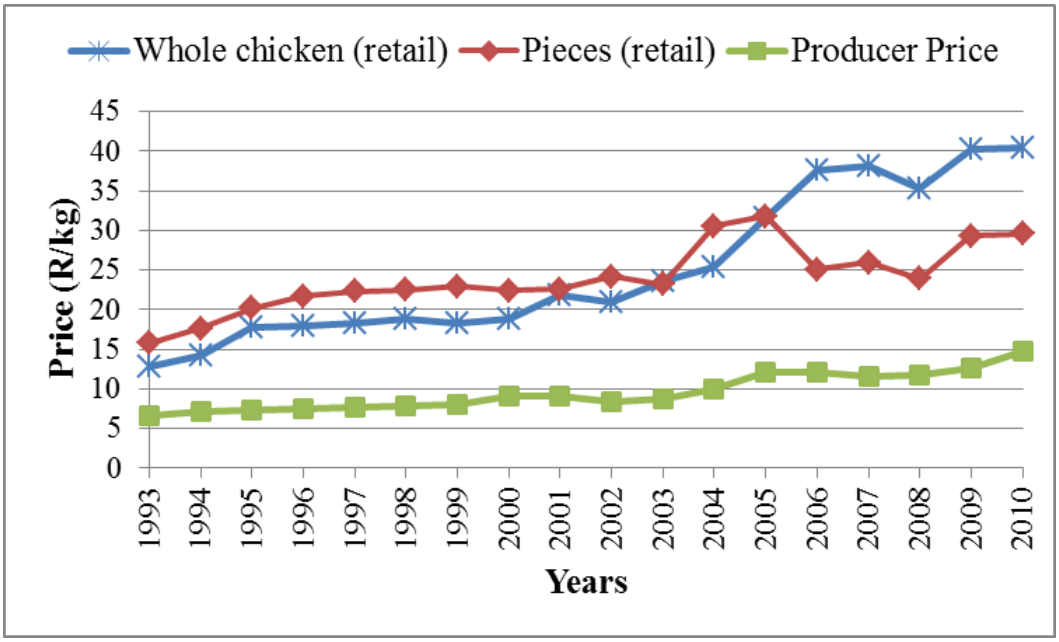

Figure 1. Farm-retail price spread for poultry in South Africa for 1994 to 2010

The spread is an aggregate representation of marketing costs and profits. Conventional economic theory suggests that the price spread is equal to the equilibrium of demand and supply of marketing services and materials per unit of product, where marginal value of the marketing services

and materials per unit of product (hereafter referred to as marketing margin) is equal to marginal cost (Ferris, 1998). From Figure 1 it can be seen that the price received by poultry farmers (producer price) has doubled over the 18 years under observation from about R7.50/kg in 1995 to about R15/kg in 2010. However, the retail price for whole chicken grew from R13/kg in 1993 to more than R40/kg in 2009 and 2010 while the retail price of chicken pieces followed a similar trend rising from just over R15/kg in 1993 to R30/kg in 2009 and 2010. The disproportionate increase in retail price compared to the producer price led to an exorbitant increase in the marketing margin. It would be interesting to elucidate whether such an increase was precipitated by increasing marketing cost on merely retailers' mark-up prices leading to more profits and increased food prices. Another point worth mentioning is that the apparent increase in producer price is deceptive because the price of inputs, particularly chicken feed and fuel escalated to unprecedented levels during 2007 to the beginning of 2009.

Figure 1 also shows another interesting trend in the retail prices for chicken meat in South Africa. Up until 2001, the price for pieces (selected chicken portions) was higher than that of whole chicken but the trend has changed with whole chicken now being more expensive. This may be an indication that consumers now demand more whole chicken than portions as whole chicken in mainly sold as fresh meat while portions are mainly sold as frozen. Another plausible explanation for the reduction in the price of portion could be the influx of cheap, low quality cuts imports that are largely sold to the lower end of the market in downtown retail outlets and rural stores.

Economic theory postulates that the price of substitutes has a direct bearing on the price of products. In this study, beef, pork and mutton were identified as substitutes for chicken meat (poultry) and Figure 2 shows the price trends of these products in relation to the price of chicken meat. It can be seen from Figure 2 that the prices of all the three substitutes for chicken meat followed the similar trends as those exhibited by the price of chicken meat. From the data, it is apparent that pork was the closest substitute to chicken meat in South Africa, in terms of prices. However, it should be borne in mind that not everyone can substitute pork for chicken meat as a substantial portion of the South African population does not consume pork, mainly for religious reasons (i.e. the Muslim community and the various Zionist Christian Movements – which jointly command a large following in the country). Be that as it may, one would expect the demand for chicken meat to be affected by the price of pork. However, the data show that this is unlikely given that the two products are very close to each other in their retail prices.

It is interesting to note that the two "white" meat types (chicken and pork) are very close to each other move in the same direction, except in 2006 when pork retail prices took a dip. The 2006 slump in the retail price of pork could be attributed to the swine flu scare that gripped the world at the time. Similarly, the two "red" meat types, beef and mutton, moved in the same direction and gap in their retail prices remained virtually constant, with mutton being the more expensive of the two. South Africa is a net importer of both beef and mutton.

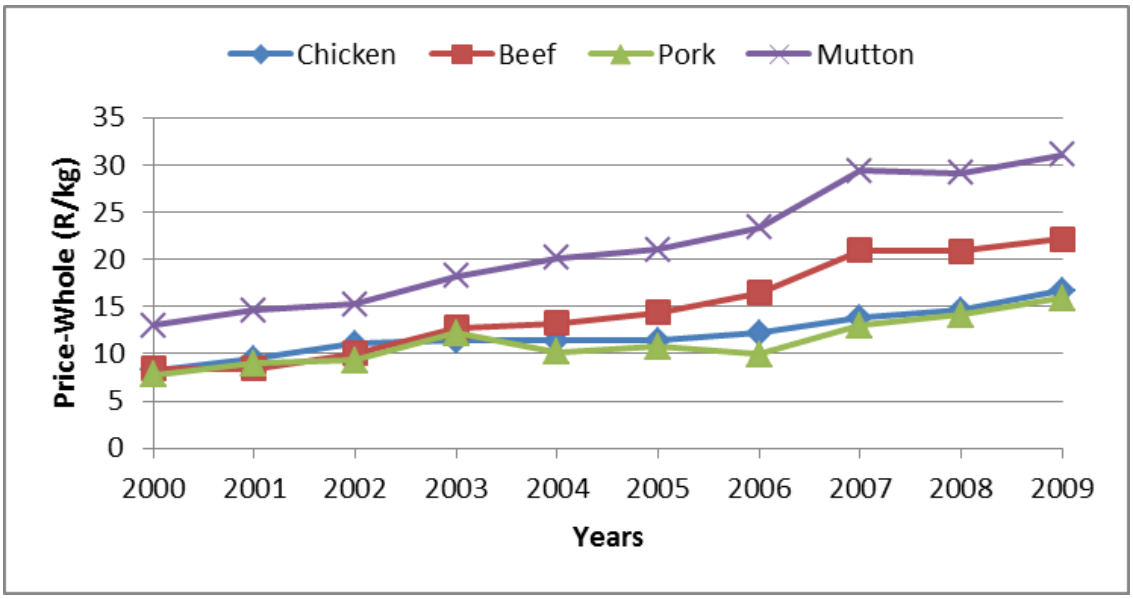

Figure 2. Comparison of retail price for chicken and its substitutes (beef, pork and mutton) from January 2000 to December 2009

Results

It was hypothesized that marketing margin, as measured by the mark-up price, and retail price of chicken meat would be linearly related. In order to test the relationship between these two variables a correlation test was done to establish the degree to which they are related as shown in Table 2. The estimated correlation coefficient of 0.9048 vindicated the hypothesis and showed that there is a strong and positive correlation between retail price and marketing margin in chicken meat industry in South Africa. The implication of the strong and positive correlation between the two variables is that it is logical to expect that as marketing costs (such as transportation cost and packaging cost) rise/fall so will the mark-up rise/fall and ultimately leading the retail price to follow the same trend.

Table 2. Kendall's rank correlation[2] among producer price, retail price and mark-up of chicken meat in South Africa, 1993 - 2010

Variable	Producer Price	Markup	Retail Price
Producer Price	1.0000		
Markup	0.7143	1.0000	
Retail Price	0.8095	0.9048	1.0000

The next logical step was to estimate the mark-up price model as depicted in Equation 1 and this was performed using generalized least squares and the results are given in Table 3. The results show that the both the retail and producer prices have significant and positive effect on the mark-

[2] The Kendall's rank correlation (ktau) was selected because of its suitability for small to moderately- sized samples (StataCorp, 2007).

up price of chicken meat in South Africa. Both retail and producer prices are only significant at the 5% level. Lagging the retail price one period yields interesting results.

Table 3. Parameter estimates of the mark-up[3] pricing model, 1993 - 2010

Variable	Coefficient	Std. Error
Dependent variable: Mark-up price		
Intercept	-2.2533	0.5019
Retail price (P_{rt})	0.6647	0.4815**
Retail price_lagged (P_{rt-1})	0.8979	0.0318***
Producer Price	0.7231	0.5019**
Adjusted R-squared	0.78880	
Akaike info criterion	0.4711	
Schwarz criterion	0.5466	
Durbin-Watson stat	2.1688	

***Statistically significant at 1% level of significance; **significant at the 5% level.

lagged retail price variable is highly significant (at the 1% level of significance) with a coefficient of 0.8979. The implication of this finding could be that retailers base their mark-up decision on historic values rather than current producer prices. This is an important finding that could provide insight into the pricing behaviour within the poultry value and better prepare all stakeholders in the value chain to anticipate future trends.

The preceding discussion provided an overview of chicken meat retail prices behaviour in response to changing producer prices. However, it is more interesting to understand the dynamic behaviour of retail prices to rising and falling producer price of chicken. In order to study the behaviour of retail chicken price in relations to changes (rising and falling) producer price, the Houck approach was adopted. The Houck approach is represented by Equation 4. It was deemed proper and appropriate to determine the lag length period of some of the variables before formally estimating the Houck approach (Equation 4). The lag lengths were decided upon as informed by the Akaike Information Criterion[4] (AIC) and the Shwarz Information Criterion[5] (SIC). Both the AIC and the SIC are used for selecting the most parsimonious correct model thus avoiding misspecified and over-parametrized models (Luddem et al., 1994). Following the Houck approach, it was found that the most reasonable time lag associated with both rising and falling farm prices was one. The results of the parameter estimates derived following the Houck approach specification are reported in Table 4. A t-test was performed on the coefficient of cumulative rising lagged farm price (ΔP^{+}_{ft-1}) of -0.3851 and the cumulative falling lagged farm price (ΔP^{-}_{ft-1}) of -0.3586 and it showed that the South African farm-to-retail price transmission for poultry was symmetric because the null hypothesis (Equation 5) could not be rejected at the 5% level of significance.

[3] Mark-up price was calculated as the difference between retail price (average of the retail price of whole chicken and pieces/cuts) and farm (producer) price at a given time period.
[4] The Akaike Information Criterion is based on the seminal work of Akaike (1974).
[5] Shwarz Information Criterion is premised on the work of Shwarz (1978) and since the Schwarz information criterion is derived using Bayesian arguments, this criterion is also known as the Bayesian Information Criterion (BIC).

Table 4. Parameter estimates of the Houck approach, 1993 - 2010

Parameter	Coefficient	Standard Error
Intercept	-0.3693	(0.5101)
ΔP_{ft}^{+}	-0.4606	(0.2298)**
ΔP_{ft-1}^{+}	-0.3851	(0.2233)*
$\sum \Delta P_{ft}^{+}$	1.2594	(0.1723)***
ΔP_{ft}^{-}	-0.6542	(0.3131)**
ΔP_{ft-1}^{-}	-0.3586	(0.2896)
$\sum \Delta P_{ft}^{-}$	1.2229	(0.2036)***
AR(1)	0.7960	(0.0524)***
R-square	0.9153	
Akaike Info Criterion	1.7151	
Schwarz Info Criterion	1.8816	
Durbin-Watson stat	2.1245	

***Statistically significant at 1%; **Significant at 5% level of significance

Since lagged price values were used it was deemed necessary to test to autocorrelation. The Durbin-Watson[6] statistic test was administered and it revealed that there was neither autocorrelation nor serial correlation since Durbin-Watson statistic value was 2.1245. The Durbin-Watson statistic value should be close to 2.0 if there is no correlation. If the statistic is near 0.0, there is evidence of positive autocorrelation and if the statistic is close to 4.0 then there is evidence of negative autocorrelation.

Following the estimation of parameters for the Houck approach, a further cointegration test was performed on the relationship between farm and retail prices following the error correction model (ECM) for Equation 8. The ECM test showed that farm and retail prices for poultry in South Africa, for period under review, were cointegrated. The results of the ECM approach are given in Table 5. The coefficients of ECT_{t-1}^{+}, ECT_{t-1}^{-}, and $\sum \Delta P_{rt-1}$

were statistically different from zero and the R-square value show that the ECM approach performed better than the Houck. The ECM approach also confirms that the South farm-retail price transmission is symmetric as indicated by the significant coefficients (at the 5% level of significance) of $\sum \Delta P_{ft}^{+}$ (0.3647) and $\sum \Delta P_{ft}^{-}$ (0.3645).

Ensuing from the findings of both the Houck and ECM approaches that suggested symmetry in the farm-retail price transmission of the poultry industry in South Africa, elasticities of price transmission from the markup model were estimated. Figure 3 shows the elasticities of price transmission for poultry from 1993 to 2010. The elasticity of price transmission is the percentage change in retail price due to one percent change in farm price. Thus the average elasticity of price transmission of 1.42, as shown in Figure 3, calculated at the sample mean can be interpret-

[6] The Durbin-Watson statistic tests for autocorrelation of the residuals which occurs when the residuals are correlated with the lagged values of themselves. That is, when e_t tends to be correlated with e_{t-1}. Thus the Durbin-Watson statistic tests for correlations between e_t and e_{t-1}, which is called serial correlation.

ed as meaning that one percent increase/decrease in farm price would lead to a 1.42 percent increase/decrease in retail price of poultry in South Africa.

Table 5. Parameter estimates of the ECM approach

Parameter	Coefficient	Standard Error
Intercept	-0.0037	0.1048
ΔP_{ft}^{+}	0.1990	0.2551
ΔP_{ft-1}^{+}	-0.4947	0.2484**
$\sum \Delta P_{ft}^{+}$	0.3647	0.0959***
ΔP_{ft}^{-}	0.6337	0.3046**
ΔP_{ft-1}^{-}	0.3716	0.3169
$\sum \Delta P_{ft}^{-}$	0.3645	0.1006***
ECT_{t-1}^{+}	0.2008	0.1920
ECT_{t-1}^{-}	-0.3718	0.1457**
$\sum \Delta P_{rt-1}$	0.7850	0.0613***
R-square	0.9234	
Akaike Info Criterion	1.6372	
Schwarz Info Criterion	1.8444	
Durbin-Watson stat	2.1432	

***Statistically significant at 1%; **Significant at 5% level of significance

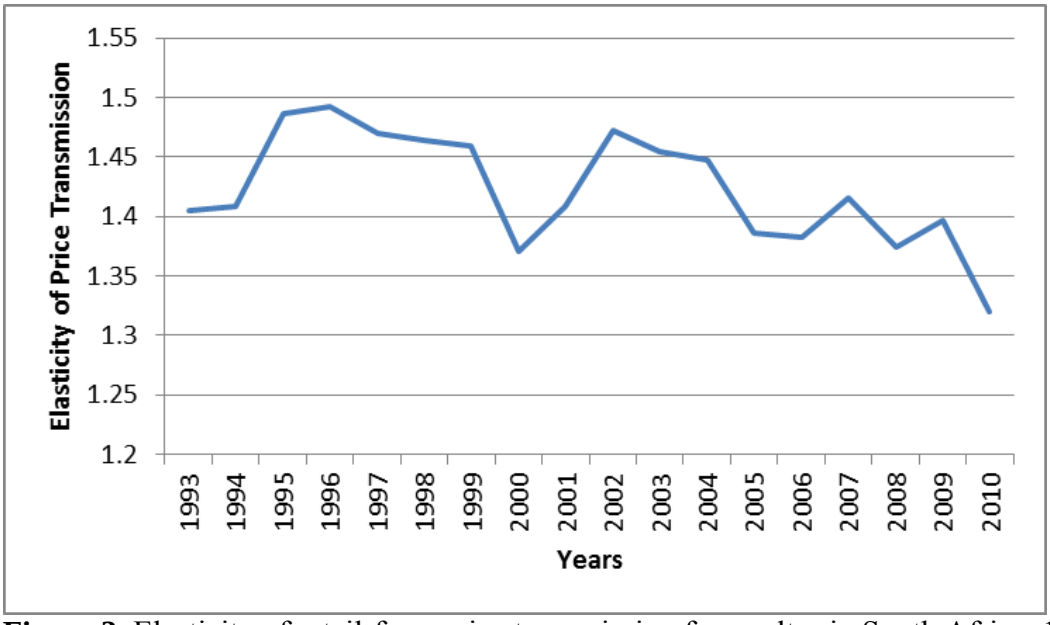

Figure 3. Elasticity of retail-farm price transmission for poultry in South Africa, 1993 - 2010

It would also be interesting to observe changes in the elasticities of price transmission over time thus Figure 3 illustrates, graphically the elasticities of South African poultry over an 18 year period (1993 to 2010). Recall that the mean elasticity of price transmission computed at the sample mean was 1.42, which interestingly was the same value as at the beginning of the observation period (1993). The period between2000 to 2002 saw the elasticity of price transmission increase from 1.42 to a1.48, signalling that an increase in producer price of chicken did not translate to a proportionate increase in the retail price of chicken meat. This could have been because of retailers keeping their mark-up price unchanged while producer prices were increasing as they might have anticipated that the increased prices were short-lived as imports of cheaper frozen chicken meat increased.

From 2002 to 2010 the elasticities of price transmission decreased from about 1.47 to a record 1.32 implying that retailers had increased their markup prices disproportionately higher than farm prices were increasing. Interestingly, this period was a built-up to the unprecedentedly high food prices of 2007 to early 2009.

A number of plausible explanations can be given for this phenomenon of increases in retail prices outstripping farm prices: 1) retailers could have been on a recovery mode following periods of reduced markup prices in the preceding years; 2) farm prices were continuing to increase and retailers were responding accordingly in anticipation of sustained increases in farm prices as prices for agricultural inputs continued to escalate, particularly crude oil which a ripple effect on production. As the food price crisis began in full swing, elasticities of price transmission for poultry began to drop as markup prices struggled to keep up with the pace of farm prices and consumers lost more and more purchasing power thus dampening demand for consumption goods, including food items, such as meat (both red and white meat); 3) lastly, the period of increasing elasticities of price transmission coincides with the period immediately after the SARS (bird flu) outbreak which saw an astonishing shift away from poultry consumption the world over, forcing retailers to cut their marketing margins (markup prices). So, the period from 2002 onwards could be viewed as a recovery period when consumers returned to consuming poultry products and the market correcting itself to reward retailers with commensurate marketing margins.

All in all, price transmission was elastic for the period under review with the lowest being 1.319 in 2010 and the highest being 1.49 in 1996 (Figure 3). After presenting the ECM approach as the most suitable model, the discussion would be incomplete without reporting on both short-run and long-run price transmission behaviours. Table 6 presents the short- and long-run elasticities of price transmission estimated at the sample mean of the data used (from 1993 to 2010). The short-run elasticities of price transmission for both rising (0.1650) and falling (0.3178) farm prices are less than unit implying inelasticity. This finding is hardly surprising as retailers are unlikely to change their marketing margins in the short-run as producer prices tend to have a triggering effect on retail prices with some time lag. Retailers are weary to increase their prices until they have a sense that their competitors will follow-suit (this is true only in a competitive market environment with many players at both the producer and retail levels). However, in the long-run, elasticities of price transmission show a different picture. The long-run elasticities of price transmission for both rising (1.1836) and falling (1.3426) prices are more than unity indicating that they are elastic. The implication for this elasticity of price transmission means that in the

long-run retail prices will respond to changes in farm price and the converse is expected to be true. Interesting to note is that retail price of poultry in South Africa is more responsive to falling farm prices than it is to rising farm prices, both in the short- and long-run. The difference is more marked for the short-run compared to the long-run.

Table 6. Estimates of short-run and long-run elasticities of farm-retail price transmission for South African poultry, 1993 - 2010

Method	Short-run elasticity of price transmission		Long-run elasticity of price transmission	
	Rising farm prices	Falling farm prices	Rising farm prices	Falling farm prices
ECM Model	0.1650	0.3178	1.1836	1.3426

Conclusions and Policy Recommendations

This paper reported on the quantitative analysis of price transmission from farm to retail in the South African poultry market using price data from 1993 to 2010. The farm-retail price transmission of poultry in South African was found to be symmetric using both the Houck and ECM approaches implying that change in farm price of poultry elucidated a similar change in the retail price of poultry in the South African market and vice versa. Furthermore, the price setting mechanism of poultry can thus be quantified by the estimated price transmission elasticities where retail price is responsive to changes in farm price. Thus, other things being constant, a unit change in farm price of chicken is expected to result in more than unit change in retail price of chicken. This finding has important policy and food security issues in South Africa given that most of the chicken feed consumed in the country is imported from uncertain and expensive markets. Unless a cheaper source of poultry feed, albeit of good quality, is found, farm prices for chicken will continue to rise unabated and this will be transmitted to the final consumer, exacerbating food insecurity at household level. For the poor in South Africa, an increase in the price of animal protein leads to consumers consuming less protein-rich food or switching to non-animal sources, which invariably affects the nutrition of vulnerable groups (i.e. children and people living with AIDS).

