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TITLE: An Analysis Of The Import Demand For Hard Red Winter And Western White Wheats In Asian Pacific Rim Nations

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Wheat is a major agricultural product in the Pacific Northwest (PNW). The market class primarily grown in the region is Western White (WW) wheat. An important export market for PNW wheat producers is the Asian Pacific Rim (APR), due to its proximity and economic growth.

Agronomic research has been conducted in recent years on developing a higher protein wheat in the PNW, known as Hard Red Winter (HRW). The justification of this research is that PNW wheat producers could perhaps become more competitive by diversifying toward HRW wheat.

The higher protein levels of HRW allow it to be used as a meat complement, producing sandwich breads and hamburger buns. The lower protein levels of WW limit its final products to be cereal-based, such as noodles and crackers.

Cross-sectional studies have indicated a change in dietary composition as economic development occurs. Countries seek improved and varied diets. They move away from cereal products such as noodles and rice, and consume more livestock products, especially meats.

The objective of this research is to ascertain whether or not a higher protein wheat (HRW), which can be used as a meat complement, becomes more income sensitive than wheat with cereal-based end uses (WW) when economic development transpires.

Import demand equations were estimated for a selected group of APR countries for the two wheat classes. The estimation was conducted using Ordinary Least Squares and Seemingly Unrelated Regression. The data period was from 1970-1971 to 1985-1986.

Only one country, South Korea, produced significant results to permit comparison of the income sensitivities for the two wheats. Both HRW and WW possessed negative income coefficients, this would suggest that South Korean consumers perceived the final products from which the demand for the two wheats are derived as inferior goods. This means that HRW and WW wheat imports would fall as income rose for South Korea. However, the food self-sufficiency policy of the South Korean government was advanced as a probable reason for the negative coefficients rather than a diminishing marginal propensity to consume food items caused by income growth.

An Analysis of the Import Demand for Hard Red Winter and Western White Wheat in Asian Pacific Rim Nations

by

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AN ANALYSIS OF THE IMPORT DEMAND FOR HARD RED WINTER AND WESTERN WHITE WHEAT IN ASIAN PACIFIC RIM NATIONS

CHAPTER I

INTRODUCTION

Wheat has been and will continue to be a leading cash crop in the Pacific Northwest (PNW), a region comprised of Oregon, Washington, and Idaho. The PNW holds a strong, natural comparative advantage for wheat production due to favorable land, water, and transportation conditions.

Pacific Northwest wheat producers rely primarily on export markets as outlets for their production. The major destinations for PNW wheat are the Asian Pacific Rim (APR) and the Middle East. For the 1986-87 marketing year, the leading importing countries (in million bushels) were Japan (115.0), South Korea (64.7), Egypt (40.4), and Taiwan (27.9) [60].

Presently, 95 percent of the production in the PNW is Western White wheat (WW) [33]. The states of Washington, Oregon, and Idaho provide about 90 percent of the U.S. production of WW wheat.

Wheat and Protein Levels

Protein content is a important characteristic of wheat and especially in the end product use. Western White wheat has six to nine percent protein while the Hard Red Spring (HRS) and Hard Red Winter (HRW) wheats are above 10.5 percent [2]. These varying protein contents lead to differing end uses for each wheat class (see Figure 1). Hard Red Spring and HRW wheats are used primarily in bread making since the additional protein in HRW and HRS permit leavening during baking. This is caused by stronger gluten, a protein complex, which improves the baking quality of flour for bread. The lower protein content of WW wheat produces flour with weaker gluten making it suitable for noodles, cakes, cookies, and pastries.

Problem for PNW Wheat Producers

Surpluses of WW wheat increased dramatically during the 1980s.[1] In earlier years, WW exports from the PNW were about 85 percent of production. In marketing year 1983-84, WW exports were about 71 percent of production, and in 1984-85, they were 69.5 percent [44]. Correspondingly, the WW farm prices per bushel have

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[1] In 1988, a severe drought in the Midwestern U.S. significantly curtailed wheat production and reduced WW wheat stocks in the Pacific Northwest.

