DEMAND FOR QUALITY CHARACTERISTICS OF

HARD RED WINTER WHEAT

By

ROSA KARINA GALLARDO

Bachelor of Science in Food Science
Universidad Nacional Agraria La Molina
Lima, Perú
1999

Engineer of Food Science and Technology
Universidad Nacional Agraria La Molina
Lima, Perú
2000

Master of Science in Agricultural Economics
Mississippi State University
Starkville, Mississippi
2004

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Thesis Approved:

Dr. Rodney B. Holcomb
Thesis Adviser

Dr. Jayson L. Lusk

Dr. Shida Henneberry

Dr. Patricia Rayas-Duarte

Dr. A. Gordon Emslie
Dean of the Graduate College

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CHAPTER I

INTRODUCTION

Current conditions of the U.S. wheat marketing system combined with the dynamics of international markets challenge U.S. leadership in wheat exports. The ability of grades and standards, established by the Federal Grain Inspection System (FGIS) in the early 1900's, to capture vertical differences in wheat quality characteristics has been questioned during the past two decades (Lyford et al. 2005). Prices received by wheat producers do not necessarily reflect grain quality, flour yielding capacity, and baking characteristics (Mercier 1993, Wilson and Preszler 1992). Although a myriad of factors affect prices in the market, premiums and discounts are mainly based on physical wheat characteristics (Baker, Herrman and Loughin 1999; Dahl, Wilson, and Johnson 2003). Domestic and overseas millers are expressing increasing interest towards end-use baking quality characteristics to supply for their clients requirements (Regnier and Holcomb 2004). The informational gaps in the wheat marketing system, increase milling companies' uncertainty about grain quality and its performance in flour processing and baking.

Major changes have occurred in international wheat markets, one obvious is the privatization of the buying process in importing countries leading to less participation of non-private entities or State Trading Enterprises (STE). The less participation of non-private entities or State Trading Enterprises (STE), the more attention given to quality issues in the decision making process. Additionally, mechanization of wheat production, milling and baking processes, industry consolidation, and end-user sophistication result in increased market segmentation and a greater demand for consistent quality parameters (Oades 2005).

Despite the strong U.S. domestic demand for wheat, foreign markets absorb 52% of the domestic production. Global wheat trade has increased, however the U.S. has lost world market share in the past two decades, 1970 it was 40% and for years 2002 – 2003 was 23% (ERS-USDA 2007). Traditionally, the U.S., the European Union and Argentina are viewed as low price suppliers, whereas Canada and Australia are viewed as quality suppliers (Lavoie 2005). Non-traditional wheat exporters that appeared in recent years, such as the Former Soviet Union (SU), Central and Eastern European countries, China, India, and Pakistan, have increased their wheat exports share (ERS-USDA 2007).

Among foreign buyers, Mexico is the third largest importer for U.S. wheat behind Egypt and Japan. From 1996/97 to 2005/06 Mexico accounted for 31% of all U.S. wheat sold to Latin America, and on average 64% of this wheat was hard red winter wheat (ERS-USDA, 2007).

Overall, this three-paper dissertation analyses the demand for quality attributes for hard red winter wheat in both domestic and international markets. The first paper analyzes the effect of physical and functionality parameters on prices paid to Oklahoma farmers during 2005 for hard red winter wheat, using a hedonic pricing model to estimate the implicit values for quality characteristics. Results showed that test weight had an implicit value of 0.77 cents/bushel, and moisture a negative value of 0.67 cents/bushel.

There is evidence that hard red winter wheat prices were not yet reflecting vertical differences in quality characteristics, especially those related with end-use functionality.

The second paper investigates Mexican millers' preferences for wheat quality attributes. A major focus of the analysis is characterizing millers' preferences for consistency (or risk) in wheat input characteristics. In-person interviews were carried out with Mexican millers, who were administered a conjoint-type survey designed to incorporate uncertainty in attribute levels. Two methods are used to model millers' risk preferences: a modified mean-variance approach and an explicit expected utility approach. Controlling for variability, Mexican millers are willing to pay premiums for increases in quality factors such as test weight, protein content, falling number, and dough strength/extensibility. We find millers' are not particularly sensitive to changes in the variability of wheat quality characteristics. Out-of-sample forecasts suggest the mean-variance model provides an accurate depiction of actual Mexican imports.

The third paper attempts to the effect of the release of information on Mexican milling companies' welfare. A non-profit marketing company's expenditure is used as a proxy to model Mexican mill's accessibility to quality information, and applied to an indirect cost function. The value that wheat marketing companies expenditures represent to Mexican millers is measured by the difference of the flour mill's compensating surplus and compensating variation. Results indicate that for the period in study, information did not necessarily increase Mexican wheat imports; nonetheless it has a positive effect on mill's welfare.

CHAPTER II

MEASURING THE EFFECT OF FUNCTIONALITY PARAMETERS ON HARD RED WINTER WHEAT PRICES

Introduction

Current U.S. wheat grades and standards do not fully reflect the quality characteristics of interest to intermediate users (millers) and end-users (bakers). Although many factors impact the final selling price of wheat, prices are mainly established according to the FGIS grades and standards, i.e., only physical attributes and protein content. The lack of "quick" tests makes it impractical to include flour yield and baking characteristics in wheat purchasing contracts between elevators and flour mills, yet this information is requested by baking firms in flour purchasing contracts with millers. Thus, protein quantity is often used as an indicator (proxy) for end-use performance. However, the ability to predict wheat and flour behavior depends also on protein quality or the proportion of gluten classes (Stiegert and Blanc 1997). The lack of knowledge regarding wheat behavior in flour processing and baking, or informational gaps, leads to increased uncertainty in cost/benefit calculations by millers. Without an assessment of quality information it is a challenge for flour mills to adjust their processes to yield flour with suitable characteristics for each end-product to be produced.

Non-profit market assistant groups (e.g., the Wheat Marketing Center in Portland, OR and Plain Grains Inc. in Stillwater, OK) have been created for the purpose of reducing the informational gaps by making information concerning wheat milling and baking quality publicly available. For example, Plains Grains Inc. (PGI) assists producers, millers, and bakers by providing geographically-determined quality information. This company facilitates sampling and quality testing of hard red winter wheat from the production area comprised of Texas, Oklahoma, Kansas, Nebraska, Colorado, South Dakota, and Montana, and conducts workshops, open to all members of the marketing chain, to educate them in the importance of grain quality parameters on the baking process (Regnier and Holcomb 2004).

Large international traders have traditionally collected quality related information; however they do not make it available to elevators and farmers. As a result, producers and country elevators seldom know the milling and baking quality of their wheat. It is suggested that these large traders are able to maintain their marketing margins partially because they are able to source wheat based on quality profiles and provide this additional information to their miller clients, for whom this information has value.

Given the recent public availability of information related to physical, and baking quality characteristics, the purpose of this study is to determine if prices paid to producers already reflect vertical differences in these quality attributes. The specific purpose is to estimate the implicit value of quality attributes including end-use (baking) quality characteristics for hard red winter wheat classes 1 and 2 in the growing regions of Oklahoma, Kansas, Texas, and Nebraska.

Considerable previous research has been conducted to measure the implicit value of wheat attributes (i.e., Veeman 1987; Wilson 1989; Larue 1991; Espinosa and Goodwin 1991; Wilson and Preszler 1992; Uri et al. 1994; Ahmadi-Esfahani and Stanmore 1994; Stiegert and Blanc 1997; and Parcell and Stiegert 1998). Veeman (1987) found that there was a $6/MT premium for a 1% increase in protein content in world prices for the time period 1976-1984. Wilson (1989) determined that the location of the shipment and destination affected the implicit values for protein. The premium for a 1% increase in wheat protein content considering cost insurance freight (CIF) prices was $3.13/MT at Japan, $21/MT at Holland, and $8.18/MT at the U.S. Pacific port on freight on board (FOB) basis.

Larue (1991) concluded that wheat purchased for different uses should be considered as different products, as implicit values for quality characteristics varied according to end-use. For high-protein wheat, there was a $5.49/MT premium for a 1% increase in protein content, for medium-protein a $1.65/MT premium, and for low-protein a $6.42/MT premium. Uri et al. (1994) found that implicit values for quality characteristics changed over time with no uniform pattern and were different across wheat types: the protein premium for hard red winter wheat was $5.64/MT, for hard red spring $14.14/MT, and for soft white wheat $6.64/MT. Ahmadi-Esfahani and Stanmore (1994) estimated the implicit values for Australian wheat and found that there was an $8.18/MT premium for each additional percent of wheat grain protein and a $5.34/MT for additional percent of flour protein. Parcell and Stiegert (1998), analyzing Kansas and North Dakota wheat markets, found that implicit values for quality characteristics in one region were affected by quality characteristics of wheat grown in the other region. For hard red winter wheat, they found that protein had a marginal value of $0.218/bushel, and the cross marginal value with respect to other region was -$0.004/bushel.

These studies have estimated the effect of FGIS grades and other physical attributes (mainly protein content) on prices across time and in different markets. Only a few studies have included end-use performance characteristics in their hedonic models. Espinosa and Goodwin (1991) found that milling and dough characteristics have an effect on Kansas wheat prices. They found a $0.0017/bushel premium for a percentage change in the farinograph water absorption lecture, a -$0.16/bushel discount for a percentage change in the dough mixing time, and a $0.019/bushel premium for a percentage change in the farinograph stability value. Stiegert and Blanc (1997) used an extension of the hedonic pricing model to analyze Japanese demand for wheat protein. They identified a $4.75-$5.75 premium for a marginal change in protein content, and found that protein premiums are related to dough stability, extensibility, and absorption and differ for low and high protein content.

The present study estimates the implicit values of wheat quality attributes, including milling and dough characteristics, for the states of Oklahoma, Kansas, Nebraska, and Texas. This analysis comprises a much wider geographical area than previous studies, implying that enough variability in growing conditions is included and considered to reflect differences in intrinsic quality characteristics that might explain price differences across locations.

This study is an attempt to ascertain the impacts of publicly available wheat quality information for 2005 on the prices paid for wheat with different intrinsic quality characteristics during the marketing year.

Conceptual Framework

This study follows the Ladd and Martin (1976) extension to Lancaster's postulate that inputs are used in a production process for their quality characteristics rather than for themselves. Rosen (1974) established that hedonic prices were the implicit price of each attribute, revealed from observed prices and varying amounts of characteristics associated with goods. Ladd and Martin (1976) extended this concept by stating that total output is the sum of all characteristics provided by each input. The hedonic pricing model is suitable for differentiated products in which quality characteristics determine the differences within the same commodity group. As mentioned by Lavoie (2005), hard red winter wheat is differentiated by classes but also by quality within classes. Protein content, test weight or farinograph water absorption may indicate different levels of quality even in the same wheat class.

The approach assumes that the price for wheat can be expressed as a function of its milling and baking attributes. From the first order conditions, it is possible to obtain the marginal value product or the hedonic price of a characteristic. The implicit prices are obtained from the regression analysis of the observed price against its quality characteristics.

Methods

Data Description

The study used a set of nearby bases for specific locations across four states in the U.S. hard red winter wheat region and a set of quality attributes for the same locations that are observed by a different entity at different points in time. Nearby bases are the differences between the nearest Kansas City Board of Trade (KCBT) futures price and the local cash prices. A variable that should have a considerable impact on the local cash prices is transportation cost; however it was not available and not included in the model. Both the bases and an indicator variable for location were used to account for the omission of transportation costs. Bases might account for variations in locations attributable to transportation because the price producers receive for grains at the country elevator derived from a central market price does not consider transportation and handling costs. Country elevator managers deduct for transfer costs to the higher-priced market when determining the bids they can offer local producers (Amosson et al. 1998). Monthly average bases for Oklahoma were obtained from a wheat marketing company in Northern Oklahoma and for Kansas, Texas, and Nebraska from the Ag Manager Info website provided by the Department of Agricultural Economics at Kansas State University. The period of the analysis comprised the 2005 crop-year[1].

Data on physical and end-use quality characteristics for each location were provided by PGI. Wheat samples were collected during June and July from the elevators in the "grainsheds" and sent to a laboratory where tests for wheat, flour, dough, and

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[1] Wheat crop year begins on June 1st and ends on May 31st of the next year. The harvest season for hard red winter wheat begins around June, wheat harvested in June remains in the market until the beginning of the next crop year.

baking parameters were conducted. A grainshed is a geographical area based on individual load-out facilities that have the capability to load either unit trains for domestic/export shipment or river barges going to the Gulf, as defined by grain marketers and state wheat commissions working with PGI. Wheat from surrounding production areas and country elevators essentially funnel into the load-out facility serving as the focal point of the grainshed. The farmers, their local elevators, grain traders, and millers all have access to the regional quality profiles and establish their respective purchasing or marketing strategies for the crop year. Because there was a mixture of yearly and monthly observed data, we assumed that quality characteristics related to end-use performance remain constant throughout the crop year. Also, it was assumed that all wheat harvested in one year was sold in the same year, i.e., no remaining wheat from previous years affected prices.

Quality characteristics consisted of wheat's physical attributes including test weight, moisture, protein, ash content, dockage, and total defects, plus milling and baking measures of flour yield, farinograph water absorption, farinograph stability time, ratio between dough strength and extensibility (the P/L ratio), alveograph W value and bake volume. A brief description of each quality characteristic is provided.

Test weight is the weight per Winchester bushel or 2,150.42 cubic inches (GIPSA 2006); it is an indicator for wheat kernel density, thus for flour yield. One would expect a positive implicit value for test weight. Moisture content indicates the proportion of dry matter in the wheat kernel; a high moisture level might lead to infestation and damage of wheat during storage. Hence, one would expect a negative effect of moisture on prices (Espinosa and Goodwin 1991).

Protein content measured at a 12% moisture base is considered as a proxy to measure end-use functionality and is expected to have a positive correlation with price. However, as mentioned by Stiegert and Blanc (1997) protein quality is also an indicator of end-use functionality; and is given by the ratio of two groups of proteins, gliadins and glutenins. Gliadins provide cohesiveness to dough and glutenins give dough the resistance to extension. Both strength and extensibility are necessary properties during the baking process. Protein quality depends on the genetics of wheat varieties while protein quantity is largely determined by the growing conditions.

Stiegert and Blanc (1997) stated that ash measured at a 14% moisture base represents the inorganic remains after incinerating a specific amount of wheat. Ash content is considered a predictor for flour quality and flour yield, thus should have a negative effect on prices. Dockage represents non-millable material in wheat and total defects is the sum of damaged kernels, foreign material, and shrunken and broken kernels. Both dockage and total defects should be negatively correlated with flour yield and should have a negative implicit value. Flour yield percentage, or milling yield, is expected have a positive implicit value, but milling yield as determined by a Buhler laboratory-scale mill may not have the expected impact.

Farinograph stability is a measure of dough strength, and according to Stiegert and Blanc (1997, p. 110), it is "the time interval in which the dough remains at or above the farinograph measure of 500 Brabender units." In general, longer stability values imply that the flour is more tolerant to over-mixing, i.e., better bread-making characteristics. However, extremely high values represent extremely strong dough implying "poor machining properties." Regnier, Holcomb, and Rayas-Duarte (2003) stated that farinograph water absorption is the amount of water required by the dough to achieve maximum consistency and determines the amount of water that flour can absorb at a given dough consistency, thus it is related with dough yield. One would expect a positive implicit value for water absorption.

Alveograph P/L is the ratio between the maximum pressure required to produce a bubble (P) and the extensibility of dough or time required for the bubble to burst (L). The P/L ratio is an indicator of bread volume and the distribution of different ingredients in the baking structure. The optimal value for P/L is one, hence the smaller the difference from one the better. For the study purposes we considered the difference from one, instead of the reported P/L value, thus we expect a negative implicit value for this quality characteristic.

The alveograph W value is the measure of both dough strength and extensibility, and should have a positive implicit value. Bake volume or bread loaf volume is the flour's potential to make bread; higher values indicate that more loaves can be made from a unit of flour and should have a positive implicit value (Regnier, Holcomb, and Rayas-Duarte 2003).

Data Analysis

Rosen (1974) claimed that hedonic functions do not identify supply or demand functions. Both observed and implicit prices can be affected by aggregate supply and demand forces; implying that quality attributes may not be constant over time and may vary with markets, or end-use. Consequently, we included in the model index variables that adjusted for the effects of market conditions. Veeman (1987) included year as a dummy variable to account for variations in time. Ethridge and Davis (1982) used quality lot averages for meaningful cotton variables. Brorsen, Grant, and Rister (1988) used the price of a reference commodity (Texas weekly long grain mill price). To account for the effect of aggregate variations in location we used the three-year average basis for each grainshed in the four states included in the study. As mentioned before, we included indicator variables for each grainshed in each state. To account for the grainshed differences across states, we used a variable indicating the interaction grainshed and state.

Because observations varied within each month and between months, month was included as an indicator variable. Wheat price variation by month is attributed to the harvest period, domestic and foreign demand, and availability of wheat. For example, during the period September-February prices are typically higher whereas during the period March-August prices are typically lower. Quality attributes are measured during July and August and are made public by the end of August. Thus bases for June, July and August did not have any relation with quality attributes and were not included.

The hedonic pricing model, when month is an indicator variable, follows:

$$Basis_{ml} = \alpha_m + \varphi \ln averagebasis_l + \sum_{k=1}^{12} \beta_k \ln q_{kl} + \gamma_l + e_{ml} \tag{2.1}$$

where $e_{ml} \sim N(0, \sigma^2)$, $Basis_{ml}$ is the monthly average basis where m represents months m=1, 2, 3, 4, 5, 9, 10, 11, 12; l represents the elevator grainsheds across the four states: Oklahoma, Kansas, Texas, and Nebraska. The number of grainsheds included in each state depended upon data availability. Both bases data and quality information were available for five grainsheds in Oklahoma, four in Kansas, three in Nebraska, and two in Texas (considering only the Panhandle area), α_m is the fixed effect for month, $averagebasis_l$ represents the three year average basis for each location, q_{kl} are the quality characteristics including physical wheat attributes: test weight, moisture, protein 12%, ash 14%, dockage, total defects, and flour yield; and end-use performance characteristics: farinograph absorption, farinograph stability, alveograph measure for the ratio of dough strength and extensibility or P/L ratio, alveograph W value, and bake volume, γ_l is the indicator variable for grainshed/location, and β_k and φ are the parameters to estimate.

A log-linear functional form was used because the elements included in the model were in different measurement units (i.e., kg/hl, %, cc, and minutes). Additionally, we scaled the quality parameters to achieve uniform values when performing the regressions. Test weight, yield, and farinograph absorption values were divided by 10. Dockage and P/L ratio values with one decimal digit were multiplied by 10. Bake volume values with three digits were divided by 100. The basis was multiplied by 100.

The mixed procedure of SAS® was used to estimate the parameters. This approach was specifically designed to fit mixed effect models, especially data with heterogeneous variances (SAS®). We used maximum likelihood as the estimation method because it produces a robust estimate when error terms are suspected of being heteroskedastic. Observations vary with respect to time and location, thus grainshed was the categorical independent or classification variable. To test for heteroskedascity we conducted the Breusch-Pagan test. Additionally, to test for normality, the Shapiro-Wilk, Kolmogorov-Smirnov, Cramer-von Mises, and Anderson-Darling tests were conducted.

Results

The first part of the analysis focused on the quality characteristics differences across the four states. Descriptive statistics of all the elements included in the model are presented in table II-1.

Table II-1. Summary Statistics for Basis and Hard Red Winter Wheat Quality Characteristics across Great Plains Region for Crop Year 2005

Attribute	Average	Standard deviation	Maximum	Minimum
Basis ($/bu)	-0.317	0.090	-0.460	-0.040
Three-year average basis ($/bu)	-0.277	0.074	-0.370	-0.020
Test weight (lb/bu)	60.528	1.373	57.400	63.100
Moisture (%)	11.339	1.099	8.700	14.000
Protein 12% (%)	12.284	1.018	10.061	14.660
Ash 14%	1.525	0.285	1.331	3.892
Dockage (%)	0.524	0.365	0.100	2.100
Total defects (%)	1.493	0.581	0.200	3.700
Flour yield (%)	69.529	1.864	65.200	74.400
Farinograph water absorption (%)	59.107	1.925	55.400	62.900
Farinograph stability time (min)	10.302	2.266	5.000	17.000
Dough strength vs. extensibility (P/L ratio)	0.941	0.268	0.488	1.629
Alveograph W value (joules)	291.547	47.581	174.000	405.000
Bake volume (cc)	836.395	75.699	675.000	1000.000

Values for test weight and total defects suggest that in general the sample wheat used was at least of grade 2 or better according to the FGIS grades. Additionally, the average value for flour yield (69.53%) is lower than the values typically obtained by millers, but this finding can easily be explained. To estimate the flour yield in a laboratory setting, wheat was milled using a Buhler laboratory mill (Buhler Inc.), equipment that does not necessarily give the same milling yield as the mass-production equipment used by large milling companies.