The South African poultry industry is dominated by few large operators with a plethora of small-scale poultry producers who rely on the large commercial poultry producers for markets through contract farming and outgrower schemes. Other market outlets for small-scale poultry producers are the informal and unreliable markets. Given the symmetry in the price transmission within the poultry value-chain, it is possible to increase the benefits accruing from such to small-scale farmers through the adoption of leaner and shorter value-chains. The shortening of the value-chain can be achieved through directly linking small-scale farmers to retail market, be it supermarkets or fast-food outlets such as Kentucky Fried Chicken, Chicken Licken and others. Another promising strategy for shortening the poultry value-chain in South Africa and similar economies elsewhere is to directly link farmers with institutions such as state hospitals and correctional centres (prisons). This strategy is beginning to bear fruits in South Africa as more and more small-scale farmers now have reliable market outlets through such institutions. However, since most small-scale farmers are too small, in terms of the volumes that they produce, horizontal integration would be beneficial in reducing transaction costs and increasing production levels, col-

lectively. Small-scale farmers coming together would also make it easier for them to access inputs and discount prices as their bargaining power would be increased.

As was discussed in the introduction section, poultry industry is important to the South African economy in more ways than one, it would be desirable for policy makers to take note of the symmetric price transmission that exists in the midst of rampant price transmission asymmetry in other industries. The symmetric price transmission in the poultry industry renders the industry one of the sectors that is more equitable in terms of income distribution between farm and retail levels. Such equity should be used by policy makers in the quest for a more egalitarian society in South Africa thus the poultry industry warrants government support and prioritizing for reducing inequality and creating more jobs. There is wide scope for further developing and growing the poultry industry in South Africa given that that South Africa is a net importer of chicken even though the capacity exists within to supply enough chicken meet. The existence of surplus demand for poultry presents a golden opportunity for agribusiness to invest in poultry production and allied activities such as the manufacture of chicken feed, establishment of abattoirs and processing plants given the growing market. However, the agribusiness manager and proprietor require certain preconditions before investments could be made. What is needed is a conducive and enabling marketing and trade dispensation to improve the competitiveness of the South Africa poultry industry both domestically and internationally. There is enough room, even within the World Trade Organisation (WTO) rules, to assist and protect the poultry industry thus also protecting consumers by ensuring more affordable prices at both farm and retail levels. Lastly, the restaurant and eat-out industry are growing with growing income levels in South Africa and this presents an opportunity for the industry to burgeon.

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New Zealand Wool Inside: A Discussion Case Study

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Abstract

The case study is aimed at discussing the strategic and organizational implications of recent value adding and branding initiatives in New Zealand's strong wool industry with special attention to decisions by a group of farmers. The objective of the case study is to discuss (a) the value of past and current generic promotion campaigns in the wool industry; (b) the viability of recent private value adding and branding campaigns, as well as of the organizations behind such initiatives; (c) the likely impact of the initiatives in the economy of the farmers; (d) if farmers should invest in any of the value adding companies or not (d) if farmers should engage collectively in supporting any of the initiatives, and if so how. This case study can be used in advanced undergrads, graduate and executive classes.

Keywords: New Zealand, wool, ingredients marketing, branding, wool carpets, case study

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IFAMA Agribusiness Case 14.3A

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Introduction

After two decades of decline in wool prices, New Zealand farmers, disillusioned with many years of generic wool advertising, recently voted to stop financing industry good promotional activities. Meanwhile, three companies had started their private value adding and branding initiatives, aimed mostly at the USA and European carpet and rugs markets. Elders Primary Wool (EPW) had created a network of alliances with retailers and manufacturers in the USA to license their Just Shorn wool brand. Wool Services International (WSI) was exporting scoured wool under several brands. Wool Partners International (WPI), the owner of the Wools of New Zealand brand, had recently put forward a prospectus inviting farmers to invest in a new wool marketing company with the goal of consolidating 50% of the country's strong wool. Although some farmers and industry participants viewed these private marketing initiatives with optimism and as a sign of vitality in the industry, others thought that the industry was still too fragmented and that a more unified approach was required. Yet another view was that farmers had little to contribute to, and gain from, any sort of international branding and value adding efforts, and that they should focus on what they do best: farming.

It was late spring 2010, and the Wairarapa hills of the Northern New Zealand Island were still looking green. The Wairarapa Wool Farmers Group had been meeting with representatives from the three main wool marketing groups to understand more clearly what exactly each one was proposing and also to assess the capacity of the organizations behind each group. It was a Saturday late afternoon and WPI was explaining their investment proposal (see a summary of the prospectus in Exhibit 1). When the meeting was over one farmer expressed the general spirit.

"There is a shared view that something must be done to revive the wool industry but there is not a clear consensus about what, if anything, the farmers should do. The wool industry is more complicated than it seems and it is not clear if any of those branding initiatives out there will make a difference back at the farms. There are too many issues to consider and this discussion is far from over."

At the end of the meeting the farmers divided themselves in three groups; each group was assigned to study one company and its respective branding value adding and branding initiative. They had agreed to meet again in two weeks when each group would present the pros and cons of each initiative to the plenary. Then they would decide what was best for the farmers. Wool farmers in New Zealand were hard working, ingenious and proud, but yet had been struggling financially for many years. Most were earning as little as NZ$ 12,000[1] from wool per year and many had been carrying substantial debts. They would not give up without a fight. Sam Poulton, the president of Wairarapa Wool Growers, explained the challenge ahead.

"The question here is if we should let the market forces decide if these initiatives are good for us or if we need to step up as a farmer group and take some sort of leadership role. We have agreed to meet again in two weeks, lock ourselves up and throw away the key until we make a decision."

[1] US$ 1 = NZ$ 1,33

New Zealand in the World of Wool

Wool was used for manufacturing apparel and interior textiles such as rugs and carpets. Based on fiber diameter, wool was classified in three types, fine (<24 micron), medium (25-32 micron) and strong wool (>32 micron). Fine wool accounted for 36% of total world production and was used for apparel manufacturing. Strong wool was used for interior textiles such as carpets, bedding and upholstery and accounted for 42% of production. Australia was the largest producer of fine wool with 85% of its production being Merino wool (< 25μm). In contrast, 90% of New Zealand's clip was strong. Strong wool was traded either raw (greasy or clean), as intermediate processed products such as carded and combed wool and yarns, and also as finished consumer products such as carpets and rugs. New Zealand's wool clip accounted for 30% of the world's strong wool output.

The wool industry had traditionally been a major contributor to the New Zealand economy. Sheep were raised in most of the countries agricultural regions with the main production areas being the high countries of Hawkes Bay, Wairarapa and Manawatu/Horowhenua in the North Island, and Nelson/Marlborough, Canterbury and Otago/Southland in the south island. New Zealand had 32 million sheep in 2010, down from a high of 70 million in the 1980's. Between 1990 and 2010 around 3.5 million hectares of land traditionally used for sheep and beef production had been converted to dairy, forests or urban development, causing the country's wool production to drop by 48% and exports by 34%.

Figure 1. New Zealand's main sheep production regions.
Source: MAF (2011).

The leading wool producing countries were Australia, China, the Commonwealth of Independent States (CIS) and New Zealand. On a clean weight basis Australia was the world's largest wool producer followed by China, New Zealand and the Commonwealth of Independent States (CIS). Together they accounted for 66% of global production (See Exhibit 2 for data on wool production).

Australia and New Zealand were the leading exporters of raw wool with 45% and 17% of the world exports respectively. In terms of imports China had increased its share of global imports considerable between 1990 and 2009 and became the most significant importer of raw wool accounting for 49% of total world imports. India had also increased its share to 10% and was the second largest importer (see trade figures in Exhibit 3).

New Zealand's exports, in value terms, were 77 % raw wool, 12% yarns, and 10% carpets and rugs; the rest was carded and combed wool and woolen fabrics. In volume terms, 62 % of raw wool exports were scoured (cleaned) while 33% was exported greasy and the remaining 2% was slipe wool (taken from the hide of the sheep after slaughtering). Over 50% of New Zealand's raw and semi processed wool went to Asia while close to a third went to Western European countries. The single largest export destination was China which took 36% of New Zealand's raw wool exports. Other important markets were India, UK and Italy. China and Australia were considered as two major conversion markets for they imported raw wool, further processed it, and on exported. It was estimated that almost 50% of the New Zealand's strong wool clip in 2009, in one form or another ended up in the UK and Europe. The UK consumed in total 55-60 million kg of wool annually and accounted for 11% of NZ's raw wool exports. Australia and New Zealand together consumed 20 million kg of New Zealand's strong wool, the majority of which went into broadloom carpet. US market consumed approximately 13 million kg annually, mainly as yarn or finished carpets.
Due to the competition of synthetic fibers, the global wool industry had witnessed decades of production decline. Between 1990 and 2009 the world's wool production went down 45% and global trade down 30%. For the first time in 100 years the production was less than two million tons in greasy equivalent. While strong wool prices in New Zealand remained largely stagnant from 1990 through to 2009, input costs such as shearing increased by 30% resulting in a 60% decline in returns per stock unit for farmers (See Exhibit 4).

The Strong Wool Value System

From its raw initial form to the manufacturing of the final product, wool had to undergo either woolen processing or worsted processing. Strong wool, which was primarily used for the production of tufted carpets, underwent a woolen processing. The main steps in woolen processing for tufted carpet manufacturing were scouring, blending, carding, dyeing, spinning and twisting, and fabric formation or tufting (Exhibit 5). The margins along the chain varied with the yields obtained from wool, with the cost of each process and with prices (Exhibit 6).

The wool value system in New Zealand (Exhibit 7) started with the more than 12,000 farmers spread out around the country. Historically farmers would sell their wool through auctions (See Exhibit 8 for an example of a sales account). In 2009 approximately 40% of wool was auctioned, 44 % sold directly and 16 % was sold as slipe wool (the wool taken from the hide of the sheep after slaughtering).

The two major auction brokers were Elders Primary Wool (EPW) with an estimated 42 % market share and Wool Partners International (WPI) with 32%. Most of the wool sold privately was purchased by independent wool merchants that cultivated long term relationships with growers on a regional basis. Some exporters and manufacturers also had procurement divisions that dealt directly with growers.

The New Zealand exporting sector had been consolidating over the years. In 2010 there were some 35 exporters; five or six of them controlled 80% of exports. Wool Services Internation-

al (WSI) was the largest with 30-35% of the market; Masural had a 15-20% share, Brooksbanks 15-20%, Furhman 10-15%, WG Robinson 10%, and Bloch and Behrens had around 6-10%.

The two major scourers in the country were Cavalier Wool Scourers with approximately a 60% share of installed capacity and New Zealand Wool Services International (WSI) with 35 %. Wool Services International was the only exporter which had its own scouring facility; the other exporters outsourced the scouring process. The exporters of yarn had the wool spun locally on a commission basis. Raw wool and yarn was sold to foreign processors or importers who then on sold to wool processors or manufacturers.

There two leading carpet manufacturers in New Zealand were Godfrey Hirst and Cavalier Corporation which together accounted for over 80% of domestic production. Both companies owned spinning mills from which they met their own yarn requirements. Cavalier Corporation was also involved in scouring, being a 50% shareholder of Cavalier Wool Scourers. Both companies sold most of their New Zealand produced carpet on the domestic market. Exhibit 9 presents a description of the leading carpet manufacturers in New Zealand.

Overseas, the organization of the importing business varied by country with the structure of the industry in each country. Such differences explained why the wool exporters had a different organization and used different channels in each country. See Exhibit 10 for a view of how the exporting process was organized differently to different markets.

The Market for Interior Textiles

Synthetic fibers represented the greatest competition to wool in the carpet and rug industry accounting for approximately 98 % of consumption in 2009. The major synthetic fibers used in carpet and rug production were nylon, polypropylene, and polyester. Nylon was used in 65 % of carpets sold in the USA, while polypropylene was used in 30 %. While the consumption of all textile fibers had increased significantly worldwide, from approximately 15 million tons in 1960 to 70 million tons in 2009, the consumption of wool had declined since the 1950's. The share of synthetics fibers increased from 10 % in 1960 to close to 60 % in 2009. Over the same period wools share declined from 10 % to less than 2 %.

Carpets and rugs made from wool were considered as having some superior attributes than those made from synthetics. Wool was recognized as having a deep, rich look and feel that had still not been fully matched by synthetic products. Wool carpets wearing performance was excellent, if treated properly, and recent research had shown that it was capable of absorbing and binding air containments such as formaldehyde, sulphur dioxide and nitrogen dioxide. Wool also had the capacity to absorb large volumes of water which enabled wool carpets and rugs to modify indoor humidity. In addition, wool was recognized as creating a superior quality carpet when used in certain textures and styles such as loop pile; it also allowed for more complex color patterns. Wools natural, renewable, and biodegradable nature was perceived as becoming increasingly important to consumers.

From the consumers perspective there were also some disadvantages associated with wool carpets and rugs. Wool carpets and rugs required greater care in terms of stain removal and minimizing piling. They were also more prone to fading if not protected from UV light and tended to wear down, which could result in bare patches in high wear areas. Another issue was that the ability of wool products to hold very high volumes of water could made them

prone to mold and shrinking. This tendency towards shrinking made them unsuited for using in modular carpets, which were growing in popularity, particularly in the commercial sector. From the carpet manufacturers perspective there were some disadvantages in using wool. One issue was that it was more expensive and complex to produce the yarn relative to synthetic fibers because it required more labor and processing steps. It was also more expensive to dye than synthetic yarn. Another problem was that it had a much lower tensile strength which limited the speed at which manufacturing equipment could operate. Output could be twice higher from machines running synthetic yarn than wool. From a price perspective, synthetic fibers had a lower cost than natural fibers such as wool and cotton (See Exhibit 11 consumption and prices of different fibers).

The USA Market for Carpets and Rugs

The USA was the largest market for interior textiles with a total consumption of 1040 mm^2 (million square meters) in 2009 and an estimated retail value of US$ 11.69 billion. Wool products accounted for approximately 2 % of total sales volumes. The USA was also the largest importer of wool floor coverings (See Exhibit 12). New Zealand strong wool was used in 45% of all wool carpet consumed in the US.

The USA carpet manufacturing sector was dominated by two companies, Mohawk Industries and Shaw Industries, which together held a 60% market share. Two medium sized manufacturers, Beaulieu and Dixie, accounted for another 20 % of the industry while approximately 25 to30 smaller manufacturers made up the rest. Shaw Industries and Mohawk each had sales in the range of US$ 4 to 5 billion while Beaulieu's were around US$ 1 billion. They were vertically integrated companies with their own synthetic fiber extrusion plants and trucking fleets. (See Exhibits 13 and 14 for Mohawk financial statement and share price history). Most of the wool carpets sold in the USA were imported and sold under private brands. Godfrey Hirst was considered to be the largest provider of wool tufted broadloom carpets in the USA.

The carpet retailers could be divided into three main categories; the large national chains (20% share), the companies affiliated with buying groups (30% share), and the independent stores with 50% share. Of the national chains, the largest ones were Lowe's and Home Depot. These large chains made companywide buying decisions giving their individual stores no flexibility as to what they stocked. Wool carpets made up 0.2% of the national chains inventories. Of the companies affiliated with buying groups, CCA Global was the largest one having a 65 % market share in this category. These organizations made collective purchases but the members had some flexibility as to what products they wanted to stock. Lastly, the independent retailers had complete control over their stocking and marketing decisions. All retail organizations would generally carry either Shaw's or Mohawk brands, but rarely both. They would complete the rest of the inventory with products from the smaller manufacturers.

The cheapest synthetic carpets had a wholesale price of US$ 11 per lineal meter, with half the synthetic market priced below US$ 40. In contrast wholesale prices for wool carpets started at US$ 40 per lineal meter for 50/50 blends and went above US$ 270 for heavy weight 100% wool. The majority of 100 % wool carpets retailed at between US$ 100 and US$ 140 per lineal meter. At the higher end of the US market the average price for wool carpets was twice of synthetics.

Some industry participants believed that there was a growing interest in the USA market for wool carpets and rugs. Consumers' preferences were moving towards more sophisticated pat-

terns and textures which were most suited to the properties of wool. The price gap between wool and synthetic products had been closing in the last decade. An increasing number of USA consumers would prefer to buy a sustainable, recyclable natural product as long as the price and other attributes were comparable to the synthetics.

Purchasing decisions vary depending on the market sector. In the case of single family homes it was most often the home owners who made the decision. When the purchase was for a new home the builder usually presented the homeowner with a number of floor covering options. In the case of condominiums and flats the purchasing decision would be made by an interior designer or facilities management staff. Interior design professionals made decisions for a very small proportion of the market.

Public Promotion of Wool

The New Zealand Wool Board had been, until 2001, the central body for the funding of wool R&D and promotion. In 2001, farmers voted for its dissolution. The Wool Board's assets were carved out and transferred to new commercial entities. In 2009 the farmers voted to stop all payments to support industry wide promotion and R&D activities.

The Woolmark (logo in Exhibit 15) was a brand created in 1964 by the International Wool Secretariat (IWS) to combat the increasing competition of synthetic substitutes in the textile industries. The International Wool Secretariat was an industry body created and funded in 1937 by New Zealand, Australian and South African wool grower organizations for the promotion of wool worldwide and for conducting technical and marketing research. Other wool producing countries such as Argentina and Uruguay also joined the IWS. The Woolmark program included quality assurance standards with specifications according to end products. There were no fees associated with the license but manufacturers were required to comply with specifications and provide volume statistics to the IWS. Woolmark was considered a global brand recognition success story.

New Zealand withdrew from the IWS and its Woolmark program in 1996. It was perceived that, although it was having a positive effect on fine wool apparel products, it had little impact on interior textiles. The other important concern was that other major strong wool producers such as the UK farmers were free-riding the program. New Zealand wool producers, who at some point were investing between half and one million dollars per week, felt that they were not seeing enough results for their money. After withdrawing from the IWS, the NZ Wool Board created Wools of New Zealand to launch and manage a new promotion program for the country's strong wool. The Fernmark logo (Exhibit 15) was then created as New Zealand's new wool brand. The new initiative included a quality assurance program covering all aspects of the supply chain back to the shearing board. It was believed that the quality assurance program would increase demand for New Zealand wool and eventually lead to price premiums. By 2001, 60,000 tons of raw wool was being channeled through the program and Wools of New Zealand had 249 brand partners in the carpet and rug sector worldwide.

In 2010 the Campaign for Wool (logo in Exhibit 15) was launched by its patron The Prince of Wales. It was a generic promotion initiative targeted at consumers and retailers and focused at promoting wool's natural and sustainable attributes as well as fire safety and durability. The funding partners were the Woolmark Company, British Wool Marketing Board, New Zealand Wool, Wools from Norway and International Wool Textiles Organization, and the National Council for New Zealand Wool Interests Inc. The members of the National Council for New Zealand Wool Interests Inc. included exporters, scourers, brokers and private mer-

chants. Amongst the organizations supporting the Campaign for Wool initiative were Elders Primary Wool, Wool Services International, and WoolFirst (the Federation of New Zealand Wool Merchants). See Exhibit 16 for how one industry participant described the Campaign for Wool.

Private Branding Initiatives

Three different groups – Elder Primary Wool, Wool Services International, and Wool Partners International, had started their wool branding initiatives after the Wool Board was discontinued (see logos in Exhibit 17). Branding ingredients, such as wool, was considered a highly challenging proposition; even more so if the brands were aimed at creating consumers recognition. Manufacturers and retailers were not to enthusiastic to carry the wool brand side by side with their own brand unless the wool brand really made a difference. There were additional challenges related to preserving the identity and integrity of the wool from origin to end product. See Exhibit 18 for how one industry participant explained the challenges faced when branding wool.

Elders Primary Wool (EPW)

Elders Primary Wool (EPW) was a 50/50 joint venture formed in 2005 between Elders Rural Holdings Limited and the Primary Wool Cooperative (PWC). The Primary Wool Cooperative contributed to the joint venture a procurement base of 110,000[2] bales of wool per year plus its storage facilities and transport operations. Elders Rural Holdings Limited had contributed a sourcing capacity of 50,000 bales, and its wool management, trade and marketing assets and expertise. EPW was a wool merchant, broker and handler, and offered wool management services to farmers with wool stores and buyers and field representatives throughout the country. By 2010 EPW was employing a team of 50 staff and handled 220,000 bales per annum. From the five board members, two were representatives from PWC and the remaining directors and the chairman were from Elders.