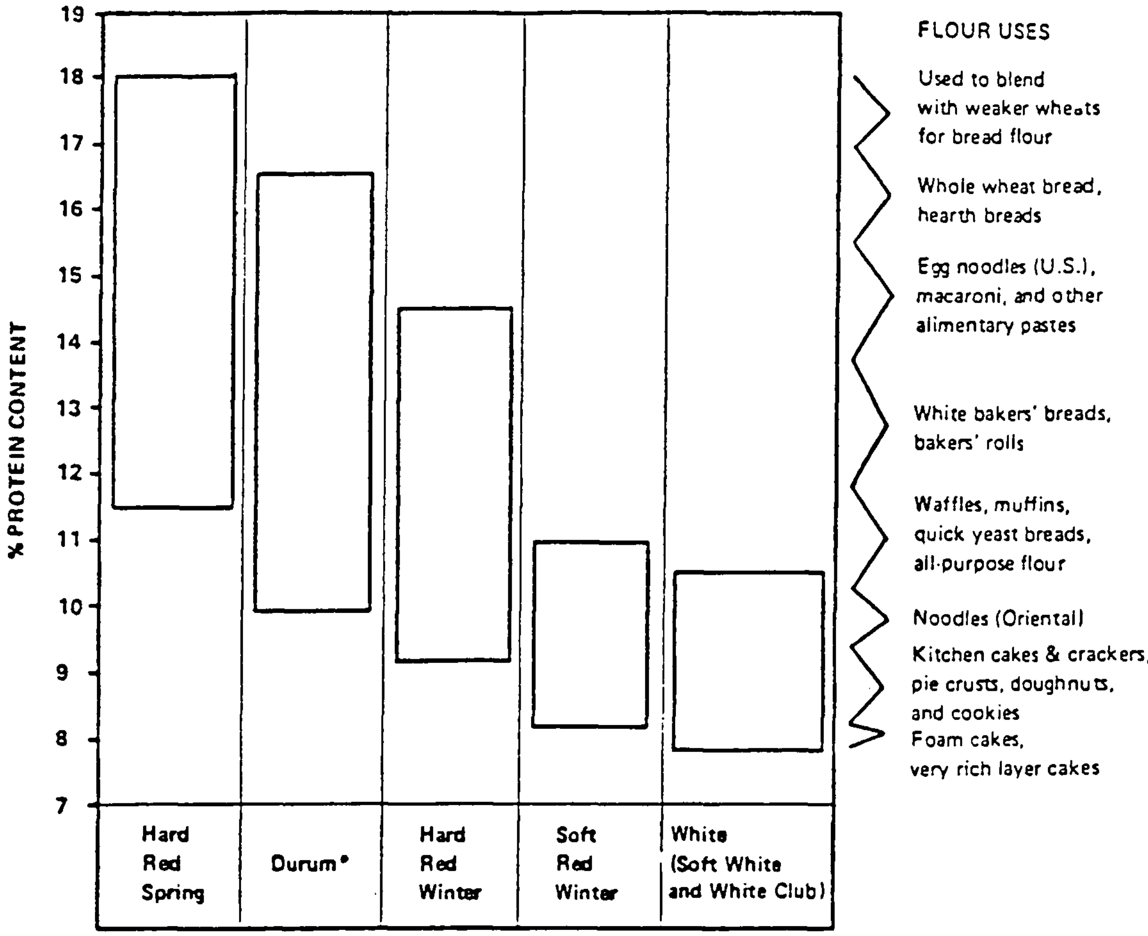

Figure 1. Protein Range and Flour Uses of Major Wheat Classes Source: [24]