A means comparison was conducted using the T-test procedure in SAS®, and results are reported in table II-2. For the crop year 2005, Kansas hard red winter wheat (HRW) test weight, protein content, flour yield, farinograph water absorption, stability time, W value, and bake volume values were significantly higher than Oklahoma and Nebraska.

Likewise, Kansas values for protein content, stability time, W value, and bake volume were superior to Texas. Values for test weight and water absorption were greater in Texas than in Nebraska, and values for protein, flour yield, water absorption, and bake volume were greater in Texas than in Oklahoma. Similarly, values for protein, water absorption, and W value were greater in Nebraska than in Oklahoma. Moisture percentage and ash content were lower for Kansas and Texas than for the other states. Texas wheat had the highest dockage percentage and Oklahoma wheat had the highest total defects level. Results in table II-2 suggest that during the crop year 2005, Kansas wheat quality was superior to Texas, Nebraska, and Oklahoma wheat. Texas wheat quality was superior to Oklahoma and Nebraska, except for the dockage content.

Table II-2. Means Comparison of Hard Red Winter Wheat Quality Characteristics across Four States in the Plains Area

Attribute	Oklahoma-Kansas	Oklahoma-Nebraska	Oklahoma-Texas	Kansas-Nebraska	Kansas-Texas	Nebraska-Texas
Test weight (lb/bu)	*[a]	*		*		*
Moisture (%)	*		*	*		*
Protein 12% (%)	*	*	*	*	*	
Ash 14%				*		*
Dockage (%)			*		*	
Total defects (%)		**[b]	**			
Flour yield (%)			*			
Farinograph water absorption (%)	*	*	*	*		*
Farinograph stability time (min)	*		*	**	*	*
Dough strength vs. extensibility (P/L ratio)						
Alveograph W value (joules)	*	**		*	*	
Bake volume (cc)	*	**	*	**	*	

[a] One (*) indicates statistical significance differences at the 5% level
[b] Two (**) indicates statistical significance differences at the 10% level

Table II-3. Pearson Correlation Coefficient among Hard Red Winter Wheat Attributes

	Test weight (lb/bu)	Moisture (%)	Protein 12% (%)	Ash 14% (%)	Dockage (%)	Total defects (%)	Flour yield (%)	Farinograph water absorption (%)	Farinograph stability time (min)	Dough strength vs. extensibility (P/L ratio)	Alveograph W value (joules)	Bake volume (cc)
Test weight (lb/bu)	1											
Moisture (%)		1										
Protein 12% (%)		(-)*[b]	1									
Ash 14% (%)				1								
Dockage (%)					1							
Total defects (%)	(-)*		(-)**[b]			1						
Flour yield (%)	(+)*[a]	(-)*				(-)*	1					
Farinograph water absorption (%)	(+)*	(-)*	(+)*			(-)*	(+)*	1				
Farinograph stability time (min)			(+)*		(-)**		(-)*		1			
Dough strength vs. extensibility (P/L ratio)	(+)*		(-)*		(+)*			(+)*		1		
Alveograph W value (joules)	(+)*		(+)*					(+)*	(+)*		1	
Bake volume (cc)			(+)*	(-)**		(-)**		(+)*	(+)*		(+)*	1

[a] (+)* indicates positive and statistical significant correlation at the 5% level
[b] (-)*, (-)** indicates negative and statistical significant correlation at the 5% and 10% level, respectively

Oklahoma wheat had higher values than Nebraska for attributes related with productivity but lower for end-use functionality characteristics. To determine if there were significant correlations among the quality characteristics included in the model we conducted a Pearson correlation test (table II-3). Results suggest a positive correlation between test weight and flour yield. Also, we found a positive correlation between protein and farinograph water absorption, farinograph stability time, alveograph W value, and bake volume. These results imply that higher protein is related with a greater ability of the dough to absorb water, associated with larger end-product yields, favorable in bread production.

As stated previously farinograph stability is an indicator of dough strength. Results indicate that the higher the protein content, the stronger the dough. A positive correlation between protein and W value indicates that the higher the protein the greater the values for strength and extensibility, which is favorable because the final quality of the baked product depends on both dough factors. The negative correlation between protein and P/L ratio might indicate the higher the protein content the more extensible the dough, which agrees with the result of positive correlation between protein and W value. Our findings coincide with Stiegert and Blanc (1997) in assessing the validity of protein as a proxy for end-use functionality characteristics.

An additional observation from table II-3 is that test weight, moisture, and total defects are correlated with flour yield. Results show that higher test weight values imply higher flour yield. As stated before, higher moisture in wheat suggests lower flour yield, and can also lead to mold infestation and shorter lifetime in storage.

To determine the effects of seasonality on wheat prices we conducted two different analyses. The first approach included month as an indicator variable, the second approach included the interaction of month with each wheat quality variable. Results for the first approach are reported in table II-4.

For the first analysis the fixed effects approach was used, with each grainshed considered as an intercept shifter. Error terms from this regression were tested with the Shapiro-Wilk, Kolmogorov-Smirnov, Cramer-von Mises, and Anderson-Darling tests. Results from these tests suggest that the error term followed a normal distribution. Additionally, results from the Breush-Pagan test indicate the presence of heteroskedascity. Given the evidence of heteroskedascity, the NLMIXED procedure and a random effects mixed model was used to obtain more robust estimates.

A positive sign for a quality characteristic suggests that an increase in the characteristic leads to an increase in basis. As stated previously, basis is the difference between local cash and KCBT near futures prices, and is a negative magnitude. An increase in basis implies less negativity or values closer to zero, i.e., higher local cash prices. Conversely, if we use the absolute value for basis, an increase in basis implies a larger difference between KCBT futures and local cash price, i.e., lower local cash prices. Either way, for higher desired quality characteristics we expect a basis closer to zero. We conducted the analysis by assuming negative values for basis, thus a desired quality characteristic should have a positive sign.

Results from the NLMIXED procedure reported in table II-4 suggest that month, average basis, test weight, moisture, protein content, ash content, and bake volume have a statistically significant effect on local cash prices. The negative and statistically

Table II-4. Parameter Estimates for Hard Red Winter Wheat Attributes, Considering Month as an Intercept Shifter

Attribute	Parameter estimate[a]	
	Fixed effects model[b]	Random effects in presence of heteroskedascity[c]
Dependent variable	Monthly average basis	
Intercept	-58.483* (18.638)	-53.769* (18.703)
Month	-0.171* (0.043)	-0.150* (0.046)
Average value of basis	0.636* (0.037)	0.654* (0.037)
Test weight	0.864)* (0.255)	0.771* (0.258)
Moisture	-0.851* (0.288)	-0.672* (0.286)
Protein 12%	-0.507 (0.323)	-0.637** (0.323)
Ash 14%	0.194* (0.076)	0.190* (0.072)
Dockage	0.068 (0.061)	0.052 (0.061)
Total defects	-0.010 (0.040)	0.015 (0.046)
Flour yield	0.007 (0.129)	0.002 (0.132)
Farinograph water absorption	0.171 (0.240)	0.174 (0.235)
Farinograph stability	0.516* (0.144)	0.452 (0.145)
Dough strength vs. extensibility (P/L ratio) difference from 1	0.141 (0.159)	0.167 (0.158)
Alveograph W value	-0.111 (0.079)	-0.091 (-0.079)
Bake volume	-0.074* (0.040)	-0.074** (0.040)
Grainshed 1	1.694 (2.279)	-
Grainshed 2	-3.207*	-

Table II-4. Parameter Estimates for Hard Red Winter Wheat Attributes, Considering Month as an Intercept Shifter

	(1.399)	
Grainshed 3	6.404*	-
	(1.588)	
Grainshed 4	8.580*	-
	(1.295)	
Grainshed 5	9.358*	-
	(1.923)	
Grainshed 6	-0.876	-
	(1.629)	
Grainshed 7	-0.544	-
	(1.796)	
Grainshed 8	0.421	-
	(1.856)	
Grainshed 9	-1.154	-
	(1.203)	
Grainshed 10	-6.280*	-
	(1.372)	
Grainshed 11	-8.428*	-
	(1.150)	
Grainshed 12	-5.199*	-
	(1.096)	
Grainshed 13	-11.484*	-
	(1.663)	
Grainshed 14	3.090	-
	(1.431)	
Grainshed 15	-3.210*	-
	(0.980)	
Grainshed 16	-3.013*	-
	(1.027)	
Grainshed covariance parameter	-	26.798*
		(9.737)

Note: * Indicates statistical significance at the 5% level
** Indicates statistical significance at the 10% level
[a] Maximum likelihood is the estimation technique
[b] Using the PROC MIXED statement of SAS
[c] Using the PROC NLMIXED statement of SAS
Values in between parenthesis are standard errors

significant estimate for month reflects the nature of the nearby basis. As mentioned before, nearby basis is the difference between the actual cash price and the Kansas City Futures Trade prices. As the month increases, the delivery month is closer, and the difference in prices or basis is smaller. Coefficient estimate signs for test weight and moisture were as expected. It appears that there is a premium for test weight, i.e., as test weight increases local cash prices increase by 7.7 cents/bu[2]. Similarly, as moisture increases there was a discount equivalent to 6.7 cents/bu.

The sign for ash content and protein content were not as expected. Results suggest that higher ash content implies higher local cash prices and higher protein lowers cash prices. We would expect a negative implicit value for ash, because the greater the ash content the lower the expected flour yield. It is probable that ash content of the flour was not taken into consideration by buyers of wheat. The negative marginal value of protein content might be explained by the abundant supply of high-protein wheat during the 2005 crop year. Because of abundant high-protein wheat millers were demanding wheat with lower protein content, which was in short supply, to meet the needs of their baking industry clients. To analyze the different effects of seasonality in wheat prices we conducted a second regression including the interaction of month with each wheat quality variable (table II-5).

As before, results from the fixed effect model indicated that the error terms follow a normal distribution and are heteroskedastic. Hence we used the PROC NLMIXED procedure and the random effects model to obtain robust estimates.

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[2] Considering the initial scaled magnitudes, these reported premium and discounts were obtained by dividing the estimated coefficient reported in Table 4 by 10.

Table II-5. Parameter Estimates for Hard Red Winter Wheat Attributes, considering the Interaction of Month and Quality Characteristics

Attribute	Parameter estimate[a]	
	Location as a fixed effect[b]	Location as a random effect and considering heteroskedascity[c]
Dependent variable	Monthly average basis	
Intercept	-11.953* (1.470)	-13.152* (1.601)
Month	-3.077 (2.116)	-3.333 (2.051)
Average value of basis	0.606* (0.037)	0.626* (0.036)
Month * test weight	0.064* (0.030)	0.066* (0.029)
Month * moisture	0.003 (0.032)	0.004 (0.031)
Month * protein 12%	-0.038 (0.040)	-0.039 (0.038)
Month * ash 14%	0.019** (0.010)	0.018** (0.009)
Month * dockage	-0.003 (0.007)	-0.002 (0.007)
Month * total defects	0.003 (0.005)	0.003 (0.005)
Month * flour yield	0.016 (0.017)	0.016 (0.017)
Month * farinograph water absorption	-0.034 (0.026)	-0.029 (0.025)
Month * farinograph stability	0.046* (0.018)	0.041* (0.017)
Month * dough strength vs. extensibility (P/L ratio) difference from 1	-0.005 (0.020)	-0.006 (0.019)
Month * alveograph W value	0.006 (0.009)	0.006 (0.009)
Month * bake volume	-0.007 (0.005)	-0.008** (0.005)
Grainshed 1	3.205 (2.049)	-
Grainshed 2	-2.400**	-

Table II-5. Parameter Estimates for Hard Red Winter Wheat Attributes, considering the Interaction of Month and Quality Characteristics

	(1.259)	
Grainshed 3	3.819*	-
	(1.211)	
Grainshed 4	6.578*	-
	(1.016)	
Grainshed 5	8.626*	-
	(1.845)	
Grainshed 6	-0.821	-
	(1.465)	
Grainshed 7	-0.640	-
	(1.781)	
Grainshed 8	-1.450	-
	(1.757)	
Grainshed 9	-0.497	-
	(1.059)	
Grainshed 10	-7.377*	-
	(1.162)	
Grainshed 11	-8.347*	-
	(0.981)	
Grainshed 12	-6.739*	-
	(0.941)	
Grainshed 13	-12.637*	-
	(1.412)	
Grainshed 14	0.268	-
	(1.228)	
Grainshed 15	-4.226*	-
	(0.898)	
Grainshed 16	-2.347*	-
	(0.969)	
Grainshed covariance parameter	-	25.008*
	-	(8.933)

Note: * Indicates statistical significance at the 5% level
** Indicates statistical significance at the 10% level
[a] Maximum likelihood is the estimation technique
[b] Using the PROC MIXED statement of SAS
[c] Using the PROC NLMIXED statement of SAS
Values in between parenthesis are standard errors

The combined effects of month with test weight, ash, farinograph stability, and bake volume were statistically significant. The coefficient estimate for month*test weight was positive and statistically significant, implying that the marginal value of test weight is higher in the fall and early winter (September-December).

Similarly, the coefficient estimate for month*ash was statistically significant at the 10% level and positive, suggesting that the farther away from the harvest season, the greater the marginal value for ash. Because high ash content is related with low flour yields we would expect a negative sign for ash content. The coefficient month*farinograph stability was positive and statistically significant, implying that as December approaches, the implicit value for farinograph stability increases. Finally the coefficient estimate for month*bake volume is negative and statistically significant, suggesting the closer to December is, the implicit value for bake volume is lower, which does not coincide with our expectations. Results proved that, in general, implicit values were greater as December drew near. This might be explained by the fact that, typically, during the time period from September to November Mexican millers buy more wheat than in any other season, increasing the demand and value given to specific quality attributes. This explanation is complemented with the fact that we used nearby bases. Cash prices and futures market prices tend to converge as the contract delivery month approaches. Thus for September, October, and November the delivery month is December.

Conclusions

The efficiency of the wheat marketing system is often questioned. Some studies contend that currently domestic prices do not reflect differences in quality characteristics, and prices are solely based on physical characteristics established by the FGIS. As a result of information gaps, milling companies face increased uncertainty which leads to increased cost/benefit calculations. Non-profit marketing companies such as PGI and the Portland Wheat Marketing Center were formed to provide information related to quality characteristics. Consequently, both domestic and international millers are able to access quality information not reflected in FGIS grades and standards, and reduce uncertainties when purchasing wheat.

This study attempted to estimate the implicit value of different wheat quality characteristics for hard red winter wheat, including those related with end-use functionality. In doing so we were able to assess prices differences associated with wheat quality characteristics in four states of the Great Plains region.

When considering month as an intercept shifter, the implicit value signs for ash, protein content, and bake volume were not as expected. Drought conditions during the spring of 2005, which often result in higher-than-average protein content in harvested wheat, might explain the unexpected sign for protein content. Because protein content is often used as a proxy for baking quality, the high protein of the 2005 wheat may have been given more consideration than the ash content and bake volume measured by the laboratory.

Estimated implicit values for test weight and moisture were positive and negative, respectively, and statistically significant. These results were as expected, since higher test weight is often attributed to higher flour yields per bushel of wheat and moisture is considered detrimental to both wheat and flour storability. When analyzing the interaction effect between month and each quality characteristic, implicit values for test weight, protein, ash, farinograph stability, and bake volume resulted statistically significant. The sign for the interaction of month with protein, ash, and bake volume were not as expected, whereas it was as expected for the interaction between month and test weight.

Results did not show strong evidence of the effect of end-use characteristics on basis variations. Furthermore, signs for some coefficient estimates were not as expected. These might be attributed to the short period of time considered for the analysis.
We also recognize that data availability is a concern as not all the variables that possibly have an effect on prices were available, such as transportation costs. To alleviate this condition, we included location (grainshed) as an explanatory variable, but location alone might not be fully reflecting the impacts of transportation costs since wheat from one region may be directed to different markets at different times during the marketing year.

The fact that test weight was the parameter estimate with the correct sign and statistical significance for the two approaches used indicates that for the crop year 2005 prices were mainly reflecting the FGIS grades and standards. Additionally, it is probable that the market's use of and reaction to available quality information will take years of transition. The company that provided the quality information (PGI) had been operating only for two years in 2005, with 2005 being the first year in which quality information was collected for grainsheds outside of Oklahoma. Further research might include replicating this analysis using a longer time period.

CHAPTER III

MEXICAN MILLER'S DEMAND FOR QUALITY AND CONSISTENCY ON HARD WINTER WHEAT

Introduction

U.S. wheat quality has been a controversial issue in international markets. International buyers claim that U.S. wheat quality is inferior in terms of cleanness and has greater variability in quality relative to competitors (Mercier, 1993). Competition in overseas markets has become more intense, and wheat quality has acquired prominent importance. The Federal Grade Inspection System (FGIS) is the official institution responsible for assigning U.S. grain grades and facilitating the transmission of minimum factors related to wheat quality to the market. In absence of any market failure, this information should be reflected in prices. However, FGIS grades and standards do not include an assessment of milling and baking quality characteristics deemed important to millers and bakers.

Millers' concerns about quality relate not just to the wheat quality characteristics per se, but to the variability in the quality of inputs. In presence of wheat quality inconsistency, milling machinery might not run continuously and the finished product might not have the desired characteristics. In most cases, millers adjust their production processes to conform to the quality of inputs, and each adjustment represents increased costs associated with possible interruptions in the production process, increased wheat inventories, extra wheat mixing during processing, and decreased milling by-products (Atwell, 2001; Wilson and Preszler, 1992; and Dahl and Wilson, 1999). Costs are higher for modern high-speed flour mills given their bigger production batches and more continuous processing than smaller mills (Peterson et al, 1998).

Wheat quality inconsistency both between and within shipments is attributed to differences in genetic varieties, handling and grading practices, and growing-environmental conditions (Dahl and Wilson, 1998). The U.S. wheat marketing system does not regulate varietal development and release. Thus, numerous wheat varieties coexist in the market, each one with different agronomic and end-use characteristics. Although the present marketing system enables farmers to choose genetic varieties with the best agronomic characteristics, it does not allow segregating and identifying different end-use purposes to ensure a uniform wheat quality (Mercier, 1993; Dahl and Wilson, 2003; Lavoie, 2005). Flour processing companies require wheat varieties with good baking quality characteristics; however these varieties might not have the highest yields or pest-resistance, which are the agronomic characteristics most valued by farmers. Wheat producers and handlers have some ability to control quality, but it is currently unknown whether the value of reducing variability exceeds the costs of changing production management and handling practices.

This paper focuses on the preferences of a major buyer of U.S. wheat, Mexico. As of 2007, Mexico is the third largest importer for U.S. wheat behind Egypt and Japan. From 1996-97 to 2005-06 Mexico accounted for 31% of all U.S. wheat sold to Latin America, and on average 64% of this wheat was hard red winter wheat (FAS-USDA, 2007). However, the U.S. competitiveness in Mexico is at risk. Overall U.S. wheat quality is viewed as inferior when compared with Canadian wheat, the major U.S. competitor in the Mexican market. Concerns are centered on quality variability between and within shipments, and the U.S. supply capability of meeting the protein levels that buyers expect (Mercier, 1993). Quality perceptions of U.S. wheat compared with Canadian competitors can be explained partially by the differences in the marketing system between both countries.

Brief Description of the Canadian and U.S. Grain Marketing System

Mexico represents 8% of all total wheat exported by Canada from 2003 to 2006. Of all the wheat exported, 73.87% was Canadian Western Red Spring (Canadian Commission, 2007). In Canada, the Canadian Wheat Board (CWB) is the sole agency responsible for marketing all wheat grown in Western Canada, for both domestic and international markets. The CWB also manages producer access to grain handling system including country elevators, railways, and terminal capacities. In relation to the prices paid to grain farmers, the CWB administers the government-guaranteed initial prices, reflecting overall market conditions rather than daily fluctuations in international trade. There is a system of annual average prices paid to producers or pooling. There are separate pools for each crop year and grain marketed. It is the CWB who receives the payment for all grain delivered, from this payment marketing costs are deducted; the remaining is the surplus for each pool. This surplus is distributed as a final payment on the basis of producer deliveries. In case of deficit, the *Canadian Wheat Board Act* mandates that losses would be paid out of resources provided by the Canadian Parliament (Canada Depository

Services Program, 2007). About 65.40% of all wheat exported to Mexico was exported through Pacific ports (Canadian Grain Commission, 2007).

In the U.S., once farmers harvested wheat they have several options: sell and deliver the wheat immediately to the local country elevator at current prevailing market prices, store the wheat on their own facilities or local elevators to sell later at higher prices, sell their wheat for delivery at a later date or forward contract, use their stored wheat for a non-recourse "price support" loan from the U. S. government. Regardless of the farmer’s choice, the marketing process begins when the wheat is delivered to a local elevator. These country elevators are in most cases privately owned by either large grain exporting companies or farmer cooperative associations. Once the wheat arrives to the elevator, samples are taken to determine its grade according to FGIS standards. If demanded by the market, tests on protein content and falling number are also performed. All these factors partially determine the price paid to elevators and consequently to local wheat farmers. In most cases, these prices reflect prices in major wheat markets in the U.S. such as Chicago, Kansas City, and Minneapolis. Wheat is then shipped to large central storage facilities or terminal elevators to export (Kansas Wheat Commission, 2007). Hard red winter wheat is exported to Mexico mainly through the Gulf ports and railroad (U.S. Bureau of Transportation Statistics, 2005).

