PRICE COMPETITION IN THE HARD SPRING WHEAT MARKET:

A MARKET SPECIFIC ANALYSIS

by

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ABSTRACT

Price competition between the United States and Canada in the hard spring wheat markets of Japan, South Korea, and Indonesia are examined using annual data over a thirty year period. A four-equation system of supply and demand functions is used to estimate parameters that measure the price relationship of U.S. and Canadian hard spring wheat in each market. The models were estimated with three stage least squares procedures. Besides the parameters measuring price movement of hard spring wheat in the South Korean and Indonesian markets, results are generally not statistically different from zero. Supply and demand equations in the Japanese market have common estimated parameters that are the correct sign and statistically significant. Econometric results of the Japanese market indicate that the United States and Canada are acting as noncolluding oligopolists. Comparing the mixed results of the South Korean and Indonesian markets with those of the Japanese market suggest that the United States and Canada are not competing as strongly in the Japanese market as they are in South Korea and Indonesia.

CHAPTER 1

INTRODUCTION

Problem Statement

Hard red spring (HRS) wheat producers in the northern plains of the United States and in western Canada produce most of the world's hard spring wheat.[1] In most marketing years, hard spring wheat is the highest valued wheat of its type to end-users. Since the 1920s, these relatively high prices received for hard spring wheats have encouraged many producers to increase acres planted to hard spring wheat varieties.

The United States exports approximately 60% of total U.S. HRS wheat production, of which 24% has been produced in Montana over the past five crop years (1996 to 2000). While hard spring wheat is not the largest class of wheat in terms of worldwide production and exports, the market of this wheat increased in several important markets.[2] Hard spring wheat grown in Canada represents 90% of its production and 95% of it's wheat exports. Both the United States and Canada export a large percentage of their hard spring wheat, and so their international market shares are important for both countries.

Participants in agricultural markets are fundamentally concerned about the factors that influence a particular commodity's price. Determining supply and demand factors

[1] Durum wheat is not considered in this analysis.
[2] Dahl and Wilson's (1996) market share analysis suggests that Canadian and U.S. hard spring wheat experienced market growth in several key markets. They attribute this growth to increased consumption of bread products and increased use of hard spring wheat as a blending agent for poorer quality wheats.

for world wheat markets is complicated by government interventions in agricultural production and trade, including those by state trading enterprises.

The activities of state trading enterprises (STEs) are a contentious issue in world wheat markets. Numerous studies have analyzed the effects of STEs, in particular the Canadian Wheat Board (CWB) (Carter et al. 1998; Brooks and Schmitz 1999; Kraft et al. 1996), but report conflicting results regarding these effects. A noticeable difference among these studies concerns the price data used in the econometric work. Studies that have supported the CWB's operations have used confidential price data supplied by them, with an agreement that the data only be made available to the researcher on a confidential basis.[3] Research not supportive of the CWB's operations, has generally used farmgate values, which is argued to better reflect the prices actually faced by producers.

The price data used in the econometric chapter of this thesis are as follows. U.S. prices are a combination of the United States Department of Agriculture's (USDA) Pacific Northwest export price and Minneapolis Grain Exchange prices. Canadian price data are pool prices received by producers for incremental protein levels. These prices are closely correlated with farm gate prices. Prices to consumers of hard spring wheat reflect port prices plus ocean freight.

The Canadian and Australian wheat exporting STEs, and several importing STEs may face pressure to change their agricultural trade practices in the next round of World Trade Organization negotiations. Trade policy negotiators in countries without STEs are expected to argue that an international trading system based on the principles of market-based economics will benefit all market participants.

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[3] Most of the recent criticism regarding STEs has been directed at the CWB.

Purpose of Study

This thesis implements tests for non-price competition that would underlie price discrimination for the hard spring market. Individual demand curves of selected countries that consume both Canadian and U.S. hard spring wheat are estimated to obtain empirical indications of price competition between Canadian and U.S wheat exporters. Of additional interest is the estimated positive price relationship between Canadian Western Red Spring (CWRS) and U.S. HRS. This thesis will present and discuss economic and econometric models to measure the price competition between these exporters in selected markets.

The remainder of this chapter presents background information about hard spring wheat markets to provide a basis for the economic and econometric models that are presented in the following chapters.

Background

Hard spring wheat is a high protein wheat that commands a price premium over other wheats. Three specific markets for hard spring wheat are considered in this thesis.

Hard Spring Wheat

The supply of high protein wheat varies and so most wheat produced worldwide has considerably lower protein than hard spring wheat. Because growing conditions are unpredictable, both the total supply of hard spring wheat and its protein level can vary dramatically from crop year to crop year. Flour Millers purchase high protein wheat because it contains desirable characteristics for bread making flours, one being a high gluten content.[4]

Canada and the United States are the two largest exporters of high protein hard spring milling quality wheat to the international wheat market. Milling quality is a broad term used to summarize the many factors that affect the milling process. These factors may include the response of the wheat to conditioning, the performance of wheat in the mill and flour yield.[5] In Montana's dryland production regions the most common hard spring wheat meets the requirements for classification as a U.S. #1 HRS.[6] Montana hard spring wheat areas generally produce wheat with higher protein content than wheat grown in other regions of the United States. Montana's hard spring wheat is unique in that it is usually graded as a #1 and generally has the highest level of protein available to the U.S. market (14.2% average protein 1996 to 2000). Canadian wheat producers also grow a hard spring wheat, Canadian western red spring (CWRS), with protein levels similar to Montana hard spring wheat. There is some debate about the substitutability of U.S. HRS and Canadian CWRS for end users (Wilson 1989), but both classes are grown in similar growing regions, have common buyers, and parties involved in the trade of these wheats appear to treat them as close substitutes.

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[4] High gluten strength, along with kernel hardness and protein characteristics allows bread to rise during baking. Obtaining these characteristics through wheat procurement is a critical step in the milling process.
[5] The conditioning of wheat involves the cleaning of wheat. Gravity tables, disc separators, and indent cylinders are machines used to remove damaged kernels and other contaminants that affect the suitability of wheat for milling.
[6] #1 HRS is defined as wheat with a test weight minimum of 58 pounds per bushel, a minimum total damage count of 2.0%,a maximum amount of 0.5% foreign material, and a shrunken and broken count of less than 3.0%.

Hard Spring Wheat Market Participants

There are many forms of government intervention in the international wheat market. U.S. trade officials claim that STEs interfere with fair trade. STEs take on many different forms. A common definition offered by the U.S. General Accounting Office is as follows: STE's are "governmental or nongovernmental enterprises, including marketing boards, which have been granted exclusive or special rights or privilege, including statutory or constitutional powers, in the exercise of which they influence, through their purchases or sales, the level or direction of imports or exports."

This thesis considers three specific markets that have imported Canadian and U.S. hard spring wheat. All three countries have experienced changes in wheat demand. Japan, South Korea, and Indonesia all imported relatively large quantities of hard spring wheat over the period 1970 to 2000. These three countries were selected because of their import volumes and the availability of price data.[7] All three of these countries have had, or currently have, their own form of an importing STE for wheat. After a description of the grain marketing systems in the United States and Canada are given, the Japanese, Indonesian, and South Korean wheat buying systems are described.

Canadian Wheat Marketing System

The Canadian wheat sector is heavily dependent on exports as only one forth of their annual production is consumed domestically for human consumption or animal feed (USDA). Wheat for export or domestic human consumption is merchandised by the

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[7] See Appendix A for a graphical illustration of import levels for Japan, South Korean, and Indonesia of U.S. and Canadian hard spring wheat.

CWB, a governmental chartered corporation. The CWB is the sole marketing agent for wheat exports and contracts with cooperatives, multinational grain firms, and importers to move wheat from country elevators to import destinations or to domestic. The CWB has tight control of plant breeding, domestic transportation, quality control, and close relationships with international and domestic end-use customers. The CWB seeks to provide price stability to producers through the pooling procedure. The returns for each crop year are pooled together according to class and grade considerations. Marketing and operation costs incurred by the board are deducted from the pool and the remaining net revenues are returned to producers. The CWB has been operating since the 1930's. For a detailed description of the CWB, see Schmitz and Furtan (2000).

United States Wheat Marketing System

The U.S. marketing system is unlike the Canadian system in that its participants are essentially all private firms. Some marketers are small country elevators with cooperative ownerships, while others are multinational grain and food companies with a presence in many levels of the marketing chain. Plant breeding, grading, domestic transportation, quality control, and international relations with customers are controlled through a number of avenues including government agencies, private and institutional funding, and competitive market forces. The main distinction between the U.S. and Canadian systems regarding hard spring wheat trade to the countries considered in this thesis is that U.S. exporting firms must buy and sell wheat, while assuming the inherent risk of market participation.

Japan Hard Spring Wheat

Japan is heavily dependent on wheat imports with only eight percent of its total wheat supply provided by domestic production (USDA, various years). Japan accounts for nearly six percent of total world wheat imports (International Grain Council, various years).

The Japanese Food Agency (JFA) is the central buying organization for wheat in Japan. In addition to controlling how much wheat is imported through a quota system, JFA selects the source and classes of wheat to be imported and charges an administratively determined price to millers and processors. The quota system is used by the government to subsidize domestic wheat producers and stabilize prices. Japanese millers play a role in this process by preparing requests for quantities and classes of wheat. The price millers pay to the JFA is generally above the world price and does not vary with the world price. The spread between the world price and the domestic price is considered an administrative cost by the JFA.

Although rice remains the most important staple food in Japan, wheat flour products have gained popularity in the Japanese diet. After World War II, wheat flour products became more popular in Japan. Increased domestic demand for wheat flour increased the demand for foreign wheat for two reasons. First, domestic wheat was not suitable for making non-traditional flour products. Secondly, prices for imported wheat were relatively low (Koo et al. 2001).[8]

[8] See Appendix A for a graphical illustration of import levels for Japan of Canadian and U.S. hard spring wheat.

Indonesian Hard Spring Wheat

Indonesia does not produce wheat at all and so all domestic consumption is served through imports. In the late 1960's and early 1970's, flour imports were used to meet Indonesia's food demand and to help control the domestic inflationary pressures of the period. Since the early 1970's, imports have been entirely in the form of wheat grain. Wheat has now replaced rice as Indonesia's most important food import. Initially, all imports were on a grant or concessional basis from wheat exporting countries through programs as the P.L. 480 program in the United States. Although Indonesia still imports a small amount of wheat on a concessional basis, most imports are now commercial (Magiera 1994).

Canadian exports into Indonesia have increased recently. A primary reason for this increase was an agreement between the CWB and Indonesia's Bogasari Flour Mills. Affective in 1996, this agreement required Bogasari to purchase 37 to 55 million bushels of wheat a year from the CWB over a five-year period (IGC).

Prior to 1998, nearly all aspects of the wheat and wheat flour markets in Indonesia were regulated by the government. The government controlled imports, regulated output and prices for Indonesia's three flour mills, and regulated the distribution of flour to licensed distributors. Indonesia's flour millers did not actually purchase wheat, but received a milling fee and were allowed to keep all byproducts. This governmental agency, Badan Urusan Logistik (BULOG), had the sole authority to import wheat and wheat flour.

The price of wheat flour in Indonesia was set by BULOG-according to the price of rice. BULOG also regulated the types of flour produced for the domestic market. The effect of the regulations was to subsidize flour millers and tax consumers of wheat flour products.

Since 1998, the BULOG has lost is sole authority to import wheat. This change in policy was in large part due to the corruption reported within BULOG. Wheat exporters now have direct contact with buyer representatives of Indonesian mills (AAFC).

South Korean Hard Spring Wheat

In 1983, South Korea ended its state monopoly on wheat imports. A trade liberalization program was instilled between 1983 and 1990 that ultimately phased out the Korean Flour Mills Industrial Association (KOFMIA), which previously held a monopoly on all wheat imports and purchases (Kim 2001).

Prior to 1983, the role of KOFMIA was similar to that of the JFA in that KOFMIA regulated wheat sales as well as the wheat imports within South Korea. This regulation included determining the needs of the domestic mills, establishing domestic prices, and determining import levels. The three largest milling firms handle about 80% of the milled wheat. Currently, these mills deal directly with traders or wheat boards in the exporting countries. Many of the smaller mills purchase wheat jointly through their millers' association (Mercier 1993).

After the Korean War, the first shipment of wheat from the United States under the P.L. 480 program arrived in South Korea. Before the Korean War, previous shipments of wheat had been in the form of flour. The U.S. aid program helped to develop their milling and wheat foods industry. As the South Korean economy grew, aid shipments slowed and the country has become a stable commercial destination for many exporters.

Korea now imports up to 147 million bushels of wheat annually (USDA). Although hard spring wheat accounts for a small percentage of these imports, the United States has an advantage in that U.S. produces can supply all three major classes of wheat that South Korea purchases.

The thesis proceeds as follows. Chapter 2 reviews the existing literature related to hedonic characteristic demand analysis, general wheat demand, and trade policy analysis. Chapter 3 develops three sets of theoretical models that establish the framework for the econometric analysis. Chapter 4 discusses the data and presents descriptive statistics. Econometric results are reported in Chapter 5. Conclusions are presented in Chapter 6.

CHAPTER 2

LITERATURE REVIEW

Three fields of literature relevant to modeling the market for high protein wheat are reviewed in this chapter. The first section reviews the hedonic or characteristic approaches that have been presented to model wheat demand and supply. The second section contains additional wheat demand studies that abstract from quality issues. The third section reviews research on trade issues and factors that may be distorting free trade in the wheat market.

Hedonic Models

Hedonic price functions are predicated on the hypothesis that individuals obtain utility from consuming characteristics or attributes that are supplied by a certain product, rather than directly from the product. It is suggested that wheat consumers demand specific grain quality characteristics such as protein, or end-use baking characteristics such as gluten, stability and absorption levels. That is, wheat consumers demand relevant components of wheat. These characteristics become properties in an individual's utility function. When quality characteristics are combined with other inputs that make up the final consumption good, the analyst can estimate the demand for the general good, in this case wheat, and the quality characteristics of wheat.

Research by Gorman (1956,1980) outlined the feasibility of analyzing product quality characteristics and differentials. This work was extended by Becker (1965) and

Lancaster (1966) into the household production function models. The household production function hypothesizes that households obtain utility from nonmarket goods or bundles of characteristics that are essentially produced in the household. For example, a baker demands certain characteristics be present in the flour used in his products. These characteristics are associated with specific classes and qualities of wheat used in the milling process. The household production function accounts for inputs such as time and effort and provides an analysis of nonmarket goods, which would be otherwise difficult to analyze. Rosen (1974) outlined a competitive equilibrium theory of hedonic price functions, but the majority of literature and applications relate only to the demand of characteristic bundles and goods made from these bundles.

Application of hedonic modeling techniques to agricultural commodity markets includes introductory work by Ladd and Martin (1976) and continued attention to the study of wheat by Veeman (1987), Wilson (1989), Espinosa and Goodwin (1991) and recently Stiegert and Blanc (1997). Specific characteristics of wheat that are analyzed include class, protein, damaged kernel content, dockage level and numerous baking specifications used to implicitly estimate the demand for wheat.

Parcell and Stiegert (1998) estimated the marginal value of wheat grading characteristics and wheat protein in a spatially competitive framework. Their estimation procedure breaks down the demand for wheat into demands for certain important characteristics that were present in different types of wheat. They considered different classes of wheat produced in North Dakota and Kansas. But they recognize that each of the two classes of wheat contains similar characteristics such as protein content, test wheat, damaged kernel content and similar baking characteristics that allow price comparisons between the two classes. Parcell and Stiegert used a hedonic function containing wheat characteristics to construct a characteristic demand system for wheat that also included interaction terms to capture shifts in the marginal value of each characteristic as the supply of those characteristics changes between wheat classes and within the same wheat class. Their results indicated that the marginal values of protein in Kansas hard red winter (HRW) and North Dakota hard red spring wheats (HRS) were affected by the levels of protein across districts within the region and by the level in the other region. For example, higher protein content of North Dakota wheat reduced the marginal value of protein in Kansas and vice versa. They concluded that wheat value was determined not only by demand, but also by the supply of each characteristic, i.e., Rosen's result.