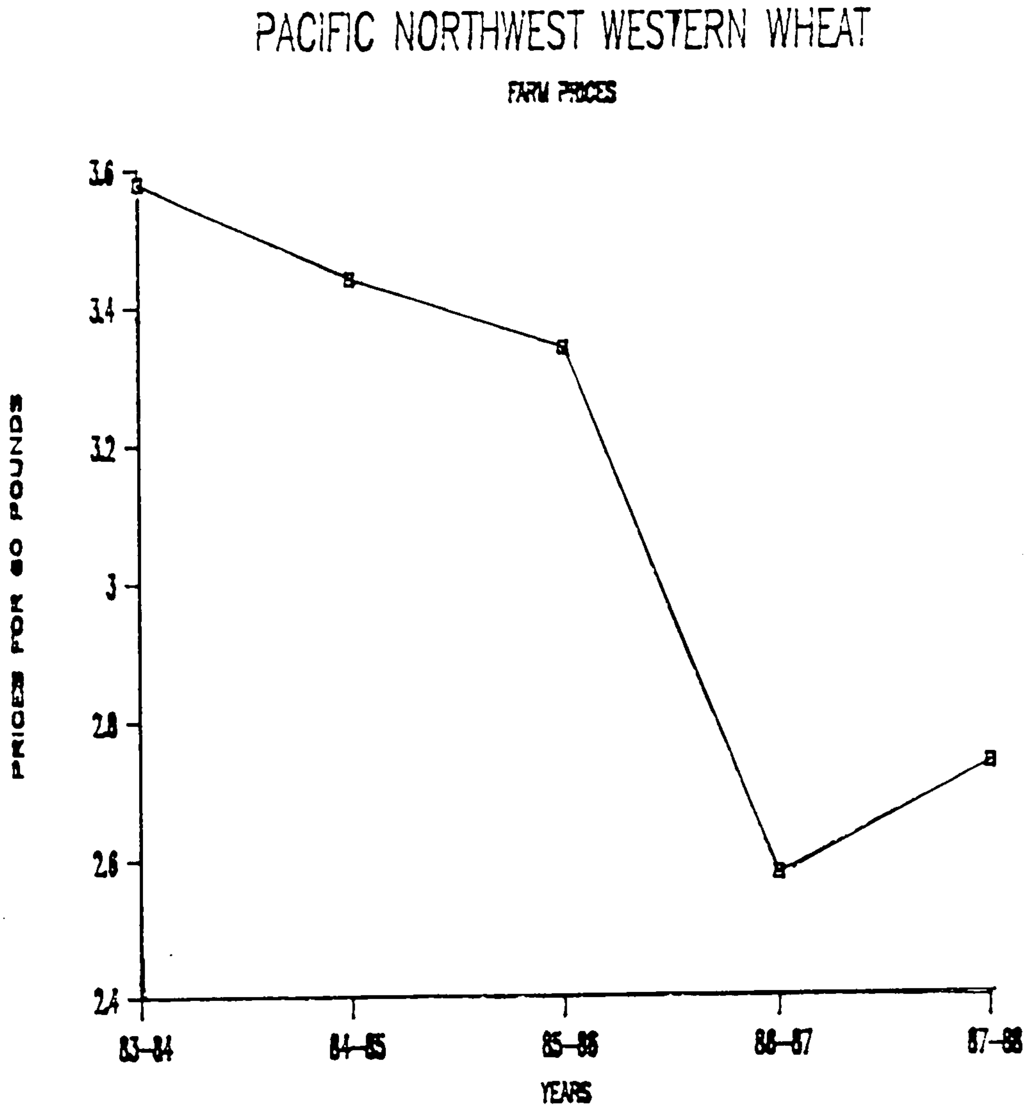

Figure 2. Pacific Northwest Western White Wheat Farm Price (Prices for 60 lbs) Source: [61]

declined during this period (Figure 2). Historically, HRW wheat grown in Montana and Colorado has been receiving consistently higher prices at PNW ports compared to WW wheat [13]. There appears to be a sustained need for PNW wheat at specific protein levels of 11 to 12 percent since Montana's HRW wheat exceeding a protein level of 12 percent is preferred less by Asian countries as noted by Kercheval [30]. This forces PNW grain exporting corporations to ship HRW wheat by rail from destinations such as Kansas and Nebraska to meet the 11 to 12 percent protein requirement [30].

Possible Solution

With the possible advantages of HRW wheat in mind, the Oregon Wheat Commission began funding the Oregon State University Crop Science Department in 1985 to assist in the development of HRW wheat varieties that are agronomically suited for PNW climates. The objective of this research is to provide greater diversity for PNW wheat producers through expanding acreage of HRW and therby complement the production of WW wheat.

Development of a new HRW wheat variety for the PNW could take many years. Presently, WW wheat possesses a distinct yield advantage over HRW wheat. In the past, the price premium for HRW wheat has not been great enough to overcome the yield advantage for WW wheat. Hence, HRW wheat yield must become competitive with WW wheat for grower incomes to be enhanced trough HRW production. Another problem is achieving an adequate protein level of up to 12 percent. An inverse relationship presently exists between wheat protein level and yield. When the protein level is raised, carbohydrates are reduced and this diminishes yield. The goal for PNW wheat producers in growing HRW is to balance yield with protein content through appropriate management practices [33].