Objectives

The objectives of this research are threefold. First, using a conjoint-type approach, we seek to identify the value that Mexican millers place on the level of and variability in selected hard red winter wheat attributes. Second, we compare two different approaches for characterizing Mexican millers' preferences for wheat quality attributes. Third, we test the external validity of our models by comparing the forecasted market shares with actual trade patterns, considering U.S. and Canada as countries supplying wheat to Mexico.

Background

Numerous studies have been conducted assessing the role of quality, consistency, and end-use (baking) characteristics in international markets. As mentioned in the previous chapter, one branch of research focused on determining the implicit value of wheat quality characteristics to buyers (i.e., Veeman 1987; Wilson 1989; Larue 1991; Espinosa and Goodwin 1991; Uri et al. 1994; Ahmadi-Esfahani and Stanmore 1994; Stiegert and Blanc 1997; and Parcell and Stiegert 1998).

Given the importance of quality consistency, especially in U.S. export markets, several papers have focused on quality attribute variability. Wilson and Preszler (1992) analyzed demand for wheat considering end-use functionality characteristics and found that excessive variability in wheat quality implied increased flour processing costs. They used the input characteristic model (ICM), a non-linear optimization model, where attribute variability is included as a probability distribution. The objective was to minimize the cost of producing flour using 5 different wheat types. Results suggested a positive relationship between attribute variability and costs, i.e., an increase in the farinograph water absorption variance from 9.24 to 10.24 implied a $0.64 increase in cost. Dahl and Wilson (1999) studied the effect of hard red spring wheat consistency on milling value. Probability distributions for each quality characteristic were used in a

Monte Carlo simulation. The simulation measured the milling value of wheat in three different ways: net wheat price, millable wheat index, and value added in milling. Results suggested that the reduction of moisture variability led to the greatest effect on milling value and reduction in foreign material, shrunken and broken kernels, and dockage variability had a smaller effect.

In this paper, we move beyond this previous literature by directly eliciting milling companies' preferences for wheat characteristics, both level and variability, by using an innovative combination of conjoint analysis, in which variability in attribute levels is explicitly introduced, and the random utility model modified to incorporate risk preferences. Previous research has relied on the use of historical, time series data to investigate wheat quality and quality variability.[3] One advantage of such an approach is that the data represent actual transactions make in real markets. A disadvantage, however, is that analyses based on time-series data can suffer from endogeneity and identification problems, measurement error, and omitted variable bias. These difficulties can be overcome by using survey-based methods where variables of interest are explicitly defined and are exogenously varied according to a pre-defined experimental design that ensures causality can be identified. This is not to say that our stated-preference survey method is *the* best approach for studying these issues, but as has been recognized in the environmental economics and marketing literatures, much can be learned by studying revealed *and* stated preferences.

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[3] One exception is the study by Pick et al. (1994) that used primary data. Their study focused on buyers' perceptions of the importance of a quality characteristic in Mercier and their suppliers' ability to provide that quality characteristic.

Conceptual Framework

To elicit milling companies' preferences, we rely on the random utility framework. A miller's utility is assumed to consist of a systematic component and a random component:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{3.1}$$

where U_{ij} is the utility derived from the j^{th} wheat alternative by the i^{th} miller, V_{ij} is the systematic component which is a function of the attributes of wheat alternative j, and ε_{ij} is a random component which accounts for all factors influencing an individual preference that cannot be observed. Consumers are assumed to choose the alternative that yields the highest utility.

A departure we make from typical random utility models is that we assume uncertainty exists in the one or more of the attributes, making V_{ij} stochastic. One way to model consumer preferences for uncertainty is the mean-variance approach. This framework assumes people evaluate outcomes based on the mean attribute level and its variance - the first two moments of the probability distribution. The assumption of mean-variance preferences produces a simple functional form for the utility function, V_{ij}, which is linear in parameters. In particular, assuming wheat option j can be characterized by K non-price attributes, each of which is independently distributed, mean-variance preferences imply:

$$V_{ij} = \alpha_j + \sum_{k=1}^{K} \beta_k mean_{ijk} + \sum_{k=1}^{K} \varphi_k \, \mathrm{var}_{ijk} + \gamma Price_j \tag{3.2}$$

where α_j is an alternative-specific constant, $mean_{ijk}$ represents the expected value of attribute k (as will be discussed later attributes are factors like: test weight, protein, falling number, farinograph stability, alveograph P/L ratio, and kernel diameter), var_{ijk} is the variance of each quality attribute, $Price_j$ is the price of alternative j, β_k is a parameter related to the marginal utility of the expected value of attribute k, φ_k is a parameter characterizing people's preferences for risk in attribute k, and γ is a parameter representing the marginal utility of income.

Although the mean-variance approach is relatively easy to implement and the associated parameters can be estimated using standard statistical software packages, the assumptions underlying the model may not be valid. The mean-variance approach is consistent with expected utility theory assuming: (a) the decision maker's utility function is quadratic in the attribute, (b) the random attribute is normally distributed, and (c) the utility function is a monotonic linear function of a single random variable (Liu 2004; Hanson and Ladd 1991). However, Collins and Gbur (1991) note these assumptions are often violated. For example, the quadratic utility function violates the non-satiation axiom and continuously increasing risk aversion is often implausible. Further, the assumption of normally distributed attributes can be violated. For example, in our survey context, it is much easier to describe a uniformly distributed attribute to survey participants than a normally distributed attribute.

To address these concerns, we move beyond the mean-variance model and also report results from an explicit expected utility specification where the decision maker's utility of each attribute is assumed to take a negative exponential functional form and where, consistent with our empirical approach, the attributes are uniformly distributed. In particular, for each attribute k, we assume individuals evaluate the attribute according to the familiar negative exponential utility form: $u_k = -e^{-r_k x_k}$, where x_k represents the level of attribute k, and where r_k captures preferences toward risk for attribute k. In particular, r_k represents the Arrow-Pratt coefficient of absolute risk aversion, where $r_k > 0$ implies risk aversion for attribute k, $r_k = 0$ implies risk neutrality, and $r_k < 0$ implies risk seeking in attribute k. In general, the expected utility from attribute k can be written as:

$$E[u_k(x_k)] = \int_{-\infty}^{+\infty} u_k(x_k) g_k(x_k) dx_k \tag{3.3}$$

where $g_k(x_k)$ is the probability density function describing the randomness in x_k. Now if we assume that x_k is uniformly distributed on the interval $[a_k, b_k]$ and that the person's utility for attribute k can be described by the negative exponential form, equation (3.3) can be re-written as:

$$E[u_k(x_k)] = \int_{a_k}^{b_k} -\frac{e^{(-r_k x_k)}}{b_k - a_k} dx_k \tag{3.4}$$

Evaluating the integral in equation (3.4) yields[4]

$$E[u_k(x_k)] = -\frac{e^{-r_k a_k} - e^{-r_k b_k}}{r_k(b_k - a_k)} \tag{3.5}$$

Because each of the attributes in our study were designed to be independently distributed, miller i's utility for wheat option j is additively separable in the expected utility of each of the k random attributes. In particular, the systematic portion of the utility function is:

$$V_{ij} = \alpha_j + \sum_{k=1}^{k} \lambda_k \left(-\frac{e^{r_k a_k} - e^{r_k b_k}}{r_k(b_k - a_k)} \right) + \gamma Price_j \tag{3.6}$$

[4] Our approach is equivalent to that followed in Yassour, Zilberman, and Rausser (1981) who illustrate the expected utility of wealth assuming a negative exponential utility function and the moment generating function for a variable following any distribution.

where λ_k, is a parameter related to the marginal expected utility of attribute k, and all other variables and parameters are previously defined.

Regardless of whether equation (3.2) or equation (3.6) characterizes the systematic portion of the utility function, it is assumed that miller i chooses the option j, out of a subject of J total options that is most desirable. The probability that option j is chosen over all competing options is the probability that $V_{ij} + \varepsilon_{ij} > V_{iq} + \varepsilon_{iq} \ \forall \ q \neq j$. If the error terms, ε_{iq}, are distributed type I extreme value, then Louviere, Hensher, and Swait (2000) show the probability option j being chosen out of J total alternatives is:

$$\text{(3.7)} \qquad \text{Prob (option } j \text{ is chosen)} = \frac{e^{V_{ij}}}{\sum_{q=1}^{J} e^{V_{iq}}}$$

Equation (3.7) describes the familiar multinomial logit model. For the mean-variance preferences case, equation (3.2) is substituted into equation (3.7). In the case of the specification assuming negative exponential preferences with uniformly distributed attributes, equation (3.6) is substituted into (3.7). With either approach the parameters of the model are obtained by maximum likelihood estimation.

Methods

An in-person survey was administered to buyers of major wheat milling companies in Mexico in January and February, 2007. CANIMOLT, the Mexican National milling industry association, provided a list with the major wheat millers in Mexico. With the assistance of CANIMOLT, 14 milling companies were contacted and surveyed, the majority of which were located in Mexico City. According to CANIMOLT, the milling capacity of the 14 companies in our sample is 17,577 MT/day and the total milling capacity in all of Mexico is 24,848 MT/day. Hence, our respondents represent 71% of the total Mexican wheat milling capacity and represents 80% of all the wheat imported into Mexico from the U.S. Thus, although the sample size is somewhat small in terms of the number of respondents, the measured preferences are responsible for the vast majority of U.S. wheat imports. To ensure high-quality, reliable responses, personal interviews were conducted with either the purchasing manager or the quality control chief for each of the 14 companies.

Survey Design

Previous literature and experts in wheat milling were consulted to identify the wheat quality attributes to include in this study. The selected attributes were test weight, protein content, falling number, farinograph stability, P/L ratio, and kernel diameter. There might be some correlation between this attributes, as demonstrated in the previous chapter. For this study purposes and ease of estimation, we assume no correlation between attributes. Each of the attributes was described in the previous chapter, except for falling number and kernel diameter.

Falling number is the measure of enzyme activity and is an indicator of wheat soundness or sprouting absence. Low values of α-amylase imply sprout-damaged wheat and can be corrected by adding extra enzyme during milling which represents an extra cost. Whereas falling number high values are detrimental to the dough handling properties and bread crumb texture (Atwell, 2001). Kernel diameter is the measure in millimeters of wheat kernels at their widest point, and is an indicator of flour extraction. The greater the kernel diameter, the greater the endosperm and the higher the flour extraction. Millers prefer a larger kernel diameter; however they express a greater concern for the consistency of the kernel size. The milling process can be adjusted for either big or small wheat kernels; repeated adjustments require extra time and costs (Lyford and Starbird, 2000).

The goal of the survey design was to create a variety of possible wheat options that differed according to each of the six quality attributes just described and ask the millers to indicate the relative desirability of each wheat option. Most conjoint analysis of this sort simply varies each attribute across several different levels, but because concerns for consistency were of importance in this analysis, we had to vary the *distribution* of each attribute. For each attribute, k, we specified a uniform distribution defined on the interval $[a_k, b_k]$. For each attribute, we wished to vary both the mean and the variability independently so that the effects of both could be identified. As such, four possible distributions were created for each attribute: high variability/high mean, high variability/low mean, low variability/high mean, and low variability/low mean. These variability/mean levels were chosen for each attribute simply by varying the bounds, a_k, b_k, on the uniform distribution.

Thus, there are six attributes, each varied at four levels. Added to this was a price attribute, varied at two levels ($170/MT or $180/MT). This means there are 4^6 x 2 = 8,192 possible wheat descriptions that could be created. This, of course, is far too many combinations for any survey respondent to reasonably evaluation. As such, a main-effects fractional factorial design was used to select 32 different combinations, which were paired to create choice options. It was further felt that 32 choice questions might be too lengthy for the respondent, so two survey versions were created, each with 16 choices.

Prior to personally administering the survey, a cover letter was sent to explain the study. The cover letter informed respondents about the purposes of the student and ensured respondents of the confidentiality of their responses. In the letter, the mill's quality control chief, purchasing agent or equivalent was asked to complete the survey. Each survey contained 16 choice questions, and each in choice question, there were three alternatives (two of wheat options and a third "I wouldn't choose either of these options"). The survey is attached in Appendix A.

Results

Mean-Variance Specification

Table III-1 reports results from the mean-variance specification. As expected, changes in the mean levels of test weight, protein, falling number, farinograph stability, and P/L ratio significantly increased Mexican millers' utility. Changes in mean kernel diameter were not statistically significant. Although most the coefficient estimates associated with the attribute standard deviations were negative (indicating millers, independent of quality levels, dislike variability in wheat quality attributes) none of the estimates were statistically significant, a result which stands in stark contrast to expressed concerns about quality variability.

That the alternative specific constants for alternatives A and B were negative, implies that the millers were more likely to choose the third, "I would not buy either option" than either of the wheat options. This behavior implies unwillingness on the part of the millers to choose a wheat option unless it possesses certain quality characteristics.

Table III-1. Multinomial Logit Estimates for the Mean-Variance Approach

Attribute	Parameter Estimate
Intercept (Option A)	-43.590*[a] (10.700)[b]
Intercept (Option B)	-43.549* (10.708)
Price ($/MT)	-0.027 (0.023)
Test weight (kg/hl)	0.403* (0.113)
Test weight standard deviation	0.386 (0.379)
Protein 12% moisture base (%)	0.617* (0.118)
Protein standard deviation	-0.091 (0.433)
Falling number 12% moisture base (%)	0.006* (0.002)
Falling number standard deviation	-0.011 (0.014)
Farinograph stability (min)	0.282* (0.057)
Farinograph stability standard deviation	-0.242 (0.216)
Dough strength vs. extensibility (P/L) ratio	1.930* (0.934)
Dough strength vs. extensibility (P/L) ratio standard deviation	-1.469 (2.742)
Kernel diameter (mm)	1.264 (0.816)
Kernel diameter standard deviation	-0.600 (1.645)

Number of observations = 224; Log likelihood value = -206.819; Pseudo R^2 = 0.160

[a] One (*) indicates statistical significance at the 5% level
[b] Numbers in parenthesis are standard errors

Table III-2 reports marginal willingness-to-pay estimates for each wheat and dough quality characteristic.

Table III-2. Willingness-to-Pay Estimates for Hard Red Winter Wheat Quality Characteristics from the Mean-Variance Approach

Willingness-to-Pay for a marginal change in …	Willingness-to-Pay ($/MT)
Test weight (kg/hl)	15.150
Test weight standard deviation	14.526
Protein (%)	23.214
Protein standard deviation	-3.421
Falling number (sec)	0.213
Falling number standard deviation	-0.406
Farinograph stability (min)	10.620
Farinograph stability standard deviation	-9.098
Dough strength vs. extensibility (P/L) ratio	72.560
Dough strength vs. extensibility (P/L) ratio standard deviation	-55.222
Kernel diameter (mm)	47.538
Kernel diameter standard deviation	-22.560

Marginal willingness-to-pay is the amount of money the individual would have to give up to be indifferent between towards a one-unit increase in the quality characteristic. This statistic is easily calculated by dividing the quality characteristic coefficient by the price coefficient (multiplied by negative one). Results indicate that Mexican milling companies are willing to pay the most for a marginal increase in P/L ratio, protein content, and test weight ($72.56/MT, $23.21/MT, and $15.15/MT, respectively).

Results coincide with our expectations that the milling industry have an expressed interest in end-use quality characteristics (i.e., dough P/L ratio). Nonetheless, Mexican millers still exhibited considerable willingness-to-pay values for wheat quality characteristics that are typically measured during the purchasing transaction (i.e., protein and test weight).

Results for the marginal value of protein content, $23.21/MT are similar to previous results from a study by Wilson (1989), who determined that a premium for protein for hard red winter wheat in the CIF Rotterdam market was $21/MT. The results are considerably higher than the findings of Parcell and Stiegert (1997), who suggested a $0.218/bushel ($8.04/MT) protein premium for the North Dakota and Kansas markets. However, any comparisons to previous studies should be made with caution due to the different data sources, geographic regions, time periods, and methodologies employed.

As expected all willingness-to-pay estimates for wheat quality variability, except for test weight, were negative. This means millers would have to be compensated by the amount shown to accept the higher level of variability. Although none of these coefficients were statistically significant, their signs indicated that Mexican milling companies are willing to discount prices when wheat quality is highly variable. The positive sign for test weight standard deviation might be associated with the lower limit of 77 kg/hl for wheat to be grade 2 or better. It appears that Mexican buyers do not show great concern for the variability of test weight as long as this value is equal to or greater than 77 kg/hl.

Although estimates of marginal willingness-to-pay are of interest, one might be interested in estimating the value of moving from “low” to a “high” level of each attribute over the range that is typically observed in reality. Thus, table III-3 reports values to from the lowest mean level (or lowest standard deviation) to the highest level employed in the conjoint survey.

Table III-3. Willingness-to-Pay for a Higher Level of a Hard Red Winter Wheat Quality Characteristic - Mean-Variance Approach

Willingness-to-Pay for …	Willingness-to-Pay ($/MT)
Test weight (kg/hl): 78 versus 80	30.301
Test weight standard deviation: 0.29 versus 0.87	8.382
Protein (%): 11 versus 13	46.428
Protein standard deviation: 0.29 versus 0.87	-1.974
Falling number (sec): 300 versus 400	21.297
Falling number standard deviation: 8.66 versus 25.98	-7.033
Farinograph stability (min): 9 versus 13	42.481
Farinograph stability standard deviation: 0.58 versus 1.73	-10.508
Dough strength vs. extensibility (P/L ratio): 0.85 versus 1.1	18.140
Dough strength vs. extensibility (P/L ratio) standard deviation: 0.03 versus 0.12	-4.749
Kernel diameter (mm): 2 versus 2.3	14.261
Kernel diameter standard deviation: 0.03 versus 0.17	-3.249

These willingness-to-pay estimates are obtained by multiplying the marginal willingness-to-pay by the difference between the high and low quality level. Results indicate that Mexican milling companies are willing to pay the most for an increase in protein content from 11% to 13%, for an increase in farinograph stability from 9 min to 13 min, and for an increase in test weight from 78 kg/hl to 80 kg/hl, willingness-to-pay are $46.23/MT, $42.48/MT, and $30.30/MT, respectively. The greatest discount was given to increased variability in farinograph stability followed by falling number.

Negative Exponential Preferences

Results assuming negative exponential preferences and uniformly distributed attributes are reported in table III-4. Because the model was highly non-linear in parameters, each attribute level was scaled so that the mean levels equaled one to help facilitate model convergence. Standard errors for each parameter estimate were calculated by using the delete-1 jackknife variance estimator as developed by Efron (1979).

As expected, the sign for the price coefficient was negative and statistically significant. The coefficients associated with the marginal expected utility of test weight, protein, and farinograph stability were statistically significant and positive. The coefficients related to the coefficients of absolute risk aversion for falling number, P/L ratio and kernel diameter were statistically significant and positive. This suggests risk aversion over these attributes (i.e., the utility function for these attributes is concave). Estimates for the absolute coefficient of risk aversion vary from 0.215 to 7.587, implying that Mexican millers concern for variability differs for each wheat quality attribute.[5]

[5] The magnitude of these risk aversion coefficients is not dissimilar to some estimates of farmer's levels of risk aversion reported in the literature (e.g., see Abdulkadri, Langemeier, and Featherstone, 2003). However, we note most estimates of coefficients of risk aversion reported in the literature deal with the curvature of the utility function over wealth – something very different than curvature of the utility function over wheat quality attributes.

In other words, respondents exhibit a more concave or more risk averse preference for falling number, kernel diameter, and P/L ratio rather than for test weight, protein, and farinograph stability.

Table III-4. Multinomial Logit Estimates - Negative Exponential Expected Utility Model

Attributes	Parameter Estimates
Intercept (Option A and B)	79.813*[a] (35.554)[b]
Price ($/MT)	-4.595* (0.279)
Test weight (kg/hl)	84.657* (30.334)
Test weight risk aversion coefficient	0.807 (1.776)
Protein 12% moisture base (%)	42.375* (15.954)
Protein risk aversion coefficient	0.215 (0.212)
Falling number 12% moisture base (%)	394.395 (862.577)
Falling number risk aversion coefficient	7.587* (3.406)
Farinograph stability (min)	11.424* (1.109)
Farinograph stability risk aversion coefficient	2.111 (17.327)
Dough strength vs. extensibility (P/L) ratio	15.007 (74.390)
P/L ratio risk aversion coefficient	3.302* (1.727)
Kernel diameter (mm)	84.788 (140.833)
Kernel diameter risk aversion coefficient	5.163* (2.655)

Number of observations = 224; Log likelihood value = -208.375; Pseudo R^2 = 0.153
[a] One (*) indicates statistical significance at the 5% level

[b] Numbers in parenthesis are standard errors

Willingness-to-pay estimates associated with a change in the attribute from the "low" to the "high" levels assuming negative exponential utility are shown in table III-5. Values for changes in the mean quality characteristic level, keeping the variability constant, were determined by calculating the price difference between two simulated wheat options, one with a specific level of quality characteristics (U_0) and the other with another level (U_1) that causes $U_0=U_1$. We similarly calculated willingness-to-pay for a change in variability holding the mean level constant.