The objective of Espinosa and Goodwin's (1991) study was to estimate the marginal implicit prices of wheat characteristics in the Kansas HRW crop. They estimated the marginal implicit prices by first applying hedonic price functions to the wheat characteristics that are commonly used to gauge wheat quality in the marketplace. These characteristics include test weight, total defects, protein, moisture and falling numbers. Secondly, a set of variables that measure the performance of wheat in its end-product uses were incorporated into the hedonic price function. Espinosa and Goodwin found that both wheat quality and end use characteristics correspond with the value of Kansas's wheat. In particular, they found that each additional percentage point of protein contributes \$0.0492/bushel to the price of wheat. Espinosa and Goodwin then used the results of their empirical estimation to draw conclusions about the grading and pricing of Kansas wheat.

Veeman (1987) used Ladd and Martin's (1976) characteristic approach to demand estimation to estimate implicit values of Canadian Western Red Spring (CWRS) wheat over competing classes of hard wheat and also the implicit value of protein for CWRS. Veeman's results indicated that a one-percentage point increase in protein content was associated with an average of 0.3% price premium from 1976/77 to 1979/80. From 1980/81 to 1983/84, their results showed an average price premium of 0.5% for one percentage point increase in protein.

Wilson (1989) measured the extent of differentiation and values of quality characteristics in the international wheat market. He used a hedonic price model and the Hufbauer index[9] to determine price differentiation in the international wheat market. His results indicated that the wheat market has become increasingly segmented in terms of class and characteristic demand since 1973/74 and that prior to 1973/74 differentials in the international wheat market were relatively small. Although all classes of wheat exhibit price differentials, notable increases have occurred in the hard spring wheat classes, especially the United States' HRS and Canada's CWRS. Of specific interest was the relative increase observed in the price of CWRS over similar classes of wheat, particularly HRS. In his research, Wilson used price data from the *World Wheat Statistics* and quality information provided from unpublished data of the International Wheat Council and the Canadian Grain Commission.

[9] The Hufbauer index is the standard deviation of a bundle of goods divided by the mean of an individual good, a modified form of the coefficient of variation. If all prices in the group of goods were the same the Hufbauer index would be zero.

Wilson also estimated the implicit value of spring-planted wheat versus winter-planted wheat. The comparison included price observations of higher protein winter wheat and spring wheats such as CWRS and HRS. His results suggest a $0.13/bushel premium for spring versus winter wheat in the Japanese import market, holding all characteristics (protein, test weight, dockage, and damaged kernels) constant. Wilson also found significant positive values for protein in both the spring wheat and winter wheat markets.

Wilson's results noted that in the CIF[10] Japan market, the implied value of protein had increased over the observed time period. Over the observed time period, the CIF Rotterdam and FOB[11] Gulf markets experienced stable premiums for protein. He suggested differences in processing technology as a potential reason for this increase in Japanese premiums.

Wilson and Prezler (1992) used the input characteristic model to estimate demand for international wheat exports into the United Kingdom. The United Kingdom predominantly imports high protein spring wheat to blend with lower protein domestic wheats. The primary suppliers in this market are Canada with CWRS and the United States with HRS. Wilson and Prezler's results indicated that the variances of specific characteristic levels such as protein and dockage for HRS were higher than CWRS. These larger characteristic variances in U.S.-produced HRS lead to higher uncertainty in the end-use performance of the wheat. Higher end-use uncertainty can lead to higher

[10] Cost Insurance Freight
[11] Freight On Board

costs for buyers. Wilson and Prezler concluded that quality characteristics and price lead to market share and segmentation in the wheat market.

Steigert and Blanc (1997) linked end-use demand for baking qualities with the way heterogenous wheat protein is priced in the international wheat market. More specifically, they linked the marginal value of wheat protein to dough stability and other dough characteristics. Stiegert and Blanc used an extension of the Ladd and Martin characteristic model to link contracted characteristics of wheat (protein content, test weight) and the noncontracted traits in baking for which they were proxy. Steigert and Blanc's results indicate a positive non-linear relationship between dough stability and protein, leading to higher marginal values of protein in high protein wheat compared to lower protein wheat.

General Wheat Demand Models

Wilson (1994) used a transcendental logarithmic function to derive demand functions that were estimated for different wheat classes imported by individual Pacific Rim countries. By using a duality condition he was able estimate wheat class demand functions for Pacific Rim countries, allowing for cross-elasticities between pairs of imports, and then tested for shifts in preferences over time. The transcendental logarithmic function allowed Wilson to use expenditures on individual wheat classes as the basis for estimating demand. The model was constructed using a group of nine countries in the Pacific Rim region. Wilson's results indicated that the impact of price varies dramatically across importers and wheat classes. Wilson also finds that in general, importing countries have shifted toward higher protein CWRS and HRS wheat classes from the United States and Canada.

Wilson and Gallagher (1990) used Case functions to determine wheat class preference and price responsiveness by wheat importers. Case functions measure cross-equation relationships among parameters, which in the case of wheat, provide information regarding wheat class preferences. Results indicated that quality differences between exporters and prices were important factors in determining wheat demand. Results suggested that Latin America and Japan were more sensitive to class and quality issues while other Asian customers tended to be more sensitive to price. Wilson and Gallagher suggested that exporters should not segment Latin America and Japan as only high protein and high quality wheat buyers. When implementing future plant breeding and marketing goals, however, Willson and Gallagher did suggest that exporters pay attention to wheat class and quality buying trends.

Ryan and Bale (1976) developed several demand and supply models that predicted price differences between wheat classes and also protein premiums for wheat of the same class. The hypothesis was that price differences and protein premiums were affected by export demand and supply on both high and low protein wheat. The dependent price variable used in their models was the ratio of high protein wheat to a low protein price. The level of exports was expected to affect the price ratio. Increasing (decreasing) the quantity of high protein wheat exports was hypothesized to increase (decrease) the price ratio, and increasing (decreasing) the level of low protein wheat exports was hypothesized to decrease (increase) the price level.

Ryan and Bale calculated the supply of protein in each market by considering the current production and carry-over stocks of a predetermined growing region. The average protein content of each region was used to determine the supply of protein for each crop year. The supply of protein in the high protein wheat crop was represented by the HRS crop in Montana and North Dakota. The Kansas winter wheat crop was used as the supply factor for the low protein wheat crop. The expectation was that an increase in average protein content or crop supply would increase the protein supply. With an increase (decrease) in the supply of protein in the high protein crop, the price ratio was expected to decrease (increase), and an increase (decrease) in the protein supply of the winter wheat crop would decrease (increase) the dependent price ratio.

The price ratio model, using the price of 14% protein HRS divided by the price ratio of 12% protein hard red wheat, explained 99% of the variation in Ryan and Bale's data. The coefficients for supply and protein content of spring and winter wheat were of the expected sign and significant. The coefficient on the variable used to measure the effect of exports was of the expected sign but not significant. Ryan and Bale concluded that protein supply was more important than exports in determining modeled price differences for HRS in Montana and North Dakota and HRW in Kansas.

Ryan and Bale's spring wheat protein premium model, using a ratio of the price of 14% protein divided by the price of 13% protein wheat, explained 97% of the variation in the data. The same independent variables as in the previously described ratio model were used; again these variables included the supply of HRS and HRW crops and their average protein content. There were two pertinent findings. First, when total supply of spring wheat increased, the protein premium decreased. Second, when the average protein content of the hard red spring wheat crop in Montana and North Dakota increased, the following protein premium decreased.

Bale and Ryan (1977) continued to pursue their research into protein levels by eliminating the export variable and including price data from different markets. Their objective was to analyze relative price effects caused by changes in available supplies of wheat of various protein levels. Results from the Portland market were of the hypothesized sign and were significant in most cases. The positive protein supply coefficient had a higher level of significance for high protein spring wheat than for low protein winter wheat. Spring wheat supply had the highest level of significance and was positively related to price.

Bale and Ryan's analysis of wheat for both the Kansas City and Minneapolis cash markets resulted in an insignificant coefficient for the quantity of low protein winter wheat. The estimated coefficient for the average protein content of the Kansas winter wheat crop was significant but of the unexpected sign. Bale and Ryan concluded that increasing the supply of protein in the HRW crop caused a shift in the demand for HRS. The shift had a larger negative affect on the 15 and 13% Minneapolis protein price than it did on the price for Kansas City HRW-ordinary.

Gilmour and Fawsett (1987) investigated the relationship between Canadian and U.S. wheat prices. They associated the asking price of #1 CWRS with the U.S. Gulf price of HRW and the USDA's average U.S. farm price, through the use of an econometric price link equation. HRW was estimated separately because it represents the largest share of US wheat production. Some success was achieved in their linkage equation estimations highlighted by the finding that "over most of the period from 1970-1983, Canada and the United States behaved as noncolluding oligopolists..." pg. 585. These remarks are based on results obtained by reaction functions in their linkage equations. Factors such as transportation, storage, and transaction costs were also included in the estimation and provide explanatory information to Canadian and U.S. wheat price relations.

Dahl and Wilson (1996) investigated trade patterns of Canadian and U.S. hard wheat exports using shift-share analysis to examine the market share of each exporter. Results concerning wheat class market share indicated that U.S. HRS, Canada other, CWRS and Canadian Hard Amber Durum (CHAD) have seen increasing market share over the past decade at the expense of U.S. Hard Amber Durum (HAD), Soft Red Wheat (SRW) and HRW. The majority of Canadian exports to high quality markets are graded No. 1, while at the same time the United States is exporting a No. 2 into the same markets. Dahl and Wilson suggested that comparing the prices of the two exporters into similar markets is irrelevant because of the disparity in quality issues.

Wilson (1983) used an equilibrium supply and demand model to estimate price dependent demand equations for HRS and HRW. Different protein levels and locations were used to investigate any logistical relationships. Specifically, the Pacific Northwest and Minneapolis/Kansas City, U.S. Gulf and Rotterdam were the market prices used in the study. Supply was predetermined in the model because of constraints faced by producers. Independent variables in the demand equations included the price of a low protein winter wheat, per capita income, supply of hard red spring wheat, and average protein contents of the North Dakota and Kansas wheat crops. Kansas represents the winter wheat crop, and North Dakota represents the spring wheat crop. Positive signs for the demand equations were expected on coefficients for the low protein wheat price, income and spring wheat average protein content. Negative signs were expected on spring wheat supply and winter wheat average protein content. The coefficients for HRS supply were not significant at the 10% level at the U.S. Gulf and Rotterdam markets. They were significant and negative at the Pacific Northwest and Minneapolis/Kansas City markets. The protein content of the HRS was insignificant in all Wilson's estimated demand curves. The protein content of the HRW crop however, was significant at the 10% level and negative when the price of HRW-ordinary was the independent variable for pricing HRW in the Kansas City cash market. As expected, price and income coefficients were significant and had positive signs.

Wilson also estimated the effects of exports on the price of high protein wheat. The quantities of exports of each wheat class were used as independent variables in demand destination. Wilson found the level of HRS protein to be insignificant on the quantity of exports demanded and also found that export levels affected the of price level, but did not significantly affect relative prices of HRS and HRW.

Koo, Mao, and Sakurai (2000) used a production theory approach based on a translog cost function to analyze import demand for food wheat. The analysis looked at wheat differentiated by class and country of origin in the Japanese wheat flour-milling sector. By using the price and quantity of wheat imported into Japan as an input cost of the Japanese Milling industry they were able to calculate price elasticities of conditional demand curves for individual classes of wheat. They found that the multiple classes and end use characteristics of US wheat enable the United States to maintain a large market share in Japan. One conclusion from this is that if Japan liberalizes its domestic wheat market, the US market share of soft wheat could increase because of its cost advantage.

Trade Issue Studies

An extension of the economic research of the wheat market addresses the affects of trading practices used by market participants. This literature evaluates market structure and the role that government intervention plays in the world market for wheat. A brief synopsis of the relevant literature is offered.

Alston and Gray (2000) studied the different ways in which Canada and the United States support wheat producers. Canada has the Canadian Wheat Board (CWB) that represents its growers in the world market as the sole exporter. The CWB can pool supplies and potentially price discriminate among export markets. The U.S. government has funded its producers through a transfer from taxpayers and with the use of export subsidies. By studying the two different ways of supporting wheat producers Alston and Gray were able to make conclusions regarding transfer efficiency and overall deadweight loss.

Alston and Gray use a simulation model to compare welfare effects using the actual export policies of the CWB versus hypothetical export subsidies constructed to be similar to the policy used in the United States. The demand conditions for Canadian wheat that prevailed in the 1991-1992 crop year were used to examine the economic consequences of the two different programs that would have provided a Canadian producer with the same income level for that crop year.

Alston and Gray's simulation model illustrated that in the absence of price discrimination and with domestic demand less elastic than foreign demand, a marketing board such as the CWB will cause a higher tax burden to domestic consumers than they would face under an export subsidy. The simulated effect on third party exporters was greater in the marketing board case than the export subsidy. For international markets where price discrimination is possible, the simulation model showed that price discrimination and pooling is a much more efficient mechanism to support producers than export subsidies. These simulation results do not include the administrative costs associated with a marketing board. Alston and Gray noted that if these costs were included, the results would further promote the price discrimination and pooling mechanism.

Carter, Lyons, and Berwald (1998) measure the domestic costs of the CWB to the Canadian wheat producer. The characteristics of the CWB, in terms of agency structure and bureaucratic authority, fit a stylized Nickanen model of bureaucratic decision-making. The Nickanen model determines that the CWB is providing excessive marketing services for Canadian wheat. Carter and Berwald conclude that allowing the market to determine the appropriate level of marketing services would lower marketing costs and increase returns to producers. From the producer's side, the CWB may be able to extract any consumer surplus available in the market for marketing services.

Carter, Lyons, and Berwald also suggest that the CWB is giving protein away in two ways. First is at the farm level where the CWB has been slow to compensate producers for higher levels of protein. The second is on the consumer side, where the CWB often over delivers protein content. The over-delivering of protein closely matches the Niskanen model and the excess marketing services provided by the CWB.

Schmitz and Gray (1999) used actual contract prices and trade volumes to develop a simulation model for the international feed and malting barley market. They concluded that Canadian barley producers received on average, 1985/1986 through 1994/1995, CN$72 million a year more in revenue under the CWB than they would have received under competitive conditions similar to those in the United States. Schmitz and Gray focused on the additional revenue obtained by the CWB over its non-STE competitors. Others such as Carter, Lyons and Berwald (1998) have studied the additional costs imposed on Canadian producers by the CWB. While the additional revenue and extra costs of the CWB have been research separately, the net performance of the board has not been assessed.

Kraft, Furtan and Tyrchniewicz (1996) compared the price of every CWB contract agreed upon by a particular importing country with a price of similar wheat sold by its competitor to that same market within a particular time frame. They concluded that from 1980/1981 through 1993/1994, the CWB received an average premium of CN/$0.36/bushel for wheat sold to both commercial and EEP-eligible markets. Moreover, they found that this average premium increased to anywhere between CN/$0.77 and CN/$0.99/bushel once United States EEP bonuses from 1985/1996 through

1993/1994 were taken into account. It should be mentioned that the price data used for Canadian exports was only made available to Kraft, Furtan and Tyrchniewicz by the Canadian Wheat Board. No clear explanation is given to the quality and other classifications of compared wheats.

Goodwin and Smith (1995) concluded that the CWB was able to act as a price leader in the international wheat market, with Australia, Argentina, and the United States following CWB prices. A Granger causality test was performed on weekly wheat price data to derive their conclusions.

Carter (1993) determined that there was no evidence of market power by the CWB in the feed barley market. A Knetner equations test was performed on annual export revenue data provided by Statistics Canada.

Brooks and Schmitz (1999) used a simple mean difference test to determine whether the law of one price held between three important markets for Canadian feed barley. The results revealed that statistically significant differences existed among the majority of market segments tested. In Japan for example, the CWB was able to realize an average premium of CN/$0.45/bushel between Japan and other market participants between 1980/81 through 1994/95.