The Primary Wool Cooperative was founded in 1972 when 400 growers from the East Coast region of the North Island came together to form what was known then as the East Coast Wool Cooperative. In 2001, the cooperative purchased Elders Wools. By 2010 the Primary Wool Cooperative had a membership of 900 farmers. Farmers' shareholding in the Primary Wool Cooperative was based on the volume of wool supplied. A member had to own 1 share, valued at $1 for every 5kg of wool, with a minimum share holding of $1000. Members were not obligated to selling their wool through the co-operative. The shareholding entitled them to receive a rebate of 3 cents per Kg of wool on the brokerage fees which were approximately 17 cents per Kg of wool. Bonus share offerings had been made periodically to increase the shareholding of the existing members. Shares were of fixed value and could be redeemed with the approval of the cooperative directors. Voting rights were based on one vote per share but were capped at 20,000 votes per shareholder. The two largest shareholders held a combined 65% share in 2010. The Primary Wool Co-operative had a board of four directors.

Elders Rural Holdings was originally an Australian owned rural services company that had started operations in New Zealand in 1903. In 2001, after an acquisition by New Zealand interests, Elders sold its wool interests to the Primary Wool Cooperative. In 2005 Elders entered the mentioned joint venture with Primary Wool Cooperative to form Elders Primary Wool.

[2] 1 bale = 180kg

Branding Initiatives by Elders Primary Wool

EPW had recently launched the *Just Shorn* wool brand in the USA market. Just Shorn was targeted at the highest end of the carpet market and aimed to encourage consumers to pay a premium for high quality carpets and rugs made from New Zealand wool and procured exclusively through EPW. The program included an on-farm accreditation system aimed at providing the assurance that high quality wool was produced in a responsible way with regards to environmental and animal welfare issues. A traceability technology developed by AgResearch was at the core of the Just Shorn quality assurance program. The process involved minute quantities of a phosphorous coated nylon fiber mixed with the wool at the scouring and blending stage. The phosphorous coating could be detected by an electronic reader allowing to preserve the identity of the wool along the entire supply chain up down until the end consumer product. The technology was aimed at assuring the provenance of wool and at stopping unscrupulous suppliers to free-ride the efforts made in New Zealand.

The major partner in the Just Shorn initiative was the USA based retailer CCA Global Partners. CCA Global Partners was a large co-operative retail group and the largest carpet retailer in the world. It had seven different retail sectors that operated under several brands such as the International Design Guild, Prosource, CarpetOne, Floor and Home, and Flooring America. The Just Shorn branded carpets were distributed through International Design Guild outlets which had 120 stores throughout the US. Elders Primary Wool licensed the brand to CCA Global Partners CCA and through it to International Design Guilds dedicated manufacturers. Elders Primary Wool invested in brand development and in-store displays while International Design Guild invested in publications and a website targeted at professionals. Marketing materials provided emotive images of Kiwi farmers as responsible custodians of land and stock. In terms of volumes, the expectation at EPW was to supply 7,000 bales of wool in the first year and 15,000 bales by the third year. The pricing strategy was to start selling yarn at the market price and then moving up the premium ladder as brand recognition and value increased. The program managers held the view, based on past experiences, that extracting premiums directly from manufacturers wasn't possible without a significant commitments and support from retailers. Communication efforts targeted the interior design consultants and architects who served high end consumers which perceived carpets as a fashion item and tended to change carpets every six to seven years. Elders Primary Wool had the yarn produced in New Zealand and exported to a select number of International Design Guild premium manufacturers such as Fabrica. Any price premiums at the retail end were to be channeled back from International Design Guild to Elders Primary Wool. Elders Primary Wool would also supply yarn to hand knotted rug producers in Nepal which had supply agreements with CCA Global Partners.

Wool Services International (WSI)

Wool Services International (WSI) was a wool exporting company which had started operations in 1992 to become the leading New Zealand wool exporter. In 2009 WSI had a 32% wool exports market share (42% of carpet type wools), sales of over NZ$ 150 million and exported to 30 countries (See in Exhibits 14 and 15 the financials and share prices of WSI). WSI was publicly listed with 65% of ownership in less than a few hands and the rest held by management and 3.500 farmers. WSI controlled 50% of New Zealand actual wool scouring. Wool was procured through auctions, private sales and independent merchants. The gross export margins would vary between 1.5% and 3%. WSI and all the major wool exporters were members of the New Zealand Council of Wool Exporters. In the history of the council,

which was around 100 years, there had never been a default in payment to any one in New Zealand by any of its members.

Branding Initiatives by Wool Services International (WSI)

WSI had three branding initiatives, Purelana, Glacial, and Redband, all targeted at carpet and rugs manufacturer. Purelana was a scoured wool brand launched in 2005. Its value proposition was based on sustainability and on a paper based traceability system from procurement through to processing and marketing. The program required growers to exclusively supply WSI for a contracted period of between one and three years. WSI offered two main direct supply options to farmers, one was a forward contracts based on a forward price of up to twelve months, and the other was a spot market contract price. The long term supply contracts were intended to create consistency in timing, quantity and quality. Direct supply system minimized costs to farmers by reducing handling costs between the farm and the wool scour, avoiding brokerage charges and marketing fees. Loyal farmers benefited from such economies.

The Glacial brand was positioned as exceptionally clean and bright scoured wool with a superior capacity to take dye. The special scouring process was twice as costly as the usual one and therefore was applied only to the best available wool. Glacial was targeted at manufacturers of pure white and pastel shades carpets and rugs. The imaging suggested that producers for this brand were encouraged to be innovative in stock management practices, pest control and shearing practices to ensure the quality of the fleece. Although still a small business, it was considered one of WSI flagship products.

Redband was an initiative aimed at visually differentiating their bales of scoured wool. Instead of using the usual brown metal bands to wrap the wool bales WSI changed to a red band so that they could be identified when their bales were in the shed of their customers together with bales from other sources. Redband offered quality controlled wool from farm gate through the WSI scour and all the way to guaranteeing how the wool performed on the customer equipment. Although the initiative was started without much expectation, overtime WSI customers perceived the red ban as a sign of quality assurance.

Wool Partners International (WPI)

Wool Partners International (WPI) was created in 2008 by PGG Wrightson as a wool trading and marketing company. PGG Wrightson was a publicly listed company with a long history as a provider of inputs and services to the rural sector in New Zealand. In 2010 PGW had assets of around NZ $ 1.5 billion and revenues of NZ $ 1.1 billion. It was a major wool broker with a tradition in the farming services business that dated back to the 19th century.

WPI was formed with the idea of becoming 50% owned by PGG Wrightson and 50% by the farmers through a holding company to be named Wool Growers Holding. The initial public offering to fund Wool Growers Holding was not successful. PGG Wrightson went ahead with the plan and transferred to WPI all its strong wool business - a wool procurement team, an auction management team, an international trading division, a network of wool stores and quality control facilities spread throughout the country, as well as the exporting company Bloch and Behrens. In 2008 WPI bought Wools of New Zealand, a wool marketing division, from Meat and Wool New Zealand.

In 2010, in a new attempt to bring the farmers on board, WPI issued an investment prospectus to create Wool Partners Cooperative. The idea was that Wool Partners Cooperative would acquire most of the wool trading assets of WPI. In November 2010 a prospectus to create Wool Partners Cooperative was released and the funding campaign started (See in Exhibit 1 a summary of the WPC investment prospectus).

Branding Initiatives by Wool Partners International (WPI)

WPI had two brands targeted at carpets and rugs manufacturers, Wools of New Zealand and Laneve. The use of the Wools of New Zealand brand in carpets and rugs required that a minimum of 80% total fiber content had to be wool and a minimum of 60% of total fiber had to be New Zealand wool. The products had to pass performance testing of durability, appearance retention and color fastness. The manufacturers were licensed to use the brand and no exclusivity was required. Wools of New Zealand had over 100 partners involved in yarn or carpet production. WPI sources claimed that the brand was carried on 25% of New Zealand products sold in the USA. Most Wools of New Zealand branded carpets and rugs sold in the US market were imported from Asia, Europe and the Pacific.

The Laneve brand was to be positioned as an integrity brand, providing assurance to the consumer that the wool was sourced from growers following high standards in terms of animal welfare and environmental sustainability. A paper based traceability system enabled the wool to be traced back to the farm. Growers had to comply with given codes of practice about health, nutrition and safety. The promotion activities were aimed at communicating directly with manufacturers and retailers and, through advertising in interior design magazine, with architects and interior designers. An online training program called the Wool College was aimed at training retail staff to communicate with consumers about the benefits of wool and the value propositions in the Laneve and Wools of New Zealand brands. The expectation was that eventually manufacturers would be willing to pay a royalty to use the brand or alternatively pay a price premium for the branded wool.

Decision Time at Wairarapa Wool Growers

In their previous meeting, the Wairarapa farmers had agreed to reconvene to decide if to invest or not in any one of the branding initiatives. The farmers had contrasting views to consider. The most extreme views were, on one side, that farmers should stay away from investing in the branding of wool and let markets work. One the other side some farmers believed that they should take total control of the exports of all New Zealand wool to. The middle of the range options were to invest, with different degrees of commitment, in one or another of the existing value adding and branding initiatives.

Sam Poulton had organized the farmers in three groups; each group was assigned to present to the plenary the strengths and weaknesses of each of the wool marketing groups and the respective branding initiatives. After listening to the three presentations, the farmers would make a decision. Sam was very much focused on the questions they needed to answer. Which one of these initiatives, if any, was best for the farmers to invest in? Would it be better to just let the market forces work? Or was it time for farmers to step up and make things happen? If so, what form of commitment should the farmers be prepared to assume?

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Appendix

Exhibit 1: Initial Public Offering for the Wool Partners Cooperative (Summary of the Prospectus)

Highlights:

- One share valued at $1.00 per kg of greasy wool produced of which $ 0.20 is payable on application and the balance to be paid over a four year period.
- Shareholders must commit 100% of their wool to the cooperative.
- Only shareholders may supply the cooperative.
- A wool market development fee of 2% of the value of all wool supplied to the cooperative must be paid.
- Wool partners cooperative will only go ahead if it is able to attract 50% of New Zealand strong wool production.
- Initially the offer was to close on the 30th of November 2010.

Funds raised in the share offering would be used to:

- Acquire certain assets of the supply, sales , marketing and corporate divisions of WPI including wools of New Zealand and Bloch and Behrens but excluding the logistics and handling business of New Zealand Wool Handlers
- Provide working capital to expand the supply, sales and marketing capability of the business
- Acquire and collaborate with other businesses within the wool value chain
- Meet costs of issue, transaction and restructuring.

Cost of acquisitions and selected expenses:

- 100% of Bloch and Behrens: $1,965,000
- 100% of Wools of New Zealand: $1,237,000
- Deferred settlement payment due to WRONZ in relation to Wools of New Zealand ($737,000)
- Assets and liabilities of WPI and its subsidiary NZ Wool Handlers which relate to the Supply, Marketing and Corporate divisions $15,271,000
- Has the opportunity to acquire an option to buy NZ Wool Handlers for option price $250,000 by 31st December 2010 and must be exercised by 30th June 2012 and settled by 30th June 2013.
- Preliminary issue expenses: $980,000 made up of:
    - Advisory, legal and accountancy costs $595,000
    - Prospectus preparation and delivery $155,000
    - Communication and marketing costs $190,000
    - Insurance and ancillary costs $ 40,000

Important points and conditions

- A minimum of $13 million must be raised for the cooperative to proceed, which equates to 50% of New Zealand's annual strong wool volume.
- Only strong wool producers and meat processors producing slipe wool may apply for membership.
- A minimum of 500 shares or their Quota shareholding, whichever is greater, is required.
- Transfer of shares is at the discretion of the board.
- Returns of shares will be in the form of rebates based on volume supplied to WPC. Dividends are payable on the equivalent number of fully paid share held by the member.
- Members have one vote per share; if shares are not fully paid up voting will be in proportion to the paid up shares.
- A maximum of 5% voting rights is allowed per shareholder.
- The board will consist of between 5 and 7 directors, of which the majority must be grower appointed; the remainder may be appointed by the board and there must be minimum of two of these directors.
- Intention is that premium earned from brands will eventually pay for the market development costs and that this fee (levy) will no longer be required.
- With Bloch and Berhens WPC would be exporting 12% of New Zealand's strong wool clip.

Exhibit 2. Wool Production

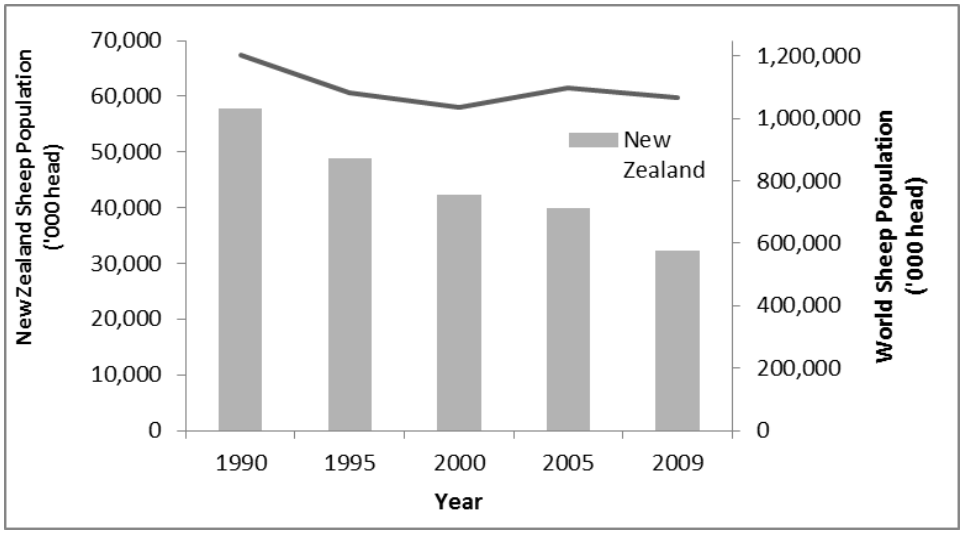

Figure 2. World and New Zealand sheep populations 1990-2009.
Source: IWTO. 2010.

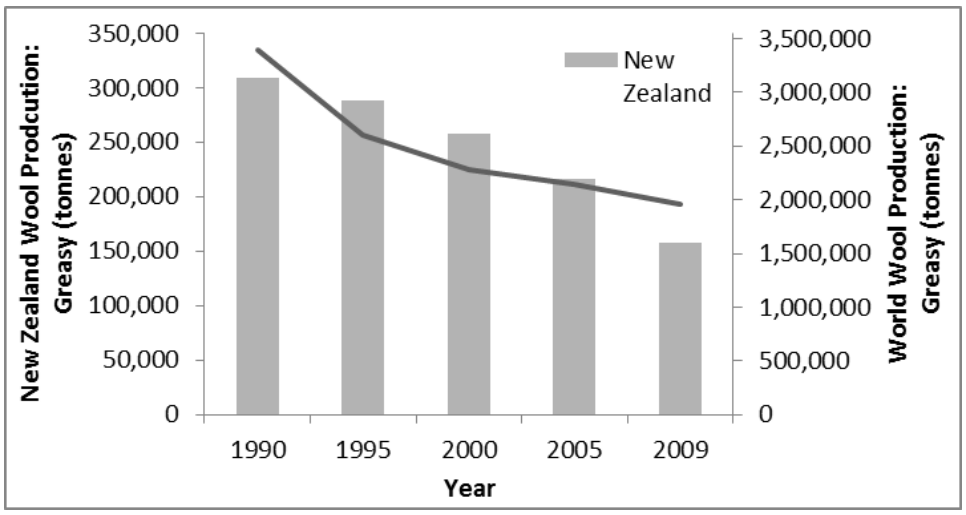

Figure 3. World and New Zealand wool production (greasy) 1990-2009.
Source: IWTO. 2010.

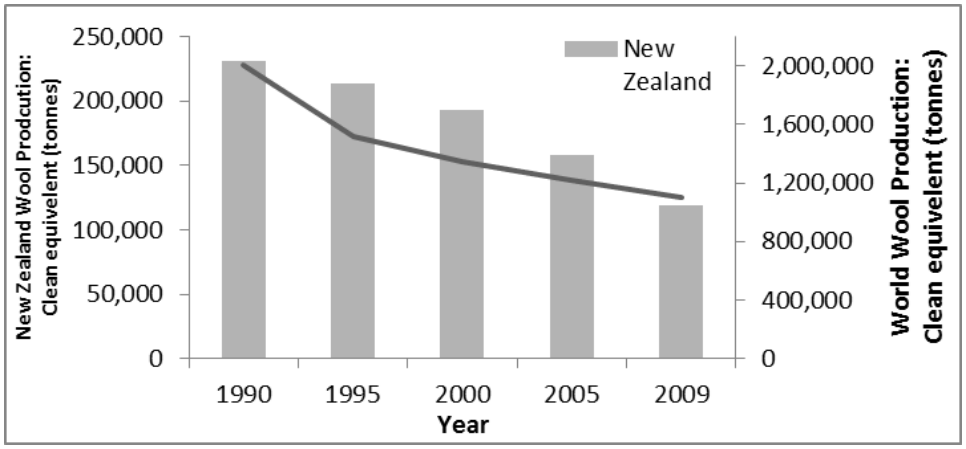

Figure 4. World and New Zealand wool production (clean equivalent) 1990-2009.
Source: IWTO. 2010.

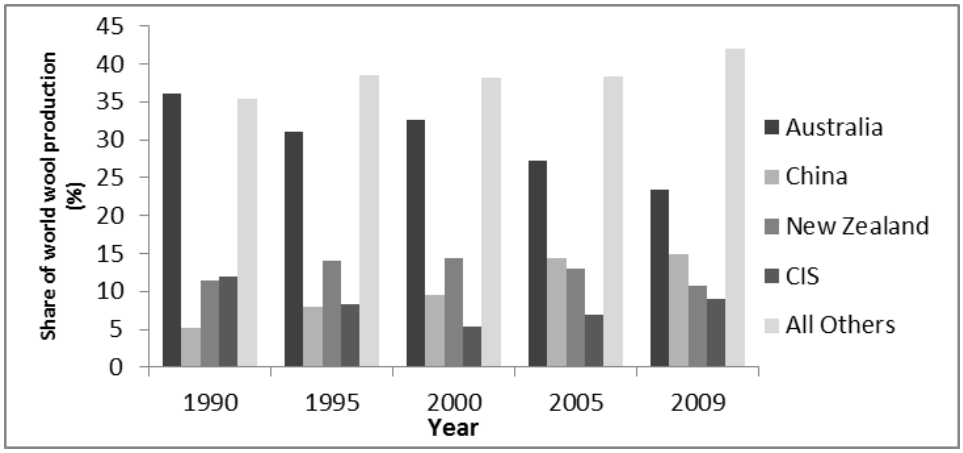

Figure 5. World wool production (clean equivalent) 1990-2009: % share of main producers.
Source: IWTO. 2010.

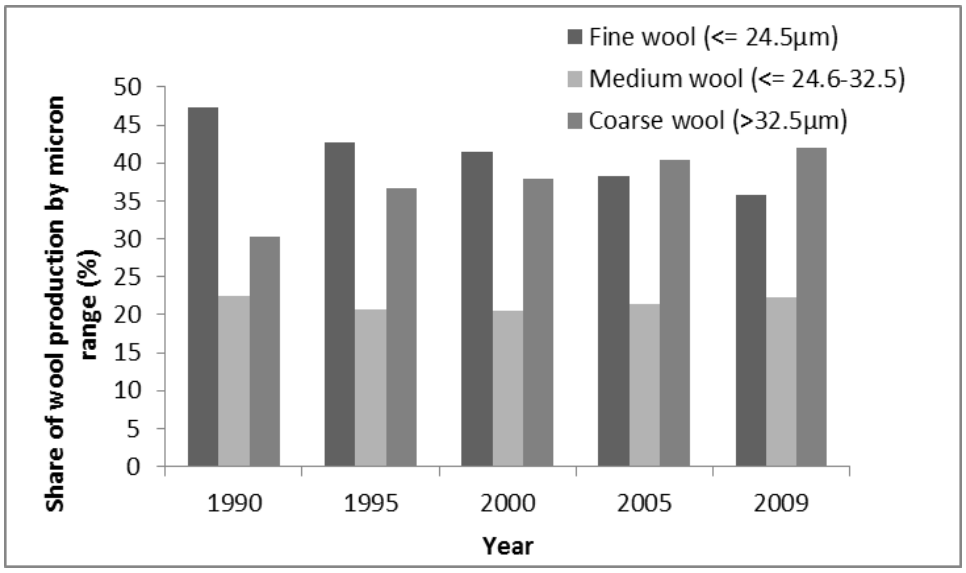

Figure 6. Share of world wool production by micron range (clean equivalent) 1990-2009.
Source: IWTO. 2010.

Exhibit3. Wool Trade

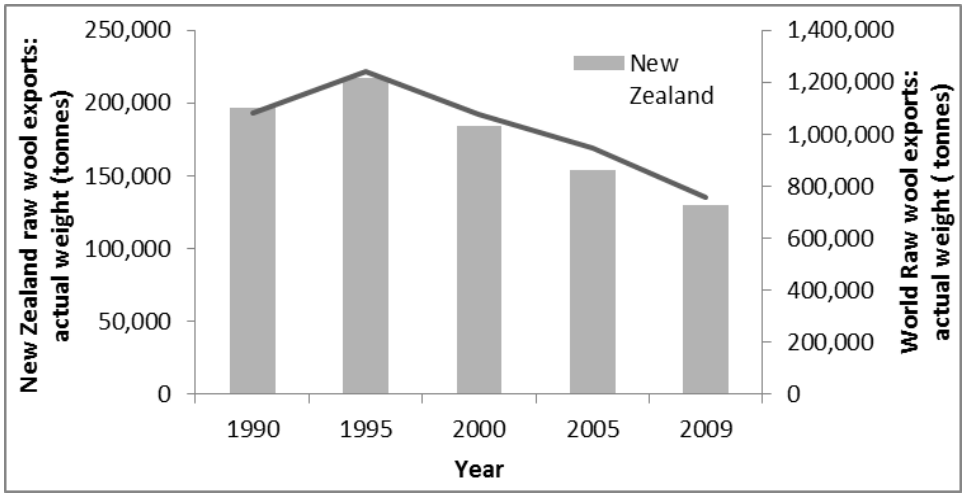

Figure 7. World and New Zealand raw wool exports (actual weight) 1990-2009.
Source: IWTO. 2010.