Table III-5. Willingness-to-Pay Estimates for a Change in Hard Red Winter Wheat Quality Characteristics – Negative Exponential Expected Utility Model

Quality characteristic	Willingness-to-pay ($/MT)
Test weight: 78 kg/hl versus 80 kg/hl	0.168
Test weight standard deviation: 0.289 versus 0.866	0.000
Protein 12% moisture base (%): 11% versus 13%	0.267
Protein 12% moisture base standard deviation: 0.289 versus 0.866	-0.001
Falling number 12% moisture base: 300 sec versus 400 sec	0.110
Falling number 12% moisture base standard deviation: 15 versus 45	-0.018
Farinograph stability: 9 min versus 13 min	0.238
Farinograph stability standard deviation: 0.333 versus 3	-0.022
Dough strength vs. extensibility (P/L ratio): 0.85 versus 1.1	0.105
Dough strength vs. extensibility (P/L ratio) standard deviation: 0.001 to 0.013	-0.013
Kernel diameter: 2 mm versus 2.3 mm	0.079
Kernel diameter standard deviation: 0.001 to 0.030	-0.013

Mexican millers were willing to pay the most for an increase in protein from 11% to 13%, increase in farinograph stability from 9 min to 13 min, and for an increase in test weight from 78 kg/hl to 80 kg/hl. The willingness-to-pay was \$0.238/MT, \$0.267/MT, and \$0.168/MT, respectively. The quality attributes with the highest willingness-to-pay coincide the attributes over which millers exhibit the least level of risk aversion (i.e., protein content, farinograph stability, and test weight). The willingness-to-pay values reported in table III-5 are considerably smaller when assuming risk aversion than when risk neutrality; however, they are not outside the range of values reported in the literature (e.g., Wilson (1989) identified a \$21/MT premium for an additional unit of protein for hard red winter wheat considering Rotterdam CIF (including cost, insurance, and freight) prices. Larue (1991) found a \$1.65/MT premium for an additional unit of protein for medium protein wheat.

Wilson and Preszler (1992) estimated that an increase in farinograph absorption, farinograph peak time, and extraction rate variability implied respectively a \$0.91/MT, \$0.93/MT, and a \$1.18/MT increase in flour production costs). Willingness-to-pay for a change in attribute variability holding the mean level constant is also reported in table III-5. The values are negative indicating millers must be compensated to accept higher levels of variability. Willingness-to-pay to reduce variability was very small: less than 3 cents for metric ton in all cases. The small size of the willingness-to-pay values for changes in attribute variability concur with the findings from the mean-variance approach, which indicate that none of the coefficient estimates for attribute standard deviation were statistically significant, implying that contrary to expressed concerns about U.S. quality variability greater emphasis is placed on attribute mean levels.

Market Share Estimation

The preceding results illustrate that the two modeling approaches yield very different results. Which model specification is most appropriate? Is either model reliable? Answering this latter question is particularly important as survey results are often looked on with a suspicious eye. To answer these questions, we investigated the external validity of the survey estimates by comparing forecasted market share of U.S. and Canadian wheat purchased by Mexican millers to the actual market share observed in 2006.

To obtain market share estimates, levels of each of the quality attributes had to be obtained for U.S. and Canada. We used the production-weighted average values for the quality characteristics from different wheat growing regions in both U.S. and Canada correspondent to the 2006 crop year, see table III-6. Values for both U.S. wheat quality attributes and production volume for each region were obtained from the U.S. Wheat Associates 2006 wheat crop quality report[6]. For Canada, the quality information was obtained from the Canadian Grain Commission 2006 crop quality data, and the production volume for each region was obtained from the National Canada Statistical Agency. Because, reports for kernel size for Canadian wheat were unavailable, we used the same values as for the U.S.

[6] The crop year for U.S. Hard Red Winter wheat starts in June and ends in May of the next year, whereas the crop year for Canadian Western Red Spring starts in August and ends in July of the subsequent year.

Prices for both U.S. and Canada were obtained respectively from U.S. Wheat Associates 2006 and Canadian Grain Commission price reports. U.S. prices were Freight on Board (FOB) measured at the Gulf of Mexico.

Table III-6. 2006 Average Quality Characteristics by Region in the U.S. and Canada

State/Region	Participation in country production	Test weight	Protein	Falling number	Farinograph Stability	P/L ratio	Kernel diameter
			United States				
Kansas	43%	78.790	13.870	393.900	12.600	0.738	2.285
Oklahoma	16%	80.443	13.729	387.286	11.429	0.867	2.289
Texas	11%	78.940	14.220	376.600	9.800	0.632	2.156
Colorado	9%	78.000	14.067	389.667	10.167	0.773	2.083
Nebraska	8%	78.620	13.100	382.400	14.400	0.702	2.156
Montana	6%	83.000	12.600	393.000	13.500	0.860	2.315
South Dakota	6%	81.100	12.900	418.500	17.250	0.630	2.225
Wyoming	1%	78.500	12.800	354.000	13.000	0.770	2.010
Weighted Average		*79.375*	*13.697*	*390.661*	*12.367*	*0.748*	*2.238*
			Canada				
Prairies	97%	81.086	13.729	388.571	11.607	1.011	
Ontario	3%	80.600	13.450	347.500	10.000	1.300	
Weighted Average		*81.071*	*13.720*	*387.339*	*11.559*	*1.019*	

While we are aware that there is a considerable amount of cereals exported to Mexico through rail[7], we use FOB Gulf prices because of its availability. As for Canada, 65% of the wheat exported to Mexico goes through a port in the Pacific and 17% goes through an

[7] The Bureau of Transportation Statistics (2005) reports that in 2005, 55% of a total of U.S.$ 1,650 millions in cereal commodities were exported to Mexico through rail and 45% through vessel.

Eastern Port. FOB prices for both regions were obtained and the price used was a weighted average for 2006. Both U.S. and Canadian prices included transportation costs from the shipping port to the point of entrance in Mexico. For the U.S. the 2006 transportation cost was $18/MT for a 40,000 MT vessel size for the route U.S. Gulf – Veracruz, Mexico (U.S. Grains Council, 2007). For Canada, because there were no data available on transportation costs from the Pacific Coast to Mexico, we used the ocean vessel freight rate from the U.S. Pacific Northwest to the Manzanillo, Mexico: $50/MT (Personal communication with John Oades, U.S. Wheat Associates at Portland, 2007).

Market shares were estimated for both model specifications considered in the analysis, and were obtained by substituting the levels of each quality attribute into either equation (3.2) or (3.6), depending on the model specification for both U.S. and Canada (i.e., the two wheat options), which were then substituted into equation (3.7).

Table III-7 reports the estimated market shares and the actual wheat volumes imported into Mexico from U.S. and Canada during 2006. Predicted imports of U.S. wheat from the mean-variance model (66.98%) are very close to the actual share of U.S. imports reported by CANIMOLT reports that for year 2006 (64%). Forecasted market shares from the negative exponential model were not as accurate (54.69%).

Table III-7. Market Share Estimates for U.S. Hard Red Winter Wheat versus Canadian Hard Red Spring Wheat

	Percentage Imported From the U.S.	Percentage Imported From Canada
Forecasted Mexican wheat imports predicted by the mean-variance model	66.978%	33.022%
Forecasted Mexican wheat imports predicted by the negative exponential model	54.686%	45.314%

Actual Mexican wheat imports in 2006	63.670%	36.330%

This result may have been obtained because this specification does not capture millers' preferences as well as the mean-variance model. Alternatively, perhaps the assumptions we made to derive the model forecasts for the negative exponential were inappropriate. In particular, the negative exponential model (assuming uniform distributions for each attribute) requires an upper and lower bound for each attribute. Such data are difficult to come by in practice (especially when dealing with volume-weighted averages). To establish these bounds in the U.S. and Canada we added and subtracted from the mean, the standard deviation multiplied by 1.96 (which would yield the upper and lower 95% confidence intervals of a normal distribution).

The results in table III-7 reveal two important outcomes. First, the mean-variance model exhibits better out-of-sample forecasting performance than the negative-exponential expected utility model. Second, the mean-variance model yield exhibits high external validity (i.e., forecasted market shares are very similar to true shares), a finding which increases the confidence we can place in the results disseminating from this survey approach.

Conclusions

This study used primary data from a group of Mexican millers to determine the millers' preferences for quality characteristics including those related with end-use performance and attribute variability. Data were analyzed using two modeling approaches, one the mean-variance approach where utility is assumed to be a linear function of the mean level and variance of a quality attribute. The second approach assumed that utility for each attribute was negative exponential and attribute variability followed a uniform distribution (the latter of which is strictly true given that our survey described each attribute as uniformly distributed). Model forecasts reveal that the mean-variance approach yielded a higher level of external validity and generated estimates quite similar to actual trade patterns.

Results suggested that Mexican millers were willing to pay premiums for increases in quality factors such as test weight, protein content, falling number, and dough strength/extensibility characteristics given by the farinograph stability and P/L ratio. Unlike the argument made in several previous studies (e.g., Wilson and Preszler, 1992), we did not find strong evidence that millers were particular concerned with quality variability.

The number of observations used in this study (14 surveys) might seem limited, however the respondents represent over 71% of Mexico's total wheat milling capacity. This study gives an assessment of Mexican millers' wheat quality requirements and in so doing should assist U.S. wheat breeders and marketers to better target Mexican customers. These results should also assist in efforts of wheat growers associations to increase/maintain the market share in international markets such as Mexico and help alleviate concerns about U.S. wheat quality and consistency.

CHAPTER IV

EFFECT OF PUBLICLY RELEASED INFORMATION ON MEXICAN MILLER'S WELFARE

Introduction

Mexico has become more dependent on wheat imports to meet its increasing domestic demand. The United Nations' Food and Agriculture Organization (FAO 2007) reports that Mexican wheat imports increased from 442,800 MT to 4,066,500 MT during the period 1990-2005. A factor contributing to the increase in wheat imports is the disparity between the type of wheat prominently domestically produced and the one demanded. Mexico's main wheat production is the durum type which is primarily used for noodles and pasta, and the most domestically demanded is hard wheat suitable for bakery products. The Department of Agriculture, Livestock, and Rural Development in Mexico (SAGARPA 2007) established that the average production for durum wheat was 5,244,113 MT compared with 520,423 MT of hard wheat for the period 2000-2006.

Other factors contributing to the increase in wheat imports are the increasing population and decreasing wheat production areas. According to the National Institute of Statistics, Geography, and Informatics of Mexico (INEGI 2007), Mexico's population in 1980 was 67.9 million and in 2005 was 103.3 million. SAGARPA (2007) reported that for 1980-1994 the average wheat production area was 1,026,042 has while for 1995-2005 was 731,798 has.

Mexico is a recognized wheat trade partner for the U.S., being the third largest wheat importer, ranked after Egypt and Japan. It is also the largest single-country buyer of U.S. hard red winter wheat from the Southern Plains. The North American Free Trade Agreement (NAFTA) has noticeably influenced Mexican wheat imports from the U.S. One NAFTA agreement was to annul all wheat import tariffs from the U.S. and Canada to Mexico beginning 2004. Additionally, U.S. and Canadian producers have technology related advantages over Mexican (Mejía and Rosales 2004).

During 1997-2007 Mexico imported 24,525,756 MT of wheat from the U.S. and 10,206,818 MT from Canada (FAS/USDA 2007, Statistics Canada 2007). The U.S. has a distance advantage over Canada, being able to offer more competitive prices given the lower transportation costs. Additionally, Mexican millers show preference for rail over ocean vessel transportation, and the well-established rail system between U.S. and Mexico is another factor favoring U.S. exports (personal interviews with selected Mexican millers 2007). Meanwhile, Canadian producers' advantage is the consistent quality given by a strong export regulatory board (Lavoie 2005; Mejía and Rosales 2004).

Despite the U.S. farmers' advantages in the Mexican wheat market, U.S. wheat quality has been questioned over the past two decades. Mexican milling companies' main claim is the lack of consistency in U.S. wheat quality, especially in wheat transported by ocean vessels. Another claim is that the quality of wheat received does not always coincide with the quality specifications prior to shipment (personal interviews with selected Mexican millers 2007). The current U.S. marketing system adds little to supply thorough quality information to foreign clients; grades and standards are based on physical characteristics including test weight, damaged, shrunken, and broken kernels, foreign material, and total defects. Physical characteristics are indicators of flour extraction rates, giving little or no information about end-use (baking) characteristics, which is of interest to the millers striving to meet their clients' requirements (Lyford et al. 2004).

U.S. wheat marketers recognize the need to adjust to new tendencies in the international wheat market and traders, as they can no longer expect to sell wheat based solely on the normal grades and standards. However, contrasting evidence is shown by studies analyzing the possibility of adjusting existing standards, which concluded that to modify the established system would be more costly than effective (Mercier 1993). Additionally, it is not possible to include end-use quality information in every transaction made in the market. There are no "quick" methods to conduct such analyses and the existing methodology demands considerable investment and time. An alternative to this situation might be to identify wheat quality characteristics by regions across the U.S. and provide this information to foreign buyers.

To address the informational gaps in the system, non-profit wheat marketing companies were created (e.g., the Wheat Marketing Center in Portland, OR and Plain Grains Inc. in Stillwater, OK). Plains Grains Inc. (PGI) is an organization designed to assist producers, millers, and bakers by providing geographically-determined quality information for each year's hard red winter wheat crop. They facilitate sampling and quality testing of hard red winter wheat from the production area of Texas, Oklahoma, Kansas, Nebraska, Colorado, South Dakota, and Montana. The disaggregated regional quality information is published for every crop year on both the PGI and the U.S. Wheat Associates websites. In addition, PGI conducts workshops, open to all members in the marketing chain, to educate them in the importance of grain quality parameters on the baking process (Regnier and Holcomb 2004).

The effect of non-profit marketing companies on wheat import demand has not yet been estimated, partially attributable to the recent beginning of operations, i.e., PGI began operations in 2004. In this study we model the effect of accessibility to quality information on Mexican milling companies' welfare. Two factors lead us to use marketing expenditures as a proxy to model access to information: a marketing company's main objective to increase foreign wheat buyers' awareness of U.S. wheat quality, and the difficulties in finding historical data related with foreign millers' accessibility to wheat quality information and the evolution of their perceptions towards quality.

Background

This study's main objective is to estimate the information effect, measured by marketing expenditures, on Mexican milling companies' welfare. The analysis consists of two steps: first, to model wheat imports in Mexico, and second, to estimate the value of information by measuring the changes in the mills' welfare as a result of the marketing expenditures.

Several studies have been conducted to model imports and exports of commodities. Overall the Armington, Rotterdam, and Almost Ideal Demand System (AIDS) models are the most widely used to analyze demand systems for agricultural commodities. The validity of these methods to model import demand systems is clearly recognized, however most of them are compatible for final goods, in other words they are based on consumer theory. Wheat is an intermediate good as it will be used as an input for flour production and flour will be used as an input for the final baked good, then it is more appropriate to model wheat import demand based on production theory. This statement is not meant to imply that all consumer theory-based studies of wheat trade are without merit. Notable exceptions to this statement include the study by Lee, Koo, and Krause (1994), which used AIDS to model Japanese wheat import demand. They stated that because import quantity restrictions are imposed, the buying decision is based on minimizing expenditures on imports rather than maximizing processors' profit.

There are, however, studies that support the assertion that wheat should be considered as an input into production for market studies. Koo, Mao, and Sakurai (2001) used a production theory approach to model the wheat import demand in the Japanese flour milling industry. They used a translog cost function and found that the Japanese import demand for wheat is highly elastic for high quality and protein content. Lavoie (2005) developed a model considering wheat as a vertically differentiated intermediate product to estimate the effect of a monopolistic market structure on U.S. wheat exports. The model included different wheat quality degrees as an element in the import demand system to infer if the Canadian Wheat Board (CWB) conducted price discrimination. Results showed that the CWB charged different prices to different countries for the same wheat quality.

As mentioned previously this paper adds to base of previous wheat import demand studies by incorporating the effect of accessibility to quality information on mill's welfare. We built this analysis on the seminal papers by Foster and Just (1998) And Teisl, Bockstael, and Levy (2001). The former study estimated the effect of information on consumer's welfare based on compensating surplus (CS) and compensating valuation (CV) concepts. An expenditure function using different combinations of prices prior and after a case of milk contamination was used to measure the effect of not releasing the contamination episode on time. They found that consumer loss was $9.88 per person for each month they did not know about the contamination. Teisl, Bockstael, and Levy (2001) applied a similar methodology to measure the impact of labeling information on consumer welfare. They found that consumer welfare losses for ignoring nutrition information in the label of six food products including milk, cream cheese, peanut butter, mayonnaise, and salad dressing, were in the range of $0.002 to $0.849 per person per month.

The problem addressed in this study differs from the two studies described above, in that we attempt to measure the effects on firms' processing costs of an uncertain change in input quality. The change might happen and if so, it can be either an improvement or a detriment. Also, this study applies the CS and CV concepts to a firm environment, as the firm's indirect cost function is used, instead of the consumer expenditure function, to estimate welfare changes as a result of the accessibility to quality information given by marketing companies. The variations in welfare will be equivalent to the cost of ignorance or the value of information.

Conceptual Framework

The first assumption of the model used in this study, is that firms (i.e., Mexican milling companies) are cost minimizing entities. Milling companies' objective function is given by:

(4.1) $$\min_{x} C = C(x, w, q) \text{ subject to } y = f(x)$$

where C is the cost function, x represents the vector of inputs, w represents the vector of input prices, y is the output level, and q is the quality of input x. Quality is uncertain and its probability distribution is described by the parameters θ.

Choosing x to minimize equation (4.1), solves for the optimal x^*. Replacing in (4.1) yields the indirect cost function given by $C(w, \bar{Y}, \theta)$ where $\bar{Y}$ is the optimal output required to minimize cost. There is a change in input quality from θ_0 to θ_1, where $\theta_0 \neq \theta_1$. Assuming perfect information implies that firms are aware of the change, and welfare gains are captured by the difference between the firms' cost associated with θ_0 and θ_1. In other words, if firms have perfect information, they will be able to adjust their use of input from x_0 to x_1 when quality changes from θ_0 to θ_1. In this case, gains are represented by the compensating variation (CV):

(4.2) $$\text{CV} = C(w_0, \bar{Y}_0, \theta_1) - C(w_0, \bar{Y}_0, \theta_0)$$

What if firms are not informed about the adjustment in the input quality? If firms are not aware of the change in quality of x they might not modify their behavior and still purchase the same input quantities, resulting in no welfare losses for them. Foster and Just (1998) approached this issue by estimating the cost of ignorance, a measure of the welfare effect of changing quality under imperfect information. When firms are not aware of a quality change, they experience fewer gains or great losses than in equation (4.2); depending on the nature of the change in quality[8]. Because they are uninformed, they do not adjust their use of inputs, and buy the same quantities with a quality level different from what they expected. The welfare gain/loss of the uninformed firm is given by the compensating surplus (CS) measure:

$$\text{(4.3)} \qquad \text{CS} = \widetilde{C}(w_0, \overline{Y}_0, \theta_1; x_0) - C(w_0, \overline{Y}_0, \theta_0)$$

where $\widetilde{C}(w_0, Y_0, \theta_1; x_0)$ represents the cost where x is constrained to be at the level that would be optimal if no change in quality had occurred. The cost of ignorance (or the value of information) is given by the difference between (4.2) and (4.3).

$$\text{(4.4)} \qquad \text{COI} = \text{CS} - \text{CV} = \widetilde{C}(w_0, \overline{Y}_0, \theta_1; x_0) - C(w_0, \overline{Y}_0, \theta_1)$$

In this analysis, both CS and CV represent gains. In either case, loss or gain, the cost of ignorance (COI) will be negative: If the change in quality is positive, the gains in CS would be smaller than CV. If the change is negative, the losses in CV would be greater than CS.