The economic research presented in this chapter suggests the market for high protein hard spring wheat has evolved over the past thirty years. The market has become increasingly segmented for different classes and quality of wheat. Price data shows there are many levels for the different types of wheat supplied to the market. Researches have attributed this segmentation to technologies in the wheat processing sector, transportation efficiencies, plant breeding, and market structure. Many economic researchers will agree that government intervention has some effect in the international wheat market, yet there appears to be limited research that models specific econometric affects of government intervention in market.

Quality segmentation is one of the stumbling blocks to modeling the international wheat market. If you were to identify a market(s) that consume a specific class and quality of wheat along with the ability to distinguish the regular suppliers of the wheat, there would be a possibility of modeling a specific class of wheat. By modeling the demand side of the market you are able to avoid the difficulty of modeling the production side and concentrate on demand side variables and shifters. As the research illustrates, there is debate as to whether State Trading Agencies constitute a government subsidy, provide merchandising power, or otherwise allow them to act as some form of a monopolist. If State Trading Agencies are able to price discriminate in the world wheat market then they may be violating certain trade agreements. The following chapter will present two models of the HSW market that try to model the presence of a dominant firm and monopolistic behavior.

CHAPTER 3

CONCEPTUAL AND ECONOMETRIC MODELS

This chapter will present three sets of economic models that describe the market for hard spring wheat. The first set will examine three country-specific wheat markets assuming perfect competition. By modeling a specific market for U.S. and Canadian hard spring wheat one can estimate demand shifters for each exporter. If the estimated parameters of an open market exporter are similar to those of a state trading enterprise (STE), then the argument set forth by United States policymakers may not carry much credence. Two alternative models are offered which measure the presence of noncompetitive or monopolistic behavior in a specific market.

The reason for modeling the hard spring wheat market with different frameworks is warranted by the contradictory results offered by previous work. One of the monopoly models is presented only in theory because of a lack of data that is essential in the model estimation process. Given the right data, the dominant firm model would be an important topic for future analysis. The competitive fringe model provides a general framework for investigating competition in the world hard spring wheat market in the presence of the CWB's single desk selling operation.

The remainder of this chapter is presented in two major sections. First, three fundamental conceptual economic models of the hard spring wheat market are presented. Then the econometric models are discussed.

The first subsection describes the theoretical competitive market for hard spring wheat. The second subsection outlines the dominant firm-competitive fringe approach, providing a discussion of its diversion from the competitive model. The third subsection outlines a model that provides the ability to econometrically measure the price relation between Canadian and U.S. hard spring wheat. The motivation for the price discrimination models stems from claims regarding the ability of the CWB to obtain a premium for CWRS over U.S. HRS.[12] A positive and significant CWB price difference is consistent with two alternative explanations. One explanation is that Canadian wheat is of a higher quality and receives a higher price for that reason. Another explanation is that the CWB is able to obtain a higher price for similar wheat because of price discrimination and market power.

Conceptual Economic Models

Competitive Equilibrium Model

Wheat is grown on an annual basis with the implicit fixed nature of wheat supplied in the short run reflecting short-term restrictions on the production process. The quantity of wheat is assumed to be determined exogenously to the model by factors affecting producers before and during the planting season. Supply is constrained by fixed (in the short run) wheat inputs (land use, seeding rates, fertilizer and chemical use), weather and changes in government programs. The empirical model is developed assuming a perfectly inelastic supply function for hard spring wheat. Due to the

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[12] Canadian Western Red Spring (CWRS), Hard Red Spring (HRS)

dynamics of supply response, total supply (production plus carry in stocks) is predetermined in any given marketing year. The key to the inelastic supply assumption is that during each crop marketing year, supply and demand equilibrium determine price, any response by producers to that marketing year's price will show up in the next years' crop's cost functions. Supply decisions made in response to current period prices will show up dynamically in years following any change to supply shifters. An equilibrium model that determines the final price received by farmers will consist of the predetermined amount supplied to the market for that marketing year and the demand of consumers buying that class of wheat supplied. The output price that profit maximizing wheat producers should use to make input decisions is an expected price. The actual price producers receive is determined after input decisions are made and weather shocks are known, through the short-term fixed supply of wheat and the demand relationship.

Total world demand for hard spring wheat is specified as the horizontal sum of the demand functions for the major consumers of hard spring wheat. Aggregate demand is derived by specifying individual functions and summing these functions to enable the market clearing assumption of total world quantity supplied equaling total world quantity demanded each year. In the following general form:

(1) $P^D_i = f_i(Q^D_i, \underline{X})$ $i = (1,2,\ldots n)$ countries

Equation (1) is defined as the individual demand curve for each country that consumes hard spring wheat. The dependent variable is the annual average price paid for hard spring wheat in the specified country. The price is dependent on quantity and a number of exogenous variables that determine demand for hard spring wheat in that country.

Equation (2) represents the supply of hard spring wheat to the international wheat market over the course of a marketing year. The amount of hard spring wheat available to the market after harvest is considered predetermined and fixed for any given marketing year.

(2) ΣQ^{RS}_{t} = short term fixed supply of hard spring wheat to the international wheat market. Each exporter will have a similar residual supply function.

where Q^{RS}_{t} is defined as

(3) $Q^{RS\,1}_{t}(\underline{X}) = Q^{S}_{t} - Q^{Dom}_{US}(\underline{X})$

Equation (3) states that production, Q^{S}_{t}, minus domestic consumption, Q^{Dom}_{US}, equals the residual supply for year t where $\underline{X}$ represents a vector of variables that affect domestic demand in the United States. Annual U. S. wheat stock data (USDA) indicate that the identity in equation (3) does not accurately portray the stock situation. Equation (3^1) includes the variable $S^{c/o}_{t}$ that defines the amount of wheat not domestically consumed or exported during year t:

(3^1) $Q^{S}_{t} - Q^{Dom}_{US} - S^{c/o}_{t} = Q^{RS\,11}_{t}$

$S^{c/o}_{t}$ is defined as a function of exogenous variables that contribute to the timing of wheat sales by producers. Econometric estimation of $S^{c/o}_{t}$ is described in detail in the econometric model section of this chapter.

Equation (4) represents the condition that prices across countries that demand hard spring wheat should equal each other after adjustments for transportation. Equation

(5) equates the quantity demanded by consuming countries with the fixed amount supplied that crop year.

(4) $P^{D}_{i} = P^{D}_{n}$

(5) $\Sigma Q^{D}_{i \ldots n} = \Sigma Q^{RS\,11}_{t}$

The general short-term supply and demand relationship for hard spring wheat with a given protein specification is illustrated in Figure 1.

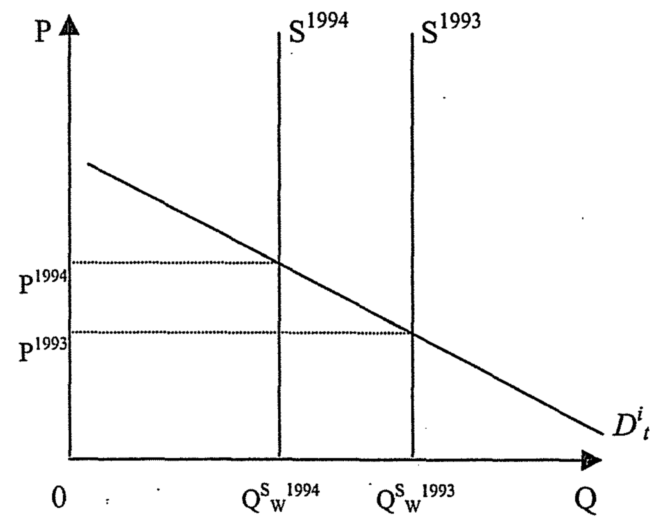

Figure 1: General supply and demand model for hard spring wheat.

The vertical supply curve represents the fixed amount of wheat available, $\Sigma Q^{RS\,11}_{t}$, to the market for the specific crop year, for example 1993/94. The summation of demand curves by countries that could potentially consume hard spring wheat is D^{i}_{t}. The resulting price, P^{1993}, is determined by the market clearing condition of supply equaling demand in 1993. P^{1993} represents an annual international price for hard spring wheat with quality and protein specifications. P^{1993} could instead represent the price relationship between competing hard spring wheat in the market, given correct supply and demand identification. A change in price will occur if there are any substantial exogenous shifts in the aggregate demand function or if Q^S_W increases/decreases, such as is illustrated for the production increase S^{1994}. If this were to occur, the equilibrium price would be P^{1994}. A more detailed look at the hard spring wheat market is provided in Figure 2.

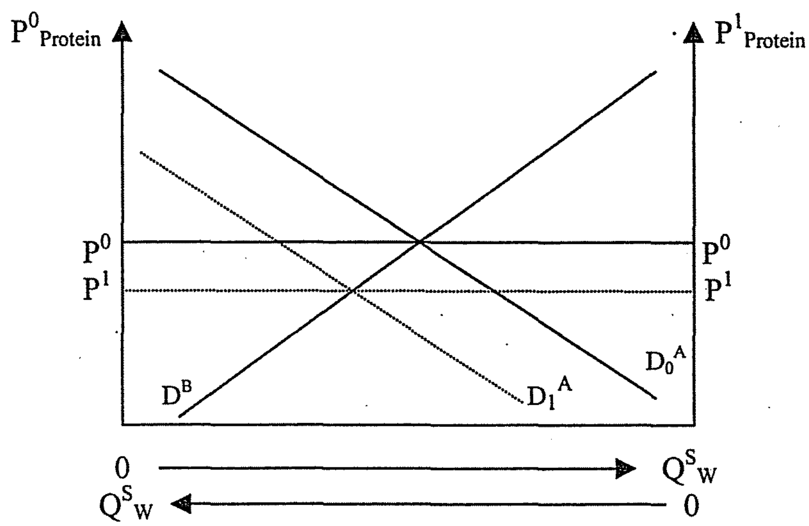

Figure 2: Two-country wheat market with an exogenous shift in demand of one country.

In this case there are no tariffs in the market and only two consumers of hard spring wheat, consumer A and consumer B, the left vertical axis represents the market price to consumer A and the right vertical represents the market price to consumer B. The horizontal axis represents the total amount of hard spring wheat available to the market during that same year. Because of the fixed supply and market clearing condition the price is determined by the intersection of the demand curves. A change in price will occur if there are exogenous shifts in either of the countries' demand functions or if Q^S_W increases/decreases.

For example, in Figure 2 if the demand of consumer A shifted from D_0^A to D^A_1, holding supply constant, the market price would decrease from P^0 to P^1. If Q^S_W were to change between crop years, the change in market price, can be illustrated by Figure 3. A change in Q^S_W during a crop year will either increase or decrease the length of the horizontal axis of Figure 3. An increase in Q^S_W would, ceteris paribus, decrease the equilibrium price in both countries. This change in the supply level and subsequent new demand position can be seen in Figure 3.

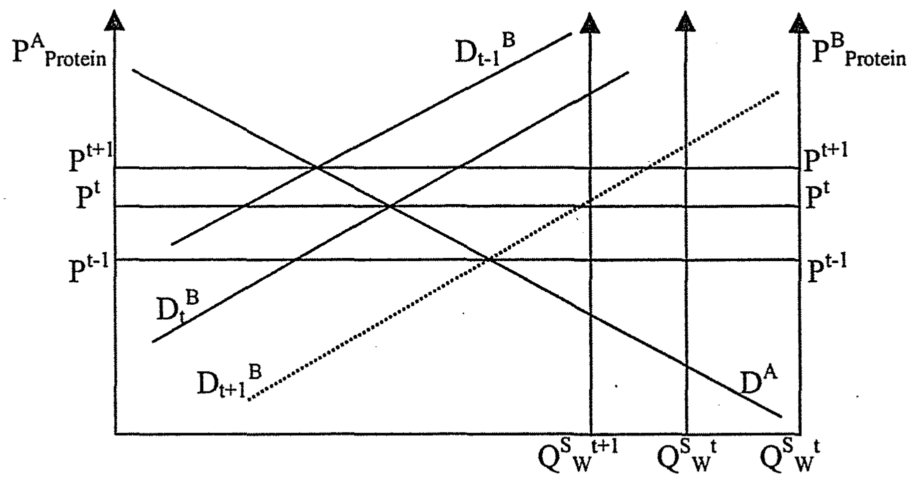

Figure 3: Two-country wheat market. Illustrates change in quantity supplied between crop years and subsequent shift in demand.

To illustrate a change in supply between crop years, consider the dramatic change in quantity supplied of hard spring wheat between the 1993/94 and 1994/95 crops. The supply of hard spring wheat was greatly reduced between these marketing years and the average market price increased substantially. In Figure 3 this would be the shift from $Q^S_W{}^t$ to $Q^S_W{}^{t+1}$. The subsequent result of this supply decrease is a shift in the demand curve of country B. A possible stimulus for this demand shift could be a cost increase of a substitute good resulting from the decreased availability of hard spring wheat. The quantity demanded must shift because of the fixed supply each crop year. The resulting price is P^{t+1}.

An extension of the basic model examines how the market responds to market tariffs (Figure 4). An import tariff raises the price paid by domestic consumers and the price received by domestic producers.

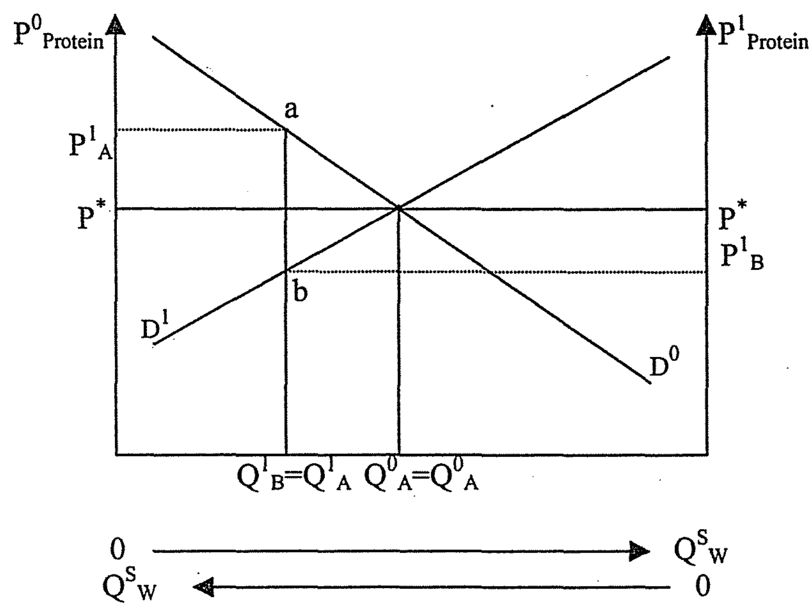

Figure 4: Two-country wheat market with the introduction of an import tariff.

In the two country economy graphically presented, an import tariff is imposed by country A, represented by line segment ab. The price increases in country A from P* to P^1_A because of the restriction put on supply by the tariff. Quantity demanded by country A is reduced to Q^1_A from Q^0_A. In country B, the hard spring wheat available to the market has increased because of the import tariff to Q^1_B and the price has decreased from

P^* to P^1_B. With the two-country economy presented by Figure 4 and short term fixed supply of hard spring wheat, there is a simple redistribution of wheat demanded resulting from the change in price available to each country. An example of reducing an import tariff and increasing quantity exchanged can be seen by looking at recent United States and Canada trade data (USDA; Canadian Grain Commission). Pursuant to the signing of the Canada United States Trade Agreement (CUSTA) and later the North American Free Trade Agreement (NAFTA), Canada began exporting wheat into the United States. By reducing the size of line segment ab in Figure 4 there is an increase in Q^1_A.

An example of a dramatic supply change was seen between the 1993/94 and 1994/95 crops when Canadian and North Dakota's supply of high protein hard spring wheat were greatly diminished because of record rainfall and subsequent crop disease that affected the quality of wheat supplied. The average price for the 1994 marketing year was substantially greater than the average price in 1993. Refer back to Figure 1 for the graphical representation of this price impact.