Income Growth and Changes in Food Consumption

Previous cross-sectional research by Pinstrup-Anderson has indicated that with increasing incomes, countries seek improved and diversified diets [46]. They move away from cereal products, such as noodles and rice, and consume more livestock products, especially meat [46]. As Figure 3 indicates, until annual per capita income reaches $700, cereal and meat consumption increase at an increasing rate. Increases from $700 to $2,000 in annual per capita income, cause cereal consumption to decrease, while meat consumption continues to increase. At incomes greater than $2,000, cereal consumption is constant and then falls, meat consumption continues to increase and eventually

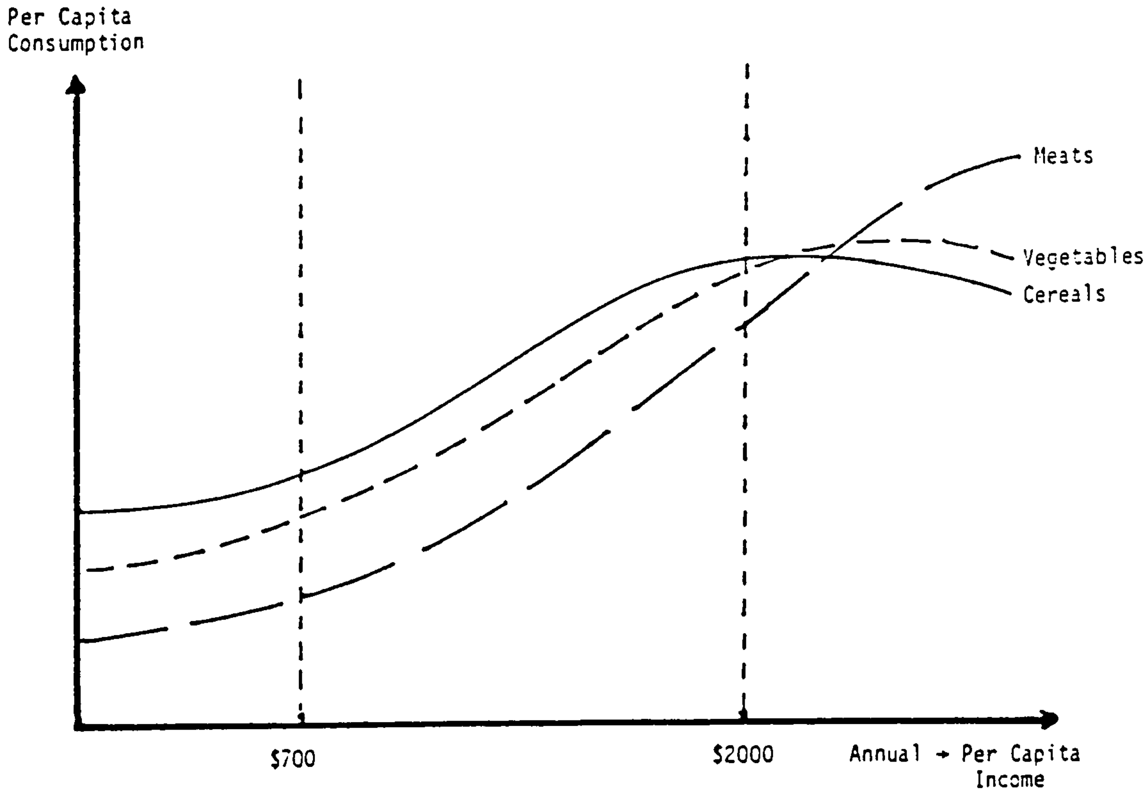

Figure 3. Consumption Patterns and Per Capita Income
Source: [46]

stabilizes. Since as countries incomes rise, cereal consumption declines while meat consumption increases, it would also appear that the demand for HRW wheat as a meat complement (e.g., sandwich breads and hamburger buns) would increase while the need for WW wheat (noodles, pastries) would fall. Seevers [52] noted that "if this pattern does emerge as incomes rise, the implications for white wheat exports are great". But Seevers also mentioned "there is at present limited quantitative evidence on which to support or reject this idea" [52].

Some recent research has been devoted to WW wheat import demand on a single-country basis. These include studies by Townsend [57]; Martin, Knowles, Gonarsyah, and Oliveria [39]; Wagenblast [63]; and Gonarsyah [19]. However, less research has been attempted at comparing WW and HRW import demand on a multiple country basis.