To ease COI estimation, Following Foster and Just (1998) defined an input price w_1 associated with the quality distribution θ_1. Same as previous assumptions, there is an initial level of input prices, output quantity, and input quality $(w_0, \overline{Y}_0, \theta_0)$. If there is a change in input quality from θ_0 to θ_1, then w_1 would be the price for x_0, the initial level of input use. The difference between w_0 and w_1 is the difference in input prices required to purchase x_0. Hence, the alternative CS is represented by expression (4.5):

[8] An improvement in quality implies welfare gains; on the contrary a detrimental change in quality will imply welfare losses.

$$(4.5)\ \text{CS}=\left[C(w_1,\overline{Y}_0,\theta_1)-w_1x_0\right]-\left[C(w_0,\overline{Y}_0,\theta_0)-w_0x_0\right]=C(w_1,\overline{Y}_0,\theta_1)-C(w_0,\overline{Y}_0,\theta_0)+(w_0-w_1)x_0$$

Consequently, the cost of ignorance is given by:

$$(4.6)\qquad \text{COI} = \text{CS} - \text{CV} = C(w_1,\overline{Y}_0,\theta_1)+(w_0-w_1)x_0-C(w_0,\overline{Y}_0,\theta_1)$$

As w_0 approaches w_1, the cost of ignorance for the firm approaches to zero.

Firms might possess an initial and possibly imperfect assessment of the quality of an input, and the risks associated when buying it. The subjective distribution of the input quality assessment is given by θ_0 which is represented by the marketing companies' expenditures. Information provided by a wheat marketing company allows firms to update their assessments. The new subjective distribution is given by θ_1, and is at least as accurate or more than the previous assessment. If milling companies are prevented from receiving the information, or the marketing company stops its operations, millers' cost of ignorance is represented by expression (4.6). Likewise the value of information is given by the negative form of the COI.

Similar to the situation described by Teisl, Bockstael, and Levy (2001) the optimal $x(\theta_1)$ may be greater or less than the optimal $x(\theta_0)$; prior information could either be less or more accurate than the better assessment. An additional consideration is that different firms have different initial assessments of the risk of quality uncertainty which is related with the firms' initial stock of quality information. Hence, the value of information for the firm will be smaller as the initial firms' knowledge is greater.

Methods

Data

The study included prices and quantities monthly observations from January 1997 to June 2007 were used. Because most U.S. wheat exported to Mexico is Hard Red Winter (HRW)[9], FOB Gulf prices for U.S. HRW grade 2 were used in the model. Most Canadian wheat exported to Mexico is Canadian Western Red Spring (CWRS), thus FOB Pacific prices for CWRS grade 1 were used. Both U.S. and Canadian wheat prices were obtained from the ERS-USDA (2007) reports, in nominal U.S. dollars. We adjusted prices from nominal to real dollar values using the Consumer Price Index (CPI) index for both U.S. and Canada. The indexes were obtained from the U.S. Bureau of Labor Statistics (2007) and Canada's National Statistical Agency (2007), respectively. Ideally, Cost Insurance Freight (CIF) prices should have been used, however these were not available. Also, none of these prices included transportation costs to the mill's site. We assumed that transportation costs per MT inside Mexico for U.S., Canadian, or Mexican wheat would be the same.

Prices for domestically produced Mexican wheat were not available on a monthly basis; we estimated them by using the Producer Price Index for wheat published by the Bank of Mexico Division of Statistics (2007). The Index accounts for nominal prices received by farmers and has December 2003 price as the base. Prices in Mexican pesos were converted into U.S. dollars using nominal exchange rates, and deflated using the Mexican CPI.

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[9] ERS-USDA (2007) reports that from 1996/97 to 2005/06 62% of all wheat exported to Mexico was HRW. The Canadian Grain Commission (2007) reports that for the crop year 2005/06 65% of all wheat exported to Mexico was CWRS.

Wheat quantities imported into Mexico from the U.S. were obtained from the Foreign Agricultural Service (FAS-USDA 2007). Wheat quantities imported from Canada were obtained from Statistics Canada (2007). Wheat quantities were not disaggregated into various grades of U.S. Hard Red Winter or Canadian Western Red Spring, although these are the primary types of wheat imported from the two countries. Thus, for both U.S. and Canada, we used the aggregated wheat imports from each country, excluding durum wheat and seed wheat.

Mexican wheat production volumes were obtained from the Agriculture, Food, and Fisheries Information Service Division (SIAP 2007). Note that these quantities are aggregated wheat production volumes. About 86% of the wheat produced in Mexico is durum, thus the production quantities included in the model were the 14% of the non-durum quantities reported by SIAP (Personal communication with SIAP statistics division chief). We use this 14% of total wheat production and prices paid to farmers for wheat produced in Mexico as a proxy for hard wheat production quantities and prices.

Quantities of flour produced in Mexico were obtained from the National Institute of Statistics, Geography, and Informatics (INEGI 2007), and included first and second class flour, and wheat milling by-products. The only other data was PGI marketing expenditures, which were obtained from PGI (2007), and included both expenditures for travel to promote U.S. wheat for a given crop year and website development and maintenance.

Empirical model

We built the empirical model on the papers developed by Marsh (2005) and Koo, Mao, and Sakurai (2001). There are two groups of inputs entering the flour process: one is wheat and the other represents inputs such as labor, capital, and energy. A milling company's objective function is represented by:

(4.7) $$\min_{x_1,x_2} C = C(x_1, x_2, w_1, w_2) = C(C_1(x_1, w_1), C_2(x_2, w_2))$$

where C represents the cost function x_1 is the vector for wheat types entering the process, x_2 is the vector for other inputs (labor, capital, and energy), w_1 is the wheat price vector, and w_2 is the price vector for other inputs. In this study we consider wheat as the solely input for flour production. This assumption is based on two considerations, the first one: weak separability. By weak separability one is imposing that a marginal change in price of other inputs has no effect on the ratio of marginal costs of wheat inputs. The second consideration is that for flour production, the cost of wheat represents 91 percent of the flour's wholesale price (Marsh 2005).

A second assumption is that firms are homogenous (i.e., face the same input prices, use same levels of inputs, and produce the same level of output). Hence, we can work with the aggregated firm cost function $C(w, y)$. A third assumption is that flour quantities for different flour types can be aggregated into a weighted average flour quantity:

(4.8) $$Y = \sum_{m=1}^{4} s y_m$$

where Y is the aggregated flour quantity; s is the quantity of flour type m produced, with m= soft, semi-fine, fine, extra-fine; and y_m is the flour type m quantity.

To model the quality information function we used a similar approach as Piggott et al. (1996). They measured the effect of demand response to advertising in the Australian meat industry. In this study, wheat marketing expenditures are used as a proxy to model Mexican milling companies' access to wheat quality information. Expenditures include travel costs for U.S. wheat promotion amongst Mexican milling companies. It also includes website development and maintenance costs in which detailed information related to U.S. wheat quality parameters is published. An assumption in this study is that expenditures will act as an input demand shifter, as shown in figure IV-1, a change in U.S. wheat quality and the availability of related information depicted by PGI expenditures is expected to shift demand for U.S. wheat to the right.

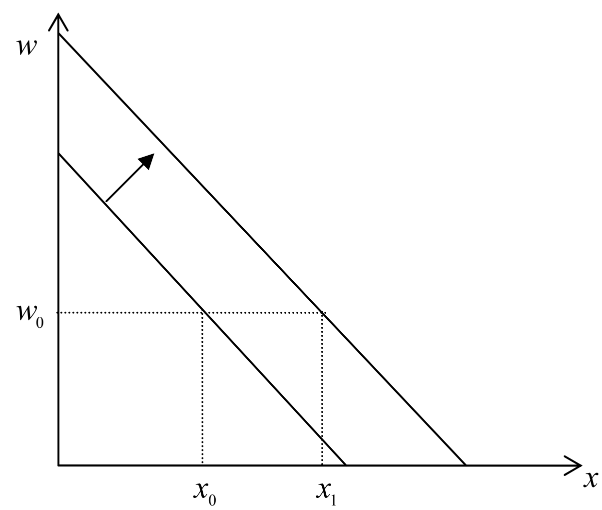

Figure IV-1. Expected input demand shift as a result of a change in quality and availability of information

Additionally, it is considered that demand response to marketing expenditures persist over time, meaning that current wheat purchases respond to expenditures in previous periods[10]. If the effect of the expenditures last for three lag periods, the marketing expenditures function follows:

(4.9) $$\theta_{US,t} = \theta_0 + \sum_{k=0}^{3} \beta 4_k (PGIt_k)(wt) + \sum_{k=0}^{3} \beta 5_k (PGIw_k)(ww)$$

where θ_0 is the parameter intercept, $PGIt_k$ represents PGI travel expenditures, wt is the weight for travel expenditures, $PGIw_k$ is the website development and maintenance spending, ww is the weight for website expenditures, $\beta 4_k$ and $\beta 5_k$ are the parameters representing the effect of an additional unit of travel and website expenditures respectively, in the current and lagged period *k*=0, 1, 2, and 3.

To model milling companies cost function we use a quadratic function because of its flexibility for price estimation, substitution elasticities, and interaction among input prices. Cost and input prices were normalized with respect to Mexican wheat prices: $Costn = \frac{Cost}{w_{MEX}}$, $w^*_{US} = \frac{w_{US}}{w_{MEX}}$, $w^*_{CAN} = \frac{w_{CAN}}{w_{MEX}}$. Milling companies' cost function is represented by:

(4.10)
$$\begin{aligned} Costn = {} & \alpha_0 + \beta 1 y_t + \sum_{i=1}^{2} \beta 2_i w^*_{it} y_t + \frac{1}{2}\beta 3 y_t^2 + \theta_{US} w^*_{US,t} + \beta 6 w^*_{CAN,t} \\ & + \frac{1}{2}\sum_{i=1}^{2}\sum_{j=1}^{2} \beta 7_{ij} w^*_{it} w^*_{jt} + \beta 8 T_t + \sum_{i=1}^{2} \beta 9_i w^*_{it} T_t + \beta 10 y_t T_t + \frac{1}{2}\beta 11 T_t^2 \\ & + \sum_{k=1}^{3} \beta 12_k QD_k + \sum_{k=1}^{3} \beta 13_k w^*_{US} QD_k + \sum_{k=1}^{3} \beta 14_k w^*_{CAN} QD_k \end{aligned}$$

[10] Piggott et al. (1996) models the effect of expenditures as it would be effective for four quarters: the current and three lag periods. In this study, we will compare the model results considering different lag periods.

where $Costn$ is the normalized indirect profit function, α_0 is the parameter intercept, y_t is the aggregated flour output produced in Mexico, w^*_{US} and w^*_{CAN} are the normalized prices of wheat imported from the U.S. and Canada, w^*_i and w^*_j represent the normalized price of wheat from U.S. and Canada, T is the time trend to take into consideration effects of technology, productivity, and other factors over time, θ_{US} is the function of the expenditures of U.S. non-profit wheat marketing companies, QD is the indicator variable for quarter period to take into consideration seasonality in Mexican wheat imports, $\beta 1$ is the marginal cost of flour produced in Mexico, and $\beta 2$, $\beta 3$, $\beta 6$, $\beta 7$, $\beta 8$, $\beta 9$, $\beta 10$, $\beta 11$, $\beta 12$, $\beta 13$, and $\beta 14$ are the parameters to estimate.

Imposing symmetry $w_{ij} = w_{ji}$ and by Sheppard's lemma, we obtain the derived the input demand functions:

(4.11) $$\frac{\partial Costn}{\partial w^*_{US}} = x_{US} = \theta_{US} + \beta 2_{US}\, y_t + \beta 7_{USCAN}\, w^*_{CANt} + \beta 7_{USUS}\, w^*_{USt} + \beta 9_{US} T_t$$

(4.12) $$\frac{\partial Costn}{\partial w^*_{CAN}} = x_{CAN} = \beta 4 + \beta 2_{CAN}\, y_t + \beta 7_{USCAN}\, w^*_{USt} + \beta 7_{CANCAN}\, w^*_{CANt} + \beta 9_{CAN} T_t$$

The system of equations (4.11)-(4.12) conform a seemingly unrelated regression (SUR) system, and the parameters are estimated by an iterative SUR. Input price elasticities are obtained by the given expression:

(4.13) $$\varepsilon_{ij} = \frac{\partial \ln x_i}{\partial \ln w_j} = \frac{b7_{ij}\, \overline{w}^*_j}{\overline{x}_i}$$

Where $b7_{ij}$ is the estimate marginal cost of wheat imported both from the U.S. and Canada, i, j= U.S. and Canada, $\overline{w}_i$ is the average wheat price, and $\overline{x}_{ij}$ is the average quantity of imported wheat. To estimate the Mexican wheat demand elasticity we imposed homogeneity:

$$\varepsilon_{MEX} = -\varepsilon_{US} - \varepsilon_{CAN} \tag{4.14}$$

To estimate the value of information or cost of ignorance, observations were divided in two groups: before Oct 2004 when PGI started their marketing activities, and after October 2004. Subscripts 0 and 1 identified respectively the before and after groups. To calculate the compensating variation and compensation surplus we use the parameter estimates from (4.10), and evaluate at the means of each group:

$$\begin{aligned} Costn\ (w_0, y_0, \theta_1) = {} & \alpha_0 + \beta 1 \overline{y}_0 + \sum_{i=1}^{2} \beta 2_{i0}\, \overline{w}^*_{i0} \overline{y}_0 + \frac{1}{2} \beta 3 \overline{y}_0^2 + \theta_{US1} \overline{w}^*_{US0} + \beta 6 \overline{w}^*_{CAN0} \\ & + \frac{1}{2} \sum_{i=1}^{2} \sum_{j=1}^{2} \beta 7 \overline{w}^*_{i0} \overline{w}^*_{j0} + \beta 8 \overline{T}_0 + \sum_{i=1}^{2} \beta 9 \overline{w}^*_{i0} \overline{T}_0 + \beta 10\, \overline{y}_0 \overline{T}_0 + \frac{1}{2} \beta 11 \overline{T}_0^2 \\ & + \sum_{k=1}^{3} \beta 12_k\, \overline{QD}_k + \sum_{k=1}^{3} \beta 13_k\, \overline{w}^*_{US}\, \overline{QD}_k + \sum_{k=1}^{3} \beta 14_k\, \overline{w}^*_{CAN}\, \overline{QD}_k \end{aligned} \tag{4.15}$$

$$\begin{aligned} Costn\ (w_0, y_0, \theta_0) = {} & \alpha_0 + \beta 1 \overline{y}_0 + \sum_{i=1}^{2} \beta 2_{i0}\, \overline{w}^*_{i0} \overline{y}_0 + \frac{1}{2} \beta 3 \overline{y}_0^2 + \beta 6 \overline{w}^*_{CAN} \\ & + \frac{1}{2} \sum_{i=1}^{2} \sum_{j=1}^{2} \beta 7 \overline{w}^*_{i0} \overline{w}^*_{j0} + \beta 8 \overline{T}_0 + \sum_{i=1}^{2} \beta 9 \overline{w}^*_{i0} \overline{T}_0 + \beta 10\, \overline{y}_0 \overline{T}_0 + \frac{1}{2} \beta 11 \overline{T}_0^2 \\ & + \sum_{k=1}^{3} \beta 12_k\, \overline{QD}_k + \sum_{k=1}^{3} \beta 13_k\, \overline{w}^*_{US}\, \overline{QD}_k + \sum_{k=1}^{3} \beta 14_k\, \overline{w}^*_{CAN}\, \overline{QD}_k \end{aligned} \tag{4.16}$$

$$\begin{aligned} Costn\ (w_1, y_0, \theta_1) = {} & \alpha_0 + \beta 1 \overline{y}_0 + \sum_{i=1}^{2} \beta 2_i\, \overline{w}^*_{i1} \overline{y}_0 + \frac{1}{2} \beta 3 \overline{y}_0^2 + \theta_{US1} \overline{w}^*_{US0} + \beta 6 \overline{w}^*_{CAN0} \\ & + \frac{1}{2} \sum_{i=1}^{2} \sum_{j=1}^{2} \beta 7 \overline{w}^*_{i1} \overline{w}^*_{j1} + \beta 8 \overline{T}_0 + \sum_{i=1}^{2} \beta 9 \overline{w}^*_{i1} \overline{T}_0 + \beta 10\, \overline{y}_0 \overline{T}_0 + \frac{1}{2} \beta 11 \overline{T}_0^2 \\ & + \sum_{k=1}^{3} \beta 12_k\, \overline{QD}_k + \sum_{k=1}^{3} \beta 13_k\, \overline{w}^*_{US}\, \overline{QD}_k + \sum_{k=1}^{3} \beta 14_k\, \overline{w}^*_{CAN}\, \overline{QD}_k \end{aligned} \tag{4.17}$$

To control for variations in cost due to change in productivity or technology, output quantity and time was kept constant through all estimations. From expressions (2) and (5) CV and CS were estimated, and the cost of ignorance is given by CV – CS.

Results

Descriptive statistics are provided in table IV-1. Note that prices paid to Mexican producers have greater variability than U.S. and Canadian FOB export prices. On average, local wheat prices in Mexico are higher than U.S. prices, reflecting the advantages that U.S. farmers have over Mexican farmers. Also note that wheat production in Mexico is noticeably more variable than the quantities imported from both U.S. and Canada, which describes the seasonality of wheat production in Mexico. Additionally, the quantities of flour milled in Mexico are less variable, indicating that nonetheless the variability in domestic wheat procurement; millers manage to meet the internal flour demand.

Table IV-1. Descriptive Statistics for Real Prices and Quantity Data from 1997-June 2007

Variable	Mean	Standard deviation	Minimum	Maximum
Quantity of flour (MT)	284,756.290	19,231.390	235,417.000	328,511.000
FOB Gulf U.S. hard red winter wheat price (U.S./MT)	$170.354	$27.041	$126.204	$237.945
FOB Pacific Canadian western hard red spring price (U.S./MT)	$203.123	$25.870	$160.334	$271.055
Price paid to Mexican producer (U.S./MT)	$183.211	$49.003	$138.402	$347.197
Quantity of U.S. wheat imported (MT)	171,774.030	59,474.490	31,564.000	355,526.000
Quantity of Canadian wheat imported (MT)	67,933.280	39,382.490	2,251.000	182,608.000
Quantity of wheat produced in Mexico (MT)	38,299.520	76,747.680	11.880	339,274.580

A Durbin-Watson test for autocorrelation was conducted. Results showed that most Durbin-Watson statistics were between the lower and upper bounds critical values.

Consequently we come to no conclusion and did not take any action to correct potential autocorrelation misspecifications.

The parameters of the model were estimated in three different ways. The first one considers PGI expenses by category, i.e., travel expenses and website creation and maintenance expenditures. The second one includes the sum of PGI expenditures as one variable. The third approach assumes a cumulative effect of marketing expenditures. For the first and second approach expenditures' persistent effect in time is analyzed considering different lag periods: no lag, and 1, 2, and 3 lags.

Results for the first approach considering the lag periods are reported in table IV-2. For the four lag periods, the estimate for flour output is positive and statistically significant, meaning that marginal cost of flour production in Mexico increased during 1997-2007. The U.S. wheat price*flour output estimate is positive and statistically significant implying that as more flour is produced in Mexico, the marginal cost of wheat imported from the U.S. increases. The flour output*flour output estimate is negative and statistically significant; as flour production increased the marginal cost of each additional unit of output decreased.

None of the coefficients for PGI travel expenses for the four lag periods are statistically significant. Conversely, for the three lag period of PGI website expenditures the LPGIw*ww*U.S. wheat price estimate is negative and statistically significant at the 10% level, implying that the one quarter lag effect of website expenditures have a negative effect on flour costs. By Sheppard's Lemma, the one lag expenditures also have a negative effect on quantities of wheat imported from the U.S.