A demand side shock can be illustrated by the recent decline in Asian income. With income being an exogenous shifter in the demand curve of an Asian country consuming hard spring wheat, there was a downward shift of the curve. For a graphical representation of the price impact, refer back to Figure 2 where this is illustrated by D_0^A shifting down to D_1^A and lowering the market price from P^0 to P^1.

Dominant Firm/Price Discrimination Models

The competitive model presented in the previous section assumes that all suppliers of hard spring wheat are price takers, resulting in the price received for wheat equaling the exporter's marginal cost at the quantity supplied. The dominant firm-competitive fringe model provides a means of measuring whether price actually equals marginal cost. STEs such as the CWB are one the most important agricultural issues facing the World Trade Organization. In question is whether STEs such as the CWB are able to price discriminate in the international wheat market. If there were non-competitive pricing in the hard spring wheat world market, there would be a gap between the marginal cost function of the exporter and marginal revenue of the importer. If one of the market participants has enough market shares to price off a downward slopping demand curve then there exists the potential of measuring the gap between the MC and MR.

Canadian exports of hard spring wheat represent 46% of total hard spring wheat traded in the international wheat market (1996-2000, *International Wheat Statistics*). The objective of the dominant firm model is to identify a specific market where these is a suspicion of non-competitive pricing. For illustration purposes, the Japanese hard spring wheat market will be modeled. Japan is a unique market to investigate the presence of non-competitive pricing. Japan imports a fairly stable amount of hard spring wheat each year. Major suppliers of hard spring wheat to Japan are Canada and the United States. While the CWB is the sole exporter of Canadian hard spring wheat, the United States has several firms that merchandise wheat around the world. The dominate firms in this trade of wheat between the United States and Japan include Cargill, Archer Daniels Midland, Bunge, ConAgra, Cenex-Harvest States (producer cooperative) and several U.S. based subsidiaries of large Japanese firms. These trading firms act as middlemen, with respect to the buying of grain from U.S. elevator companies and the selling of wheat to Japanese buyers. A parallel arrangement exits for other importing countries.

As discussed earlier, Canada and the US are the only consistent suppliers of hard spring wheat to Japan. If the CWB is able to price discriminate in Japan, the CWB administrators would account for the volume available from the United States and consider the remaining market for high protein hard spring wheat as a captive market for themselves.

Carlton and Perloff (1994) offer a model that is used to identify market power. The model allows for competitive, dominant firm, and intermediate types of behavior by the CWB. The dominant firm-competitive fringe model describes a market with multiple suppliers that produce a similar product. In the case of hard spring wheat, Canada, because of the CWB, can be modeled as the dominant firm. The fringe suppliers of hard spring wheat will be represented by the large trading firms mentioned earlier. Japan is the targeted market. Over the course of some crop years there have been other fringe suppliers outside of the United States, however, their quantities and quality of hard spring wheat are limited.

The Carlton and Perloff model assumes product homogeneity. This assumption may be too strong for the hard spring wheat market. There are many different varieties of hard spring wheat grown around the world. In particular the hard spring wheat supplied by U.S. Northern Plains producers and Canada varies widely in characteristics. It has been suggested in previous work, Dahl and Wilson (1996) that comparing US HRS and Canadian CWRS should not be done because these wheats are not exactly the same type of wheat. Although the physical characteristics of HRS and CWRS may not be identical, trade patterns suggest that important buyers consider them competing classes of high protein hard wheat. The dominant firm-competitive fringe model offers a means of investigating the presence of effective market power.

In regard to how the Carlton and Perloff model applies to the hard spring wheat market, an important issue is the CWB's share of the total hard spring wheat market. The CWB faces a residual demand for hard spring wheat, defined as the total Japanese demand for hard spring wheat minus the U.S. supply. A graphical representation of the dominant firm model as applied to the Japanese hard spring wheat market is shown in Figure 5.

Figure 5 illustrates the rotational shift of the demand curve brought about by the interaction term in the residual demand curve. Assuming a competitive market the initial equilibrium is the intersection of MC_C and D_1. This combination of price and quantity can also be attributed to a cartelized market with the intersection of MC_m and MR_1. The key to this model is the new equilibrium after the rotation of the demand curve. If the equilibrium remains at P_0 and Q_0, the market can be assumed to be competitive. If however, the equilibrium is determined to be at P_1 and Q_1, from the intersection of MC_m and D_2, the market has the presence of a cartel. Thus, whether or not the equilibrium shifts reveals whether or not the market is competitive.

As indicated in the beginning of this chapter, the dominant firm model is presented only in theory because of the lack of good instruments to use to define the non-linear rotation of the CWB demand curve that is required to measure any gap between the

MC and demand curves. The model's homogeneity assumption between Canadian and US wheat also points to the need for an alternative econometric model.

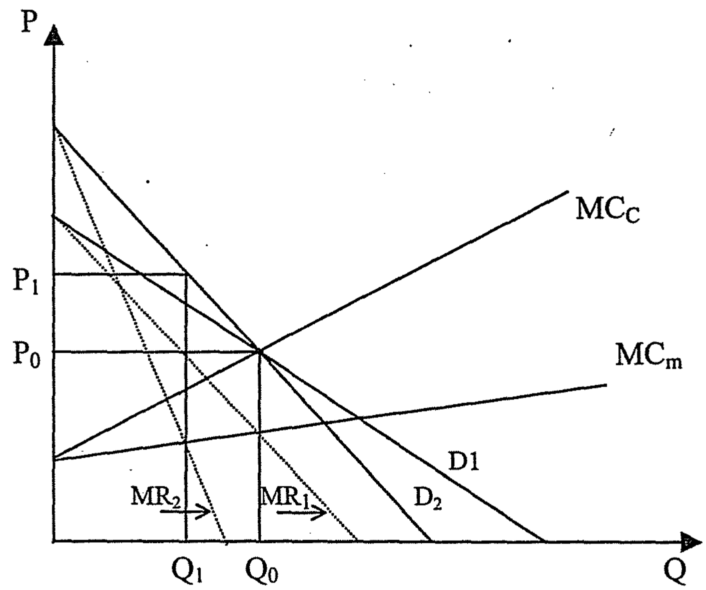

Figure 5: Dominant Firm/Competitive Fringe Model.

Canadian-U.S. Price Relation Model

Another way to look at the CWB as a potential price discriminator is to say that the board competes with the U.S. exporting firms in certain markets for hard spring wheat. The assumption has been made earlier that CWRS and HRS are closely substitutable and thus can be modeled together in a demand and supply scenario. Looking at price data for hard spring wheat in Japan for instance, there appears to be a positive price response for Canadian hard spring wheat. The price difference may arise due to market power or possibly a perception that Canadian hard spring wheat is of higher quality. The intent of this research is to model and estimate the price relation and how it is affected by measurable underlying factors.

A positive Canadian price measurement signifies that the CWB is able to extract additional revenue for wheat that is closely substitutable with US HRS. The ability to receive a positive price difference for similar wheat allows for the conclusion that there is economic rent being competed for in the marketplace. From an economic welfare perspective the presence of price discrimination would indicate a net loss of economic welfare in the marketplace.

Fair trade has become an important topic around the world because many industrialized nations have become dependent on international trade for market growth. In the wheat market, a government intervention by one exporting country meant to help producers might lead other exporting nations to also support their agriculture. The choice not to provide government assistance by an exporting country may be followed by a loss of market share or producers possibly operating below their cost of production. These, of course, are hypothetical assertions but they are often quoted as the justification for government intervention in the agriculture sector.

Because the world wheat market is dominated by large multinational grain companies and STEs, the market seems far from a competitive market. As mentioned previously in the literature review, any incomplete model specification of a market so influenced by competing government intervention is going to face skepticism. The competitive model is included in the theory portion of this chapter to introduce two concepts that are required to econometrically measure for a price difference between two substitutable wheats. These concepts include the individual demand curves of countries that demand hard spring wheat and the stock carryover equation. By extending the competitive model to encompass a supply and demand simultaneous equation system for specific markets we are able to test for the presence of a positive price relationship. Once the cross price coefficient has been estimated, interaction variables are added that allow for the measurement of items that change the coefficient.

The four-equation system is an extension of the competitive model presented earlier. It will use the same demand curves of Japan, South Korea, and Indonesia discussed in the competitive model but will include variables to estimate the existence and size of any positive price difference the CWB may be obtaining for CWRS. An addition will then be made to include factors that may influence the size of any price difference. Systems models are estimated separately for South Korea, Indonesia, and Japan.

The system will include supply equations for U.S. HRS and Canadian CWRS and country-specific demand equations for U.S. HRS and Canadian CWRS. Equations (6) and (7) are the supply equations for the United States and Canada. The price in the importing country is a function of the amount of hard spring wheat exported to country *i* and other right hand side variables that influence supply. Because the marketing systems and government participation in agriculture are different in the United States and Canada, variables that affect the availability of wheat for export differ.

(6) $P^D_i = f_i(Q^{US}_i, \underline{X}_{US})$ $i = (1,2,\ldots n)$ country demanding wheat

(7) $P^D_i = f_i(Q^{CAN}_i, \underline{X}_{Can})$ $i = (1,2,\ldots n)$ country demanding wheat

The demand equations include exogenous right hand side variables ($\underline{Z}$). The dependent variables are the price of CWRS 13.5% protein and the price of 13% U.S.

HRS. Included on the right hand side will be the quantity of CWRS and HRS, as well as the price of HRS for the demand equation for CWRS, or the CWRS price for the demand for U.S. HRS. The demand equations will allow the estimation of the price relationship between CWRS and U.S. HRS in country *i*. The Canadian price variable in the U.S. demand equation should also provide an indication about the price relationship between the countries hard spring wheat.

(8) $P^{CN}_i = (Q^D_i, \underline{Z}, P^{US}_i)$

(9) $P^{US}_i = (Q^D_i, \underline{Z}, P^{CN}_i)$

Equations (8) and (9) represent the price of CWRS (HRS) as a function of the quantity of hard spring wheat imported (Q^D_i), the price of HRS (CWRS) in country *i*, and the vector $\underline{Z}$ of exogenous variables affecting the demand for hard spring wheat. Equations (8) and (9) are identical to equation (1) in the competitive model with the addition of P^{US}_i and $P^{CN}i$ as right hand variables.

Econometric Models

The empirical portion of this thesis will concentrate on the economic models that estimate the price relation between U.S. and Canadian hard spring wheat. At issue is whether the CWB is able to receive a higher price for CWRS in markets which they compete with U.S. HRS. The two models estimated will include the U.S. and Canadian carryout estimation, and the Canadian-U.S. price relation model. The carryout estimation models are included to provide a source of instruments that are used in the Canadian-U.S. price relation system model. The carryout equation includes factors that contribute to the timing of wheat sales by U.S. producers. These variables become instruments for the endogenous explanatory variables in the supply and demand model of the Canadian-U.S. price relation model.

The Canadian-U.S. price relation model is estimated for specific import markets for hard spring wheat. The empirical results of this model are the key to this research because they model specific import markets where the United States and Canada are the primary suppliers of hard spring wheat. By having the flexibility to model specific markets one can test for a price difference in the market between the two suppliers.

Carry Out Estimation

The data used in this study are reported on an annual basis. The nature of wheat production provides a logical explanation for using annual data when analyzing the wheat market. But it is not logical to assume is that all wheat produced during a crop year is consumed during that same year. By defining the stock situation for an exporter we are able to identify variables that contribute to the amount of wheat available for export each crop year. Because we are interested in modeling specific markets that demand U.S. and Canadian hard spring wheat we have to model the supply to each of these markets. Considering the market clearing situation of supply equaling demand, equation (17) represents the wheat stock situation for the United States or Canada.

(17) $$Q^{prod}_{t} + S^{c/o}_{t-1} = Q^{dom}_{t} + Q^{exp}_{t} + S^{c/o}_{t}$$

where:

Q^{prod}_{t} = the quantity of wheat production during year t.

$S^{c/o}_{t-1}$ = the quantity of wheat stocks carried in from the previous year.

$S^{c/o}_t$ = the quantity of wheat not domestically consumed or exported during year t.

Q^{exp}_t = the quantity of wheat exported during year t.

Q^{dom}_t = the quantity of domestic wheat consumption during year t.

The left side of equation (17) represents the total amount of wheat available to an exporting country at the beginning of a marketing year. The right side of the equation accounts for total usage during the same marketing year. Q^{dom}_t is treated as fixed in this thesis. For the United States, $S^{c/o}_t$ is estimated in equation (18) using the following variables: an interaction term modeling the opportunity cost of not selling wheat is the product of the Minneapolis Grain Exchange (MGE) futures price times the interest rate of the United States three month Treasury Bill ($INT*P^{MGE}$)[13]; lagged corn carryover stocks, which is used as a proxy to measure available storage space and the use of wheat as a feed ingredient ($CORNCO_{t-1}$); the government loan rate for wheat (LR); and hard spring wheat carryover stocks lagged one crop year ($S^{c/o}_{t-1}$). Quantity of HRS produced in crop year *t* is not included because of the correlation of error terms among the variables. The other right hand side variables in equation (18) were selected to provide the appropriate properties to avoid the problems with the error terms had production been included.

$$(18) \quad S^{U.S.\text{-}c/o}_t = \phi_o + \phi_1(INT*P^{MGE}) + \phi_2(CORNCO_{t-1}) + \phi_3(LR) + \phi_4(S^{c/o}_{t-1}) + \varepsilon_t$$

In equation (18) ε_t is a normal error term capturing random fluctuations in the carry out stocks of hard spring wheat.

By estimating equation (18), estimates of variables are obtained that help explain the availability of wheat in the marketplace. The variables in equation (18) that are

[13] The MGE price was tabulated by averaging the daily nearby futures price over the course of the crop marketing year.

statistically significant after performing ordinary least squares will be used as explanatory variables in the export supply equation for the United States and Canada. The export supply equations will be defined in the next section of this chapter. Equation (19) models carry out stocks for Canada.

(19) $$S^{Can\_c/o}_t = \rho_o + \rho_1(INT*P^{MGE}) + \rho_2(TRANSELE) + \rho_3(P^{initial}) + \rho_4(S^{c/o}_{t-1}) + \varepsilon_t$$

In equation (19), $S^{c/o}_t$ representing carry out stocks for Canada, $(INT*P^{MGE})$ an interaction term which is the product of the Minneapolis Grain Exchange futures price times the interest rate of the United States three month Treasury Bill, (TRANSELE) is Canadian prairie rail freight plus elevation fees, $(P^{initial})$ is the initial price quote of #1 CWRS given by the CWB, and $(S^{c/o}_{t-1})$ is lagged carry out stocks. The same use as instruments of the significant variables will be carried out for Canada as in the U.S. carryover estimation.[14]

Canadian-U.S. Price Relation Estimation

Equations (20) to (23) provide the econometric representation of the economic model presented in equations (6) to (9). The system of equations that are modeled use the single demand equations of the competitive model but go one step further by including an export supply equation to form the system of structural equations. The importance of estimating these equations as a system can be explained by examining the variables used to construct the supply and demand equations. The inherent nature of

[14] If the coefficients on the interaction term between the MGE futures price and the interest rate in the U.S. and Canadian stocks equations were estimated significantly, then the use of the estimated stocks variable in the systems estimated would have created an errors problem. However, these interaction variables were not found to be significant in the estimation so the use of the estimated stocks in the systems estimation should not substantially confound the errors structure.

supply and demand modeling involves modeling equations that contain endogenous variables among the explanatory variables. In the case of equations (20) to (23), the exogenous right hand side variables are the dependent variables of other equations in the system. Because some of the explanatory variables are dependent variables in other equations the error terms among the equations may be correlated. Also, having dependent variables as explanatory variables causes the disturbance to be correlated with these variables violating the basic assumptions of ordinary least squares and single equation estimation. Modeling the equations as a system and estimating them with three stage least squares (3SLS) corrects the error term problem and provides consistent unbiased estimators (StataCorp 1997).