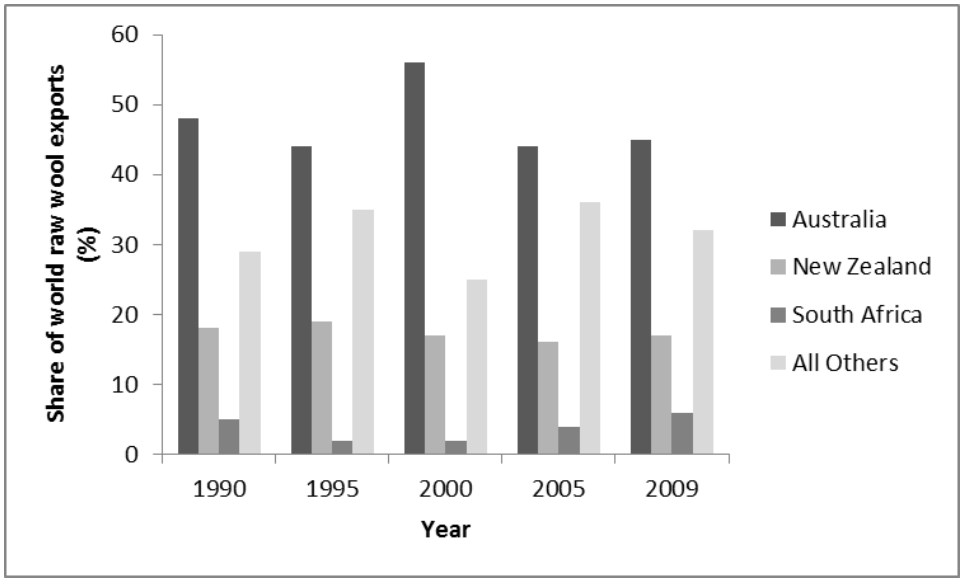

Figure 8. World raw wool exports (actual weight)1990-2009: % share of main exporters.
Source: IWTO. 2010.

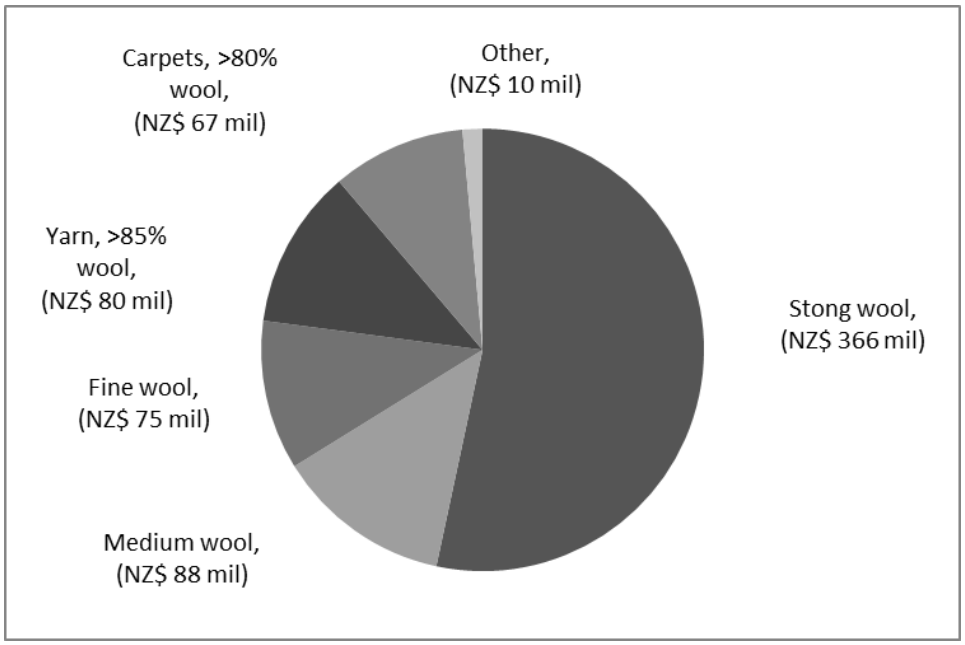

Figure 9. Export values of New Zealand wool and wool products for year ended March 2010.
Source: MAF

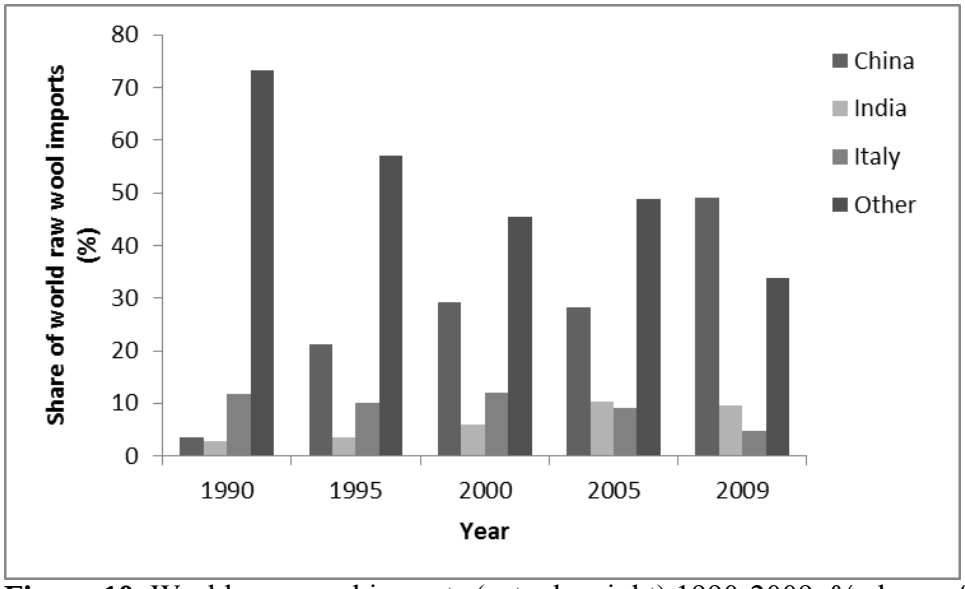

Figure 10. World raw wool imports (actual weight) 1990-2009: % share of main importers.
Source: IWTO. 2010.

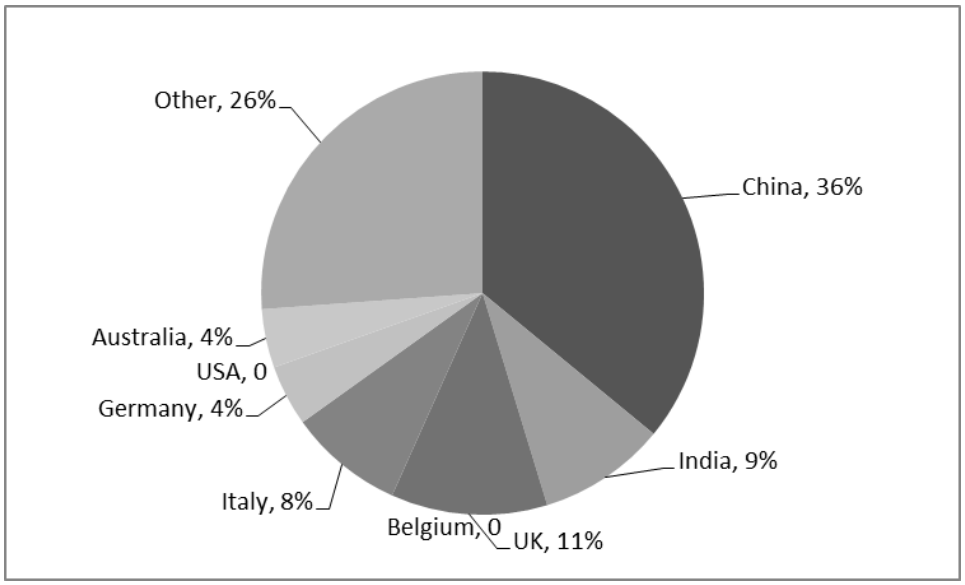

Figure 11. New Zealand raw wool export markets by volume (clean weight equivalent) for 2009.
Source: (Beef and Lamb, 2010a)

Exhibit 4. Wool Prices and Returns

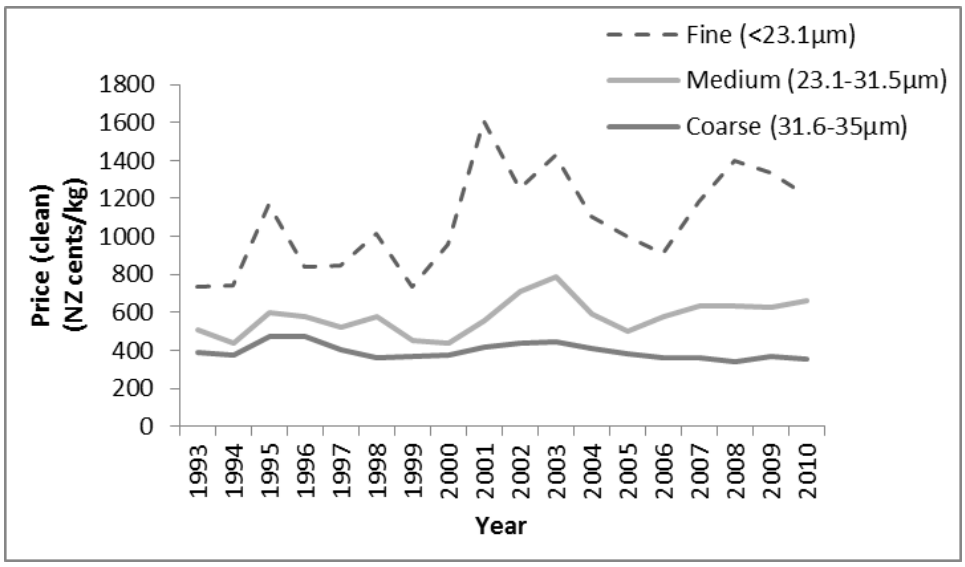

Figure 12. New Zealand clean wool prices. Source: IWTO (2010).

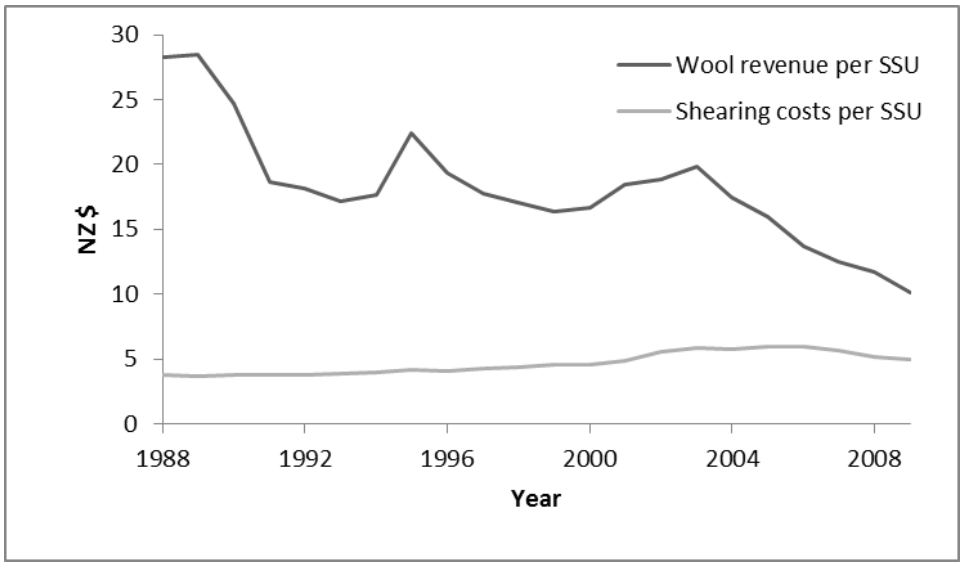

Figure 13. Trend in average farm real returns and shearing costs per sheep stock unit (SSU). 2004-05 was used as the base year. 2008 values are provisional results. 2009 values are an estimate.
Source: MAF, 2010b.

Exhibit 5. Wool Value Adding Processes
Source: University of Waikato, 2010

Wool undergoes either woolen processing or worsted processing). Finer wool that will be used for woven apparel, carpets and upholstery will go through worsted processing. Strong wool, which is primarily used for the production of tufted carpets, goes through woolen processing. The main steps in woolen processing for tufted carpet manufacturing are scouring, blending, carding, dyeing, spinning and twisting, and fabric formation (tufting).

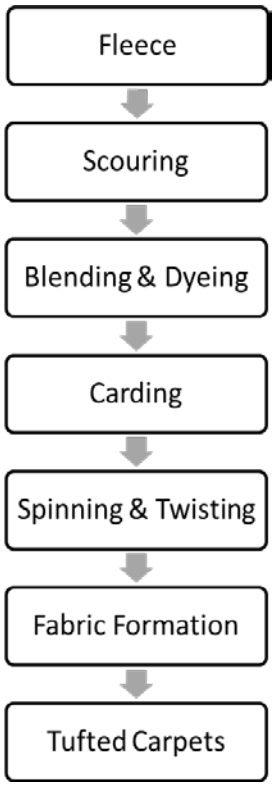

Figure 14. Woolen processing flow chart.

Scouring

Scouring is a washing process used to remove the dirt, sweat and grease that has accumulated in the fleece during the growing season.

Blending and Dyeing

Different batches of wool will often be blended to give the yarn the specific properties that are desired. Because of the strong absorption characteristics wool can be dyed at a number of stages. Wool is most commonly dyed after scouring or after spinning and weaving.

C**arding**

Carding involves combing the wool to remove small particles of vegetable matter (such as leaves, twigs and seeds) and shorter wool fibres that are undesirable in yarn. It also aligns and straightens the fibres to form narrow ropes called ‘slivers’. These are gently twisted into strands that are wound into balls in preparation for spinning.

Spinning and twisting

The combed wool is spun into a singles yarn, two or more singles yarns will then be twisted together to form a thicker, stronger yarn which will be used for producing carpets.

Fabric Formation
Tuft carpets are made by stitching the yarn to a backing fabric (tufting). This process creates loops which are either left as loops or cut, depending on the style of carpet being produced. An adhesive is than applied to the base of the carpet to seal and lock the wool yarn in place.

Exhibit 6. Wool Processing Yields, Costs, Prices and Margins

The amount of clean wool that could be obtained from greasy wool varies greatly but in New Zealand on average 1 kg of greasy wool would yields 780g of clean wool after scouring. One kg of clean wool would yield 0.93 kg of yarn. It is estimated that it takes approximately 1.3-1.7 kg of clean wool to produce a square meter of broadloom carpet. It takes approximately 1.35 kg of clean wool to produce an average 40 ounce carpet. A medium weight pure wool carpet (40 ounce) required approximately 4 kg of yarn per lineal meter or an equivalent of 4.3 kg of clean wool. A lineal meter of carpet was 3.66 meters wide. The process of yarn manufacturing costs approximately NZ$ 13.50 per kg and the process of tufting around NZ$ 22 per lineal meter.

The prices of carpets vary mostly with the type of fiber and the weight. In the New Zealand market, carpets targeted at the low end of the price range such as those made from Polypropylene and light weight solution dyed nylon carpets wholesaled for approximately NZ$ 50 per lineal meter (1 x 3.66 m). Middle range carpets such as medium weight solution dyed nylon, wool blends are priced up to NZ$ 110 and the higher end heavy weight (up to 90 ounces) pure wool and solution dyed nylon can be priced up to $300 or more. A medium weight pure wool carpet (40 ounce) will have a wholesale value of approximately $ 120 and retail for around $ 180.

Wool carpets sit at the higher end of the US market with the wholesale prices starting at US$ 40 per lineal meter for 50/50 blends to US$ 270 per lineal meter for heavy weight 100% wool. The majority of 100 % wool carpets fall between US$ 100 and US$ 140 per lineal meter. In contrast the cheapest synthetic carpets sell for US$ 11 per lineal meter, with half the synthetic market priced below US$ 40 per lineal meter. The average price for a synthetic carpet in the US market was approximately half the price of a wool carpet.

Exhibit 7. Diagram of the Wool Value System

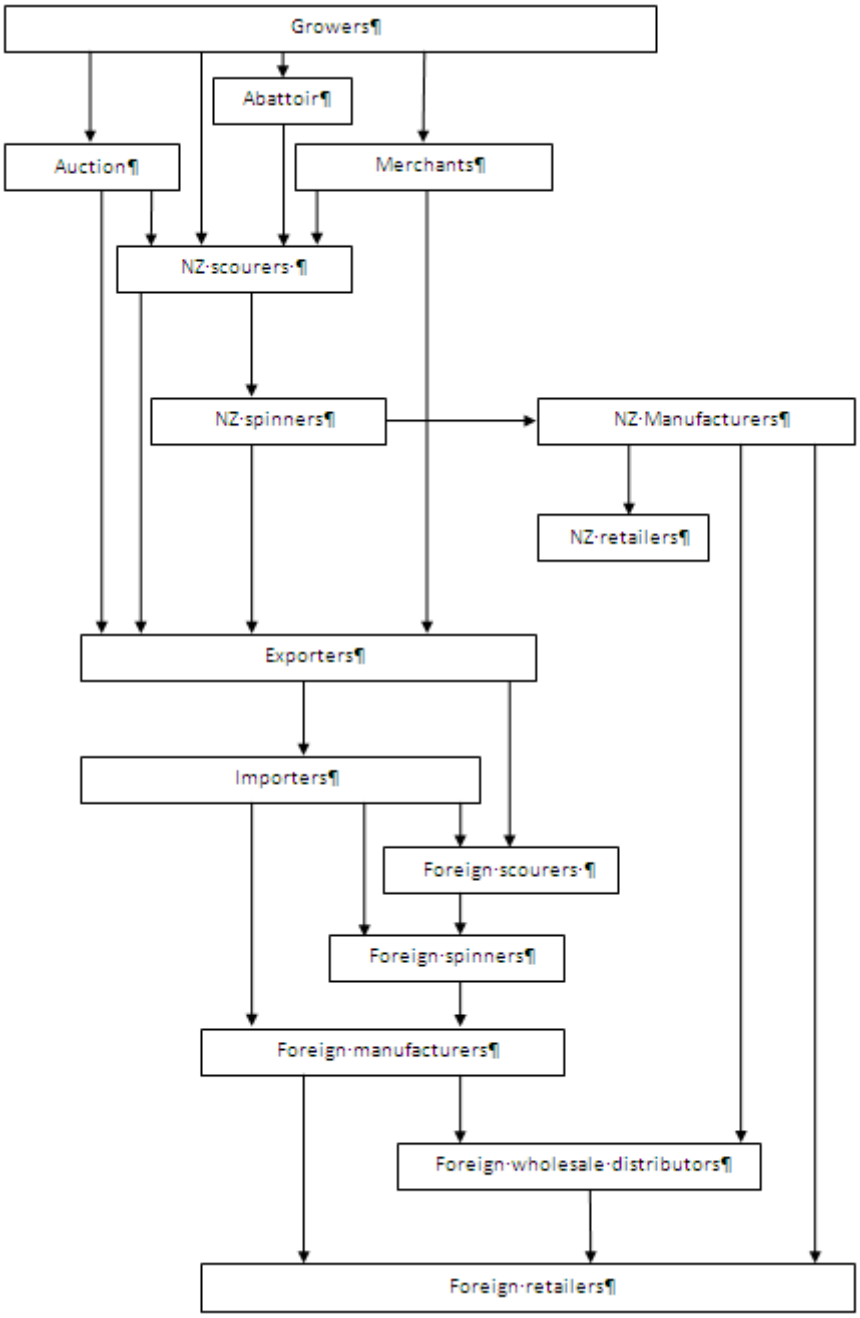

Figure 15. Flow of wool through the New Zealand Strong wool value chain

Exhibit 8. Account of Wool Sales Example

Wool Partners International
ACCOUNT SALES OF WOOL SOLD
RECIPIENT CREATED TAX INVOICE/TAX INVOICE

P O Box 12001, Napier 4144
Phone 0800 497496 Fax 06 8337799
GST:100-084-643

Proceeds	Grsy kg	$
Main line sales	2,420	9,776.80
Credit value of samples	4	8.08
Total	**2,424**	9,784.88
Add 15.0% GST on proceeds		1,467.73
Gross Proceeds		**11,252.61**

	$	$
Broker charges		
Consolidated Charge		412.08
Total broker charges		412.08
Other Costs		
Insurance		39.14
Wool Market Development Fee		293.55
Core Testing		67.10
Total non broker charges		399.79
15.0% GST on charges	121.78	
Total charges		**933.65**

GST Input	$121.78
GST Output	$1,467.73
Net Proceeds excluding GST	**$8,973.01**

Net Proceeds for this Account Sale **10,318.96**

Lot no	Description	Bales	Greasy Net kg	Greasy Price	Gross $ Amount	Clean Price	Mic	SD Yield	VM	Colour		Staple test information					
												SL		SS	POB			Haut
										Y	Y-Z	SL	CVL		T	M	B	
5702	H	17.	2,420	404	9776.80	529.	31.9	76.4	0.1	62.2	3.5							
Totals	**Sold**	17.	2,420		9,776.80													
	Passed																	

Exhibit 9. New Zealand's leading carpet manufacturers

Cavalier Corporation was a New Zealand publically listed carpet manufacturer with revenues of NZ$ 247 million and assets of NZ$ 196 million. It specialised in wool carpets and manufactured about 1 million lineal meters per year. Half of its sales were in New Zealand or Australia; its main export markets were Canada, USA, North Asia and UK where it targeted high end residential consumers. Cavalier was a vertically integrated company having interests in operations throughout the supply chain. It owned Elco Direct which purchased 60,000 bales of wool directly from farmers each year. It also had a 50% share in Cavalier Wool Scours and two spinning mills with a combined capacity of approximately three million kg of wool yarn per year. Cavalier management believed that the essential product attributes to compete successfully in the carpet market were performance, functionality and appearance. Provenance or the story surrounding the product in terms of history, heritage, ethics and sustainability could influence buying decisions but only if the other attributes were in place. For that reason Cavalier concentrated its efforts on design and on meeting industry wide grading standards such as the Australian Carpet Classification Scheme (ACCS) to assure quality irrespective of fibre type. Cavalier wasn't carrying any wool brands on their products.