Table IV-2. Parameter Estimates Considering PGI Travel and Website Expenditures as Separate Variables

	Parameter Estimate			
Variables	No lags	1 lag	2 lags	3 lags
Dependent variables: Cost normalized, U.S. wheat quantities exported, Can wheat quantities exported				
Intercept	-3964027.000*[a]	-4012285.000*	-3978435.000*	-3988843.000*
	(874191.000)[b]	(884204.000)	(890929.000)	(898713.000)
Flour output	27.696*	28.117*	27.935*	27.897*
	(6.313)	(6.402)	(6.450)	(6.497)
U.S. wheat price*flour output	0.441*	0.436*	0.397*	0.401*
	(0.071)	(0.071)	(0.073)	(0.073)
Can wheat price*flour output	-0.196	-0.130	-0.115	-0.091
	(0.220)	(0.224)	(0.226)	(0.227)
0.5*flour output*flour output	-0.0001*	-0.0001*	-0.0001*	-0.0001*
	(0.00002)	(0.00002)	(0.00002)	(0.00002)
PGIt*wt*U.S. wheat price	-16.117	-12.416	-38.693	-42.247
	(18.992)	(19.622)	(35.952)	(40.317)
LPGIt*wt*U.S. wheat price	-	-2.660	-7.436	-25.143
		(25.430)	(35.251)	(37.572)
LLPGIt*wt*U.S. wheat price	-	-	687.371	855.248
			(683.200)	(692.300)
LLLPGIt*wt*U.S. wheat price	-	-	-	-35.948
				(94.906)
PGIw*ww*U.S. wheat price	-11.220	-11.541	-17.161	-17.844
	(16.683)	(15.526)	(16.407)	(16.278)
LPGIw*ww*U.S. wheat price	-	-16.735	-25.075	-26.112**[c]

Table IV-2. Parameter Estimates Considering PGI Travel and Website Expenditures as Separate Variables

		(14.023)	(15.826)	(15.689)
LLPGIw*ww*U.S. wheat price	-	-	-1596.611* (602.400)	-1730.253* (627.400)
LLLPGIw*ww*U.S. wheat price	-	-	-	24.557 (15.147)
Can wheat price	135124.000* (67647.100)	116569.000** (68613.500)	111680.000 (69001.300)	103881.000 (69438.400)
Can wheat price*U.S. wheat price	121510.000* (32625.900)	129003.000* (33463.700)	141817.000* (33737.500)	136714.000* (35311.200)
0.5*U.S. wheat price*U.S. wheat price	-177044.000* (47579.000)	-183909.700* (48544.400)	-194135.600* (48713.500)	-196006.800* (50872.200)
0.5*Can wheat price*Can wheat price	-91813.870* (32141.300)	-97568.130* (32487.200)	-106662.800* (32507.200)	-102099.900* (33476.000)
Time	-4574.005** (2352.000)	-4755.169** (2409.600)	-4986.611* (2425.900)	-4721.440** (2491.800)
U.S. wheat price*Time	1223.990* (235.500)	1219.950** (238.100)	1485.330* (257.900)	1587.310* (268.300)
Can wheat price*Time	54.122 (198.300)	21.884 (199.300)	-6.404 (199.800)	-5.610 (202.300)
Flour output*Time	0.014** (0.008)	0.015** (0.009)	0.016** (0.009)	0.015** (0.009)
0.5*Time*Time	-0.241 (9.298)	-1.276 (9.559)	1.075 (9.851)	-1.037 (10.067)
First quarter	10001.500	8609.560	7396.020	7369.260

Table IV-2. Parameter Estimates Considering PGI Travel and Website Expenditures as Separate Variables

	(15749.000)	(16178.400)	(16389.300)	(16552.000)
U.S. wheat price*first quarter	13635.900	13905.600	12329.000	11899.900
	(10064.700)	(10234.500)	(10175.900)	(10356.100)
Can wheat price*first quarter	-47596.990*	-44404.780*	-42854.200*	-42658.110*
	(9880.600)	(10085.500)	(10232.300)	(10288.600)
Second quarter	162381.000*	161335.000*	160437.000*	162095.000*
	(17729.900)	(17939.400)	(18084.900)	(18245.200)
U.S. wheat price*second quarter	-26603.640*	-26967.970*	-30692.220*	-29510.570*
	(9901.200)	(10010.100)	(10056.200)	(10215.200)
Can wheat price*second quarter	-29461.530*	-26923.630*	-25972.770*	-25295.680*
	(11391.100)	(11478.700)	(11533.700)	(11578.600)
Third quarter	-423.870	-1227.513	-1997.786	-1143.651
	(15905.900)	(16088.000)	(16212.400)	(16325.300)
U.S. wheat price*third quarter	15564.000	17050.100	12889.300	14166.900
	(10333.800)	(10527.700)	(10363.500)	(10446.800)
Can wheat price*third quarter	-23374.920*	-22225.500*	-21756.550*	-21398.280*
	(9810.600)	(9817.200)	(9845.700)	(9888.500)
Adj R2 Cost normalized	0.680	0.677	0.671	0.681
Adj R2 U.S. wheat quantities exported	0.512	0.506	0.526	0.530
Adj R2 Can wheat quantities exported	0.197	0.189	0.184	0.186
Log likelihood value	-4513.090	-4476.440	-4437.040	-4399.860

Number of observations = 126 [a] One (*) indicates statistical significance at the 5% level
[b] Numbers in parenthesis are standard errors [c] Two (**) indicates statistical significance at the 10% level

Similarly, LLPGIw*ww*U.S. wheat price is negative and statistically significant for the two and three lag models, suggesting that the two quarters lag effect of U.S. marketing expenditures have a negative effect on flour production costs and wheat quantities imported from the U.S. These results are contrary to our expectations, as we expected that the more quality related information given would increase wheat imports into Mexico. Results might be indicating that Mexican millers, when having U.S. quality information and noting that this quality is not as expected or inferior than Canadian wheat, substitute U.S. wheat with higher quality, less variable Canadian wheat. Although the latter is higher priced, they still are able to lower their production costs. These findings are depicted graphically in figure IV-2.

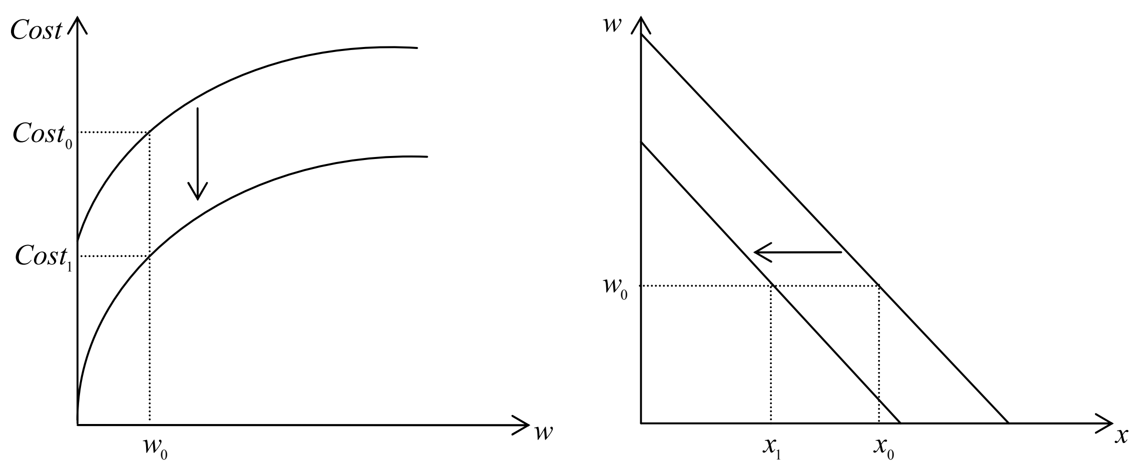

Figure IV-2. Cost and input demand shift as a result of change in quality and availability of information

Results obtained leads us to question if the unexpected shifts in wheat demanded reflect the availability of information or actual changes in quality? To address this concern we report in table IV-3, selected quality parameter values from 1998 to 2007, obtained from the U.S. Wheat Associates (2007) and Canadian Grain Commission (2007) harvest quality reports. There is evidence that quality fluctuates from year to year and that Canadian wheat quality is superior to the U.S., especially after PGI started operations.

Table IV-3. U.S. and Canadian Selected Wheat Quality Parameters across Years 1998-2007

Year	Test weight (kg/hl)		Protein 12% (%)		Falling number (sec)		Farinograph stability (min)		Alveograph P/L ratio	
	US	Canada	US	Canada	US	Canada	US	Canada	US	Canada
1998	79.60	81.50	11.70	13.70	364.00	395.00	11.30	9.50	1.29	0.99
1999	77.70	82.00	11.40	13.70	352.00	385.00	10.20	10.00	0.92	1.23
2000	77.90	81.30	12.00	13.80	393.00	375.00	11.20	8.50	0.96	0.68
2001	79.40	83.10	12.10	13.80	407.00	425.00	11.10	8.50	1.10	1.14
2002	77.50	81.20	14.30	13.80	425.00	345.00	11.20	9.50	1.14	1.07
2003	79.40	82.40	12.80	13.80	409.00	395.00	10.20	11.00	1.13	1.18
2004	77.40	81.40	13.55	13.80	382.00	395.00	12.40	12.50	0.78	1.30
2005	78.80	81.40	13.00	13.80	401.00	400.00	10.50	11.50	0.82	1.22
2006	79.60	81.50	14.65	13.80	392.00	400.00	12.60	13.50	0.74	1.13
2007	78.50	80.20	12.45	13.80	417.00	410.00	7.90	10.50	0.58	1.03
Average Before PGI	78.41	81.84	12.55	13.77	390.29	387.86	11.09	9.93	1.05	1.09
Average After PGI	78.97	81.03	13.37	13.80	403.33	403.33	10.33	11.83	0.71	1.13

Source: U.S. Wheat Associates and Canadian Grain Commission Harvest Quality Reports

The signs for LLPGIt*wt*U.S. wheat price for two and three lag expenditure models are positive implying a positive effect on quantities imported from the U.S. Similarly, the sign for LLLPGIw*ww*U.S. wheat price is positive implying that as PGI increases the information load through the web, wheat imports to Mexico increases. However these two last parameter estimates were not statistically significant.

The Can wheat price estimate is positive and statistically significant at the 5% level for the no lag period, and significant at the 10% for the 1 lag period, which suggests that an increase in the price of Canadian wheat has a positive effect on flour costs. The marginal cost of Canadian wheat increases with an increase in U.S. wheat prices as U.S. wheat price*Can wheat price is positive and statistically significant. It also means that an increase in Canadian wheat prices increases the quantities of wheat imported from the U.S., suggesting that such products are substitutes.

The U.S. wheat price*U.S. wheat price and Can wheat price*Can wheat price estimates are negative and statistically significant, as expected and concurrent with economic base literature, an increase in price decreases wheat quantities demanded.

As for the effect of time in the model, cost of producing flour in Mexico has decreased from 1997 to 2007, at least in real dollar terms, which also implies that Mexican wheat milling productivity has improved over this period. Additionally, model findings indicate that U.S. wheat exports to Mexico and quantities of wheat flour produced in Mexico have increased over the period in study, agreeing with the increasing demand for bread products and the increasing population in Mexico (CANIMOLT 2007, INEGI 2007).

Table IV-4. Parameter Estimates Considering PGI Travel and Website Expenditures as One Variable

	Parameter Estimate			
Variables	No lags	1 lag	2 lags	3 lags
Dependent variables: Cost normalized, U.S. wheat quantities exported, Can wheat quantities exported				
Intercept	-3963977.000*[a]	-4017113.000*	-4002450.000*	-3996908.000*
	(872032.000)[b]	(881430.000)	(888746.000)	(892992.000)
Flour output	27.697*	28.151*	28.049*	27.874*
	(6.298)	(6.381)	(6.434)	(6.456)
U.S. wheat price*flour output	0.441*	0.440*	0.442*	0.447*
	(0.071)	(0.071)	(0.072)	(0.072)
Can wheat price*flour output	-0.197	-0.131	-0.117	-0.099
	(0.220)	(0.224)	(0.225)	(0.226)
0.5*flour output*flour output	-0.0001*	-0.0001*	-0.0001*	-0.0001*
	(0.00002)	(0.00002)	(0.00002)	(0.00002)
PGI*U.S. wheat price	-12.583	-11.680	-11.069	-14.175
	(12.062)	(12.141)	(12.214)	(12.181)
LPGI*U.S. wheat price	-	-8.361	-7.804	-9.245
		(12.311)	(12.387)	(12.250)
LLPGI*U.S. wheat price	-	-	-4.433	-5.794
			(12.485)	(12.358)
LLLPGI*U.S. wheat price	-	-	-	20.686**[c]
				(12.101)
Can wheat price	135336.000**	116890.000**	113859.000	109024.000
	(67648.000)	(68651.100)	(68834.900)	(69229.600)
Can wheat price*U.S.	121554.000*	126668.000*	128112.000*	125218.000*

Table IV-4. Parameter Estimates Considering PGI Travel and Website Expenditures as One Variable

wheat price	(32575.300)	(33395.400)	(34170.900)	(35365.700)
0.5*U.S. wheat price*U.S. wheat price	-177035.800*	-182110.000*	-183083.500*	-183447.700*
	(47477.900)	(48439.900)	(49726.200)	(51737.800)
0.5*Can wheat price*Can wheat price	-91892.300*	-95955.180*	-97721.730*	-96431.280*
	(32112.200)	(32489.300)	(32889.500)	(33628.000)
Time	-4569.005**	-4782.624**	-4765.845**	-4384.936**
	(2346.100)	(2402.200)	(2420.200)	(2475.300)
U.S. wheat price*Time	1221.130*	1223.760*	1215.070*	1218.950*
	(234.600)	(238.100)	(344.700)	(252.900)
Can wheat price*Time	54.567	24.826	15.873*	29.594
	(198.200)	(199.300)	(201.000)	(203.600)
Flour output*Time	0.014**	0.015**	0.015**	0.014
	(0.008)	(0.009)	(0.009)	(0.009)
0.5*Time*Time	-0.232	-0.859	-1.155	-3.801
	(9.278)	(9.531)	(9.777)	(9.936)
First quarter	9997.780	8228.290	7657.500	8029.500
	(15709.100)	(16118.600)	(16333.400)	(16431.100)
U.S. wheat price*first Quarter	13856.800	13426.500	13704.300	13159.500
	(9985.300)	(10229.300)	(10563.000)	(10724.200)
Can wheat price*first Quarter	-47611.45*	-44504.780*	-43244.56*	-43177.340*
	(9879.700)	(10082.700)	(10218.800)	(10274.800)
Second quarter	162290.000*	161345.000*	161182.000*	163537.000*
	(17679.000)	(17878.700)	(18014.400)	(18089.800)
U.S. wheat price*second quarter	-26578.020*	-27497.080*	-28203.650*	-25934.910*

Table IV-4. Parameter Estimates Considering PGI Travel and Website Expenditures as One Variable

	(9880.500)	(10021.400)	(10331.300)	(10452.400)
Can wheat price*second quarter	-29494.250*	-27018.610*	-26498.740*	-26031.660*
	(11389.700)	(11477.300)	(11514.400)	(11556.600)
Third quarter	-426.173	-1101.098	-1056.029	7.832
	(15866.000)	(16030.500)	(16146.800)	(16188.900)
U.S. wheat price*third quarter	15858.700	15978.700	15478.900	16233.000
	(10228.000)	(10269.000)	(10391.700)	(10398.600)
Can wheat price*third quarter	-23385.420*	-22223.890*	-22051.650*	-21893.490*
	(9809.500)	(9814.700)	(9836.400)	(9878.600)
Adj R2 Cost	0.681	0.676	0.670	0.684
Adj R2 X1	0.514	0.508	0.498	0.502
Adj R2 X2	0.197	0.189	0.186	0.187
Log likelihood value	-4513.110	-4477.000	-4441.700	-4404.620

Number of observations = 126

[a] One (*) indicates statistical significance at the 5% level

[b] Numbers in parenthesis are standard errors

[c] Two (**) indicates statistical significance at the 10% level

Analyzing the effect of seasonality or the quarter indicator variables, we note that Canadian wheat prices differ from quarter to quarter. Also, during the second quarter flour production costs are higher and U.S. wheat prices are lower than for the rest of the year.

As mentioned previously, the model was analyzed considering PGI travel and website expenses as one variable[11]. Overall parameter estimates have the same signs and statistical significance as for the model considering expenditures variables as separate, except for the parameters involving expenditures themselves. Results are reported in table IV-4. LLLPGI*U.S. wheat price is positive and statistically significant implying that an increase in U.S. marketing expenditures lagged by three periods, increases the cost of flour produced in Mexico and increases the quantities of wheat imported from the U.S.

Price elasticities were also estimated, and reported in table IV-5. Elasticity values are similar among the four lag approaches. Results indicate that Canadian wheat demand is more price elastic than U.S. Mexican millers appear to be more sensitive to Canadian wheat, or high quality wheat. These results are similar to Koo, Mao, and Sakurai (2001) findings, Japanese millers were more sensitive to price of high quality wheat classes. Note that Mexican wheat demand is more inelastic than U.S. and Canadian, a reasonable outcome considering that milling companies in Mexico demand primarily wheat from national producers.

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[11] Marketing expenditures were also modeled by following a cumulative effect. Results for this approach were not sounded, i.e., as the own price elasticity for Mexico resulted positive. Thus, parameter estimates for this modeling were not included

Table IV-5. Price Elasticity Estimates

Elasticities	Model	Elasticities			
		No lag	1 lag	2 lags	3 lags
U.S.-U.S.	PGI travel and website expenditures separate	-1.006	-1.041	-1.092	-1.104
	PGI expenditures as one variable	-1.011	-1.039	-1.043	-1.047
CAN-CAN	PGI travel and website expenditures separate	-1.549	-1.638	-1.784	-1.711
	PGI expenditures as one variable	-1.551	-1.611	-1.635	-1.617
MEX-MEX	PGI travel and website expenditures separate	-0.328	-0.272	-0.139	-0.276
	PGI expenditures as one variable	-0.328	-0.299	-0.299	-0.391
U.S.-CAN	PGI travel and website expenditures separate	0.826	0.873	0.955	0.922
	PGI expenditures as one variable	0.831	0.865	0.874	0.855
CAN-U.S.	PGI travel and website expenditures separate	1.713	1.809	1.981	1.913
	PGI expenditures as one variable	1.713	1.776	1.791	1.753
U.S.-MEX	PGI travel and website expenditures separate	0.179	0.167	0.137	0.182
	PGI expenditures as one variable	0.180	0.174	0.169	0.855
MEX-U.S.	PGI travel and website expenditures separate	0.585	0.540	0.455	0.596
	PGI expenditures as one variable	0.584	0.557	0.542	0.600
CAN-MEX	PGI travel and website expenditures separate	-0.163	-0.171	-0.197	-0.203
	PGI expenditures as one variable	-0.163	-0.165	-0.155	-0.137
MEX-CAN	PGI travel and website expenditures separate	-0.257	-0.267	-0.316	-0.319
	PGI expenditures as one variable	-0.256	-0.258	-0.243	-0.209

Anecdotic evidence suggests that whenever domestic grain is exhausted they proceed to import[12].

This study's elasticities are reasonably close to Marsh (2001) who found that U.S. hard red winter wheat own price elasticity was -0.864. However, Koo, Mao, and Sakurai (2001) in their analysis of Japanese wheat demand found that U.S. hard wheat own price elasticity was -5.860. This difference might be attributable to intrinsic differences of each market. Note that the cross price elasticity between Canadian and Mexican wheat demand is negative; implying that Mexican millers would buy even small quantities of high quality Canadian wheat to mix with local wheat or imported U.S. wheat to achieve the quality required.

As mentioned in the previous section, to estimate the cost of no having the quality information we calculated the cost function value, using different input prices and marketing expenditures in time, i.e., before and after PGI began operations, and holding time and output production constant, as depicted in expressions (4.15)-(4.17). Results are reported in table IV-6. Overall, the quantities reported are similar for all modeling types: considering different lag expenditures and PGI expenses as one and separate variables. Note that cost at time 0, i.e. before PGI started operations (COST00) is higher than cost at the same time but including PGI expenditures in the equation (COST01). This suggests that controlling for input prices, output quantity and time, the greater the information or the different the quality, the greater the costs faced by Mexican millers. Cost at time 1, marketing expenditures included, (COST11) is noticeably higher than the

[12] The Mexican Association for Agricultural Development (2007) in their Planning Report for the Wheat System Product establishes that 43% of the internal hard wheat demand is supplied by local farmers, being necessary to import the remaining 57%.

two previous cost values. This implies that not having the information and input quantities not being adjusted to the change in quality increases even more miller's costs.

Table IV-6. Cost for Different Average Price Inputs and Average Marketing Expenditures Before and After PGI Began Operations, Holding Output Production Constant

Cost	Model	Cost			
		No lag	1 lag	2 lags	3 lags
COST01	Separate PGI expenses	211278.190	214252.920	209955.580	208139.680
	Joint PGI expenses	258434.200	259660.090	260435.970	260534.390
COST00	Separate PGI expenses	211374.190	214431.180	216509.290	215057.130
	Joint PGI expenses	259244.370	260950.420	261936.490	261083.480
COST11	Separate PGI expenses	260713.190	256351.180	249232.750	240179.550
	Joint PGI expenses	307678.850	300480.100	299712.610	295643.670

Compensating variation (CV), surplus (CS) and cost of ignorance where estimated following equations (4.2), (4.5), and (4.6); and are reported in table IV-7.

Table IV-7. Compensating Variation, Compensating Surplus, Cost of Ignorance Values

Welfare Measure	Model	Welfare Change			
		No lag	1 lag	2 lags	3 lags
CV	Separate PGI expenses	-96.007	-178.259	-6553.710	-6917.450
	Joint PGI expenses	-810.170	-1290.330	-1500.520	-549.084
CS	Separate PGI expenses	-50312.670	-57649.400	-60470.500	-67707.790
	Joint PGI expenses	-50503.020	-58927.650	-60471.030	-64638.390
Cost of Ignorance	Separate PGI expenses	-50216.660	-57471.140	-53916.780	-60790.340
	Joint PGI expenses	-49692.850	-57637.320	-58970.510	-64089.310

Results showed CV and CS are negative; meaning that the released information indicated that wheat quality was not as expected or lower than Canadian. As mentioned in the previous section, CV is the welfare change assuming perfect information, and CS is the welfare change when millers are not aware of the change in quality. These findings coincide with our expectations; millers not being aware of the change in quality have a greater welfare loss than if they knew about this change. For this specific case, information about U.S. wheat did not reflect the quality Mexican buyers expected, or quality from Canada was superior. Consequently, marketing expenditures in disseminating quality information did not increase U.S. wheat exports to Mexico. Nonetheless, the remarkable outcome of this study is that Mexican millers are better off knowing with more detail the quality of the wheat, even if their expectations are not met. The welfare loss for ignoring quality information goes from $50,216.66 to $64,089.31. The more lagged periods or the persistent effect of the marketing expenditures over time in the model, the greater the welfare loss.