For notation simplification Japan's four-equation system will be the only one that will be presented in this chapter. A similar four-equation supply and demand system will be modeled for South Korea and Indonesia. The estimation results for each system will be included in the following results chapter. Equations (20) and (21) are supply equations for the United States and Canada. The four equations in the system will be linear with respect to their functional form.

(20) $P^{D}{}_{US} = \beta_0 + \beta_1 Q^{S}{}_{US} + \beta_2 S^{c/o}{}_{t-1} + \beta_3 OCEANFR + \beta_4 M^{US} + \beta_5 LR + \varepsilon_i$

(21) $P^{D}{}_{Can} = \alpha_0 + \alpha_1 Q^{S}{}_{Can} + \alpha_2 S^{c/o}{}_{t-1} + \alpha_3 OCEANFR + \alpha_4 M^{Can} + \alpha_5 TRANSELE + \varepsilon_i$

The amount available for export by each exporter is dependent on a number of factors which differ for each exporter. Equation (20) states that the price of HRS in Japan depends on amount of HRS available to the export market, the government loan rate on wheat, U.S. per capita income which is an instrument for wheat consumption in the United States, ocean freight costs from the PNW to Japan, and lagged carryover stocks.

Equation (21) states the price of CWRS in Japan depends on the amount of CWRS available to the export market, elevation charges and prairie rail freight, which are standardized in the Canadian grain marketing system, Canadian per capita income, ocean freight between Canada and Japan, and lagged carryover stocks of CWRS. As noted in the carryover model in the previous section, some of the right hand side variables in the U.S. and Canadian export supply equations are variables that were found to influence the movement of grain in the respective exporter's wheat channel.

Equations (22) and (23) are the Japanese demand equations for U.S. and Canadian hard spring wheat.

(22) $P^D_{US} = \gamma_0 + \gamma_1 Q^D_{Japan} + \gamma_2 P^D_{Can} + \gamma_3 M_t + \gamma_4 Rice_t + \varepsilon_i$

(23) $P^D_{CN} = \delta_0 + \delta_1 Q^D_{Japan} + \delta_2 P^D_{US} + \delta_3 M_t + \delta_4 Rice_t + \varepsilon_i$

where:

Q^D_i = domestic consumption of hard spring wheat.

P^D_i = Landed price of hard spring wheat in the specified country that is being analyzed.

M_t = annual per capita income.

$Rice_t$ = Price of rice Bangkok, Thailand.

ε_I = random error terms capturing fluctuations in demand.

One of the objectives in estimating these models is to examine how closely together prices for HRS and CWRS move. Equation (23) will yield this result in the coefficient δ_2. The desired test is relative to a value of one for the estimated coefficient.

An estimated value of close to one is consistent with market prices moving closely together. Other results that can be obtained by this system are measuring how the cross price coefficient changes. By including an interaction term in equation (23), you can draw inferences about how the coefficient on the cross price variable changes with the interaction variable employed. For example, by changing the specification of the demand equation with the interaction term provides information regarding whether the new variable changes the coefficient on $P^D{}_{US}$. For a trade policy maker this would provide valuable information about past, current, and future trade law. Equation $(23)^1$ illustrates the inclusion of the interaction variable, where (MS) is the Canadian market share of hard spring wheat in Japan.

$$(23)^1 \quad P^D{}_{Can} = \delta_0 + \delta_1 Q^D{}_{Japan} + \delta^0{}_2 P^D{}_{US} + \delta^1{}_3 (P^D{}_{US} * MS) + \delta_4 M_t + \delta_5 Rice_t + \varepsilon_i$$

Other variable options for the interaction term may include a time trend variable ($P^D{}_{US}$*TT) or a quality factor ($P^D{}_{US}$*PRO) such as protein content.

Econometrically, the approach used is to estimate the four-equation system (20) to 23) with 3SLS. An important step before estimating a system of structural equations is determining whether the system is identified. Identification means that there is enough exogenous information in the equations to estimate the parameters. Under identification usually results in a singular matrix in the computation. The commonly violated order condition involves the amount of dependent and independent variables. The general rule for identification is that there must be as many noncollinear independent variables in the system as there are dependent right hand side variables in an equation. For each structural equation in the system this condition must hold. Each of the equations presented in the above system is over identified.

The first stage of 3SLS develops instrumented values for all of the endogenous variables. These instrumented values can be considered the predicted values resulting from a regression of each endogenous variable on all exogenous variables in the system. The second stage obtains a consistent estimate for the covariance matrix of the equation disturbances. These estimates are established by the residuals from a two stage least squares estimation of each structural equation. The third stage deals with the consistency problem caused by autocorrelation among the error terms in the system. This is done by forming a generalized least square estimator for the parameters of the system. By using the covariance matrix estimated in the second stage and the instrumented variables in place of the dependent regressors, consistency is restored for the estimates (StataCorp 1997; Pindyck and Rubinfeld 1991).

From the 3SLS regression the coefficient δ_2 will give the sign and size of any price difference present in the data. Once δ_2 is estimated, the interaction variables are added to form equation (23)[1]. This new Japanese demand equation for Canadian wheat replaces equation (23) in the four-equation system. The amended system is estimated by 3SLS with the desired test being whether δ_2 has changed in size and sign from the original estimation coefficient δ_2. The other interaction variables can be added separately to determine whether they have any influence on the cross price coefficient.

Summary

In this chapter the conceptual and econometric models were described and rationalized. Three conceptual models were discussed in an attempt to present a complex global market that has many implications for Montana's HRS producers. Two econometric models were derived from the economic theory models with an emphasis on obtaining information about the competition between U.S. and Canadian hard spring wheat producers. The following two chapters present the summary statistics of the data used in this research and regression results obtained from the econometric models.

CHAPTER 4

DATA

Introduction

This chapter describes the data utilized in this study. This study investigates hard spring wheat market for Japan, South Korea and Indonesia over the period of 1970/1971 to 1999/2000. Data availability restricted the scope of this study to this period. Given that the focus of this thesis is on markets for hard spring wheat, markets were identified that import a similar classes and qualities of wheat. Canadian CWRS and U.S. HRS were chosen because of their similar quality characteristics, logistical proximity, and substitutability.[15] Data are presented separately for Japan, South Korea, and Indonesia in Tables 1 through 3. Additional data related to U.S. and Canadian supplies are presented in Table 4. Charts illustrating the volume of hard spring wheat shipped to these markets are presented in Appendix A.

Price Data

U.S. price data were obtained from the Montana Wheat and Barley Committee via the United States Department of Agriculture (USDA), the International Grain Council's (IGC) *World Grain Statistics*, and the Minneapolis Grain Exchange. Canadian price data were obtained from the CWB.

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[15] Canadian Western Red Spring (CWRS) and Hard Red Spring (HRS)

The United States loan rate for wheat effectively serves as a price floor for U.S. wheat producers. If, for example, the wheat loan rate was $2.58/bushel, an eligible producer can apply for a loan at this rate for all or a portion of current wheat production. The term of the loan in this program is currently nine months beyond the month the loan is originated. At the end of this term, if the market price is above the loan rate, the producer recovers the wheat used as collateral by paying $2.58/bushel plus any interest accrued over the term of the loan. If the market price is at or below the loan rate the producer can choose to forfeit the wheat to the USDA at the loan rate.

The Canadian price is the pool price received by producers. Actual CWB sale contract values are kept confidential to seller and buyer, a policy that has been in place since the inception of the CWB and that is the source of much of the controversy concerning its ability to price discriminate. Some wheat and barley contract values have been made available by the CWB to select groups of Canadian researchers with an agreement of confidentiality. The motivation for using pool prices follows that offered by Carter et al. (1998) in that Canadian pool prices better reflect returns to producing wheat in Canada, similar to the annual average U.S. market prices used to analyze the U.S. market. Ocean freight cost data were obtained from the IGC annual publication, *World Wheat Statistics*.

Estimates of the South Korea and Indonesian markets use a constructed average price series. These average Canadian and U.S. annual prices (1970/71 through 1999/2000 crop years) used for each specified market were calculated by taking the Pacific Northwest (Portland, OR-U.S. and Vancouver, B.C.-Canada) landed price and adding average annual ocean freight to the specific market. U.S. prices reflect an average price for #1 HRS 13% protein and Canadian prices reflect an average price for #1 CWRS 13.5% protein. Prices are reported in U.S. dollars (1992=100) per bushel (1 bushel=60 lbs.).

Price Canada (#1 CWRS 13.5%) is the annual average price for #1 CWRS, minimum protein of 13.5%. Prior to 1981, the CWB did not offer producers a premium for higher levels of protein. The Canadian price data used in the South Korean and Indonesian regression were constructed as follows: The price of #1 CWRS ordinary protein plus ocean freight is utilized for years prior to 1981. After 1981, the CWB established a premium for 13.5% minimum protein and this price was used to construct the remaining data in the series. Because this research is investigating the price competition between two exporters of hard spring wheat, using the Price of #1 HRS 13% and #1 CWRS 13.5% is an attempt to analyze similar types of wheat available to the market. Dahl and Wilson's (1996) results indicate that the quality of Canadian and U.S. hard spring wheat exported to South Korea, and Japan can be classified by official USDA grading standards as A #1 grade.

The IGC *World Grain Statistics* lists a landed annual Japanese price for #2 HRS 14% protein and #1 CWRS 13.5% protein. Because quoted landed prices are the ideal prices for this type of research, the IGC Japanese prices were used with an adjustment made for the difference in quality of U.S. HRS. The adjustment involved adding the price premium for a #1 HRS over a #2 HRS 14% protein. After estimating the Japanese system of equations with this price data, an alternative estimation was performed using similar price data in the South Korean and Indonesian systems. The results of this estimation were similar to those of the estimations using the IGC landed prices. Thus, the Japanese price data used in the reported estimations are from the IGC price data.

Quantity Data

U.S. export quantity data were obtained from various issues of the USDA's *Wheat Situation and Outlook Report*. Canadian export quantity data were provided by the Canadian Grain Commission and the CWB. U.S. and Canadian carryover stocks of hard spring wheat are from the USDA.

The U.S. quantity variable in each regression model is the amount of HRS imported by the specific importing country. The Canadian quantity variable is the amount of CWRS imported by Japan, South Korea, and Indonesia. RICE represents the price per metric ton of rice in Bangkok, Thailand. The price of rice is used as the price of a substitute for wheat. Rice is still the major source of starch and a nutritional staple in these countries, but the increased popularity of the western diet, has resulted in increased wheat consumption.

Other Data

The Gross Domestic Product deflator (1992=100), exchange rates, and interest rates are from the *Economic Report of the President* (2000). Population, income data and the price of rice (Bangkok, Thailand), are from the International Monetary Fund's, *International Financial Statistic Yearbook* (2000).

The remainder of this chapter presents the summary statistics of the data used in the econometric estimation reported in Chapter 5.

Summary Statistics

Table 1: Data Descriptive Statistics-Japanese Hard Spring Wheat (Annual 1970/1971 to 1999/2000)

Variable	Observation	Mean	Std Dev	Min	Max
Price U.S. #1 HRS 13%	30	7.829	2.907	4.426	16.412
Price Canada #1 CWRS13.5%	30	8.323	2.993	4.995	17.275
Quantity U.S. (million bushels)	30	48.841	4.436	37.809	62.198
Quantity Canada (million bushels)	30	36.538	10.234	16.219	58.000
Ocean Freight PNW to Japan (per bushel)	30	.780	.400	.288	1.986
Rice Price Bangkok, Thailand (mt)	30	470.785	296.531	179.462	1533.994
Income (per capita-,000)	30	22.143	9.574	7.308	40.361

Table 2: Data Descriptive Statistics-South Korea Hard Spring Wheat (Annual 1970/1971 to 1999/2000)

Variable	Observation	Mean	Std Dev	Min	Max
Price U.S. #1 HRS 13%	30	7.111	3.283	3.568	16.167
Price Canada #1 CWRS13.5%	30	6.544	3.168	3.207	16.432
Quantity U.S. (million bushels)	30	8.741	4.383	1.691	15.688
Quantity Canada (million bushels)	30	4.592	14.318	0	71.969
Ocean Freight PNW to South Korea	30	.860	.697	.300	3.172
Rice Price Bangkok, Thailand (mt)	30	470.785	296.531	179.462	1533.994
Income (per capita-,000)	30	4.673	2.877	.970	9.811

Table 3: Data Descriptive Statistics-Indonesia Hard Spring Wheat (Annual 1970/1971 to 1999/2000)

Variable	Observation	Mean	Std Dev	Min	Max
P^D_{US} #1 HRS 13%	30	7.24	3.025	3.968	15.684
P^D_{CN} #1 CWRS13.5%	30	6.682	2.934	3.607	16.112
Q^D_{US} (million bushels)	30	5.155	4.822	0	14.915
Q^D_{CN} (million bushels)	30	8.936	11.370	0	48.319
Ocean Freight PNW to Indonesia	30	.998	.512	.501	3.352
Rice Price Bangkok, Thailand (mt)	30	470.785	296.531	179.462	1533.994
Income (per capita-,000)	30	.665	.189	.246	.987

Table 4: Data Descriptive Statistics-Miscellaneous Data (Annual 1970/1971 to 1999/2000).

Variable	Observation	Mean	Std Dev	Min	Max
U.S. Carryover Stocks Hard Spring Wheat (million bushels)	30	250.258	110.584	87.200	498.251
Canada Carryover Stocks Hard Spring Wheat (million bushels)	30	361.285	119.707	185.794	734.138
U.S. Wheat Loan Rate	30	3.367	1.106	2.081	5.062
Canada Initial Price #1 CWRS	30	5.538	2.580	2.850	13.260
U.S. Per Capita Income	30	24.191	3.515	18.099	32.176
Canada Per Capita Income	30	18.839	1.742	14.413	22.618
U.S. Carryover Stocks Corn (million bushels)	30	1562.767	1144.887	362.012	4881.254
U.S. Protein Level HRS	30	14.373	.526	13.7	16.4
Canada Prairie (Freight + Elevation)	30	.530	.158	.340	.854

CHAPTER 5

EMPIRICAL RESULTS

In this chapter the empirical results are presented and discussed for estimates of the econometric models presented in Chapter 3. Structural equations are estimated for carryover wheat stocks in the United States and for Canada. These carryover stocks equations provide instrumental variables for the supply equations in the supply and demand model.

Parameter estimates for the carryover stock models are presented first. Then, parameter estimates are presented for the individual supply and demand models for South Korea, Indonesia, and Japan. The supply and demand models are estimated using two specifications for each country to assess the importance of an alternative treatment of carryover stock instruments in the system of equations.

Carryover Estimation Results

Table 5 presents the estimated parameters for the U.S. and Canadian carryover stock models. Both models were estimated using ordinary least squares procedures. In both the U.S. and Canadian equations, other than the intercept, the only parameter estimated to be statistically different than zero was for carryover stocks lagged one time period. In both equations the estimated coefficient for this variable is positive and significant at the 5% level, as expected. The lagged carryover stock variable is included in the supply equations for the Canadian-U.S. price relation model because of its role in determining the amount of hard spring wheat available to the marketplace. The difficulty with estimating the carryover stock situation of an exporter is in identifying right hand side variables that do not create problems with the error structure of the equation. Using production would introduce an endogenous variable onto the right hand side of the carryover stocks equation. Also, identifying explanatory variables that are not serially correlated limits the specification of the equations.

Table 5: Estimated Regression Coefficients-Carryover Stocks.