Godfrey Hirst was a privately owned Australian carpet manufacturer with considerable operations in New Zealand. Most of its production capacity was in Australia where it employed 2000 people. It employed 700 people in New Zealand and had spinning mills in Christchurch, Lower Hutt and Dannevirke. It had recently sold its scouring facilities to Cavalier who closed them down. Godfrey's product range included 100% wool carpets, 80/20 wool rich blends, 50/50 wool blends, 100% nylon and 100% polypropylene. About 50% of its production was pure wool, 25% were blends and 15-20% pure synthetic. The retail price range of its wool carpets would vary between as low as $89-99 to a high of $360 (GST included) per lineal metre (12 ft or 3.66 meters wide). It had offices in the UK, USA and Asia. Half of the yarn produced in New Zealand was exported to Australia; 75% of its carpet production was sold in Oceania and the rest exported mainly to the UK and the USA. Godfrey Hirst was one of the largest, if not the largest, supplier of wool and carpets to the American market. Thirty percent of its wool products sold in the USA were sold to CCA Global. Wool was procured through independent agents and scouring was contracted out to Cavalier scours. As one of its executives said *"I think at the moment Godfrey Hirst is about the 7th largest manufacturer of carpet in the world, but when compared with the big ones we are like a drop in the bucket."*

Exhibit 10. The organisation of wool exporting to different markets
(view of one industry participant)

"... places likely Nepal and India in particular are low labor cost places and very hands on making rugs, so you'll have one person over there who will import a twenty foot container of wool which is about twenty tons. They will then sell that wool out, half a bale or 200-300 kg to an individual who will take it home and spin it into the yarn and then bring the yarn back to that person and he'll pay them for doing that job. He then amalgamates all those yarns together and he will sell that yarn to the next stage processor so it can be a very cottage industry in a place like India. So there could be hundreds or thousands of individuals. Now you go to China, China still has a lot of low labor cost but they are very mechanized, they do it on scale, so instead of just doing a few kilos here and there they are buying in thousands of tons and converting thousands of tons into the next stage of processing. Turkey is mechanized; you would have twenty major players in Turkey. Maybe in China you could have 40-50 major players. You'd have 50 or so players around UK and Europe that are takers of New Zealand wool.... So it's quite convoluted how you get wool in to some of these countries. In Europe basically you have a combination of agents who act as principals which means they will purchase the wool even though they say they are agents and on sell it in smaller lots. They'll buy twenty tons and carve off and sell 2 tons to a smaller processer here and 5 tons to somebody else there and then you have the big mills that will import 20 container loads of wool each month for their own full usage to turn it all the way through to carpeting so you have all those different types of importing structures. In markets like Iran we can't sell directly to any carpet producer. You have to go through an agent who facilitates the business due to cultural and language differences as well as a major labyrinth of bureaucracy to get around. It depends on which country you are working with, which model or combination of models suits best. We are using a range of models all the time, in some countries we are selling directly to the mill, in other places we are selling to a distributor who will buy a box and then split it off to half a dozen different people, in other markets we have our own agents."

Exhibit 11. Consumption and prices of different textiles fibers

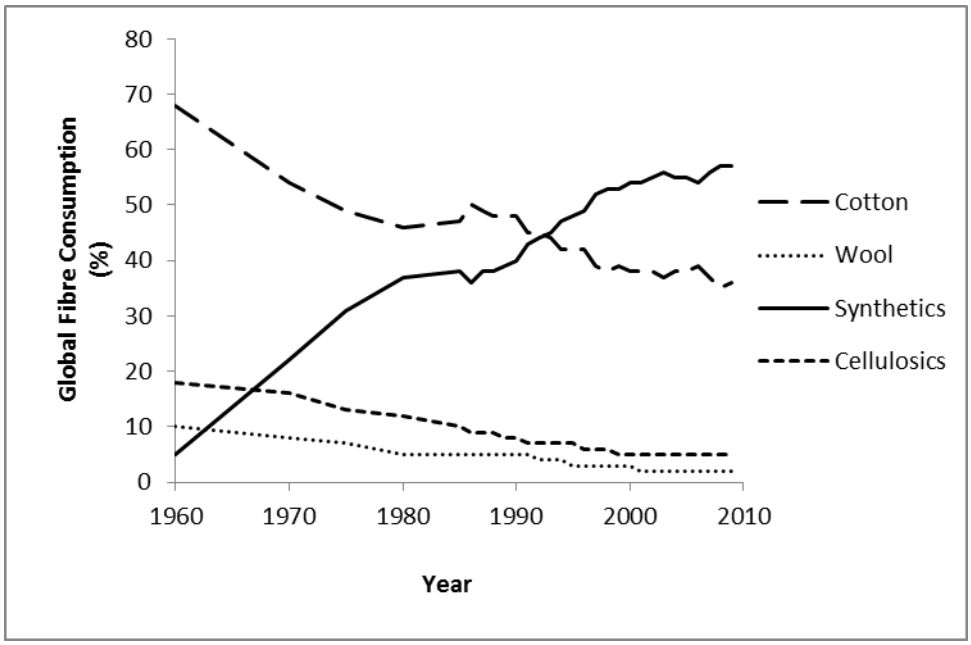

Figure 16. Percentage share of fiber types making up total world fiber consumption.
Source: Oerlikon. 2010.

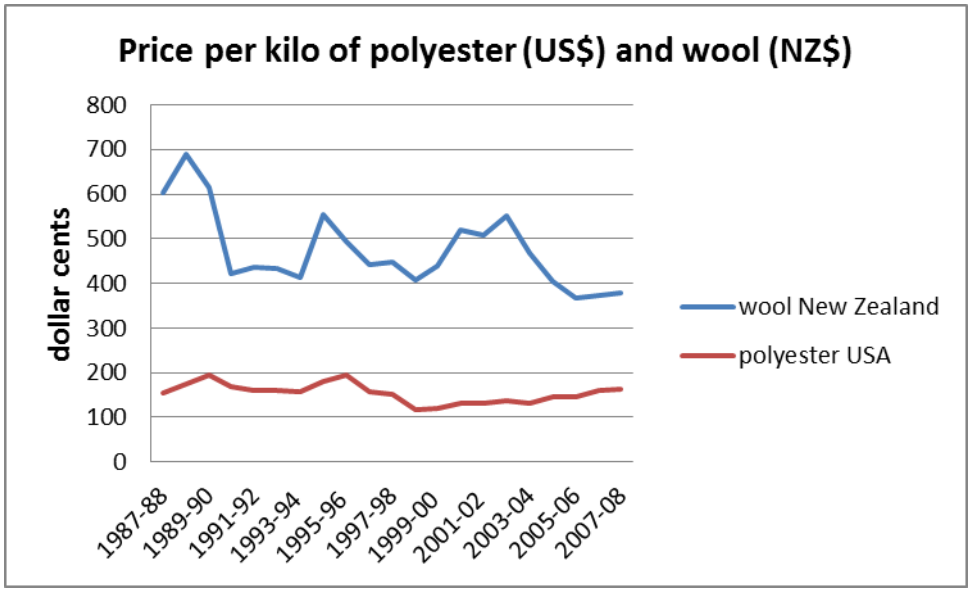

Figure 17. Prices of polyester and wool fibers.
Source: IWTO

Exhibit 12. Imports of floor coverings

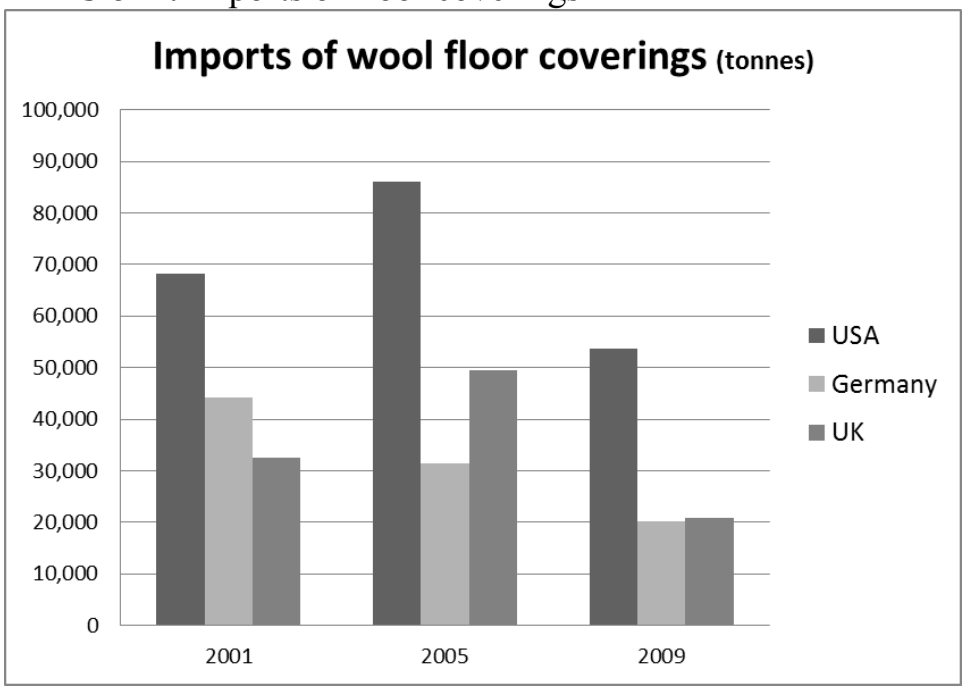

Figure 18. Imports of wool floor coverings into the USA.
Source: IWTO

Exhibit 13. Financial data for selected companies

Table 1. New Zealand Wool Services International financial statements 2000-2009.

	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
	NZ$000	NZ$000	NZ$000	NZ$000	NZ$000	NZ$000	NZ$000	NZ$000	NZ$000	NZ$000
Financial Performance										
Operating Revenue	150,561	179,215	144,599	131,599	119,052	124,723	131,160	134,508	127,545	116,084
Surplus Before Tax	(3,821)	3,580	1,948	4,429	561	4,835	5,287	5,115	1,763	2,046
Net Surplus	(4,380)	2,390	2,868	2,908	985	3,470	3,743	3,564	1,393	1,690
Financial Position										
Total current assets	61,663	100,637	77,804	47,149	40,562	53,748	53,091	38,674	43,644	44,517
Total non-current assets	25,612	25,142	26,506	17,599	18,800	982	8,264	7,586	8,271	8,202
Total assets	87,275	125,779	103,590	64,748	59,362	63,640	61,355	46,260	51,915	52,719
Total current liabilities	56,061	90,187	66,549	28,590	24,374	32,203	30,489	16,262	23,548	24,401
Total non-current liabilities	859	485	4,336	5,203	6,141	-	-	-	-	1,375
Total liabilities	56,920	90,672	70,885	33,793	30,515	32,203	30,489	16,262	23,548	25,776
Total Equity	30,355	35,107	32,705	30,955	28,847	31,437	30,866	29,998	28,367	26,943

Source: NZWSI (2010a) & NZWSI (2010b).

Table 2. Cavalier Corporation financial statements 2000-2009.

	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
	NZ$000	NZ$000	NZ$000	NZ$000	NZ$000	NZ$000	NZ$000	NZ$000	NZ$000	NZ$000
Financial Performance										
Operating Revenue	246,686	250,056	205,516	201,747	207,840	198,633	193,222	164,787	188,780	218,391
Surplus Before Tax	20,732	26,700	23,712	21,951	21,402	32,194	28,316	20,520	16,292	19,401
Net surplus	14,899	17,937	15,724	14,390	14,110	21,433	18,856	13,534	10,995	13,097
Financial Position										
Total current assets	91,884	109,171	80,252	84,715	79,680	66,961	65,984	57,635	61,826	85,828
Total non-current assets	104,580	112,974	97,145	68,308	68,147	62,778	49,526	48,307	48,475	41,088
Total assets	196,464	222,145	177,397	153,023	147,827	129,739	115,510	105,942	110,301	126,916
Total current liabilities	47,960	49,206	36,553	28,563	24,121	25,054	23,718	21,776	41,508	18,412
Total non-current liabilities	61,182	87,835	65,161	59,976	59,802	37,288	28,566	26,467	13,595	28,409
Total liabilities	108,869	137,041	104,829	88,539	83,923	62,342	52,284	48,243	55,103	46,821
Total Equity	87,595	85,104	72,568	64,484	63,904	67,397	63,226	57,699	55,198	80,095

Source. Cavalier Corporation Limited (2010a) & Cavalier Corporation Limited (2010b).

Table 3. Mohawk Industries Inc. financial statements 2000-2009.

	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
	US$000	US$000	US$000	US$000	US$000	US$000	US$000	US$000	US$000	US$000
Financial Performance										
Operating Revenue	5,344,024	6,826,348	7,586,018	7,905,842	6,620,099	5,880,372	4,999,381	4,516,957	3,441,267	3,400,905
Surplus Before Tax	(77,713)	(1,272,472)	611,716	685,051	609,272	577,389	488,434	443,629	291,416	267,629
Net surplus	1,019	1,452,534	714,413	464,573	394,277	368,622	310,149	284,489	188,592	162,599
Financial Position										
Working capital (includes short-term debt)	1,474,978	1,369,333	1,238,220	783,148	1,277,087	968,923	592,310	640,846	449,361	427,192
Total assets	6,391,446	6,446,175	8,680,050	8,212,209	8,066,025	4,403,118	4,163,575	3,596,743	1,768,485	1,795,378
Long term debt (including current portion)	1,854,479	1,954,786	2,281,834	2,783,681	3,308,370	891,341	1,012,413	820,427	308,433	589,828
Total equity	3,234,282	3,184,933	4,738,843	3,744,468	3,078,522	2,666,337	2,297,801	1,982,879	948,551	754,360

Source: Mohawke Industries Inc. (2010a) & Mohawke Industries Inc. (2010b).

Exhibit 14. Share prices for selected companies

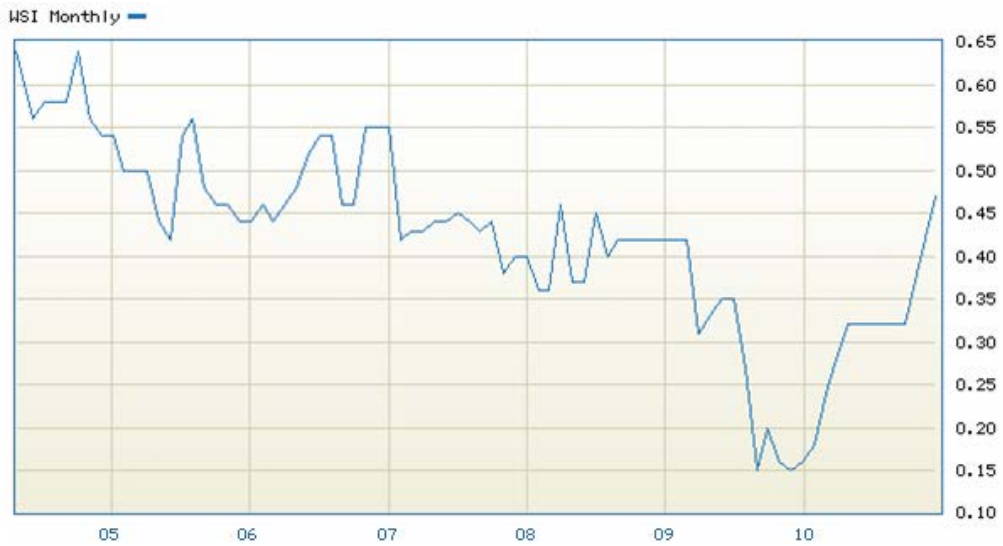

Figure 19. New Zealand Wool Services International ordinary share price history 2004-2010 (NZ$). Vertical axis is price, horizontal axis is year.
Source: NZSX. 2010a.

Figure 20. Cavalier Corporation Ltd. ordinary share price history 2001-2010(NZ$). Vertical axis is price, horizontal axis is year.
Source: NZSX (2010b).

Figure 21. Mohawk Industries, Inc. ordinary share price history 2001-2011 (US$). Vertical axis is price, horizontal axis is year.
Source: NASDAQ (2011).

Exhibit 15. Public wool promotion initiatives

WOOLMARK	Generic wool promotion brand initiated by the International Wool Secretariat in 1974 and eventually sold to the Woolmark Company
wools OF NEW ZEALAND	Created by the Wool Board after 1996 to promote strong wools of New Zealand. In 2001 licensed to Wool Interiors Ltd and then to Canesis. Sold to Wool Partners International in 2008.
THE CAMPAIGN FOR WOOL PATRON: HRH THE PRINCE OF WALES	Generic wool promotion brand initiated by Prince of Wales and supported by many organisations in several countries

Exhibit 16. The Campaign for Wool (as explained by one industry participant)

"What is happening with the Campaign for Wool is that every country and every association, like the Council of Wool Exporters are adding funding to it; we have a funding program that is taking off every certificate that is generated post auction, like all the scours certificates, all the export certificates. There is a royalty fee being collected off that to do the funding for this and other projects. The carpet manufacturers are funding it, growers in other countries are funding it, the British wool marketing board are funding it. Now there are growers, but also the manufacturers and the exporters and the scourers in those countries are contributing funding to it. So this time even though it's a generic promotion it is funded by everybody along the pipeline instead of just the farmers picking up the tabs. So you have got a far better buy in at every level. Now what you get for every dollar of input you get 10 dollar of kind, by that I mean you get expertise, knowledge, time; companies are prepared to donate their effort to go to meetings and be part of the organization committee. We do that in company time, there is no cost, there is no charge, we are donating it basically to the campaign. That's what I mean by 'in kind'. This is happening in every area within the industry, instead of just saying we need dollars and we need to employ people to do this, it's being done in house by a lot of people and through that you are getting a huge amount of commitment and a massive amount of buy in, which is why this sort of approach we feel has a far better chance of success, because you are not just paying outside people to work on your behalf.

Exhibit 17. Private brands and logos

	Created by Elders Primary Wool in 2009; targeted at high end segments and licensed through retailers.
	Created by Wool Services International to brand scoured wool and aimed at manufacturers.
	Created by Wool Services International to brand premium scoured wool; aimed at manufacturers
REDBAND	Initiative by Wool Services International to differentiate their bales of scoured wool by using red bands to wrap the wool bales.
	Created by Wool Partners International in 2010 to target high end consumers
	Purchased by Wool Partners International in 2008

Exhibit 18. Challenges in the branding of wool
(as explained by one industry participant)

"...there are two types of selling chains, there is the silo selling chain and there is the vertical mill selling chain. Vertical mill is where it goes from let's say a scouring processor or exporter and it is sold to the person who turns it into the finished product and even has some of their own outlets or has an alliance with places where they sell it through. For example Cavalier and Godfrey Hirst sell their carpet; they are a vertical mill, they buy the raw wool, they turn it in to a yarn, they turn it into a carpet and then they sell their carpet out under their own branding through retail outlets. That is the pathway where you have the opportunity to actually keep your branding strategy and some possible connection in one way or another all the way through to possibly the retail end of it. Unfortunately only about ten or 15 % of New Zealand's wool goes down that pathway. Now the rest of it goes down the silo pathway and that is where the farmer sells it, someone process it, then sell it to the yarn maker who takes ownership of it. Once he has paid for it he can do what he likes with it; he turns it into another form of product, which means he may take our wool and mix it with some UK wool and maybe mix it with synthetics and make a stock yarn or a specification yarn for a specific mill. He then sells that yarn to the next stage processor who pays him at the time of shipping that product over. So the line is broken again and that is how about 85% of New Zealand's wool clip is sold. How do you attach a brand all the way through that pipeline?"