The Asian Pacific Rim Market

The Asian nations which border the Pacific Ocean, countries known collectively as the Asian Pacific Rim (APR), are excellent candidates for confirming whether HRW wheat import demand rises with increased incomes more than WW wheat. Population in these nations now comprise 60 percent of the world's total, and their economic growth has averaged about 7.5 percent [8]. In

1980, Asia surpassed Europe as the leading export market for U.S. agricultural products. Since this time, the percentage of U.S. agricultural exports going to Asia has steadily increased, while the percentage of agricultural exports to Europe has correspondingly declined [45]. In fiscal 1987, Asian markets accounted for 43 percent of U.S. agricultural exports, while Europe's share was about 26 percent [45].

The tremendous growth of these Asian nations in both national economic output (GNP) and international trade has been due to a rapid transformation from agrarian to industrial economies. McCalla [40] noted this transition:

> "results in rising incomes, changes in the location of employment (and residence), changes in the patterns of exports (first to labor intensive exports--e.g., textiles--and then to higher technology exports), and in food consumption patterns."

In the early stages of this transformation, population growth remains rapid. Combining rising incomes and population causes growth in food demand to often exceed the growth in domestic agricultural production. To remedy this situation, countries can either 1) constrain consumption by rationing or raising prices (both politically difficult) or 2) increase imports [40].

Since World War II, Japan has followed this pattern of transformation of agricultural imports from the U.S. During the late 1950s and early 1960s, Japan increased commercial wheat imports. Feed imports grew rapidly after 1965 and meat imports after 1970. Fruits and vegetables have exhibited the most growth recently [40]. Japan is now the leading developed country in the Asian Pacific Rim.

This pattern also has repeated itself, at least with respect to wheat and feed grains, in the Newly Industrialized Countries (NICs), specifically Taiwan and South Korea, during the 1970s [40]. These changes in food consumption with rising incomes are consistent with the previous research cited.

Problem Statement

There is a serious lack of information regarding the long-term demand for HRW wheat versus WW wheat in a major PNW export market such as the Asian Pacific Rim. This information is necessary to determine if developing a new HRW wheat variety for PNW producers will create a net benefit through greater and longer-term export sales.

Testable Hypothesis

Analysis has shown, along with *a priori* expectations, that the income sensitivities for meat products are greater than cereals. This is especially true in middle-income countries experiencing rapid income growth [50]. To confirm this for HRW wheat, whose end products can be considered meat complements, the following hypothesis will be tested:

> The import demand of APR countries for HRW wheat will be more income sensitive or elastic than the import demand for WW wheat.

Research Objectives

The central questions of this research will be addressed through the following objectives:

(1) Delineate the variables that should be the demand determinants suggested by economic theory.

(2) Estimate import demand functions for HRW and WW wheat using these demand determinants.

(3) Test the hypothesis regarding income elasticities of the two market classes.

(4) Draw inferences, conclusions, and recommendations from this research and suggest further research.

Thesis Organization

The remainder of this thesis is organized as follows: Chapter II is a discussion of the economic theory pertaining to the thesis and a review of the relevant literature. Chapter III is an explanation of the methodology used and a presentation of the proposed model. Chapter IV reports and interprets the results of the thesis. Finally, Chapter V summarizes and draws relevant conclusions from this research.

CHAPTER II

ECONOMIC THEORY AND LITERATURE REVIEW

The first part of this chapter will review economic theory relevant to this research. The discussion summarizes the importance of U.S. agricultural trade and the rationale for trade. The concepts of demand theory are then presented: demand function, derived demand, hedonic demand, and excess demand. Finally, the elasticity of demand with regard to price and income is examined in terms of definitions, importance, and recent debates among agricultural economists. The remainder of this chapter is devoted to a survey of the recent literature regarding the modeling of international wheat trade.

Importance of Trade for U.S. Agriculture

The rise in U.S. agricultural exports from the early 1970s has placed increased emphasis on the foreign markets as an outlet for the Nation's agricultural production. Over the past 10 years, agricultural exports ranged from almost $24 billion (fiscal 1977) to nearly $44 billion (fiscal 1981) [1]. During this time, wheat was the third-ranking agricultural export commodity, following corn and soybeans [1].

The U.S. exports of wheat reached a high of 46 percent of the world export market during 1981, but fell to a low of 31 percent in 1985. The U.S. share of the world wheat market rose during 1987 to 34 percent and is projected to climb to 37 percent in 1988 [45].