Coefficients with respect to independent variables (t-statistics)		
Estimator	**Ordinary Least Squares**	
	Equations: Dependent Variable =	
Parameters Estimated	Quantity U.S. Carryover Stocks	Quantity Canadian Carryover Stocks
Intercept	33.39 (0.57)	201.33 (3.23)**
Hard Spring Wheat Carryover Stocks Lagged	0.86 (3.20)**	0.44 (3.24)**
Corn Carryover Stocks Lagged	-0.03 (-1.02)	
P^{MGE}*real interest rate	0.51 (0.43)	-1.00 (-0.84)
U.S. Loan Rate	12.04 (0.76)	
CWB Initial Price #1 CWRS		-1.11 (-0.16)
Observations	29	29
R-Squared	.57	.32

* = significant at the .10 level of significance
** = significant at the .05 level of significance

Canadian-U.S. Price Relation Model Results

The four-equation simultaneous system of equations is estimated using the three stage least squares (3SLS) procedures in STATA Release 5.0. Two specifications of the system of equations (20-23) in Chapter 3 are presented. The first set of results for each country use the significant variables of the carryover stocks model in the U.S. and Canadian supply equations as instruments. The second set of estimation results utilize the predicted or fitted values of the carryover stocks estimation as an alternative instrument. Parameter estimates for South Korea, Indonesia, and Japan are presented separately. Comparisons of the results for the three markets are then presented.

South Korea Results

Parameter estimates for the regression model of the hard spring wheat market in South Korea are presented in Table 6. In the U.S. and Canadian export supply equations, only coefficients for the intercept term in each equation and the ocean freight variables with respect to the landed price of U.S. and Canadian hard spring wheat are statistically significant from zero and positive. The results indicate that an increase in the cost of shipping wheat to South Korea increases the landed price.

That the estimated parameters of the ocean freight variables were significant is not surprising considering the variable's relation to the constructed dependent price variables. The dependent price variables are the sum of the U.S. and Canadian domestic coast values plus ocean freight. While the inclusion of the freight variable as an explanatory variable may cause a potential problem with the error structure of the system, the empirical situation is a by-product of data availability and the inherent problem of analyzing markets in which arbitrage and freight costs are a large component of the delivered price of a good. The freight variable is an important component of the wheat market and is included to provide consistency with respect to the Japanese model—which does not use this constructed dependent variable. The relationship between the ocean freight rate and the dependent price variables will be an important factor when comparing the results of the South Korean model to those of the Japanese model, which use landed export prices.

Parameter estimates for the lagged carryover stock variables in the U.S. and Canada supply equations are negative, as expected, but are not significantly different from zero. Other variables in the supply equations are not significantly different from zero.

The lack of significant supply equation variables, combined with the demand equation parameter estimates, suggest that the South Korean hard spring wheat market is to some degree price competitive.

The coefficients on quantity and South Korean per capita are not significantly different from zero in the South Korea demand equation for U.S. wheat. The price of rice is included as the price of a substitute good for wheat. The increase in the price of rice is expected to increase the price of wheat caused by an outward shift in the demand curve of wheat. The coefficient on rice in the South Korean demand equations for U.S. and Canadian wheat are statistically significant but are very small in magnitude in both equations.

As discussed in Chapter 3, the estimates of primary interest in the systems of equations are the cross price relationship of U.S. and Canadian hard spring wheat. The relevant test is whether or not the estimated coefficient differs from 1.0. In the South Korean demand equation for Canadian wheat, if the coefficient on the U.S price variable were 1.0 it would imply that a one-unit change in the U.S. price would cause a one unit change in the Canadian price.

In the South Korean demand equation for U.S. wheat a 1.0 unit increase in the price of Canadian CWRS relates to a 1.14 unit increase in the price of U.S. HRS. Although this finding is consistent with the result in the Canadian demand equation the result is not statistically different from 1.0. In the South Korean demand equation for Canadian wheat a 1.0 unit increase in the price of U.S. HRS causes a 0.89 increase in the price of Canadian CWRS. This estimated coefficient is statistically significantly different from 1.0. This estimate indicates that the United States has a positive price relation for its #1 HRS 13% protein in South Korea over the Canadian price. These findings raise some questions regarding claims by Kraft et al. (1996) and Veeman (1987) that the CWB is able to obtain premiums for CWRS in markets which they compete with U.S. HRS and similar classes of wheat. The price data used in these regressions, however, may not reflect accurately the true prices charged by the CWB.

Table 6: Estimated Regression Coefficients - South Korea.

Coefficients with respect to right hand side variables (t-statistics)				
Log-Likelihood = 17.86	Equations: Dependent Variable =			
Estimation Procedure	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**
Parameters Estimated	Supply-U.S. Price #1 HRS 13%	Supply-Canada Price #1 CWRS 13.5%	South Korea Demand - U.S. Price #1 HRS 13%	South Korean Demand – Canada Price #1 CWRS 13.5%
Intercept	4.21 (2.05)**	2.45 (1.20)**	.72 (1.47)	-0.68 (-1.58)
Quantity Imported/Exported	-0.09 (-0.83)	-0.01 (-0.85)	0.14 (0.51)	-0.002 (-0.33)
Carryover Stocks lagged 1 period	0.0006 (0.42)	0.0002 (0.13)		
U.S. Wheat Loan Rate	-0.07 (-0.24)			
U.S. per capita income	0.01 (0.12)			
Ocean freight South Korea	4.26 (13.11)**	0.63 (15.91)**		
Price Canada Hard Spring Wheat			1.14 (12.88)**	
Price U.S. Hard Spring Wheat				0.89 (14.99)**
Canada Prairie (Freight + Elevation)		-0.18 (-0.20)		
Canada Per Capita Income		0.03 (0.36)		
South Korea Per Capita Income			-0.08 (-1.41)	0.06 (1.37)
Rice Price			-0.002 (-1.82)*	0.001 (2.34)**
Observations	29	29	29	29

* = significant at the .10 level of significance
** = significant at the .05 level of significance

Table 7 presents a similar supply and demand model of the South Korean hard spring wheat market using different instruments. Instead of using as instruments the significant variable (lagged stocks) from the carryover stock equation, the fitted values of the estimated carryover estimations were used. Estimates of the price relation coefficients and other estimated parameters remained relatively stable. The estimated coefficient on predicted carryover stocks in the Canadian and U.S. supply equations are not statistically different from zero.

The addition of an interaction variable to the original South Korean demand equation for Canadian wheat was discussed in Chapter 3. The interaction variables are P^{D}_{US}*marketshare, P^{D}_{US}*time trend, and P^{D}_{US}*U.S.protein. Including these interaction variables permits an assessment of the affect of the interaction variable on the coefficient measuring the cross-price relationship between U.S. and Canadian wheat. For example, does having a higher protein level in the U.S. hard spring wheat crop relative to the Canadian wheat crop protein level change the dynamics of the price relationship? The procedure was performed on the system of equations presented in Table 7.

Results for the modified system are presented in Appendix B. An F-test using the value of the Log-Likelihood function was performed to determine whether the interaction variables have a statistically significant affect on the system. In all three cases, the F-test indicates that including the interaction variables did not provide any additional explanatory power. In these models, the interaction variables-time, protein, and market share data - are not statistically significantly related to U.S. and Canadian hard spring wheat prices in the South Korean market.

Table 7: Estimated Regression Coefficients - South Korea.

Coefficients with respect to right hand side variables (t-statistics)				
Log-Likelihood = -66.52	Equations: Dependent Variable =			
Estimation Procedure	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**
Parameters Estimated	Supply-U.S. Price #1 HRS 13%	Supply-CN Price #1 CWRS 13.5%	South Korean Demand – U.S. Price #1 HRS 13%	South Korean Demand – Canada Price #1 CWRS 13.5%
Intercept	4.31 (2.30)**	2.64 (1.78)*	1.33 (1.96)**	-1.02 (-1.65)*
Quantity Imported/Exported	-0.09 (-0.91)	-0.01 (-0.70)	-0.14 (-1.24)	-0.03 (-1.42)
Predicted Value Carryover Stocks	-0.0007 (-0.46)	-0.001 (-0.48)		
U.S. per capita income	0.01 (0.12)			
Ocean Freight South Korea	4.19 (11.77)**	17.28 (17.28)**		
Price Canada Hard Spring Wheat			1.10 (9.94)**	
Price U.S. Hard Spring Wheat				0.91 (11.14)**
Canada Per Capita Income		0.03 (0.56)		
South Korea Per Capita Income			0.11 (0.72)	0.13 (1.81)*
Rice Price			-0.001 (-1.32)	0.001 (1.64)*
Observations	29	29	29	29

* = significant at the .10 level of significance
** = significant at the .05 level of significance

As discussed in Chapter 1, South Korea had a state run marketing board (KOFMIA) that purchased wheat for domestic users. KOFMIA had its exclusivity curtailed over an eight years period eventually being replaced by a more price competitive approach to buying wheat. To test whether this policy shift had any influence on the price relationship between U.S. and Canadian hard spring wheat a dummy variable was included in both demand equations. The value of the dummy variable was 0 between the 1970 and 1982 crop marketing years. A time trend variable represented the phase out period followed by a constant through the end of the data series. The phase out of the monopolistic marketing board is expected to have a positive affect on the price received by exporters. The estimated parameter in both demand equations revealed that the inclusion of the dummy variable does not have a statistically significant influence on the price of U.S. and Canadian hard spring wheat.

Indonesia Estimation Results

Parameter estimates of the four-equation supply and demand model for hard spring wheat in Indonesia are presented in Table 8. In the U.S. and Canadian export supply equations, the coefficient on the ocean freight variable with respect to the constructed landed price of U.S. and Canadian hard spring wheat is statistically significant and positive.[16]

[16] Refer back to the South Korean results for a discussion of the statistical results and inclusion of the ocean freight in the Indonesian system of equations.

Table 8: Estimated Regression Coefficients-Indonesia.

Coefficients with respect to right hand side variables (t-statistics)				
Log-Likelihood = -62.07	Equations: Dependent Variable =			
Estimation Procedure	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**
Parameters Estimated	Supply-U.S. Price #1 HRS 13%	Supply-Canada Price #1 CWRS 13.5%	Indonesia Demand-U.S. Price #1 HRS 13%	Indonesia Demand-Canada Price #1 CWRS 13.5%
Intercept	7.23 (2.31)**	3.98 (1.02)	0.70 (1.55)	-0.20 (-.51)*
Quantity Imported/Exported	-0.004 (-0.06)	-0.16 (-3.81)**	-0.003 (-0.02)	-0.003 (-0.23)
Carryover Stocks lagged 1 period	-0.003 (-1.26)	-0.003 (-1.18)		
U.S. Wheat Loan Rate	0.52 (1.48)			
Ocean Freight Indonesian	3.82 (8.19)**	4.06 (8.31)**		
Price Canada Hard Spring Wheat			1.21 (12.76)**	
Price U.S. Hard Spring Wheat				0.76 (11.17)**
Canada Prairie Costs (Freight + Elevation)		5.90 (2.57)**		
U.S. Per Capita Income	-0.19 (-2.13)**			
Canada Per Capita Income		-0.10 (-0.64)		
Indonesia Per Capita Income			-0.77 (-1.33)	0.49 (1.01)
Rice Price			-0.002 (-2.34)**	0.002 (3.27)**
Canada Indonesia Trade Agreement				0.05 (0.14)
Observations	29	29	29	29

* = significant at the .10 level of significance
** = significant at the .05 level of significance

U.S. per capita income is negative and significant in the U.S. supply equation. In the case of wheat being a normal good, if an exporter's income is increasing the price of the product would be expected to increase. The negative sign in this case indicates that wheat is an inferior good in the United States, or that U.S. per capita income is in some other way negatively related to the price for wheat exports to Indonesia, possibly U.S. government aid or Indonesian importing directives.

In the Canadian supply equation, the coefficient for quantity supplied is negative and significant. Price and quantity should have a positive relationship in a supply scenario. Canada has only recently become a consistent supplier of hard spring wheat to Indonesia. In the early period of this study Canada shipped limited quantities to Indonesia which may be causing problems with the error structure of the Canadian supply equation.[17] The Canadian prairie freight and elevation fee variable is positive and statistically significant. The freight and elevation fees represent a cost to producers of getting wheat to the export facility, which should increase the landed price if those costs increase. Thus, the estimated coefficient has the expected sign.

In the Indonesian demand equations, the statistically significant coefficients on the cross price variables suggest a price relationship that is different from a one-for-one price relation. A 1-unit increase in the price of U.S. HRS is estimated to cause a .74 unit increase in the Canadian price. This scenario may describe a situation in which the CWB is selling at a lower price to possibly gain access to a new market, which Indonesia has been for Canada in recent years. This result may also stem from Canada's low volumes during the earlier years of this study period. The coefficient for Indonesian per capita

[17] See Appendix A for a graphical illustration of U.S. and Canadian export volume into Indonesia.

income is not different from zero in either of the demand equations. Similar to the case in South Korea, the price of rice in the Indonesian demand equations for U.S. and Canadian wheat is significant but virtually zero. Obtaining accurate information on rice prices was difficult because in Indonesia the rice market is heavily influenced by the Indonesian government.

In the Indonesian demand equation for Canadian wheat a dummy variable is included to estimate the effects of a trade agreement between the CWB and Indonesia. This 1994-95 agreement specified that Indonesia would import no less than 37 million bushels of Canadian wheat annually. This five-year agreement ended after the 1999/2000 crop year. The estimated coefficient for this dummy variable was not significantly different than zero.

Table 9 presents a similar supply and demand model of the Indonesian hard spring wheat market with an adjustment made to the U.S. and Canadian supply equations. Instead of including as instruments the variables significant in the carryover stock equation, the fitted values of the estimated carryover estimations were used. The results of the key price relation coefficients remained relatively the same as the estimates in Table 8. The coefficients on the predicted carryover stocks in the U.S. and Canadian supply equations were not significant.

As in the South Korean system of equations, interaction variables were added to the Indonesian demand equation for Canadian wheat to measure their affects on the U.S. price coefficient. The interaction variables are P^D_{US}*marketshare, P^D_{US}*time trend, and P^D_{US}*U.S.protein. Parameter estimates for this model are presented in Appendix B. In all three cases, as in the South Korean model, F-tests indicate that the interaction variables do not provide any additional explanatory power.

Table 9: Estimated Regression Coefficients–Indonesia.

Coefficients with respect to right hand side variables (t-statistics)				
Log-Likelihood = -57.30	Equations: Dependent Variable =			
Estimation Procedure	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**
Parameters Estimated	Supply-U.S. Price #1 HRS 13%	Supply-Canada Price #1 CWRS13.5%	Indonesia Demand-U.S. Price #1 HRS 13%	Indonesia Demand-Canada Price #1 CWRS 13.5%
Intercept	10.83 (4.73)**	6.20 (1.42)	0.62 (1.36)	-0.31 (-0.79)
Quantity Imported/Exported	0.07 (0.89)	-0.06 (-2.30)**	0.01 (0.68)	0.01 (0.77)
Predicted Carryover Stocks	-0.004 (-1.20)	-0.003 (-0.70)		
Ocean freight Indonesian	3.92 (7.51)**	4.70 (9.70)**		
Price Canada Hard Spring Wheat			1.26 (12.76)**	
Price U.S. Hard Spring Wheat				0.74 (10.65)**
U.S. Per Capita Income	-0.27 (-3.39)**			
Canada Per Capita Income		-0.13 (-0.80)		
Indonesia Per Capita Income			-0.90 (-1.52)	0.49 (0.98)
Rice Price			-0.003 (-2.80)**	0.003 (3.67)**
Canada Indonesia Trade Agreement				-0.32 (-0.84)
Observations	29	29	29	29

* = significant at the .10 level of significance
** = significant at the .05 level of significance

Japanese Estimation Results

Parameter estimations for Japanese hard wheat indicate that Japan is comparatively a more price competitive market for U.S and Canadian hard spring wheat than the South Korean and the Indonesian markets. Table 10 contains the estimated coefficients for the model represented by equations (20-23) in Chapter 3.

In the U.S. supply equation, the coefficient on quantity is not significantly different from zero. Lagged carryover stocks are negative and significant. The wheat loan rate is positive and significant. Ocean freight between the U.S. and Japan is positive and statistically significant. The inclusion of this variable in the supply equations does not have the problem that it has in the South Korean and Indonesian system of equations. Because the price data in the Japanese market are quoted on a delivered basis, the freight component of the price has been accounted for in the arbitrage of the wheat market.

In the Canadian supply equation, the quantity parameter estimate is positive and marginally significant. As in the U.S. supply equation, the coefficient on lagged carryover stocks is negative and significant. The coefficient on ocean freight rates is positive and significant.