There were also challenges related to extracting and capturing margins and premiums along the value chain. Another participant explained,

"Most of the efforts to identify and brand the wool don't carry a margin. It is actually a cost process to do that these days. You cannot extract from the market place significant margins because of that. It is about consumer confidence more than anything else. Attaching another brand, to say Cavalier or Godfrey Hirst carpets, which are marketed under their own brand, is very hard to do unless you have something else that you are prepared to put in with it to give them a marketing edge. Most of the manufacturers will say that they have spent a lot of money and time establishing their own imagery and their own branding on their own product. Why should they take your branding along with it? They want the confidence of your branding up to them but it's hard to take it past them to the next stage and extract and additional premium."

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U.S. Commodity Futures Trading Commission vs. Marketing Advisory Services, Inc.: A Case Study

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Abstract

Students are asked to evaluate the merits of a lawsuit that agricultural producers filed, along with the U.S. Commodity Futures Trading Commission (CFTC), against their marketing advisory service. The lawsuit was motivated by apparent losses in their commodity accounts allegedly caused by speculative trading.

Keywords: risk management, lawsuit, agricultural commodities, CFTC, hedging, speculation

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IFAMA Agribusiness Case 14.3B

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Dennis Hollingsworth received the following statement in the mail. It had more than 40 entries under the headings of YOUR ACTIVITY THIS MONTH and POSITIONS IN YOUR ACCOUNT. Listed on the right side were DEBITs and CREDITs.

DATE	AT	LONG/BUY	SHRT/SELL	DESCRIPTION	EX	PRICE/LEGND	CC	DEBIT	CREDIT
* * * * * * * * * * * * * * *				Y O U R A C T I V I T Y T H I S M O N T H					
9/04/2	F1	57	57	PUT DEC 02 CORN	220 01	MEMO P&L	US		
9/04/2	F1	57		PUT DEC 02 CORN	220 01	NET PREM	US	751.83	
9/04/2	F1			CK 063145		CHKPAID	US	20,000.00	
				CHECKS PAID					
9/09/2	F1		18	PUT DEC 02 CORN	270 01	NET PREM	US		3,790.08
9/09/2	F1	18	18	CALL DEC 02 CORN	290 01	MEMO P&L	US		
9/09/2	F1	18		CALL DEC 02 CORN	290 01	NET PREM	US	12,634.92	
9/09/2	F1		18	CALL DEC 02 CORN	320 01	NET PREM	US		4,015.08
9/19/2	F1	18	18	CALL DEC 02 CORN	320 01	MEMO P&L	US		
9/19/2	F1	18		CALL DEC 02 CORN	320 01	NET PREM	US	1,131.17	
9/23/2	F1	38	38	DEC 02 CORN	01	P&L	US	26,575.00	
9/23/2	F1		38	DEC 02 CORN	01	FEE/COMM	US	1,023.72	
9/23/2	F1	38	38	CALL DEC 02 CORN	260 01	MEMO P&L	US		
9/23/2	F1	38		CALL DEC 02 CORN	260 01	NET PREM	US	17,363.72	
9/23/2	F1		31	CALL JUL 03 CORN	320 01	NET PREM	US		11,672.36
9/23/2	F1	2	2	CALL NOV 02 SOYBEAN	620 01	MEMO P&L	US		
9/23/2	F1	2		CALL NOV 02 SOYBEAN	620 01	NET PREM	US	178.88	
9/24/2	F1		60	PUT JUL 03 CORN	240 01	NET PREM	US		20,583.60
9/24/2	F1	60		PUT DEC 02 CORN	250 01	NET PREM	US	22,478.90	
9/24/2	F1			9/23 DEC CORN OVERCHG		ADJUSTMENT	US		760.00
9/30/2	F1					BBNKDEP	US		31,000.00
				BRANCH BANK DEPOSIT					

* * * * * * * * * * * * * * *				P O S I T I O N S I N Y O U R A C C O U N T					
8/23/2	F1	38		DEC 02 CORN	01	2.71 1/2	US	38,000.00	
		38*		OPEN TRADE EQUITY		2.51 1/2		38,000.00*	
9/23/2	F1		60	PUT JUL 03 CORN	240 01	.07	US	26,250.00	
			60*	OPTION MARKET VALUE		.08 3/4		26,250.00*	
				EXPIRE 6/21/03					
9/23/2	F1	5		PUT DEC 02 CORN	250 01	.07	US		2,312.50
9/23/2	F1	34		PUT DEC 02 CORN	250 01	.07 1/4	US		15,725.00
9/23/2	F1	12		PUT DEC 02 CORN	250 01	.07 1/2	US		5,550.00
9/23/2	F1	9		PUT DEC 02 CORN	250 01	.07 3/4	US		4,162.50
		60*		OPTION MARKET VALUE		.09 1/4			27,750.00*
				EXPIRE 11/23/02					
5/13/2	F1		8	CALL DEC 02 CORN	260 01	.07 3/4	US	2,700.00	
5/14/2	F1		3	CALL DEC 02 CORN	260 01	.07 3/4	US	1,012.50	
5/14/2	F1		27	CALL DEC 02 CORN	260 01	.08	US	9,112.50	
			38*	OPTION MARKET VALUE		.06 3/4		12,825.00*	
				EXPIRE 11/23/02					
8/19/2	F1		1	PUT DEC 02 CORN	270 01	.09 3/4	US	1,137.50	
8/19/2	F1		19	PUT DEC 02 CORN	270 01	.10	US	21,612.50	
9/09/2	F1		18	PUT DEC 02 CORN	270 01	.04 3/4	US	20,475.00	
			38*	OPTION MARKET VALUE		.22 3/4		43,225.00*	
				35,150.00- SIM EXPIRE 11/23/02					
6/25/2	F1		17	CALL DEC 02 CORN	290 01	.04 1/4	US	1,593.75	

DATE	AT	LONG/BUY	SHRT/SELL	DESCRIPTION	EX	PRICE/LEGND	CC	DEBIT	CREDIT
6/25/2	F1		21	CALL DEC 02 CORN	290 01	.04 1/2	US	1,968.75	
			38*	OPTION MARKET VALUE		.01 7/8		3,562.50*	
				EXPIRE 11/23/02					
9/23/2	F1		10	CALL JUL 03 CORN	320 01	.07 1/2	US	3,125.00	
9/23/2	F1		21	CALL JUL 03 CORN	320 01	.07 3/4	US	6,562.50	
			31*	OPTION MARKET VALUE		.06 1/4		9,687.50*	
				EXPIRE 6/21/03					
7/15/2	F1		2	CALL NOV 02 SOYBEAN	620 01	.09 1/2	US	75.00	
			2*	OPTION MARKET VALUE		.00 3/4		75.00*	
				EXPIRE 10/26/02					

Figure 1. Dennis Hollingsworth's Statement of Account

At the end of the statement was an account summary. A few of the lines showed large positive dollar figures, but many lines were negative – and they were large. The difference between lines labeled BEGINNING and ENDING BALANCE was a minus $30,317.02. The combined value of FUTURES OPEN TRADE EQUITY and OPTIONS MARKET VALUE exceeded a negative $100,000. Dennis didn't know what the entries on the activities and positions meant, and the negative dollar figures in the account summary were a concern, but he didn't know why they should be.

Table 1. FCM Statement, ACCOUNT SUMMARY

	US$-SEGREGATED(F1)	* CONVERTED TO USD *
BEGINNING BALANCE	151,135.77	151,135.77
THIS MONTH'S ACTIVITY	30,317.02-	30,317.02-
ENDING BALANCE	120,818.75	120,818.75
NET FUTURES PROFIT OR LOSS	26,838.72-	26,838.72-
NET OPTION PREMIUM	14,478.30-	14,478.30-
FUTURES OPEN TRADE EQUITY	38,000.00-	38,000.00-
OPTIONS MARKET VALUE	67,875.00-	67,875.00-
ACCOUNT VALUE AT MARKET	14,943.75	14,943.75
CONVERTED MARKET VALUE	14,943.75	14,943.75

Almost every Wednesday morning around 7:00 AM, Dennis and other farmers gathered for coffee at the local Ampride C-Store. Dennis initiated a conversation about the statement he had received to see if any of his friends could explain what was going on. His nearby neighbors Jim Olson, Dave Trask and Rod Beem said they had received similar statements and didn't know how to read theirs either. Like Dennis, their statements had many entries and negative dollar figures in the account summary.

After they finished their coffee, Jim and Dennis drove their pickups to the offices of Market Advisory Services, Inc. There they met with Wes Rogers, the general manager. They had known Rogers for a number of years. Theirs kids played summer baseball together and their families went to the same church. Rogers offered them coffee but Jim and Dennis said they had already reached their limit for the morning. Rogers explained that the negative figures in an account showed paper losses in the futures and options markets. Those would be offset by the gains in value of their physical commodity, in this case, corn. They were told not to worry their accounts were in good shape.

Background

Two years before, Marketing Advisory Services, Inc. (the Company), began a trading program for the benefit of agricultural producers by purchasing and selling futures and options contracts associated with their production and marketing of corn. The Company explained to producers that the trading program was intended to hedge the market risk of a fall in the price of corn. The Company used agreement forms with official language recognized by the U.S. Commodity Futures Trading Commission stating that "the purpose of the trading program was to hedge the risk associated with the ownership and marketing of corn". Approximately 100 agricultural producers, including Dennis, Jim, Dave and Rod, had signed a hedge agreement.

As a producer of agricultural commodities the Hollingsworth farm is a large family business. It includes Dennis, his wife Marsha, a son at home, and daughter away at college. In a normal year, they plant 1,200 acres of corn and an equal amount of soybeans. The scale of the operation requires the family to spend long hours involved in the preparation of farm ground, planting, spraying and harvesting. Center pivot irrigation is used during the summer months

and the weather must be monitored continuously. Dennis checks commodity prices on the Internet, but because he spends so much time and effort on production activities, typically the corn and soybeans are sold at harvest taking the available price. Sometimes he stores the commodities for a later sale but this worries him about the financial loss that would come if there were a fall in prices. Dennis thought it would be beneficial to contract with the Company to handle the price risk management for his corn. That way he and his family could concentrate on the production activities, and he could sleep at nights. While the farm sizes vary, Jim, Dave, Rod and the other agricultural producers were similar to Hollingsworth farm in their business activity.

Since receiving the initial statements in the mail, a few months went by and subsequent statements continued to show negative figures. Dennis' concerns grew each time he was required to deposit additional funds into the account. He didn't understand why hedging 190,000 bushels of corn would require such a large amount of money. Dennis had gone to Iowa State University years before and learned about the concept of hedging. He vaguely understood margin calls. But, he thought those happened when prices were going up and a hedge had already locked in a price. The price of corn was not going up and yet he was adding more funds to his account.

One day Jim approached Dennis recalling their earlier conversation in the coffee shop. He said a number of producers were worried. Jim explained that they all have concerns about the negative figures and the amount of money being required in their brokerage accounts. No one was satisfied with the explanation coming from Rogers, the general manager at the Company. Subsequently, Dennis, Jim, Dave, Rod and a group of producers met to discuss their collective situation. They decided to engage an attorney, John Casper. Dennis and Jim had known John since childhood. They had been in cub scouts together and later on played high school football on the same team. They also contacted the U.S. Commodity Futures Trading Commission (CFTC) to see if experts there could shed some light on the situation. Dennis thought to himself, "Nobody said managing a business was going to be this complicated"!

Two months went by and John called all of them to a meeting. He, along with the CFTC, had drafted a lawsuit alleging the Company and general manager had speculated with their customers accounts. It was at this time that some producers felt they could not participate in the lawsuit because of their long-time personal and family relationships with Wes Rogers. John showed them the following document.

UNITED STATES DISTRICT COURT

UNITED STATES COMMODITY	)
FUTURES TRADING COMMISSION,	)
Dennis Hollingsworth, Jim Olson, Dave	)
Trask, Rod Beem, et al.	)
Plaintiffs	)
v.	)
	)
MARKETING ADVISORY SERVICES,	)
INC., Wes Rogers	)
Defendants	)

Marketing Advisory Services and the Manager Allegedly Made Unauthorized, Speculative Trades in Commodity Hedge Accounts that Caused Producers $5 Million in Losses

Specifically, the lawsuit alleges that defendants were engaged to manage hedge accounts for the producers. As further alleged, without approval from the producers, and rather than following the explicit instructions in the producers' hedge account agreements, defendants executed a speculative trading strategy that resulted in approximately $5.1 million in trading losses for those producers. According to the lawsuit, defendants consistently led the producers to believe that the defendants' trading strategy would reduce the producers' trading risks when, in fact, the trading strategy substantially increased the producers' risks and their ultimate exposure to adverse price fluctuations.

Commodity Futures Trading Commission

Professor Chet Hill's phone rang in the early afternoon that day when the end of spring semester was about three weeks away.

> *"Hello, this is Robin Henke from the Division of Enforcement of the Commodity Futures Trading Commission in Washington, DC. I have on the line with me, Scott Robert, and we are attorneys investigating the case of a company in your state called Marketing Advisory Services, Inc. We got your name from an Internet search and understand you are an expert on commodity futures and options. We see that you teach a graduate course for finance students. Is that correct?"*
>
> Chet responded, *"Yes, you have the right person."*
>
> Robin continued, "We would like to engage you, or someone you recommend, as an expert to help us untangle and evaluate the complicated trades that took place in the accounts of agricultural producers who were customers of Marketing Advisory Services. A potential lawsuit could take place in the District Court in your state and the expert would need to explain to a jury what happened and why. Are you interested?"
>
> After some additional conversation Chet said, "Please send me any information you think would help me understand the situation. I will keep it confidential and let you know in about two weeks, if that works for you?"
>
> "*That's fine,*" said Robin. *"I'll send the details electronically and talk to you in about two weeks."*

Chet Hill reviewed the material and thought he could untangle the multiple positions recorded on the futures commission merchants statements. The CFTC wanted to know which of the positions, if any, were speculative and which ones were hedges.

Two weeks later he called Robin and expressed an interest in being an expert for the case. Subsequently, Chet, Robin and Scott flew to Chicago and met at the offices of the CFTC. The purpose was two-fold. The attorneys wanted to personally evaluate the communication skills and maturity of Hill to see if he would be a capable expert on the witness stand in a court room. They knew he had a good intellectual quotient (IQ) but wanted to evaluate his emotional quotient (EQ). Sometimes an academic can go off on an argumentative, emotional tangent - a behavior that a skillful defense attorney might provoke and exploit.

They also wanted to see how he would present an analysis to a jury. Futures and options transactions are complicated. Explaining hedging and speculation to someone who has no background or experience with the same can be a daunting task. The attorneys were comfort-

ed when Hill expressed his expectation that a jury's comprehension level was at the same level as a twelve-year old. Any written material or verbal presentations had to be pitched at the same level as a Reader's Digest magazine.

Hill showed the attorneys some examples of how he would evaluate the futures and options positions on the futures commission merchant statements similar to ones Dennis, Jim, Dave and Rod had received. In presenting the results to a jury, he would translate positions into simple graphs showing when a downward price move in the cash market would be offset by a hedge protecting the value of a producer's commodity. He would use the same graphical analysis to show any positions offering no downward price protection resulting in speculation. A week after the meeting in Chicago, Robin called Chet and invited him to be their expert.

Exhibits

Dr. Hill prepared a detailed, written report and summary evaluation of the 13 months of trading positions placed by Marketing Advisory Services, Inc. on behalf of their 100 customers. The report included supporting documentation and was 250 pages in length. In early October, Robin Henke and Scott Robert came from Washington, DC to Dr. Hill's university. Chet met them at the airport, got them checked into the hotel, stopped at a deli for sandwiches to go, and they all sat down to work going through the report in detail.

The attorneys for the CFTC wanted a clear determination on which, if any, trade activity and positions in an account were speculative. If any positions were speculative, then the defendants could be charged with breach of contract, at a minimum, and there would be civil penalties. If defendants had producers sign the hedge agreement and knowingly intended to take speculative positions, then fraud was possible as a criminal offense and the penalties would be much higher.

In preparation for a possible jury trial, the following exhibits developed by Dr. Hill are attached.

Exhibit A: Interpretation of the Commodity Futures Trading Commission's Definition of Hedging
Exhibit B: Futures Contract
Exhibit C: Options
Exhibit D: Gains and Losses on Positions in the Cash, Futures & Options Markets

Opening Questions for the Case

Once Dennis, Jim, Dave and Rod along with other producers, saw the proposed lawsuit against Marketing Advisory Services, Inc. and the general manager, they were unsure of what to do.

- Should they go ahead and file the lawsuit?
- Even with the CFTCs participation in the lawsuit, does the case have merit?
- Were they going to have financial losses from the trading activity?

Exhibit A: Interpretation of the Commodity Futures Trading Commission's Definition of Hedging

It is necessary to understand the components that make up the definition of hedging and that apply in this case. The CFTC definition in 1.3(z) has the following text:

> Bona fide hedging transactions and positions … shall mean transactions or positions in a contract for future delivery on any contract market, or in a commodity option,

The text "transactions or positions in a contract for future delivery on any contract market" means that the customer bought or sold a futures contract on a board of trade designated by the CFTC as a contract market. An example would be the sale on July 15 of a December 2010 corn futures contract on the CBOT. If the customer still holds the December futures contract when it expires, typically in late November, then the customer is obligated to deliver corn to Chicago.

The text "or in a commodity option" means that the customer bought or sold an option contract. An example would be to buy a December 2010 put for corn. This gives the customer the right, but not the obligation, to exercise the option and sell a December corn futures contract. The same delivery conditions apply as above if the option is exercised and the futures contract is held until expiration.

The next component in the definition of hedging adds to the text above. It is critical to determining if a transaction or position is a bona fide hedge and is as follows:

> *where such transactions or positions normally represent a substitute for transactions to be made or positions to be taken at a later time in a physical marketing channel,*

This means that the customer has taken a position in the futures or options market as a substitute for a corresponding type of transaction to be made later on in a physical market. An example would be to sell a December 2010 corn futures contract on July 15 of 2010. This sale in the futures market is often called the sale of "paper bushels". The futures market sale of "paper bushels" serves as a substitute for the sale of physical bushels at a later time in the local cash market. The physical bushels would normally be available for sale after harvest.

The same could be done using a commodity option. An example would be to buy a December 2010 put. This put gives the customer the right, but not the obligation, to sell a December 2010 futures contract. Either the put option or the futures contract would serve as a substitute for the sale at a later time of physical corn in the local cash market.

The next component of the definition of hedging adds to the text above:

> *and where they are economically appropriate to the reduction of risks in the conduct and management of a commercial enterprise,*

The "they" refers to the hedging transactions or positions taken in the futures or options market as in the examples given above. And, those transactions or positions reduce the economic risks associated with a commercial business, such as a farm operation. An example of eco-

nomic risk for a farm is the variability of corn prices over time. A ny corn owned or being produced by the farmer is not priced until it is sold. A position in the futures or options market is one way to fix the price of the corn so the farmer has some assurance of knowing what price will be received for the corn. Fixing the price of corn reduces the economic risk.

The next component of the definitions follows the text above, and where they arise from:

> (i) The potential change in the value of assets which a person owns, produces, manufactures, processes, or merchandises or anticipates owning, producing, manufacturing, processing, or merchandising,

The "they" again refers to the hedging transactions or positions taken in the futures or options market. The need for the positions arises from "the potential change in the value of assets which a person owns," etc. An example in this case is that corn owned or being produced by a farmer is an asset.

Text for the definition of hedging continues as follows:

> (ii) The potential change in the value of liabilities which a person owns or anticipates incurring, or
> (iii) The potential change in the value of services which a person provides, purchases, or anticipates providing or purchasing.

This text refers to liabilities or services and does not apply in this case. Additional clarification on hedging continues with the following text:

> Notwithstanding the foregoing, no transactions or positions shall be classified as bona fide hedging unless their purpose is to offset price risks incidental to commercial cash or spot operations and such positions are established and liquidated in an orderly manner in accordance with sound commercial practices and, for transactions or positions on contract markets subject to trading and position limits in effect pursuant to section 4a of the Act, unless the provisions of paragraphs (z)(2) and (3) of this section and §§ 1.47 a nd 1.48 of the regulations have been satisfied.

Exhibit B: Futures Contract

Examples of Hedging Using Futures Contracts

One of the functions of a futures market is to manage price level risk for a commercial hedger by transferring it to a second party. This can be done with hedging.

Example 1:

The goal is to fix the price of an anticipated transaction in the cash market – one that will occur at some future date. The transaction in the futures market acts as a temporary substitute for a cash sale that will happen later. On May 1 a farmer has finished planting corn that will be harvested in the fall around October 15. T he farmer wants to avoid the economic risk from the variability of corn prices during the season so a decision is made to fix the price. The following table shows the entries for the CASH and FUTURES markets, and the BASIS.

Date	Cash	Futures	Basis
May 1	Plants corn for target price $2.50	Sell December futures at $2.70	$0.20 under
October 15	Sell cash corn for $2.18	Buy December future at $2.38	$0.20 under
	-$0.32	+$0.32	$0.00

On May 1 the quote for the December futures price on the Chicago Board of Trade (CBOT) is $2.70 per bushel as shown in the FUTURES column. The farmer knows from past history that the local cash price at harvest is normally 20 cents under the December futures price. This is shown in the **Basis** column for May 1. Using this information the farmer calculates a local target price of $2.50 ($2.70 December futures on May 1 less the expected 20 cents difference between the futures and cash price at harvest). This is shown in the CASH column. The farmer's goal on May 1 is to fix the price at $2.50.