Conclusions

This study used compensating surplus and compensating variation concepts to measure the welfare effects for Mexican milling companies of publishing information related to U.S. wheat quality. Because it was not possible to find data to model Mexican millers' accessibility to quality information, we used the expenditures of a non-profit U.S. marketing company whose main purpose is to publish quality information and heavily promotes this information to the Mexican market. The CV and CS concepts were applied to a normalized cost function.

Most parameter estimates for the system of equations were as expected. For instance, own price estimates were negative, flour quantities and time were positive implying that flour production increased over time, and time had a negative effect on real costs, suggesting that technology and other factors over time improved production efficiency. Findings showed that PGI expenditures had a negative effect on flour production costs and on wheat quantities imported from the U.S. for 2004-2007. These results were consistent with further findings that compensating valuation and surplus were negative, indicating that U.S. quality was not as Mexican millers expected, leading them to buy less wheat from the U.S.

Some of the efforts being made by members of the U.S. wheat industry to better satisfy the Mexican milling market, include giving information related with U.S. wheat quality. In this study we demonstrated that this information did not increase Mexican demand for U.S. wheat. With this we do not imply that information will consistently have a negative impact on U.S. exports to Mexico, as this might be the case for only the 2004-2007 period, and for the variability in U.S. quality with respect to Canada. This result contrasts some anecdotal evidence suggesting that the availability of quality information in recent years has led Mexican buyers to pursue wheat procurement via rail direct shipments from geographic regions where the published quality information annually shows a close match to their milling needs (Personal communication with Mark Hodges).

On either case, it has been demonstrated that Mexican millers are better off having extended wheat quality information, as welfare losses due to possible changes in quality are greater when millers do not have the information rather than when they actually do. Despite the limitations of this study as the limited time period of operations of PGI, our findings prove that wheat quality information does represent a value to foreign U.S. wheat buyers.

CHAPTER V

CONCLUSIONS

The previous three chapters consist of separate but related studies examining the value of quality information in the U.S. hard red winter wheat market. The first study focused on domestic prices and the estimation of the implicit value of different wheat quality characteristics for hard red winter wheat, including those related with end-use functionality. The second paper focused on eliciting Mexican milling companies' preferences for hard red winter wheat quality attributes and consistency to help U.S. wheat marketers better understand the customer preferences in their largest foreign market. The third paper used compensating variation and compensating surplus concepts applied to the flour mill's indirect cost function to estimate the impact of publicly released U.S. wheat quality information on Mexican milling companies' welfare.

Overall implications of this dissertation can be summarized by the following statements:

1. Domestic wheat prices still mainly reflect FGIS grades and standards with protein content and test weight used as proxies for milling and baking quality. This could mean that the system is still in transition and that a longer time period of study might show the effect of published end-use functionality data on local cash prices.

2. Mexican millers are willing to pay premiums for higher average values of test weight, protein and farinograph stability in the wheat they purchase. However, there is no strong evidence of possible discounts for increased variability in quality.
3. Information on U.S. wheat quality does have an effect on Mexican millers' welfare, during the periods 1997-2004, and 2004-2007, years before and after a non-profit wheat marketing company made quality information available to Mexican wheat buyers. Although for the latter period of study the information reflected lower than expected quality and consequently negatively affected U.S. wheat exports to Mexico.

As for the contributions of the papers included in this dissertation, the first study used the already widely employed hedonic pricing model. However, the data set used was unique, since no previous study included geographic quality observations organized by grainshed, considering different states across the U.S. Great Plains.

The contribution to the base of economic literature from the second study is the inclusion of variability in the systematic component of the random utility theory. Variability was included following two approaches, the first one was an application of the mean-variance theory; given the linearity of the utility function, this case assumed risk neutral preferences. The second approach used the expected utility theory considering respondent's risk aversion as depicted in the negative exponential utility functional form.

The third paper's contribution was the innovative application of the compensating variation and surplus concepts on the normalized indirect cost function of flour mills. This is an extension of two seminal papers (Foster and Just 1998; Teisl, Bockstael, and

Levy 2001) in which a similar methodology was applied to the consumers' expenditure function to investigate the effect of information on consumer's welfare. Because wheat is an intermediate product, we considered more appropriate to use a production theory perspective, thus cost minimization was selected.

The studies in the present dissertation can be improved, as we recognize some limitations. In the first paper, the number of years used was limited, ideally we would have a combination of cross sectional and time series data on quality parameters and local cash prices. Another ideal scenario would have been to know the actual prices paid to the elevators along with the exact location of the buyer (miller or trader), to account for transportation costs. Most variations in prices at the elevator site are attributable to transportation costs affiliated with a transaction. With these data improvements, the study would depict more closely if prices are yet reflecting differences in quality attributes. These results would help farmers choose those wheat varieties yielding higher values for those quality parameters with superior implicit prices. It is evident that the wheat market system is negatively impacted by incomplete information. To address this issue, it was demonstrated by previous studies (Mercier, 1993) that modifying the existing grades and standard system would be costly and probably not effective. Hence, wheat grower associations should increase and support the presence of non-profit wheat marketing entities whose main objective is to address the informational gaps in the system by publishing quality related information.

As for the second paper, ideally we could have access to a larger number of milling companies' representatives responding the survey. We recognize that survey respondents are heterogeneous. First, there is a regional segmentation in tastes and preferences across Mexico. Another source of heterogeneity is the nature of the clients the flour mills supply, i.e., if they mostly supply to artisan type or highly mass automated bakeries, or both. Since there are noticeable differences in the wheat and flour quality requirements according to each type of bread processing. With a larger number of observations, we would have been able to use a different estimation method rather than the multinomial logit model, for example the mixed logit model. Difficult convergence and too few observations prevent us from using this model.

To prove the validity of the two methodologies used we compared results from this study with actual wheat quantities imported by Mexico in 2006. To estimate the market share, actual quality characteristics from U.S. and Canada were used. There were remarkable differences between harvest quality reports from the two countries. Ideally, Canadian quality reports would have been disaggregated by provinces, thus it would be possible to obtain a weighted average for attribute quality and variation. When considering prices, the ideal case would have been to use the actual cost that imported wheat represented to a Mexican flour mill in 2006, accounting for transportation costs, insurance, and others.

To identify the value Mexican millers put on wheat quality parameters might help U.S. farmers in choosing wheat varieties yielding those characteristics with higher premiums. Results from this study, different from the previous one, reveal an interest in end-use characteristics (i.e., farinograph stability) from Mexican milling companies, which reinforces the idea that the information gaps should be addressed through publishing quality related information. To have a monetary assessment of wheat inconsistency will permit U.S. wheat marketers to adjust their system to reduce this variability. For example, to promote wheat transportation rail rather than by ocean vessels, and to connect the Mexican wheat buyer directly with the U.S. farmer or elevator.

For the third paper, the ideal case would have been to consider a larger period for non-profit marketing expenditures. Also, ideally we would have Cost freight insurance (CIF) prices for both U.S. and Canadian exported wheat. In addition, data on wheat exports should have been disaggregated by classes, hard red winter for the U.S. and hard red spring for Canada. As for Mexican data, the ideal case would have been to have access to actual quantities and prices of domestic hard-type wheat procured to the flour mills.

Additionally, to measure the sole effect of quality-based expenditures on flour processing costs and wheat imports it would have been ideal to control for changes in quality. Our study reflects that given the information, costs and U.S. wheat quantities imported decreased. This might be the result of the variations in quality, rather than the availability of information per see. Wheat quality would change from year to year, even when dealing with the same wheat variety and same growing regions. This change is uncertain: quality might or might not be improved through out the years, and this event cannot be controlled. For example, the 2004-2007 period coincided with a drought in the U.S. wheat growing region.

This study gives a monetary value of the effect of non-profit wheat marketing companies on wheat buyers in Mexico. With this information, wheat grower associations might realize the importance of these institutions in better addressing buyers' requirements. Hence, it might be favorable to market U.S. wheat, to increase the geographical area of study of these institutions, and to expand to wheat types other than hard red winter.

Further research considering the improvements previously suggested is recommended since both methodologies and implications of the studies included in this dissertation are of interest for both the base of economic literature and the wheat industry.

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APPENDICES

APPENDIX A -- INSTITUTIONAL REVIEW BOARD LETTER

Oklahoma State University Institutional Review Board

Date:	Thursday, May 25, 2006
IRB Application No	AG0635
Proposal Title:	Increasing U.S. Hard Red Winter Wheat Competitiveness in Latin American Markets
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved   Protocol Expires: 5/24/2007

Principal Investigator(s

Rodney Holcomb
114 FAPC
Stillwater, OK 74078

Rosa K. Gallardo
421A Ag Hall
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

[X] The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 415 Whitehurst (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Sue C. Jacobs

Sue C. Jacobs, Chair
Institutional Review Board

APPENDIX B -- SURVEY ON HARD RED WINTER WHEAT QUALITY PREFERENCES

Oklahoma State University

Division of Agricultural Sciences and Natural Resources
Department of Agricultural Economics
308 Agricultural Hall
Stillwater, OK 74078 – 6026
405-744-6157, 6154, 6108
Fax: 405 – 744-8210

Dear Purchasing Manager,

We would tremendously appreciate your assistance in our study related to hard red winter wheat quality attributes. This is study is conducted by the Department of Agricultural Economics of Oklahoma State University with the support of the National Association of the Milling Industry (CANIMOLT). The purpose of this study is to obtain information about your preferences and the value you assign to hard red winter wheat attributes, especially those related with end-use performance, that are rarely include in the contract specification. This information is unique and is not available from previous studies. This survey is a tool that is going to give us the information needed to better understand your preferences. This study will help suppliers offer a product able to meet your most strict requirements.

Your participation is important to the success of this research effort. Completion of this questionnaire is completely voluntary and you do not have to answer any question for which you feel uncomfortable. All information provided will be held in strict confidentiality. No individual's names will ever be published and only statistical analyses of data will be documented. Your identity will not be given to any outside sources.

On behalf of the researchers; we would like to thank you for your participation. If you have any questions or comments regarding this survey, please contact Ms. Karina Gallardo at 001-405-7449985 or by e-mail: karina.gallardo@okstate.edu.

Thank you very much for your assistance,

Karina Gallardo

Graduate Student
Department of Agricultural Economics
Oklahoma State University
Stillwater, OK 74075

Quality Preferences Hard Red Winter Wheat

We ask for the Quality Control or Purchase chief or equivalent to answer this questionnaire. You are going to be presented with different scenarios simulating wheat sale offers. Each scenario includes three alternatives; two of them were assigned different combinations of attributes and prices and a third one of rejection. Please select by putting an "X" on the option that you would choose.

Consider:

- ✓ Each scenario represents a different wheat offer.
- ✓ The parameters were generated following a statistical design so it would be possible to infer the value assign to each parameter and their ranges of variability.
- ✓ The values presented are hypothetical; they may or may not be the values you are used to see when buying wheat.
- ✓ The price as Freight on Board (FOB); does not include transportation costs, basis, storage, pesticide application and no other additional cost.

Scenario 1

Features	Option A	Option B	Option C
1) Test weight minimum (kg/hl)	78	80	I would NOT choose any of the alternatives presented
Test weight values within the range:	77.5-78.5	79.5-80.5	
2) Wheat protein 12% (%)	11	11	
Wheat protein values within the range:	10.5-11.5	9.5-12.5	
3) Falling number minimum 14% (sec)	300	400	
Falling number values within the range:	285-315	355-445	
4) Farinograph stability minimum (min)	13	13	
Farinograph stability values within the range:	10-16	10-16	
5) Alveograph P/L ratio	0.85	0.85	
Alveograph P/L ratio values within the range:	0.65-1.05	0.8-0.9	
6) Kernel diameter (mm)	2.0	2.3	
Kernel diameter values within the range:	1.95-2.05	2.25-2.35	
7) Price ($/MT)	180	180	
I would choose*			

* If you choose option C please indicate why: ________________________________

<u>On a scale 1-7, being 1 the least preferred and 7 the most preferred, how would you rate these two options for your milling preferences?</u>

Option A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Option B	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Remember:

- ✓ Each scenario represents a different wheat offer.
- ✓ Each scenario includes three options, two of them with different parameters, and variability ranges and prices. The third one is rejection. Please indicate with an "x" the option you would choose.
- ✓ Parameters were generated following a statistical design so we can infer the value you assign to each quality characteristic and range of variability.
- ✓ The value parameters are hypothetical they might or not be similar to the ones you are used to see in reality.
- ✓ Wheat price is in U.S. dollars. It is hypothetical and does not include transportation, basis, pesticide application and any other additional cost.

Thank you so much for your participation!

Scenario 2

Features		Option A		Option B		Option C
1) Test weight minimum (kg/hl)		78		80		I would NOT choose any of the alternatives Presented
Test weight values within the range:		77.5-78.5		79.5-80.5		
2) Wheat protein 12% (%)		11		11		
Wheat protein values within the range:		9.5-12.5		9.5-12.5		
3) Falling number minimum 14% (sec)		300		300		
Falling number values within the range:		255-345		285-315		
4) Farinograph stability minimum (min)		9		13		
Farinograph stability values within the range:		8-10		12-14		
5) Alveograph P/L ratio		1.1		1.1		
Alveograph P/L ratio values within the range:		1.05-1.15		0.9-1.3		
6) Kernel diameter (mm)		2.3		2.0		
Kernel diameter values within the range:		2.0-2.6		1.7-2.3		
7) Price ($/MT)		170		170		
I would choose*						

* If you choose option C please indicate why: ______________________________

<u>On a scale 1-7, being 1 the least preferred and 7 the most preferred, how would you rate these two options for your milling preferences?</u>

Option A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Option B	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Remember:

- ✓ Each scenario represents a different wheat offer.
- ✓ Each scenario includes three options, two of them with different parameters, and variability ranges and prices. The third one is rejection. Please indicate with an "x" the option you would choose.
- ✓ Parameters were generated following a statistical design so we can infer the value you assign to each quality characteristic and range of variability.
- ✓ The value parameters are hypothetical they might or not be similar to the ones you are used to see in reality.
- ✓ Wheat price is in U.S. dollars. It is hypothetical and does not include transportation, basis, pesticide application and any other additional cost.

Thank you so much for your participation!

Scenario 3

Features	Option A	Option B	Option C
1) Test weight minimum (kg/hl)	78	78	I would NOT choose any of the alternatives Presented
Test weight values within the range:	77.5-78.5	76.5-79.5	
2) Wheat protein 12% (%)	13	13	
Wheat protein values within the range:	12.5-13.5	12.5-13.5	
3) Falling number minimum 14% (sec)	300	300	
Falling number values within the range:	255-345	255-345	
4) Farinograph stability minimum (min)	9	13	
Farinograph stability values within the range:	8-10	12-14	
5) Alveograph P/L ratio	1.1	1.1	
Alveograph P/L ratio values within the range:	0.9-1.3	0.9-1.3	
6) Kernel diameter (mm)	2.0	2.0	
Kernel diameter values within the range:	1.95-2.05	1.95-2.05	
7) Price ($/MT)	180	170	
I would choose*			

* If you choose option C please indicate why: ______________________________

<u>On a scale 1-7, being 1 the least preferred and 7 the most preferred, how would you rate these two options for your milling preferences?</u>

Option A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Option B	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Remember:
- ✓ Each scenario represents a different wheat offer.
- ✓ Each scenario includes three options, two of them with different parameters, and variability ranges and prices. The third one is rejection. Please indicate with an "x" the option you would choose.
- ✓ Parameters were generated following a statistical design so we can infer the value you assign to each quality characteristic and range of variability.
- ✓ The value parameters are hypothetical they might or not be similar to the ones you are used to see in reality.
- ✓ Wheat price is in U.S. dollars. It is hypothetical and does not include transportation, basis, pesticide application and any other additional cost.

Thank you so much for your participation!

Scenario 4

Features	Option A	Option B	Option C
1) Test weight minimum (kg/hl)	78	78	I would NOT choose any of the alternatives Presented
Test weight values within the range:	77.5-78.5	76.5-79.5	
2) Wheat protein 12% (%)	13	11	
Wheat protein values within the range:	11.5-14.5	9.5-12.5	
3) Falling number minimum 14% (sec)	300	300	
Falling number values within the range:	285-315	255-345	
4) Farinograph stability minimum (min)	13	13	
Farinograph stability values within the range:	10-16	10-16	
5) Alveograph P/L ratio	0.85	0.85	
Alveograph P/L ratio values within the range:	0.8-0.9	0.8-0.9	
6) Kernel diameter (mm)	2.3	2.3	
Kernel diameter values within the range:	2.0-2.6	2.0-2.6	
7) Price ($/MT)	170	170	
I would choose*			

* If you choose option C please indicate why: ______________________________

On a scale 1-7, being 1 the least preferred and 7 the most preferred, how would you rate these two options for your milling preferences?

Option A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Option B	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Remember:

- ✓ Each scenario represents a different wheat offer.
- ✓ Each scenario includes three options, two of them with different parameters, and variability ranges and prices. The third one is rejection. Please indicate with an "x" the option you would choose.
- ✓ Parameters were generated following a statistical design so we can infer the value you assign to each quality characteristic and range of variability.
- ✓ The value parameters are hypothetical they might or not be similar to the ones you are used to see in reality.
- ✓ Wheat price is in U.S. dollars. It is hypothetical and does not include transportation, basis, pesticide application and any other additional cost.

Thank you so much for your participation!

Scenario 5

Features	Option A	Option B	Option C
1) Test weight minimum (kg/hl)	78	78	I would NOT choose any of the alternatives Presented
Test weight values within the range:	76.5-79.5	76.5-79.5	
2) Wheat protein 12% (%)	11	11	
Wheat protein values within the range:	10.5-11.5	9.5-12.5	
3) Falling number minimum 14% (sec)	400	400	
Falling number values within the range:	355-445	355-445	
4) Farinograph stability minimum (min)	9	9	
Farinograph stability values within the range:	6-12	8-10	
5) Alveograph P/L ratio	0.85	1.1	
Alveograph P/L ratio values within the range:	0.8-0.9	1.05-1.15	
6) Kernel diameter (mm)	2.3	2.3	
Kernel diameter values within the range:	2.25-2.35	2.0-2.6	
7) Price ($/MT)	180	170	
I would choose*			

* If you choose option C please indicate why: ______________________________

On a scale 1-7, being 1 the least preferred and 7 the most preferred, how would you rate these two options for your milling preferences?

Option A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Option B	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Remember:

- ✓ Each scenario represents a different wheat offer.
- ✓ Each scenario includes three options, two of them with different parameters, and variability ranges and prices. The third one is rejection. Please indicate with an "x" the option you would choose.
- ✓ Parameters were generated following a statistical design so we can infer the value you assign to each quality characteristic and range of variability.
- ✓ The value parameters are hypothetical they might or not be similar to the ones you are used to see in reality.
- ✓ Wheat price is in U.S. dollars. It is hypothetical and does not include transportation, basis, pesticide application and any other additional cost.

Thank you so much for your participation!

Scenario 6

Features		Option A		Option B		Option C
1) Test weight minimum (kg/hl)		78		78		I would NOT choose any of the alternatives Presented
Test weight values within the range:		76.5-79.5		76.5-79.5		
2) Wheat protein 12% (%)		11		11		
Wheat protein values within the range:		9.5-12.5		9.5-12.5		
3) Falling number minimum 14% (sec)		300		400		
Falling number values within the range:		285-315		355-445		
4) Farinograph stability minimum (min)		13		13		
Farinograph stability values within the range:		12-14		10-16		
5) Alveograph P/L ratio		1.1		0.85		
Alveograph P/L ratio values within the range:		0.9-1.3		0.65-1.05		
6) Kernel diameter (mm)		2.0		2.0		
Kernel diameter values within the range:		1.7-2.3		1.95-2.05		
7) Price ($/MT)		170		180		
I would choose*						

* If you choose option C please indicate why: ______________________________

<u>On a scale 1-7, being 1 the least preferred and 7 the most preferred, how would you rate these two options for your milling preferences?</u>

Option A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Option B	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Remember:

- ✓ Each scenario represents a different wheat offer.
- ✓ Each scenario includes three options, two of them with different parameters, and variability ranges and prices. The third one is rejection. Please indicate with an "x" the option you would choose.
- ✓ Parameters were generated following a statistical design so we can infer the value you assign to each quality characteristic and range of variability.
- ✓ The value parameters are hypothetical they might or not be similar to the ones you are used to see in reality.
- ✓ Wheat price is in U.S. dollars. It is hypothetical and does not include transportation, basis, pesticide application and any other additional cost.

Thank you so much for your participation!