In the demand equations, the coefficients for the cross price coefficients reflect a nearly one for one price movement between U.S. and Canadian hard spring wheat. In both demand equations, results fail to reject the null that the coefficients equal one. This finding suggests that U.S. and Canadian prices move very closely together in the Japanese market. Japanese per capita income and the price of rice do not significantly affect the price of hard spring wheat in either of the demand equations.

Table 10: Estimated Regression Coefficients-Japan.

Coefficients with respect to right hand side variables (t-statistics)				
Log-Likelihood = -68.89	Equations: Dependent Variable =			
Estimation Procedure	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**
Parameters Estimated	Supply-U.S. Price #1 HRS 13%	Supply-Canada Price #1 CWRS 13.5%	Japan Demand-U.S. Price #1 HRS 13%	Japan Demand-Canada Price #1 CWRS 13.5%
Intercept	3.18 (1.07)	1.27 (0.22)	-0.19 (-0.28)	1.29 (0.83)
Quantity Imported/Exported	0.05 (0.71)	0.15 (1.623)*	0.005 (0.38)	-0.02 (-0.77)
Carryover Stocks lagged 1 period	-0.005 (-2.91)**	-0.003 (-1.68)*		
U.S. Wheat Loan Rate	0.30 (2.158)**			
US per capita income	-0.04 (-0.31)			
Ocean Freight Japan	5.76 (7.72)**	6.72 (9.84)**		
Price Canada Hard Spring Wheat			0.93 (14.19)**	
Price U.S. Hard Spring Wheat				1.02 (13.03)**
Canada Prairie (Freight + Elevation)		0.46 (0.38)		
Canada Per Capita Income		-0.24 (-1.54)		
Japan Per Capita Income			0.01 (0.86)	-0.01 (-0.91)
Rice Price			-0.0004 (-0.64)	0.001 (1.47)
Observations	29	29	29	29

* = significant at the .10 level of significance

** = significant at the .05 level of significance

The results of the Japanese system with the fitted values of the carryover stocks replacing the significant variables from the carryover estimations are presented in Table 11. As is the case for the South Korean and the Indonesian markets, there is little change in the estimated coefficients from those in Table 10. The important variables in the two supply equations maintained their signs and retained statistical significance.

Adding the interaction terms P^{D}_{US}*marketshare, P^{D}_{US}*time trend, and P^{D}_{US}*U.S.protein to the Canadian demand equation to test whether they had any affect on the U.S. price coefficient provided no statistical improvements to the Japanese wheat model. In all three cases the F-test failed to reject the null hypothesis that the coefficient on the interaction term is zero. These results are presented in Appendix B.

Comparison of Estimated Hard Spring Wheat Markets

Most Parameter estimates for the South Korea and Indonesian hard spring wheat market models were not statistically significant. Potential sources for these weak econometric results could be the specification of the equations within systems and the parsimonious number of explanatory terms. It is also possible that the competitive model imposed on these individual markets is not appropriate. Additionally, an inherent problem with estimating a system of equations is that if any of the equations is not specified correctly the errors for the entire system may be affected.

Table 11: Estimated Regression Coefficients-Japan.

Coefficients with respect to right hand side variables (t-statistics)				
Log Likelihood = -74.72	Equations: Dependent Variable =			
Estimation Procedure	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**
Parameters Estimated	Supply-U.S. Price #1 HRS 13%	Supply-Canada Price #1 CWRS 13.5%	Japan Demand-U.S. Price #1 HRS 13%	Japan Demand-Canada Price #1 CWRS 13.5%
Intercept	7.31 (3.01)**	0.55 (0.09)	0.17 (-0.24)	2.21 (1.35)
Quantity Imported/Exported	0.04 (0.57)	0.14 (1.74)*	-0.006 (-0.33)	-0.04 (-1.10)
Predicted Carryover Stocks	-0.006 (-2.80)**	-0.004 (-0.94)		
US per capita income	-0.14 (-0.89)			
Ocean Freight Japan	5.57 (7.10)**	6.48 (9.56)**		
Price Canada Hard Spring Wheat			0.97 (13.40)**	
Price U.S. Hard Spring Wheat				0.96 (11.72)**
Canada Per Capita Income		-0.13 (-0.86)		
Japan Per Capita Income			.03 (1.34)	-0.02 (-1.01)
Rice Price			-0.0009 (-1.25)	0.002 (2.02)**
Observations	29	29	29	29

* = significant at the .10 level of significance
** = significant at the .05 level of significance

The empirical results suggest that Canadian and the U.S. exporters are competing aggressively through price in the Japanese market. Parameter estimates for the Japanese hard spring wheat market indicate a one-for-one relationship between price changes for U.S. and Canadian exporters in this market. These results are consistent with the Bertrand price competition model which describes a market with an oligopolist structure where firms employ price as the decision variable resulting in the same price and quantity as the competitive equilibrium (Hirschleifer and Hirschleifier 1998). This Bertrand model is consistent with those of Gilmour and Fawcett (1987) which describe the CWB and U.S. grain marketing firms as noncolluding oligopolists. The parameter estimates for the Japanese market demand signify that both of the exporters are competing primarily by matching competitors' prices. The results of the Japanese hard spring wheat market raise questions about claims made by the CWB that it is able to extract a higher price or economic rent for their CWRS over U.S. wheat.

The South Korean and Indonesian wheat markets were also chosen for analysis because these two markets were among the few that the United States and Canada had shipped hard spring wheat to over the last 30 years. The econometric results indicate that the United States and the CWB are not competing as strongly on price as they are in the South Korean and the Indonesian markets as they do in Japan.

In terms of comparing the results in this chapter with others that have measured the economic welfare of the CWB, the Japanese results are consistent with Carter (1993) and Carter et al. (1998), which conclude that the CWB is not able to obtain a premium for the wheat that they export. The coefficient estimates for the Indonesian and South Korean markets suggest that the CWB may be striving to increase market share through price offerings. There are, however, important data limitations for both the South Korean and the Indonesian markets that limit the implications that can be drawn from these findings.

CHAPTER 6

CONCLUSION

The importance of export markets to the wheat sector makes equitable trade in the international wheat market an important concern for U.S wheat producers. U.S. wheat producers and lawmakers have suggested that the use of STEs by other wheat market participants distorts trade and breaches trade agreements. In order to gauge the effects of these STEs, markets for specific wheat classes must be identified and analyzed. The intent of this research was to identify these classes of wheat and develop an econometric model that allowed the estimation of the price relationship between these wheat classes.

The high protein hard spring wheat market has several important characterists. Canada and the United States are the primary suppliers of this class of wheat, and there are a relatively small number of specific markets in which they compete. While there are some differing opinions regarding the substitutability of U.S. HRS and Canadian CWRS for end users, research by Wilson (1994) and others has suggested that some importers are shifting demand towards the higher protein spring wheats, particularly HRS and CWRS. The increased market share coupled with the competition claimed by those in the business of trading wheat, indicates the relevance of examination of price competition supplies of these two suppliers of hard spring wheats.

Japan, South Korea, and Indonesia markets were examined to investigate the competition between the U.S. and Canada in the hard spring wheat export market.

Equilibrium supply and demand models were estimated to investigate price competition between the United States and Canada in each of these importing countries.

Annual time series data for the period 1970/71 to 1999/2000 were used to estimate parametric supply and demand models. A four-equation simultaneous system was used to model the hard spring wheat market in each importing country. The four-equation system consisted of two individual export supply equations–one for the United States and one for Canada–and two demand equations–one for wheat demand for imports from the United States and one for wheat demand for imports from Canada. The advantage of modeling these equations as a system is that it provides a mechanism to account for endogenous right hand side variables and autocorrelation in the error structure.

Estimation results of the individual markets vary. Estimation results in the South Korea and Indonesian hard spring wheat markets showed a general lack of explanatory power. The lack of explanatory power may imply that the United States and Canada are heavily competing in price for market share in these two markets. While the estimated cross price parameters suggest that the CWB may be offering lower prices than are available to firms trading United States origin hard spring wheat, the price data used in the econometric models does not reflect actual transaction prices which limits the interpretation of these results. Other possible reasons for the relative lack of explanatory power include specification error of variables in the individual equations or the nature of the CWB's pooled price.

The estimation results for the Japanese model indicate that there maybe some non-price competition between the United States and Canada. Estimated demand parameters are consistent with both the U.S. and Canada competing primarily by matching each other's prices. This result is consistent with the Bertrand model of price competition in a market with limited suppliers. Other statistically significant parameters in the Canadian and U.S. supply equations support this conclusion.

The price data in this study are different from similar work in that price variables were constructed to reflect comparable qualities of hard spring wheat. Other research (Veeman 1987, Kraft et al 1996, and Wilson 1989,1990, and 1994) has used price data for different grade factors of Canadian and U.S. hard spring wheat to estimate demand models. Clear statistical tests of market competition between the United States and Canada requires that the price data used must recognize these quality constraints.

The ability to analyze competition between wheat exporters has implications for trade policy negotiators as well as wheat market participants. Knowledge regarding variables that influence the supply and demand of wheat in the export market allow market participants to use this information to assist in marketing decisions. Legislators and policy makers can make use of this type of analysis to identify potential inequalities in the market place.

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APENDICES

Appendix A

Hard Spring Wheat Quantity Charts

Figure 6: Hard Spring Wheat South Korea Imports.

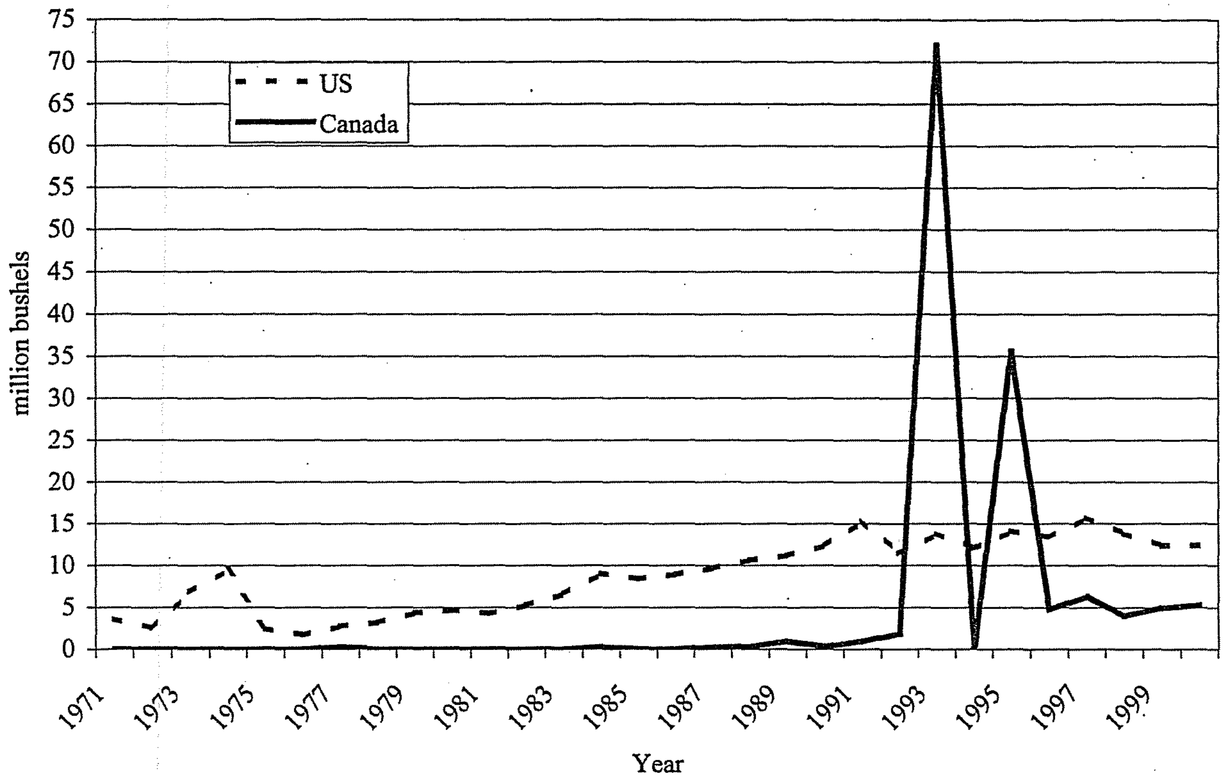


Figure 7: Hard Spring Wheat Indonesia Imports.

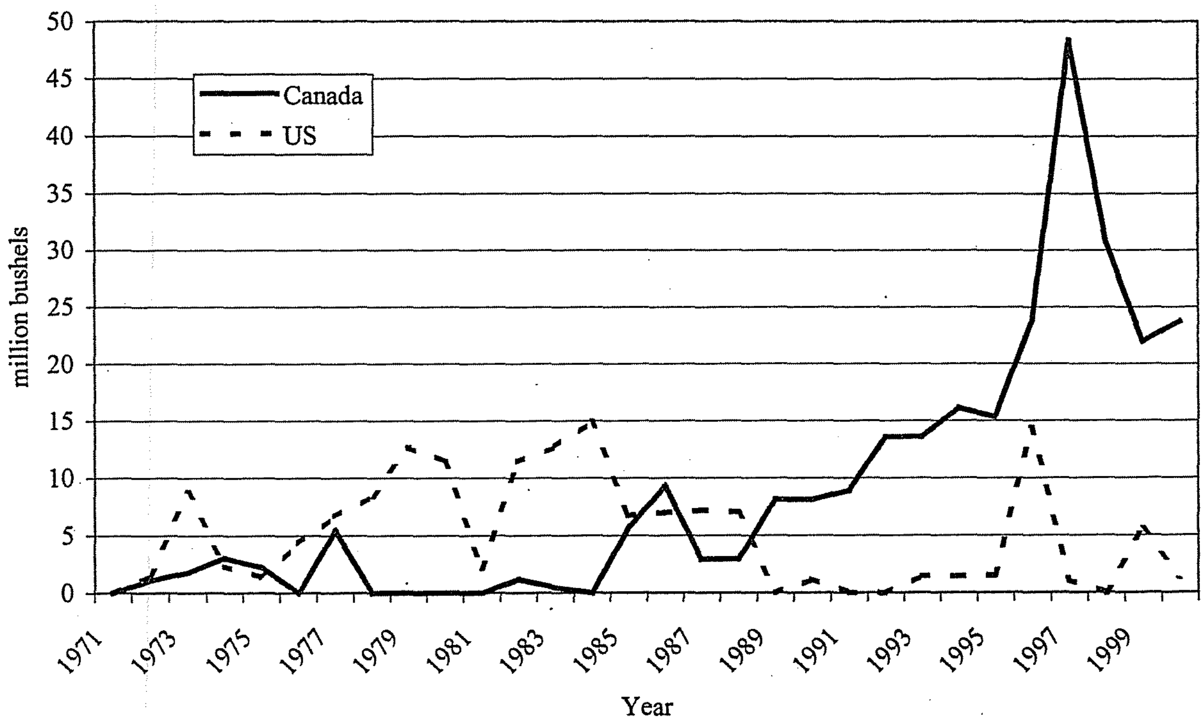
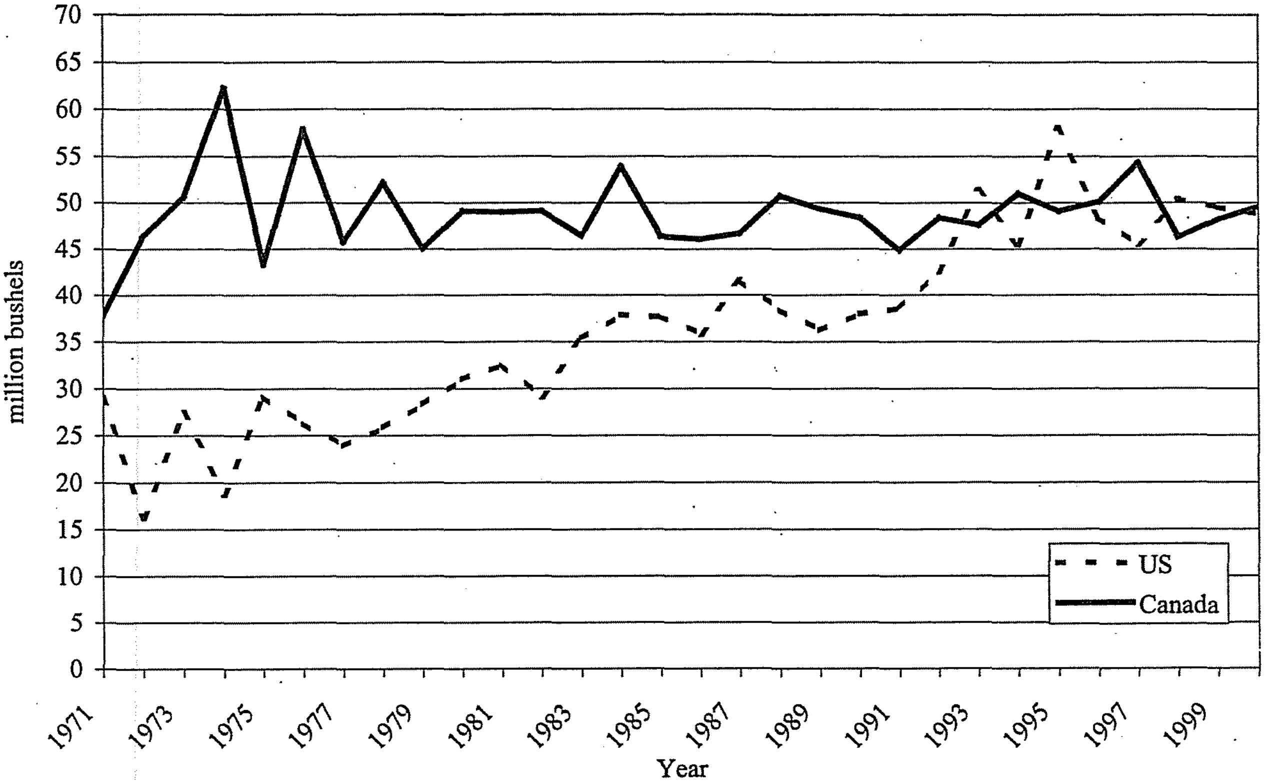


Figure 8: Hard Spring Wheat Japan Imports.