In order to fix the price, the farmer has a broker sell a December futures contract for corn on the Chicago Board of Trade (CBOT) at the current quote of $2.70 on May 1. The sale of the December futures contract is a substitute for the cash sale that will occur later in the fall.

In the fall the farmer harvests the corn and decides to sell it in the local market on October 15. The local cash price is $2.18 showing a decline of $0.32 from the target price of $2.50 hoped for on May 1. Without a hedge, the decline in the local cash price would have resulted in a revenue loss to the farmer.

At the same time as the cash sale on October 15, the farmer is ready to offset the May 1 sale of the December futures contract. On October 15 the farmer has the broker buy a December futures contract on the CBOT at a price of $2.38, and this clears out the farmer's position in the futures market. The gain in the futures market is $0.32. This comes from the May 1 sale of the December contract at $2.70 and the purchase of an offsetting contract on October 15 at $2.38.

In this example, there is no change in the basis over the time period. On October 15 the actual difference between the December futures price and the local cash price (BASIS) remains at $0.20 under.

The final selling price on October 15 for the corn is $2.50 (the $2.18 cash price received on October 15 plus $0.32 from futures market). The sale of the December futures contract on May 1 served as a substitute for the cash sale that came later on October 15. Once the cash sale was made, the buying of a December futures contract offset the May 1 position in the futures market. By fixing the price for corn in early May, the farmer reduced the economic risk from price variability.

Example 2 – Basis Gain:

Local cash prices in Nebraska and the December futures prices on the CBOT do not always move up or down in exact parallel. Local supply and demand conditions affect the local price. Expectations about future supply and demand at the U.S. and world level affect futures prices. As a result the BASIS can change. This hedge removes the price level risk the same as in Example 1, but the basis changes.

Date	Cash	Futures	Basis
May 1	Plants corn for target price $2.50	Sell December futures at $2.70	$0.20 under
October 15	Sell cash corn for $2.18	Buy December futures at $2.35	$0.17 under
	-$0.32	+$0.35	+ $0.03

The final selling price for the corn on Oct 15 is $2.53 (the $2.18 cash price received on Oct 15 plus $0.35 from the futures market). The change in the basis added 3 cents to the original target price of $2.50.

Example 3 – Basis Loss:

Date	Cash	Futures	Basis
May 1	Plants corn for target price $2.50	Sell December futures at $2.70	$0.20 under
October 15	Sell cash corn for $2.18	Buy December futures at $2.41	$0.23 under
	-$0.32	+$0.29	- $0.03

The final selling price on October 15 for the corn is $2.47 (the $2.18 price received on October 15 plus $0.29 from the futures market). The change in the basis reduced the target price by $0.03.

Graphic Analysis

One way to understand hedging using futures contracts can be shown with the help of Figure 2. In the earlier examples two specific dates were used - May 1 and October 15, when looking at the cash and futures prices. This graphic analysis shows what happens over a range of prices.

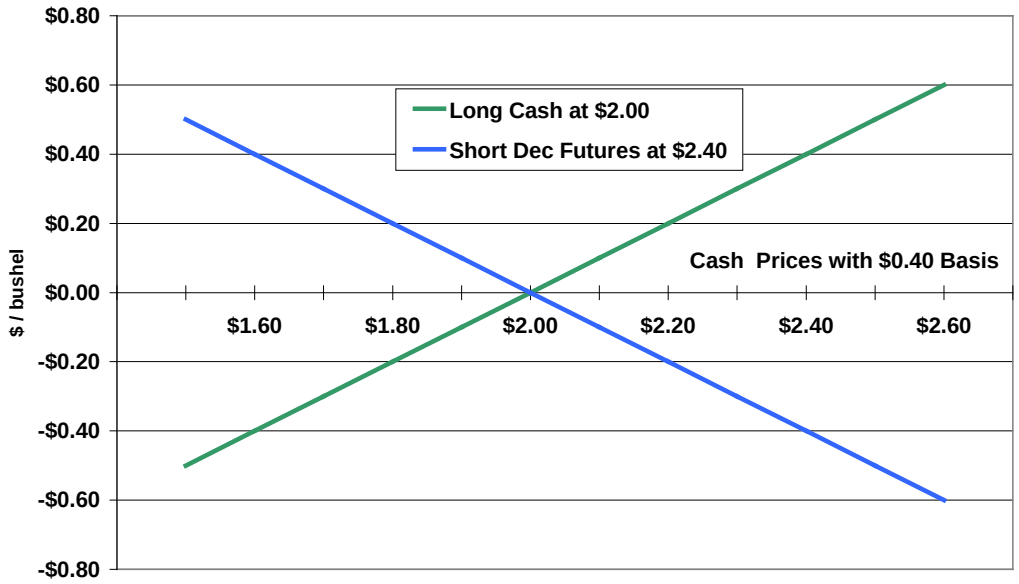

Figure 2. Long Cash and Short December Futures

In this example, a farmer who owns corn is defined as being in a "long" position. The goal is to lock in a local cash price of $2.00 so the legend on the graph shows "Long Cash at $2.00". The sale of a December futures contract is defined as being in a "short" position. The difference in price between the December futures contract and the local cash price is 40 cents – recall this is the basis. The legend on the graph shows "Short Dec Futures at $2.40". The hedge table using the May 1 date starts out as follows:

Date	Cash	Futures	Basis
May 1	Long (own) corn at $2.00	Short (sell) December futures at $2.40	$0.40 under

In Figure 3, the local cash price increases over time from $2.00 to $2.20 on the x-axis. The intersection of the $2.20 price level with the Long Cash line results in a cash market gain of $0.20. This is shown on the y-axis.

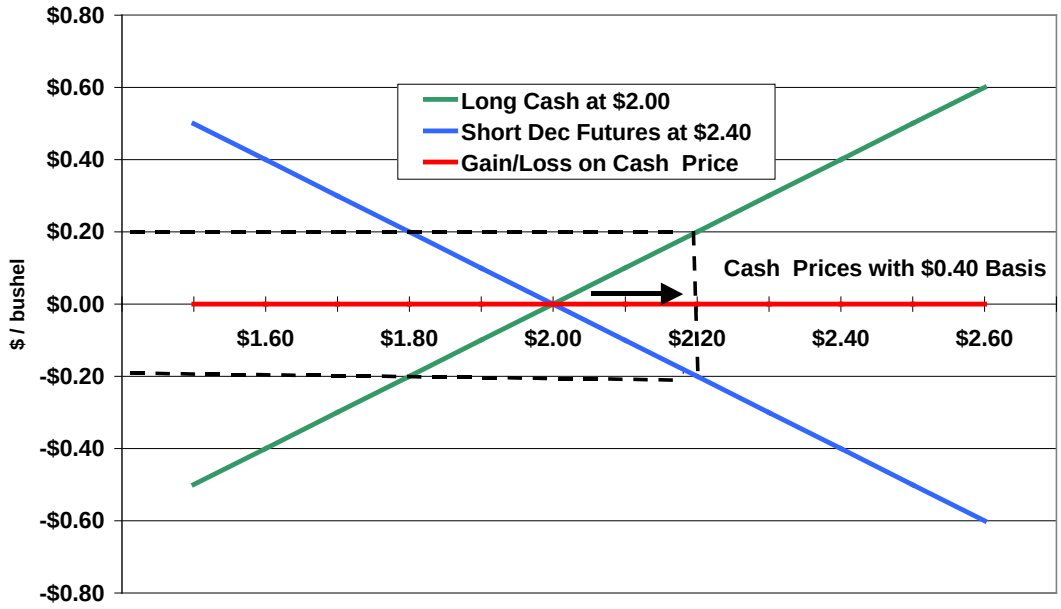

Figure 3. Long Cash and Short December Futures

Assuming no change in the basis, the December futures price will also increase in parallel with the cash price going from $2.40 to $2.60. This is equivalent to the cash price moving from $2.00 to $2.20 as is shown on the x-axis. However, the sale of a futures contract results in a loss of $0.20.

The gain in the local cash market is equally offset by the loss in the futures market. The net price remains locked in at $2.00. This is shown in the figure by the line "Gain/Loss on Cash Price". The gain or loss was zero and the farmer ends up with a final selling price of $2.00 ($2.20 from the cash sale less $0.20 in the futures market). The complete hedge table is as follows:

Date	Cash	Futures	Basis
May 1	Long (own) corn at $2.00	Short (sell) December futures at $2.40	$0.40 under
October 15	Sell cash corn for $2.20	Long (buy) December futures at $2.60	$0.40 under
	+$0.20	-$0.20	$0.00

If the local cash price moves down over time, say to a $1.70, then the loss without hedging is $0.30. Placing a hedge using the December futures contract would result in a gain of $0.30 to offset the loss, and the final selling price remains at $2.00. This is shown in Figure 4.

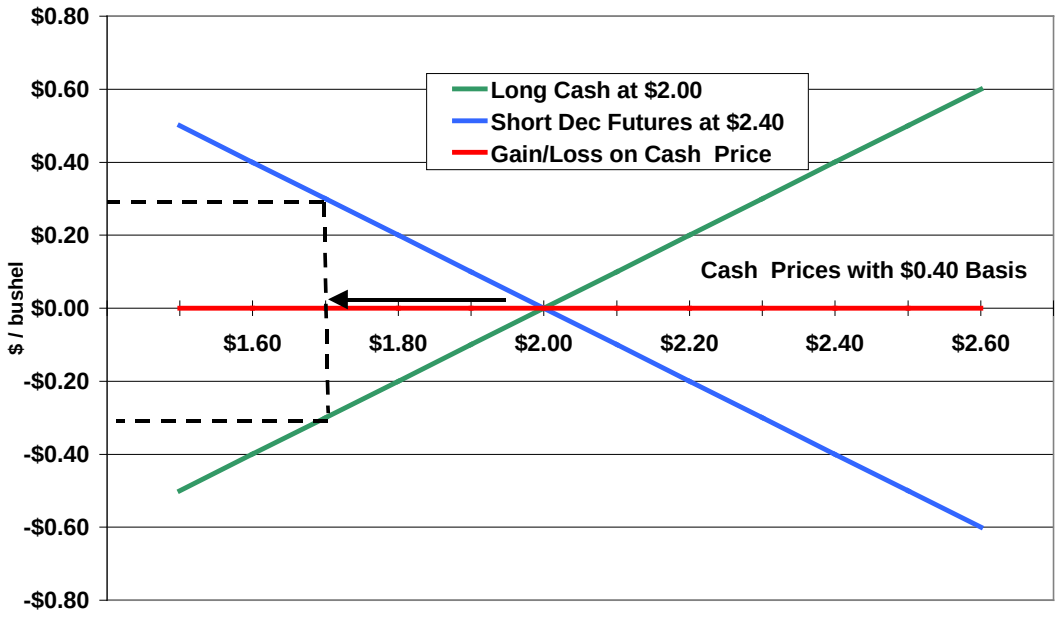

Figure 4. Long Cash and Short December Futures

In the first scenario the local cash price moved up from $2.00 to $2.20. If the farmer had not hedged and chosen to not fix the price, then this would be considered a speculative gain realized from continuing to take the economic risk associated with market price variability.

In the second scenario the local cash price went down from $2.00 to $1.70. Without the hedge there would be a speculative loss. The benefit from hedging, the matching of a long position in the local cash market with a corresponding short position in the futures market, is to reduce the economic risk of price variability.

Exhibit C: Options

The word "option" helps describe what is involved with an option contract. By paying a price, called a premium, a person can buy an option that gives them the choice of acquiring an asset or not. If acquiring the asset becomes attractive, the person can choose to exercise the option. Otherwise the person can let the option expire and the only cost is the premium paid.

A person cannot only buy an option on an asset, but can also sell an option for which a premium is received. Under the contract, the person is obligated to deliver the asset if the option is exercised. Either way, the seller of the option gets to keep the premium.

Insurance Analogy

Using options to reduce price risk by farmers is somewhat the same as buying car insurance. We pay a premium to insure against the risk of an accident or damage to our car. The insurance company's role is to reduce the financial costs of an accident or damage to our car, if that happens. If no claims are made, then our cost is the premium. If we have a claim, we recover an amount to pay for the damages – an amount that is typically much greater than the premium. We are reducing our risk and the insurance company is assuming the risk. It does so by collectively pooling the premiums from many customers knowing that only a few will suffer from an accident.

A farmer hedges a price and reduces the economic risk by paying a premium for an option contract. The option contract is like an insurance policy. If the price of the corn goes up, the farmer has no financial loss and may receive a gain. If the price of the corn goes down in the cash market this creates a loss of revenue. The option contract becomes worth more and upon exercising the option, the farmer can recover a payment to offset the loss in the physical market.

When a farmer buys a PUT option the risk of economic loss is reduced. The farmer is selling the risk to someone else who is willing to assume the risk for a price – the price of the option. That someone else is like the insurance company and the farmer is like the insurance customer.

However, when selling an option, either a PUT or a CALL, the farmer is taking on the role of the insurance company. The farmer is assuming someone else's risk, rather than reducing his or her own risk, and collecting a premium for it.

Options Terminology

An option contract gives the owner:

- The right to:
  Buy (referred to as a *CALL* option), or
  Sell (referred to as a *PUT* option)
- An underlying asset (e.g., futures contract)
- For a certain agreed upon price
- Called an *exercise* or *strike* price
- For a limited period of time

Examples of buying and selling option contracts using the following table will help explain the terminology.

Table 2. Relationship between Strike Prices and Option Premiums

	Strike Prices	Premiums PUTs		Premiums CALLs	
Underlying	$2.50	$0.33		$0.01	
December	$2.40	$0.24	in-the-money	$0.03	out-of-the-money
corn futures	$2.30	$0.15		$0.04	
at $2.20/bu.	$2.20	$0.05	at-the-money	$0.05	at-the-money
	$2.10	$0.04		$0.15	
	$2.00	$0.03	out-of-the-money	$0.24	in-the-money
	$1.90	$0.01		$0.33	

Buying a PUT Option

Buying a PUT option gives the owner the right, but not the obligation, to a short position in the underlying futures contract. Buying a PUT gives the owner the right to sell a futures contract.

The decision to buy a PUT option involves choosing the futures contract month and a *strike price*. See the above table. In this example, the contract month is for the December futures, and on this particular day the futures price is $2.20. In the options market a number of strike prices are established on either side of the underlying futures price. Here they range from a low of $1.90 to a high of $2.50 shown at 10-cent intervals.

In the PUTs column are quoted market-determined *premiums* for either buying or selling a PUT. The premium for a chosen strike price of $2.20 is $0.05. This means a customer will need to pay $0.05 per bushel ($250 for a 5,000 bushel contract) for the PUT option. Ownership gives the customer the right to exercise the option.

If the underlying December futures price declines, then the option may become more valuable and the customer will need to decide whether or not to exercise it. December futures prices would need to be at or below $2.15 ($2.20 minus the $0.05 premium cost) for the customer to consider exercising the option. See the following Figure 5.

Let's say December futures prices dropped to $2.05 and the customer exercised the option. The customer's account receives a short December futures contract at $2.20. To offset that position the customer can now buy a December futures contract for $2.05. The net gain is $0.10 and is calculated as follows: $2.20 minus $0.05 for the option premium and minus $2.05 for the purchase cost of the more recent December futures contract. For a 5,000 bushel contract the net gain would be $500 above the $250 cost of the option. Commission and fees charged by the broker are not included in these calculations.

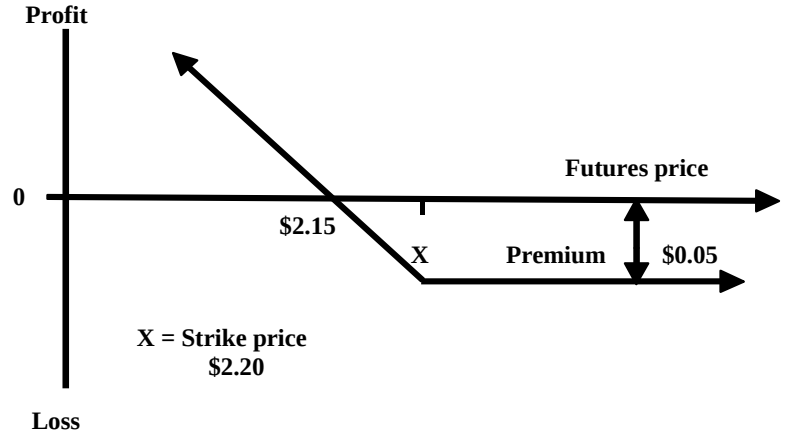

Figure 5. Long Put Option

If the December futures price stays above $2.15 for the time period involved, the customer has no financial incentive to exercise the option and lets it expire. See the above figure. The out-of-pocket cost is $0.05 or $250 on a 5,000-bushel contract plus commission and fees.

The purchase of the December PUT option at a strike price of $2.20 for a $0.05/bu. premium is shown as being *"at-the-money"*. This means that the strike price is the same as the price of the underlying December futures contract. Not considering the premium cost, the $2.20 strike price is at a financial breakeven point.
With the underlying December futures price of $2.20, the purchase of a PUT option at a higher strike price, for example $2.40 is *"in-the-money"*. The customer can exercise the option and receive a short December futures contract that has a price of $2.40. One could immediately offset that short position with a long December futures contract at the current price of $2.20, and receive a net gain of $0.20 ($2.40 - $2.20). The option with a $2.40 strike price is "in-the-money" by $0.20. At the $2.50 strike price the option is "in-the-money" by $0.30.

The PUT option premium at the $2.20 strike price is $0.24. This is made up of the $0.20 "in-the-money" value (formally called the intrinsic value) of the option, and the remaining $0.04 reflects the markets determination of value until the option is no longer traded on the exchange (formally called the time value).

In a similar manner, when the strike price is below the underlying futures price, then the value of the option is *"out-of-the-money"*. The strike price of $2.00 is $0.20 below the underlying futures price of $2.20. Exercising the option would generate a loss of $0.20. That is, being short a December futures contract at $2.00 and offsetting it with the purchase (long) December futures at $2.20. Plus, one would also be out the option premium of $0.03. There is no financial incentive to exercise the option as long as the underlying December futures price remains above $1.97 ($2.00 strike price - $0.03 premium).

Hedging with a PUT Option

The previous section tells about buying a PUT option and the decision to exercise it or not depending on profitability. The buying of a PUT option can also be used to hedge the price of corn owned in the local market. An example is shown in the following table.

Table 3. Establish a floor prices with a PUT option and exercise the option when the price declines.

Date	Local Market	Cash Price	Futures Price	Basis	Options	Strike minus Futures Price	Premium		
4/19	own	$2.00	$2.20	$0.20	Buy December PUT $2.40 Strike Price	$0.20	$0.24		
10/30	sell	$1.70	$1.90	$0.20	*Exercise December PUT*	$0.50			
Net Changes		-$0.30	$0.30	$0.00					
Cash price:		$1.70							**Minimum Price**
Final price with exercised options:		$1.70				+ $0.50	- $0.24	=	$1.96
Cash price less premium:		$1.70					- $0.24	=	$1.46

On April 19 a grower of corn owns the commodity in the local market somewhere in storage. The local cash price is $2.00 per bushel. The December futures price is $2.20, which is $0.20 above the local cash price as shown by the basis.

The owner wants to fix a minimum or floor price to avoid any economic loss in value below that price. At the same time the owner wants the opportunity to gain from a price increase should that occur. A decision is made to buy a PUT option on the December futures contract at a strike price of $2.40. The premium cost is $0.24 per bushel.

On October 30, the owner decides to sell the corn out of storage into the local market. The local cash price has declined to $1.70, and the December futures price moved down with it by the same amount - thus the basis remained at $0.20. By not exercising the December PUT option the owner would receive a net price of $1.46 ($1.70 - $0.24).

Exercising the option gives the owner the right to a short position in the futures market. The owner receives a short December futures contract priced at the original strike price of $2.40. The actual December futures price on October 30 is $1.90. The owner buys a December futures at $1.90 to offset the short December futures at $2.40, and receives a gain of $0.50 from the transaction.

The final net price received is $1.96, and is made up of the $1.70 from the cash sale, plus the $0.50 from the options and December futures transactions, less the $0.24 premium cost of the option contract. The $1.96 price is in contrast to the cash price of $1.70 without an options position.

In addition, the $1.96 price is considered a minimum or floor price. Even if the cash price declined to $1.60 or even to $1.50, the owner would still receive the floor price of $1.96. (This assumes that the basis does not change so the futures price declines by the same amount as the cash price.)

As an example, let the local cash price be $1.55. The December futures contract would be bought for $1.75 to offset the short position of $2.40 from exercising the option. The final net

price received of $1.96 would be made up of $1.55 from the cash sale, plus $0.65 from the options and December futures transactions, less the $0.24 premium.

What happens when the cash price increases from $2.00 to $2.30?

Table 4. Hedging with a PUT option and letting it expire when the price increases.