Scenario 7

Features	Option A	Option B	Option C
1) Test weight minimum (kg/hl)	78	80	I would NOT choose any of the alternatives Presented
Test weight values within the range:	76.5-79.5	79.5-80.5	
2) Wheat protein 12% (%)	13	13	
Wheat protein values within the range:	12.5-13.5	12.5-13.5	
3) Falling number minimum 14% (sec)	300	400	
Falling number values within the range:	285-315	355-445	
4) Farinograph stability minimum (min)	13	13	
Farinograph stability values within the range:	12-14	10-16	
5) Alveograph P/L ratio	1.1	0.85	
Alveograph P/L ratio values within the range:	1.05-1.15	0.65-1.05	
6) Kernel diameter (mm)	2.3	2.0	
Kernel diameter values within the range:	2.25-2.35	1.7-2.3	
7) Price ($/MT)	180	170	
I would choose*			

* If you choose option C please indicate why: ______________________________

<u>On a scale 1-7, being 1 the least preferred and 7 the most preferred, how would you rate these two options for your milling preferences?</u>

Option A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Option B	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Remember:

- ✓ Each scenario represents a different wheat offer.
- ✓ Each scenario includes three options, two of them with different parameters, and variability ranges and prices. The third one is rejection. Please indicate with an "x" the option you would choose.
- ✓ Parameters were generated following a statistical design so we can infer the value you assign to each quality characteristic and range of variability.
- ✓ The value parameters are hypothetical they might or not be similar to the ones you are used to see in reality.
- ✓ Wheat price is in U.S. dollars. It is hypothetical and does not include transportation, basis, pesticide application and any other additional cost.

Thank you so much for your participation!

Scenario 8

Features	Option A	Option B	Option C
1) Test weight minimum (kg/hl)	78	80	I would NOT choose any of the alternatives Presented
Test weight values within the range:	76.5-79.5	79.5-80.5	
2) Wheat protein 12% (%)	13	13	
Wheat protein values within the range:	11.5-14.5	12.5-13.5	
3) Falling number minimum 14% (sec)	300	400	
Falling number values within the range:	255-345	355-445	
4) Farinograph stability minimum (min)	9	13	
Farinograph stability values within the range:	6-12	12-14	
5) Alveograph P/L ratio	0.85	1.1	
Alveograph P/L ratio values within the range:	0.65-1.05	1.05-1.15	
6) Kernel diameter (mm)	2.0	2.3	
Kernel diameter values within the range:	1.7-2.3	2.25-2.35	
7) Price ($/MT)	170	180	
I would choose*			

* If you choose option C please indicate why: ______________________________

On a scale 1-7, being 1 the least preferred and 7 the most preferred, how would you rate these two options for your milling preferences?

Option A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Option B	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Remember:

- ✓ Each scenario represents a different wheat offer.
- ✓ Each scenario includes three options, two of them with different parameters, and variability ranges and prices. The third one is rejection. Please indicate with an "x" the option you would choose.
- ✓ Parameters were generated following a statistical design so we can infer the value you assign to each quality characteristic and range of variability.
- ✓ The value parameters are hypothetical they might or not be similar to the ones you are used to see in reality.
- ✓ Wheat price is in U.S. dollars. It is hypothetical and does not include transportation, basis, pesticide application and any other additional cost.

Thank you so much for your participation!

Scenario 9

Features	Option A	Option B	Option C
1) Test weight minimum (kg/hl)	80	78	I would NOT choose any of the alternatives presented
Test weight values within the range:	79.5-80.5	77.5-78.5	
2) Wheat protein 12% (%)	11	13	
Wheat protein values within the range:	10.5-11.5	11.5-14.5	
3) Falling number minimum 14% (sec)	300	400	
Falling number values within the range:	255-345	385-415	
4) Farinograph stability minimum (min)	13	9	
Farinograph stability values within the range:	12-14	8-10	
5) Alveograph P/L ratio	0.85	0.85	
Alveograph P/L ratio values within the range:	0.8-0.9	0.65-1.05	
6) Kernel diameter (mm)	2.3	2.3	
Kernel diameter values within the range:	2.0-2.6	2.0-2.6	
7) Price ($/MT)	180	180	
I would choose*			

* If you choose option C please indicate why: ______________________________

<u>On a scale 1-7, being 1 the least preferred and 7 the most preferred, how would you rate these two options for your milling preferences?</u>

Option A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Option B	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Remember:

- ✓ Each scenario represents a different wheat offer.
- ✓ Each scenario includes three options, two of them with different parameters, and variability ranges and prices. The third one is rejection. Please indicate with an "x" the option you would choose.
- ✓ Parameters were generated following a statistical design so we can infer the value you assign to each quality characteristic and range of variability.
- ✓ The value parameters are hypothetical they might or not be similar to the ones you are used to see in reality.
- ✓ Wheat price is in U.S. dollars. It is hypothetical and does not include transportation, basis, pesticide application and any other additional cost.

Thank you so much for your participation!

Scenario 10

Features	Option A	Option B	Option C
1) Test weight minimum (kg/hl)	80	78	I would NOT choose any of the alternatives presented
Test weight values within the range:	79.5-80.5	77.5-78.5	
2) Wheat protein 12% (%)	11	13	
Wheat protein values within the range:	9.5-12.5	11.5-14.5	
3) Falling number minimum 14% (sec)	300	400	
Falling number values within the range:	285-315	385-415	
4) Farinograph stability minimum (min)	9	9	
Farinograph stability values within the range:	6-12	6-12	
5) Alveograph P/L ratio	1.1	1.1	
Alveograph P/L ratio values within the range:	0.9-1.3	1.05-1.15	
6) Kernel diameter (mm)	2.3	2.0	
Kernel diameter values within the range:	2.25-2.35	1.95-2.05	
7) Price ($/MT)	170	170	
I would choose*			

* If you choose option C please indicate why: ________________________________

Scenario 11

<u>On a scale 1-7, being 1 the least preferred and 7 the most preferred, how would you rate these two options for your milling preferences?</u>

Option A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Option B	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Remember:

- ✓ Each scenario represents a different wheat offer.
- ✓ Each scenario includes three options, two of them with different parameters, and variability ranges and prices. The third one is rejection. Please indicate with an "x" the option you would choose.
- ✓ Parameters were generated following a statistical design so we can infer the value you assign to each quality characteristic and range of variability.
- ✓ The value parameters are hypothetical they might or not be similar to the ones you are used to see in reality.
- ✓ Wheat price is in U.S. dollars. It is hypothetical and does not include transportation, basis, pesticide application and any other additional cost.

Thank you so much for your participation!

Features	Option A	Option B	Option C
1) Test weight minimum (kg/hl)	78	80	I would NOT choose any of the alternatives presented
Test weight values within the range:	77.5-78.5	78.5-81.5	
2) Wheat protein 12% (%)	13	11	
Wheat protein values within the range:	12.5-13.5	10.5-11.5	
3) Falling number minimum 14% (sec)	300	400	
Falling number values within the range:	285-315	385-415	
4) Farinograph stability minimum (min)	9	9	
Farinograph stability values within the range:	6-12	6-12	
5) Alveograph P/L ratio	1.1	1.1	
Alveograph P/L ratio values within the range:	1.05-1.15	1.05-1.15	
6) Kernel diameter (mm)	2.0	2.0	
Kernel diameter values within the range:	1.7-2.3	1.7-2.3	
7) Price ($/MT)	180	180	
I would choose*			

* If you choose option C please indicate why: ________________________________

On a scale 1-7, being 1 the least preferred and 7 the most preferred, how would you rate these two options for your milling preferences?

Option A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Option B	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Remember:

- ✓ Each scenario represents a different wheat offer.
- ✓ Each scenario includes three options, two of them with different parameters, and variability ranges and prices. The third one is rejection. Please indicate with an "x" the option you would choose.
- ✓ Parameters were generated following a statistical design so we can infer the value you assign to each quality characteristic and range of variability.
- ✓ The value parameters are hypothetical they might or not be similar to the ones you are used to see in reality.
- ✓ Wheat price is in U.S. dollars. It is hypothetical and does not include transportation, basis, pesticide application and any other additional cost.

Thank you so much for your participation!

Scenario 12

Features	Option A	Option B	Option C
1) Test weight minimum (kg/hl)	80	80	I would NOT choose any of the alternatives presented
Test weight values within the range:	79.5-80.5	78.5-81.5	
2) Wheat protein 12% (%)	13	11	
Wheat protein values within the range:	11.5-14.5	10.5-11.5	
3) Falling number minimum 14% (sec)	300	400	
Falling number values within the range:	255-345	385-415	
4) Farinograph stability minimum (min)	13	9	
Farinograph stability values within the range:	12-14	8-10	
5) Alveograph P/L ratio	0.85	0.85	
Alveograph P/L ratio values within the range:	0.65-1.05	0.65-1.05	
6) Kernel diameter (mm)	2.3	2.3	
Kernel diameter values within the range:	2.25-2.35	2.25-2.35	
7) Price ($/MT)	170	170	
I would choose*			

* If you choose option C please indicate why: ______________________________

<u>On a scale 1-7, being 1 the least preferred and 7 the most preferred, how would you rate these two options for your milling preferences?</u>

Option A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Option B	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Remember:

- ✓ Each scenario represents a different wheat offer.
- ✓ Each scenario includes three options, two of them with different parameters, and variability ranges and prices. The third one is rejection. Please indicate with an “x” the option you would choose.
- ✓ Parameters were generated following a statistical design so we can infer the value you assign to each quality characteristic and range of variability.
- ✓ The value parameters are hypothetical they might or not be similar to the ones you are used to see in reality.
- ✓ Wheat price is in U.S. dollars. It is hypothetical and does not include transportation, basis, pesticide application and any other additional cost.

Thank you so much for your participation!

Scenario 13

Features	Option A	Option B	Option C
1) Test weight minimum (kg/hl)	80	80	I would NOT choose any of the alternatives presented
Test weight values within the range:	78.5-81.5	78.5-81.5	
2) Wheat protein 12% (%)	11	13	
Wheat protein values within the range:	10.5-11.5	11.5-14.5	
3) Falling number minimum 14% (sec)	300	300	
Falling number values within the range:	285-315	285-315	
4) Farinograph stability minimum (min)	9	9	
Farinograph stability values within the range:	8-10	6-12	
5) Alveograph P/L ratio	0.85	1.1	
Alveograph P/L ratio values within the range:	0.65-1.05	0.9-1.3	
6) Kernel diameter (mm)	2.3	2.3	
Kernel diameter values within the range:	2.0-2.6	2.25-2.35	
7) Price ($/MT)	180	170	
I would choose*			

* If you choose option C please indicate why: ______________________________

<u>On a scale 1-7, being 1 the least preferred and 7 the most preferred, how would you rate these two options for your milling preferences?</u>

Option A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Option B	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Remember:
- ✓ Each scenario represents a different wheat offer.
- ✓ Each scenario includes three options, two of them with different parameters, and variability ranges and prices. The third one is rejection. Please indicate with an "x" the option you would choose.
- ✓ Parameters were generated following a statistical design so we can infer the value you assign to each quality characteristic and range of variability.
- ✓ The value parameters are hypothetical they might or not be similar to the ones you are used to see in reality.
- ✓ Wheat price is in U.S. dollars. It is hypothetical and does not include transportation, basis, pesticide application and any other additional cost.

Thank you so much for your participation!

Scenario 14

Features	Option A	Option B	Option C
1) Test weight minimum (kg/hl)	80	80	I would NOT choose any of the alternatives presented
Test weight values within the range:	78.5-81.5	78.5-81.5	
2) Wheat protein 12% (%)	11	13	
Wheat protein values within the range:	9.5-12.5	11.5-14.5	
3) Falling number minimum 14% (sec)	300	300	
Falling number values within the range:	255-345	285-315	
4) Farinograph stability minimum (min)	13	9	
Farinograph stability values within the range:	10-16	8-10	
5) Alveograph P/L ratio	1.1	0.85	
Alveograph P/L ratio values within the range:	1.05-1.15	0.8-0.9	
6) Kernel diameter (mm)	2.0	2.0	
Kernel diameter values within the range:	1.95-2.05	1.7-2.3	
7) Price ($/MT)	170	180	
I would choose*			

* If you choose option C please indicate why: ______________________________

<u>On a scale 1-7, being 1 the least preferred and 7 the most preferred, how would you rate these two options for your milling preferences?</u>

Option A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Option B	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Remember:

- ✓ Each scenario represents a different wheat offer.
- ✓ Each scenario includes three options, two of them with different parameters, and variability ranges and prices. The third one is rejection. Please indicate with an “x” the option you would choose.
- ✓ Parameters were generated following a statistical design so we can infer the value you assign to each quality characteristic and range of variability.
- ✓ The value parameters are hypothetical they might or not be similar to the ones you are used to see in reality.
- ✓ Wheat price is in U.S. dollars. It is hypothetical and does not include transportation, basis, pesticide application and any other additional cost.

Thank you so much for your participation!

Scenario 15

Features		Option A		Option B		Option C
1) Test weight minimum (kg/hl)		80		78		I would NOT choose any of the alternatives presented
Test weight values within the range:		78.5-81.5		77.5-78.5		
2) Wheat protein 12% (%)		13		11		
Wheat protein values within the range:		12.5-13.5		10.5-11.5		
3) Falling number minimum 14% (sec)		300		300		
Falling number values within the range:		255-345		285-315		
4) Farinograph stability minimum (min)		13		9		
Farinograph stability values within the range:		10-16		8-10		
5) Alveograph P/L ratio		1.1		0.85		
Alveograph P/L ratio values within the range:		0.9-1.3		0.8-0.9		
6) Kernel diameter (mm)		2.3		2.0		
Kernel diameter values within the range:		2.0-2.6		1.95-2.05		
7) Price ($/MT)		180		170		
I would choose*						

* If you choose option C please indicate why: ______________________________

<u>On a scale 1-7, being 1 the least preferred and 7 the most preferred, how would you rate these two options for your milling preferences?</u>

Option A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Option B	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Remember:

- ✓ Each scenario represents a different wheat offer.
- ✓ Each scenario includes three options, two of them with different parameters, and variability ranges and prices. The third one is rejection. Please indicate with an "x" the option you would choose.
- ✓ Parameters were generated following a statistical design so we can infer the value you assign to each quality characteristic and range of variability.
- ✓ The value parameters are hypothetical they might or not be similar to the ones you are used to see in reality.
- ✓ Wheat price is in U.S. dollars. It is hypothetical and does not include transportation, basis, pesticide application and any other additional cost.

Thank you so much for your participation!

Scenario 16

Features	Option A	Option B	Option C
1) Test weight minimum (kg/hl)	80	78	I would NOT choose any of the alternatives presented
Test weight values within the range:	78.5-81.5	77.5-78.5	
2) Wheat protein 12% (%)	13	11	
Wheat protein values within the range:	11.5-14.5	10.5-11.5	
3) Falling number minimum 14% (sec)	300	300	
Falling number values within the range:	285-315	285-315	
4) Farinograph stability minimum (min)	9	13	
Farinograph stability values within the range:	8-10	10-16	
5) Alveograph P/L ratio	0.85	1.1	
Alveograph P/L ratio values within the range:	0.8-0.9	0.9-1.3	
6) Kernel diameter (mm)	2.0	2.3	
Kernel diameter values within the range:	1.95-2.05	2.0-2.6	
7) Price ($/MT)	170	180	
I would choose*			

* If you choose option C please indicate why: ______________________________

<u>On a scale 1-7, being 1 the least preferred and 7 the most preferred, how would you rate these two options for your milling preferences?</u>

Option A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Option B	**1**	**2**	**3**	**4**	**5**	**6**	**7**

ADDITIONAL QUESTIONS….

To complete our study we would like to have additional information about your company. <u>This section is voluntary to answer; however by responding to these questions you will tremendously help us.</u> Please consider that confidentiality is guaranteed and that we will use this information strictly for research purposes.

Please, put a circle around the alternative that best answers the following :						
17)	How many metric tons of hard red winter wheat you bought in 2006?	Less than 10 000 MT	Between 10,000 and 50,000 MT	Between 50,000 and 100,000 MT	Between 100,000 and 300,000 MT	More than 300,000 MT
18)	On average, how much (FOB) did you pay for a MT of imported hard red winter wheat in 2006?	$170/MT	$175/MT	$180/MT	Other (Please specify) …………………….	
19)	If you imported wheat in 2006; from what country did you buy it?	United States	Canada	Australia	Other (Please specify) …………………….	
20)	Lately, information about functionality wheat attributes has been publicly available; do you think this information will represent a benefit to your company?	It will not represent a benefit	It will represent a very limited benefit	It will represent some benefit	It is crucial to know this information	
	If you imported hard red winter wheat from the United States in 2006…					
21)	How would you qualify the quality of hard wheat you bought?	Very poor	Poor	Average	Good	Excellent
22)	How would you qualify the quality of service from the supplier?	Very poor	Poor	Average	Good	Excellent
23)	Did the quality specifications of wheat shipped coincide with the laboratory test results done at your company?	They never coincide	They coincide only for approx. the 25% or less of the shipment lots received	They coincide for approx. the 50% of the shipment lots received	They coincide for approx. the 75% or more of the shipment lots received	They Always coincide
	If you imported wheat DNS from Canada in 2006 …					
24)	How would you qualify the quality of hard wheat you bought?	Very poor	Poor	Average	Good	Excellent
25)	How would you qualify the quality of service from the supplier?	Very poor	Poor	Average	Good	Excellent
26)	Did the quality specifications of wheat shipped coincide with the laboratory test results done at your company?	They never coincide	They coincide only for approx. the 25% or less of the shipment lots received	They coincide for approx. the 50% of the shipment lots received	They coincide for approx. the 75% or more of the shipment lots received	They Always coincide

If you have any additional comments, please let us know: ______________________________

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VITA

Rosa Karina Gallardo

Candidate for the Degree of

Doctor of Philosophy

Dissertation: DEMAND FOR QUALITY CHARACTERISTICS OF HARD RED WINTER WHEAT

Major Field: Agricultural Economics

Biographical:

Personal Data: Born in Lima, Perú, On January 25, 1975, the daughter of Andrés Gallardo and Rosa Llanos.

Education: Received Bachelor of Science Degree in Food Science and Technology from Universidad Nacional Agraria La Molina in December 1997; received Professional Degree in Food Science and Technology with Specialization in Total Quality Management and Productivity in August 2000; received Master of Science Degree in Agricultural Economics from Mississippi State University in August 2004. Completed the Requirements for the Doctor of Philosophy degree at Oklahoma State University in December 2007.

Experience: Employed as a Production Supervisor in Nestlé Perú Fábrica D'onofrio June 1999-July 2000; employed as a Quality Supervisor in Agro Industrias Backus April 2001-December 2002; employed as a graduate assistant at q Mississippi State University, Department of Agricultural Economics, June 2003-August 2004; employed as a graduate assistant at Oklahoma State University, Department of Agricultural Economics, September 2004-December 2007.

Name: Rosa Karina Gallardo Date of Degree: December, 2007

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: DEMAND FOR QUALITY CHARACTERISTICS OF HARD RED WINTER WHEAT

Pages in Study: 123 Candidate for the Degree of Doctor of Philosophy

Major Field: Agricultural Economics

Scope, Method of Study, and Findings: The present three-paper dissertation analyses the demand for quality attributes for hard red winter wheat in both domestic and international markets. The first paper analyzes the effect of physical and functionality parameters on prices paid to Oklahoma farmers during 2005 for hard red winter wheat, using a hedonic pricing model to estimate the implicit values for quality characteristics. Results showed that test weight had an implicit value of 0.77 cents/bushel, and moisture a negative value of 0.67 cents/bushel. There is evidence that hard red winter wheat prices were not yet reflecting vertical differences in quality characteristics, especially those related with end-use functionality.

The second paper investigates Mexican millers' preferences for wheat quality attributes. A major focus of the analysis is characterizing millers' preferences for consistency (or risk) in wheat input characteristics. In-person interviews were carried out with Mexican millers, who were administered a conjoint-type survey designed to incorporate uncertainty in attribute levels. Two methods are used to model millers' risk preferences: a modified mean-variance approach and an explicit expected utility approach. Controlling for variability, Mexican millers are willing to pay premiums for increases in quality factors such as test weight, protein content, falling number, and dough strength/extensibility. We find millers' are not particularly sensitive to changes in the variability of wheat quality characteristics. Out-of-sample forecasts suggest the mean-variance model provides an accurate depiction of actual Mexican imports.

The third paper attempts to the effect of the release of information on Mexican milling companies' welfare. A non-profit marketing company's expenditure is used as a proxy to model Mexican mill's accessibility to quality information, and applied to an indirect cost function. The value that wheat marketing companies expenditures represent to Mexican millers is measured by the difference of the flour mill's compensating surplus and compensating variation. Results indicate that for the period in study, information did not necessarily increase Mexican wheat imports; nonetheless it has a positive effect on mill's welfare.

ADVISER'S APPROVAL: Dr. Rodney B. Holcomb