Appendix B

Interaction Variable Regression Results

Table 12: Estimated Regression Coefficients-South Korea Amended System–Protein.

Coefficients with respect to right hand side variables (t-statistics)				
Log-Likelihood = -74.71	Equations: Dependent Variable =			
Estimation Procedure	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**
Parameters Estimated	Supply-U.S. Price #1 HRS 13%	Supply-CN Price #1 CWRS 13.5%	South Korean Demand – U.S. Price #1 HRS 13%	South Korean Demand – Canada Price #1 CWRS 13.5%
Intercept	3.25 (1.696)*	2.68 (1.40)	1.44 (2.12)**	0.001 (0.001)
Quantity Imported/Exported	-0.19 (-1.96)**	-0.03 (-1.39)	-0.17 (-1.75)*	-0.01 (-0.41)
Predicted Value Carryover Stocks	-0.0002 (-0.11)	-0.0006 (-0.22)		
U.S. Per Capita Income	0.09 (0.93			
Ocean Freight South Korea	4.08 (11.85)**	4.21 (16.08)**		
Price Canada Hard Spring Wheat			1.08 (10.65)**	
Price U.S. Hard Spring Wheat				0.26 (0.17)
(Price U.S.*Protein)				0.03 (0.32)
Canada Per Capita Income		0.01 (0.17)		
South Korea Per Capita Income			0.15 (1.20)	0.04 (0.45)
Rice Price			-0.001 (-1.24)	0.002 (1.50)
Observations	29	29	29	29

* = significant at the .10 level of significance
** = significant at the .05 level of significance

Table 13: Estimated Regression Coefficients-South Korea Amended System–Time.

Coefficients with respect to right hand side variables (t-statistics)				
Log-Likelihood = -68.37	Equations: Dependent Variable =			
Estimation Procedure	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**
Parameters Estimated	Supply-U.S. Price #1 HRS 13%	Supply-CN Price #1 CWRS 13.5%	South Korean Demand – U.S. Price #1 HRS 13%	South Korean Demand – Canada Price #1 CWRS 13.5%
Intercept	3.24 (1.59)	2.88 (1.37)	1.08 (1.76)*	-0.31 (-0.78)
Quantity Imported/Exported	-0.20 (-2.10)**	-0.03 (-1.29)	-0.10 (-1.37)	-0.01 (-0.53)
Predicted Value Carryover Stocks	-0.0002 (-0.10)	0.0008 (0.29)		
U.S. Per Capita Income	0.10 (0.97)			
Ocean Freight South Korea	4.04 (11.29)**	4.22 (15.73)**		
Price Canada Hard Spring Wheat			1.14 (12.08)**	
Price U.S. Hard Spring Wheat				-1.83 (-0.12)
(Price U.S.*Time)				0.001 (0.17)
Canada Per Capita Income		-0.002 (-0.03)		
South Korea Per Capita Income			0.07 (0.66)	0.04 (0.35)
Rice Price			-0.001 (-1.97)	0.002 (3.73)*
Observations	29	29	29	29

* = significant at the .10 level of significance
** = significant at the .05 level of significance

Table 14: Estimated Regression Coefficients-South Korea Amended System–Market Share.

Coefficients with respect to right hand side variables (t-statistics)				
Log-Likelihood = -48.85	Equations: Dependent Variable =			
Estimation Procedure	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**
Parameters Estimated	Supply-U.S. Price #1 HRS 13%	Supply-CN Price #1 CWRS 13.5%	South Korean Demand – U.S. Price #1 HRS 13%	South Korean Demand – Canada Price #1 CWRS 13.5%
Intercept	4.29 (2.10)**	2.83 (1.14)	1.08 (1.87)*	-0.18 (-0.38)
Quantity Imported/Exported	-0.21 (-2.12)**	-0.02 (-1.48)	-0.07 (-1.09)	-0.01 (-0.40)
Predicted Value Carryover Stocks	-0.001 (-0.72)	0.001 (0.40)		
U.S. Per Capita Income	0.07 (0.70)			
Ocean Freight South Korea	3.91 (11.35)**	4.25 (15.27)**		
Price Canada Hard Spring Wheat			1.14 (12.28)**	
Price U.S. Hard Spring Wheat				1.05 (2.22)**
(Price U.S.*Market Share)				-0.27 (-0.57)
Canada Per Capita Income		-0.01 (-0.11)		
South Korea Per Capita Income			0.02 (0.18)	-0.003 (-0.04)
Rice Price			-0.001 (-2.00)**	0.002 (3.85)**
Observations	29	29	29	29

* = significant at the .10 level of significance
** = significant at the .05 level of significance

Table 15: Estimated Regression Coefficients-Indonesia–Amended System–Protein.

Coefficients with respect to right hand side variables (t-statistics)				
Log-Likelihood = -81.53	Equations: Dependent Variable =			
Estimation Procedure	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**
Parameters Estimated	Supply-U.S. Price #1 HRS 13%	Supply-CN Price #1 CWRS 13.5%	Indonesia Demand – U.S. Price #1 HRS 13%	Indonesia Demand – Canada Price #1 CWRS 13.5%
Intercept	10.60 (4.49)**	5.02 (1.16)	0.64 (1.33)	-0.34 (-0.95)
Quantity Imported/Exported	0.05 (0.59)	-0.06 (-2.27)**	0.01 (0.38)	-0.003 (-0.19)
Predicted Value Carryover Stocks	-0.002 (-0.81)	-0.002 (-0.47)		
U.S. Per Capita Income	-0.28 (-3.36)			
Ocean Freight Indonesia	4.02 (7.53)**	4.72 (9.53)**		
Price Canada Hard Spring Wheat			1.16 (11.42)**	
Price U.S. Hard Spring Wheat				-0.09 (-0.09)
(Price U.S.*Protein)				0.06 (2.42)**
Canada Per Capita Income		-0.08 (-0.55)		
Indonesia Per Capita Income			-0.63 (-0.98)	0.91 (1.88)*
Rice Price			-0.01 (-1.65)*	0.001 (2.49)**
Canada Indonesia Trade Agreement				0.12 (0.27)
Observations	29	29	29	29

* = significant at the .10 level of significance
** = significant at the .05 level of significance

Table 16: Estimated Regression Coefficients-Indonesia–Amended System–Time.

Coefficients with respect to right hand side variables (t-statistics)				
Log-Likelihood = -96.15	Equations: Dependent Variable =			
Estimation Procedure	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**
Parameters Estimated	Supply-U.S. Price #1 HRS 13%	Supply-CN Price #1 CWRS 13.5%	Indonesia Demand – U.S. Price #1 HRS 13%	Indonesia Demand – Canada Price #1 CWRS 13.5%
Intercept	10.57 (4.48)**	5.39 (1.32)	0.58 (1.19)	-0.59 (-1.62)
Quantity Imported/Exported	0.05 (0.67)	-0.06 (-2.42)**	0.15 (0.61)	-0.0004 (-0.02)
Predicted Value Carryover Stocks	-0.002 (-0.77)	-0.002 (-0.48)		
U.S. Per Capita Income	-0.28 (-3.40)**			
Ocean Freight Indonesia	4.08 (7.61)**	4.68 (9.49)**		
Price Canada Hard Spring Wheat			1.21 (12.38)**	
Price U.S. Hard Spring Wheat				-14.54 (-2.28)**
(Price U.S.*Time)				
Canada Per Capita Income		-0.10 (-0.70)		
Indonesia Per Capita Income			-0.74 (-1.15)	-0.32 (-0.55)
Rice Price			-0.002 (-2.17)**	0.002 (4.41)**
Canada Indonesia Trade Agreement				-0.28 (-0.65)
Observations	29	29	29	29

* = significant at the .10 level of significance

** = significant at the .05 level of significance

Table 17: Estimated Regression Coefficients-Indonesia–Amended System–Market Share.

Coefficients with respect to right hand side variables (t-statistics)				
Log-Likelihood = -91.32	Equations: Dependent Variable =			
Estimation Procedure	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**
Parameters Estimated	Supply-U.S. Price #1 HRS 13%	Supply-CN Price #1 CWRS 13.5%	Indonesia Demand – U.S. Price #1 HRS 13%	Indonesia Demand – Canada Price #1 CWRS 13.5%
Intercept	9.90 (4.09)**	5.89 (1.34)	0.77 (1.65)*	-0.40 (-0.74)
Quantity Imported/Exported	0.09 (1.04)	-0.06 (-2.30)**	0.001 (0.06)	-0.05 (-0.88)
Predicted Value Carryover Stocks	-0.004 (-1.14)	-0.003 (-0.68)		
U.S. Per Capita Income	-0.25 (-2.98)**			
Ocean Freight Indonesia	4.14 (7.60)**	4.78 (9.78)**		
Price Canada Hard Spring Wheat			1.10 (8.95)**	
Price U.S. Hard Spring Wheat				0.85 (6.87)**
(Price U.S.*Market Share)				-0.10 (-0.91)
Canada Per Capita Income		0.12 (-0.73)		
Indonesia Per Capita Income			-0.50 (-0.82)	1.20 (1.15)
Rice Price			-0.001 (-0.91)	0.002 (1.70)*
Canada Indonesia Trade Agreement				1.17 (0.88)
Observations	29	29	29	29

* = significant at the .10 level of significance
** = significant at the .05 level of significance

Table 18: Estimated Regression Coefficients-Japan-Amended System–Protein.

Coefficients with respect to right hand side variables (t-statistics)				
Log-Likelihood = -119.41	Equations: Dependent Variable =			
Estimation Procedure	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**
Parameters Estimated	Supply-U.S. Price #1 HRS 13%	Supply-CN Price #1 CWRS 13.5%	Japan Demand – U.S. Price #1 HRS 13%	Japan Demand – Canada Price #1 CWRS 13.5%
Intercept	11.00 (3.55)**	-3.86 (-0.46)	-0.007 (-0.007)	4.27 (1.12)
Quantity Imported/Exported	0.15 (1.83)*	0.27 (2.26)**	-0.0007 (-0.02)	-0.08 (-0.96)
Predicted Value Carryover Stocks	-0.008 (-2.817)**	-0.006 (-0.93)		
U.S. Per Capita Income	-0.45 (2.23)**			
Ocean Freight Japan	5.96 (6.60)**	6.49 (7.62)**		
Price Canada Hard Spring Wheat			.92 (12.37)**	
Price U.S. Hard Spring Wheat				-0.02 (-0.02)
(Price U.S.*Protein)				0.07 (0.99)
Canada Per Capita Income		-0.22 (-1.01)		
Japan Per Capita Income			0.02 (0.53)	-0.01 (-0.64)
Rice Price			-0.0002 (-0.32)	0.0004 (0.36)
Observations	29	29	29	29

* = significant at the .10 level of significance

** = significant at the .05 level of significance

Table 19: Estimated Regression Coefficients-Japan-Amended System–Time.

Coefficients with respect to right hand side variables (t-statistics)				
Log-Likelihood = -96.15	Equations: Dependent Variable =			
Estimation Procedure	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**
Parameters Estimated	Supply-U.S. Price #1 HRS 13%	Supply-CN Price #1 CWRS 13.5%	Japan Demand – U.S. Price #1 HRS 13%	Japan Demand – Canada Price #1 CWRS 13.5%
Intercept	11.22 (3.56)**	-4.36 (-0.52)	0.24 (0.25)	1.91 (0.69)
Quantity Imported/Exported	0.17 (2.06)**	0.27 (2.21)**	-0.02 (-0.47)	-0.04 (-0.61)
Predicted Value Carryover Stocks	-0.008 (-2.79)**	-0.005 (-0.87)		
U.S. Per Capita Income	-0.49 (-2.41)**			
Ocean Freight Japan	6.07 (6.59)**	6.47 (7.63)**		
Price Canada Hard Spring Wheat			0.94 (13.66)**	
Price U.S. Hard Spring Wheat				-5.26 (-0.26)
(Price U.S.*Time)				0.003 (0.31)
Canada Per Capita Income		-0.20 (-0.93)		
Japan Per Capita Income			0.03 (0.98)	-0.03 (-0.64)
Rice Price			-0.0005 (-0.71)	0.001 (0.74)
Observations	29	29	29	29

* = significant at the .10 level of significance

** = significant at the .05 level of significance

Table 20: Estimated Regression Coefficients-Japan-Amended System-Market Share.

Coefficients with respect to right hand side variables (t-statistics)				
Log-Likelihood = -58.63	Equations: Dependent Variable =			
Estimation Procedure	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**	**3 Stage Least Squares**
Parameters Estimated	Supply-U.S. Price #1 HRS 13%	Supply-CN Price #1 CWRS 13.5%	Japan Demand – U.S. Price #1 HRS 13%	Japan Demand – Canada Price #1 CWRS 13.5%
Intercept	8.26 (2.93)**	4.97 (0.81)	-0.31 (-0.44)	1.24 (0.67)
Quantity Imported/Exported	0.12 (1.96)**	0.05 (0.57)	-0.003 (-0.16)	-0.01 (-0.35)
Predicted Value Carryover Stocks	-0.005 (-2.02)**	-0.00 (-1.18)		
U.S. Per Capita Income	-0.33 (-2.04)**			
Ocean Freight Japan	6.03 (7.21)**	6.87 (10.44)**		
Price Canada Hard Spring Wheat			1.00 (15.72)**	
Price U.S. Hard Spring Wheat				0.97 (5.79)**
(Price U.S.*Market Share)				-0.04 (-0.12)
Canada Per Capita Income		-0.14 (-0.95)		
Japan Per Capita Income			0.02 (0.98)	-0.02 (-0.92)
Rice Price			-0.001 (-1.42)	0.001 (1.61)
Observations	29	29	29	29

* = significant at the .10 level of significance
** = significant at the .05 level of significance