Date	Local Market	Cash Price	Futures Price	Basis	Options	Strike minus Futures Price	Premium		
4/19	own	$2.00	$2.20	$0.20	Buy December PUT $2.40 Strike Price	$0.20	$0.24		
10/30	sell	$2.30	$2.50	$0.20	*Exercise December PUT*	-$0.10			
Net Changes		$0.30	-$0.30	$0.00					
Cash price:		$2.30							**Minimum Price**
Final price with exercised options:		$2.30				-$0.10	- $0.24	=	$1.96
Cash price less premium:		$2.30					- $0.24	=	$2.06

If the option were exercised, then the final price would be $1.96 or the minimum price. The best decision would be to let the option expire because the net price received would be $2.06 (cash price of $2.30 minus premium cost of $0.24).

The placing of a hedge with the purchase of the PUT option helps reduce the economic risk that can occur with declining prices. In addition, a PUT option can capture some of the price increase, if that occurs. These two features show the advantage of a PUT option over the use of a futures contract.

What happens if there is no change in the cash and futures prices? The following table shows that in this case the best decision is to exercise the option to regain $0.20 of the premium since the strike price was in-the-money.

Table 5. Hedging with a PUT option and exercising it even with no price change.

Date	Local Market	Cash Price	Futures Price	Basis	Options	Strike minus Futures Price	Premium		
4/19	own	$2.00	$2.20	$0.20	Buy December PUT $2.40 Strike Price	$0.20	$0.24		
10/30	sell	$2.00	$2.20	$0.20	*Exercise December PUT*	$0.20			
Net Changes		$0.00	$0.00	$0.00					
Cash price:		$2.00							**Minimum Price**
Final price with exercised options:		$2.00				+ $0.20	- $0.24	=	$1.96
Cash price less premium:		$2.00					- $0.24	=	$1.76

However, if the original PUT option had a strike price of $2.10 that was out-of-the-money by $0.10, then the best decision would be to let the option expire and receive $1.97 as shown in the following table.

Table 6. Hedging with a PUT option and letting it expire when prices do not change.

Date	Local Market	Cash Price	Futures Price	Basis	Options	Strike minus Futures Price	Premium
4/19	own	$2.00	$2.20	$0.20	Buy December PUT $2.10 Strike Price	-$0.10	$0.03
10/30	sell	$2.00	$2.20	$0.20	*December PUT Expire*	-$0.10	
Net Changes		$0.00	$0.00	$0.00			
Cash price:		$2.00					**Minimum Price**
Final price with exercised options:		$2.00				-$0.10	- $0.03 = $1.87
Cash price less premium:		$2.00					- $0.03 = $1.97

Graphic Analysis for Options

The understanding of options contracts and positions can be shown with the help of the following figure. In the earlier tables on hedging two specific dates were used – April 19 and October 30, when comparing the cash price to the net price received using options. The following graphic analysis shows what happens over a range of prices.

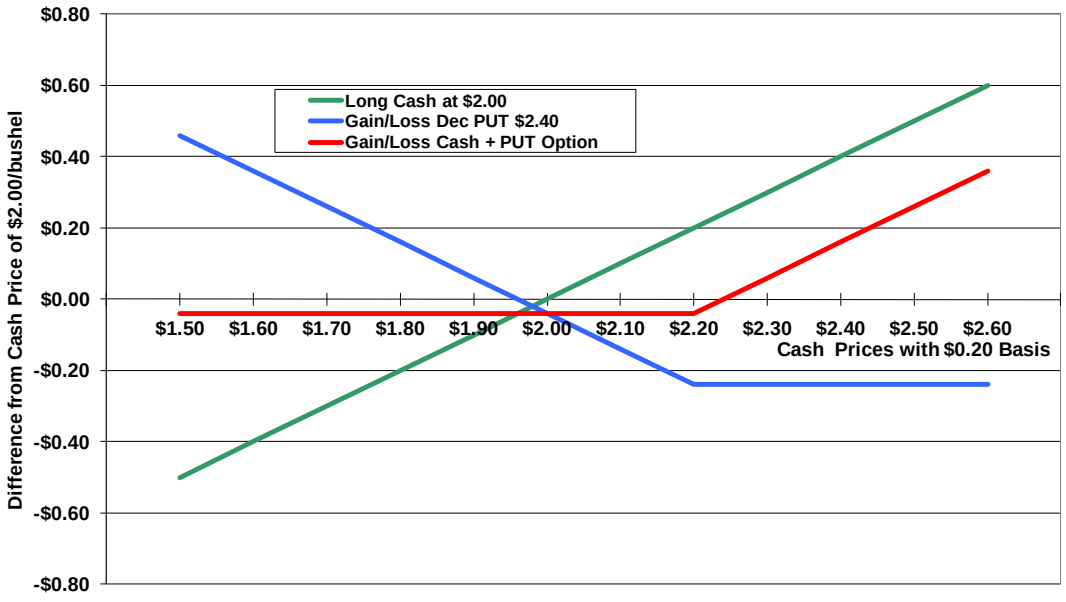

Figure 6. Long Cash with December PUT Option

As the cash price ranges from $1.50 to $2.60, the line "Long Cash at $2.00" shows the difference from the initial cash price of $2.00 to be hedged on April 19. For example, if the cash price after April 19 is $1.60, then the difference shown on the y-axis is a minus $0.40.

The strike price on the December PUT option was $2.40 and the premium was $0.24. At a cash price of $2.20, and given the basis of $0.20, the December futures price would match the

option strike price. The option would still be out-of-the money by $0.24, the cost of the option. The line "Gain/Loss Dec PUT $2.40" shows the $0.24 loss on the y-axis at the $2.20 cash price.

At the lower cash price of $1.60 and a December futures price of $1.80, the option would be in-the-money by $0.36. The option would be exercised and the hedger would receive a short position in a December futures contract at $2.40. A December long position is bought at $1.80 to offset the short position for a gross gain of $0.60. Subtracting the $0.24 cost of the PUT option results in a net gain of $0.36 as shown on the y-axis.

The combination of the lines "Long Cash at $2.00" and "Gain/Loss Dec PUT $2.40" is shown by the line "Gain/Loss Cash + PUT Option". At the $1.60 cash price, the final net price received would be $1.96 ($1.60 plus $0.36 from the option). This is the minimum or floor price. The difference of minus $0.04 from the desired $2.00 cash price is shown on the y-axis.

If the cash price moves above $2.20, then the line "Gain/Loss Cash + PUT Option" moves in a positive direction and the difference shown on the y-axis turns positive. At a cash price of $2.30, the difference from the $2.00 hedge price is a positive $0.06. The final net price received would be $2.06 ($2.30 from the cash price less the premium cost of $0.24). As described in a previous table for a price increase, the option would not be exercised in this case and allowed to expire.

The following figure shows the net price received over the range of cash prices.

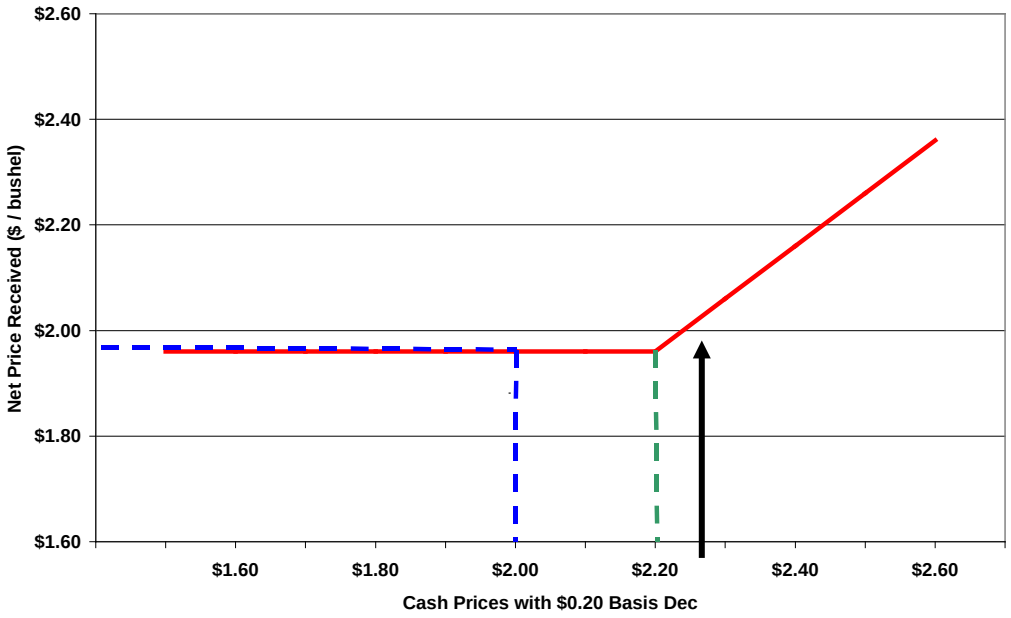

Figure 7. Net Price Received Using a PUT Option.

On the x-axis at the cash price of $2.00 being hedged on April 19, the minimum or floor price that would be received is $1.96 as shown on the y-axis. The same holds for any decline in cash prices between April 19 and October 30. If cash prices increase to $2.20, the same floor price would be received.

Above the $2.20 cash price, the net price received moves above the $1.96 floor as shown by the upward sloping line. At $2.24 cash, the arrow shows the price received would equal the desired hedge price of $2.00.

Above $2.24 the price received exceeds the hedge price of $2.00 and illustrates the motivation for using PUT options to hedge. The owner of corn can have a floor price that reduces the economic risk of declining prices, and at the same time be in a position to receive a higher price if prices go up.

Buying a CALL Option

Buying a CALL option gives the owner the right, but not the obligation, to a long position in the underlying futures contract. Buying a CALL gives the owner the right to buy a futures contract.
The procedures that apply to buying a PUT option also apply for buying a CALL option. For example, buying a December CALL option at a strike price of $2.00 gives the owner the right to exercise the option and receive a long December futures contract with a price of $2.00. It is "in-the-money" because an offsetting futures contract can be sold for $2.20. It is in-the-money by $0.20 (long futures at $2.00 and sell at $2.20).

The decision to exercise the option also needs to take into account the premium cost. In this example it is $0.24. As shown in Figure 8, it becomes profitable to exercise the option when the futures price goes above $2.24. Otherwise, the owner would let it expire.

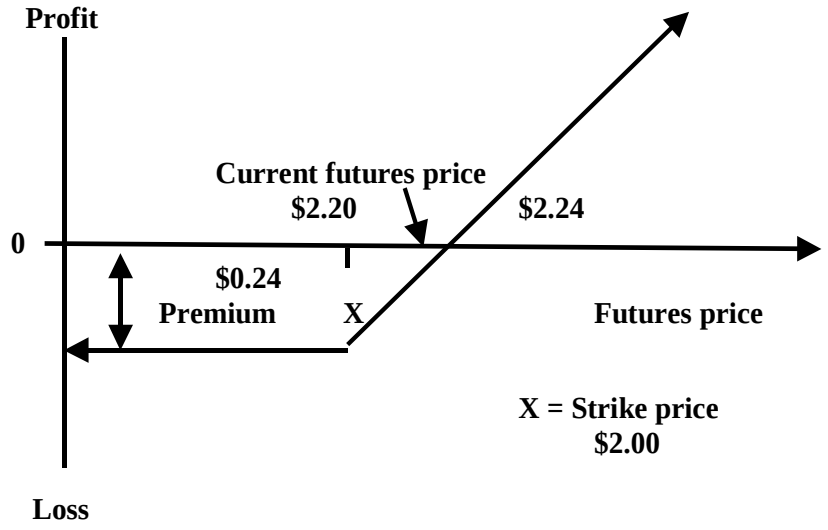

Figure 8. Long Call Option

Selling a PUT Option

Selling a PUT option can obligate the seller to place the buyer in a short position in the underlying futures contract. The seller is placed in a long position opposite the one given to the buyer. This can happen at any time when the buyer exercises the option. Selling a PUT gives the buyer a right to a short position in the futures contract, if the buyer exercises the option.

A person that sells a PUT option with a strike price of $2.40 will receive a premium of $0.24/bu. ($1,200 for a 5,000 bu. contract). This is similar to an insurance company that sells insurance contracts for a premium. The buyer of the PUT, similar to the insurance customer, paid $0.24 and has the right to a short position in the December futures contract at $2.40.

What happens if the underlying December futures price declines? If the futures price does go below $2.16 then there is a financial incentive for the PUT buyer to exercise it. For example, if the December futures price goes to $2.10, then the PUT buyer can realize a net gain of $0.06. The buyer exercises the option and receives a short December futures contract at $2.40, buys an offsetting contract for $2.10, subtracts the $0.24 premium cost and ends up with a $0.06 gain not counting commission and fees.

The seller of the PUT option is placed in a long position in the futures contract opposite the short position provided the buyer. The seller is long December futures at $2.40. To offset this position, the seller goes short a December futures at the current price of $2.10. The loss to the seller is $0.06 (long at $2.40 minus the short sale at $2.10, plus the premium received of $0.24). See the following figure that shows the situation for the seller.

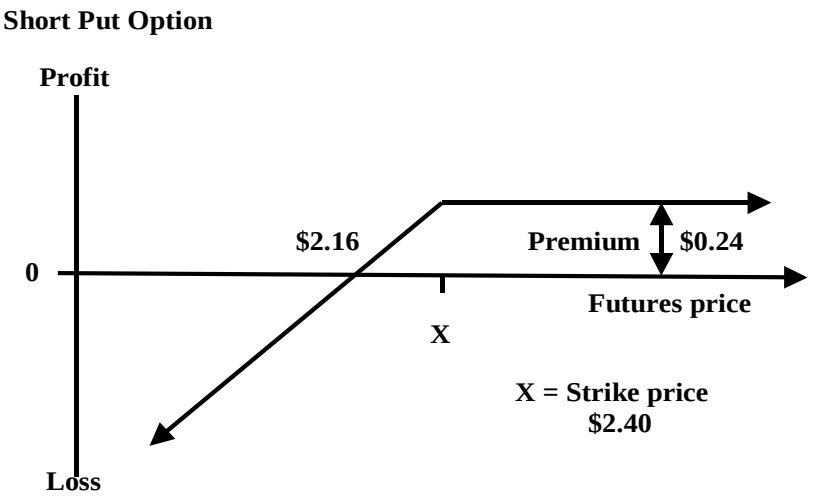

Figure 9. Short Put Option

Selling a PUT option has a certain amount of downside risk. Hypothetically if the December futures price went to zero dollars, then the seller's loss would be a maximum of $2.16 in this example. That is, long at $2.40 minus a short sale at $0.00, plus the premium received of $0.24.

The seller of the PUT is betting that the underlying December futures price will not decline below $2.16 ($2.40 strike price - $0.24 premium cost to the buyer). The buyer will let the option expire and the seller will get to keep the premium.

Selling a CALL Option

Selling a CALL option can obligate the seller to place the buyer in a long position in the underlying futures contract. The seller is placed in a short position opposite the one given to the buyer. This can happen at any time when the buyer exercises the option. Selling a CALL

gives the buyer a right to a long position in the futures contract, if the buyer exercises the option.
A person that sells a CALL option with a strike price of $2.40 will receive a premium of $0.03/bu. ($150 for a 5,000 bu. contract). The buyer of the CALL paid $0.03 and has the right to a long position in the December futures contract at $2.40.

What happens if the underlying December futures price increases? If the futures price does go above $2.43 then there is a financial incentive for the CALL buyer to exercise it. For example, if the December futures price goes to $2.50, then the CALL buyer can realize a net gain of $0.07. The buyer exercises the option and receives a long December futures contract at $2.40, sells an offsetting contract for $2.50, subtracts the $0.03 premium cost and ends up with a $0.07 gain not counting commission and fees.

The seller of the CALL option is placed in a short position in the futures contract opposite the long position provided the buyer. The seller is short December futures at $2.40. To offset this position, the seller goes long a December futures at the current price of $2.50. The loss to the seller is $0.07 (long at $2.50 minus the short sale at $2.40, plus the premium received of $0.03).

Selling a CALL option has an unlimited amount of upside risk. Hypothetically the December futures price could go up to unheard of levels. In this example, if the December corn futures went to $4.00 (which has happened in the past), then the seller's loss would be $1.57. That is, short at $2.40 minus a long sale at $4.00, plus the premium received of $0.03. If the December price went to $5.00 the loss would be $2.57, which could be more than the total value of the underlying cash commodity being hedged. See the following figure that shows the situation for the seller.

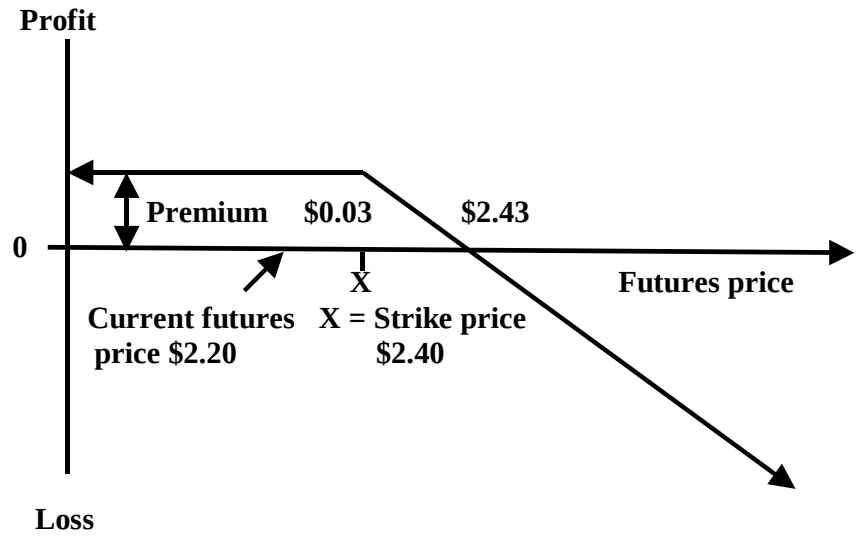

Figure 10. Short Call Option

The seller of the CALL is betting that the underlying December futures price will not go above $2.43 ($2.40 strike price + $0.03 premium cost to the buyer). The buyer will let the option expire and the seller will get to keep the premium.

Differences between an option contract and a futures contract:

- The owner of an option contract has the right but not the obligation to buy or sell at the strike price.
- Exercising the option contract and taking a position in the underlying asset (futures contract) is at the owner's discretion.
- The decision to exercise the option will depend on the financial incentives/disincentives associated with the option contract and the underlying asset.
- The buyer of an option (put or call) makes only one premium payment.
- There is no margin account, initial margin or margin call.
- If the option expires without being exercised the owner does not make or take delivery of the asset in the underlying futures contract.
- The downside loss on an option contract is limited to the premium payment.
- The upside gain is unlimited depending on what happens to the underlying asset (futures contract), and the underlying commodity associated with the futures contract.

Exhibit D: Gains and Losses on Positions in the Cash, Futures and Options Markets

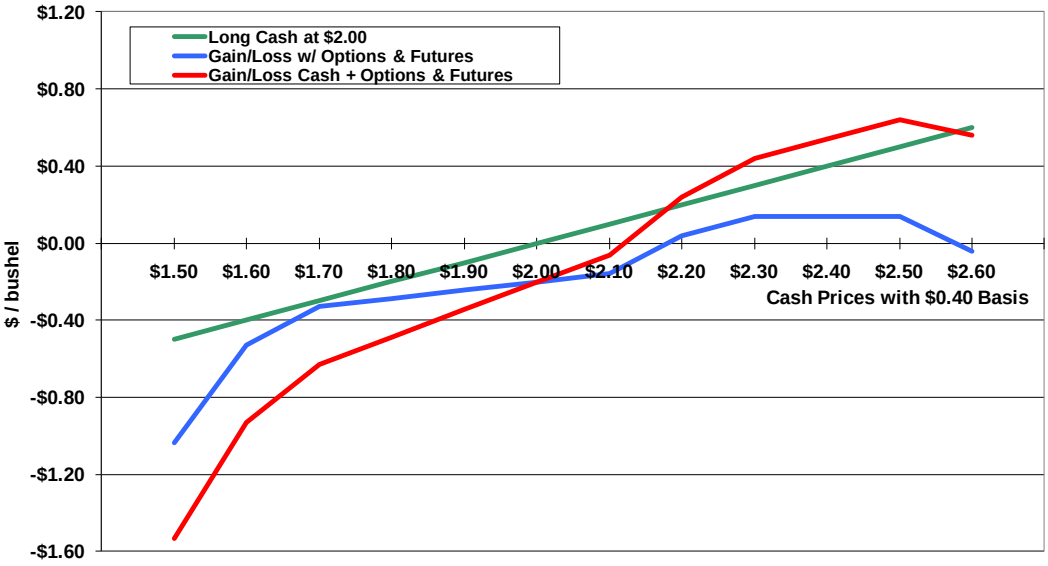

Figure 11. May, June, July, August and September 2002.

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Tacit Knowledge about Italian Valpolicella Wine
An Executive Video Interview with Dr. Paolo Zardini[1]

By Alyse Reichard[Ⓘ]

Abstract:

Dr. Paolo Zardini, an enologist and agronomist is the owner of the Tenuta Chevalier Winery located in the heart of the Italian wine region of Veneto. Dr. Zardini shares history and secrets from generations ago about the farming methods his family still utilizes to produce Amarone Valpolicella wine.

Keywords: wine production, Veneto region, tacit knowledge.

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[1] Dr. Paolo Zardini is the owner of Tenuta Chevalier Winery. Visit the website at: http://www.chevalier.it/

Ⓘ Alyse M. Reichard is a senior at the University of Illinois. She is studying Agribusiness Markets and Management with a certification in Global Studies, specializing in Italian.