Rationale for Trade

Trade between countries occurs to increase the amount of goods and resources available to each country, which ultimately improves their standard of living. Trade is beneficial since it permits each country to specialize in producing and exporting the goods in which it has abundant resources; then importing the goods which it has little or no resources to produce. For example, if one country is labor abundant with little capital stock, it is better off producing mainly labor-intensive goods and trading these for capital-intensive goods from a capital abundant, labor scarce country. Each country is benefited since each now enjoys more capital and labor intensive goods at lower costs. This is the key to why trade occurs, relative prices for goods must differ in each country for trade to be mutually advantageous. Additionally, voluntary trade will only happen if one or more parties to the trade are made better off without making another party worse off

[12]. Several theoretical discussions of the benefits of trade are presented in [12, 21, 36].

Demand Function

The quantity of a commodity, such as steel or wheat, that consumers purchase in a market is influenced by several variables. These include the price of the good, prices of related items, level of consumer incomes, tastes and preferences of consumers, consumer expectations regarding future prices, incomes, product availability, and the number of potential consumers [55]. These and other demand determinants show the demand for a product to be the result of a complex interaction of forces. Mathematically, this relationship is expressed as a demand function.

$$Q_d = f(P, P_r, Y, T, E, N, O)$$

where

d = quantity demanded of the good

P = own price of the good

P_r = prices of complement and substitute goods

Y = income of consumers

T = consumer tastes and preferences

E = consumer expectations

N = number of consumers

O = all other factors influencing Q_d

Derived Demand

This thesis research concerns estimating wheat import demand functions for two different market classes of wheat. Since consumers do not eat wheat directly but instead consume the end product, the demand for wheat at the farm level is said to be "derived" from the demand for bread, biscuits, cakes, and pastries [56]. The demand for these end products at the retail level is known as "primary demand". The difference between the price received at the retail (primary demand) level and the farm (derived demand) level is the "marketing margin" [56]. These are the additional costs added to wheat in the form of milling, baking, packaging, and transportation. All of these activities give the end products more utility for the consumer than wheat.

Hedonic Demand

Wheat with its different market classes is a heterogenous rather than homogenous good. Since consumers obtain utility from the end products of these various wheat classes rather than the wheat per se, it can also be said that hedonic demand for wheat exists. A hedonic demand function assumes that the demand of a heterogenous good is a function of the characteristics or attributes of that good.

The theory of hedonic demand was initially developed in 1956 by Gorman [20], who analyzed quality differentials of the egg market. The theory was developed further in the succeeding years by Becker [3], Lancaster [34], and Muth [41]. Recently, Veeman [62], applied hedonic demand to wheat in the estimation of hedonic price functions for wheat in world markets.

Excess Demand

The derived demand functions for wheat are obtained from the importing country's or region's import demand for wheat, which is in "excess" of their domestic supply.

In Figure 4, an excess demand function is derived in the following manner; wheat is traded between two regions, the U.S. and the rest-of-the-world (ROW), with the U.S. and the ROW exporting and importing regions, respectively. Assuming that trade between these two regions is conducted in a perfectly competitive market, under free trade, with no transportation costs, and equal exchange rates, implies that the U.S. export price equals the ROW import price.

Prior to trade (autarky), equilibrium prices are determined by the equilibrium of domestic demands and supplies in both regions. The prices under autarkic equilibrium are P_A for the U.S. and P_A* for ROW.

The excess demand and supply functions are given in the middle panel. Excess demand (ED) is derived for the ROW market by subtracting at each possible price the domestic supply (S′) from the domestic demand (D′). Excess demand shows the relationship between the quantity of imports demanded by the ROW from the U.S. over a given range of prices in the world market. Similarly, excess supply (ES) is obtained from the U.S. market by subtracting the domestic supply (S) from the domestic demand (D) over a given range of prices.

The U.S. wheat producers want to sell at prices above their autarkic domestic price (P_A). They will increase the quantity sold and move up the ES function with higher prices. Rest-of-the-World wheat importers want to purchase wheat at prices lower than their autarkic domestic price (P_A*). They will demand more wheat and move down the ED curve with lower prices. Movements along the ED and ES functions will continue until equilibrium occurs, resulting in a free trade price of P_F. At this price, the U.S. produces S_x, consumes D_x, and exports $X = S_x - D_x$. The ROW demands D_m, produces S_m, and imports $M = D_m - S_m$. Therefore, exports are equal to imports by the following:

$$X = S_x - D_x = D_m - S_m = M$$

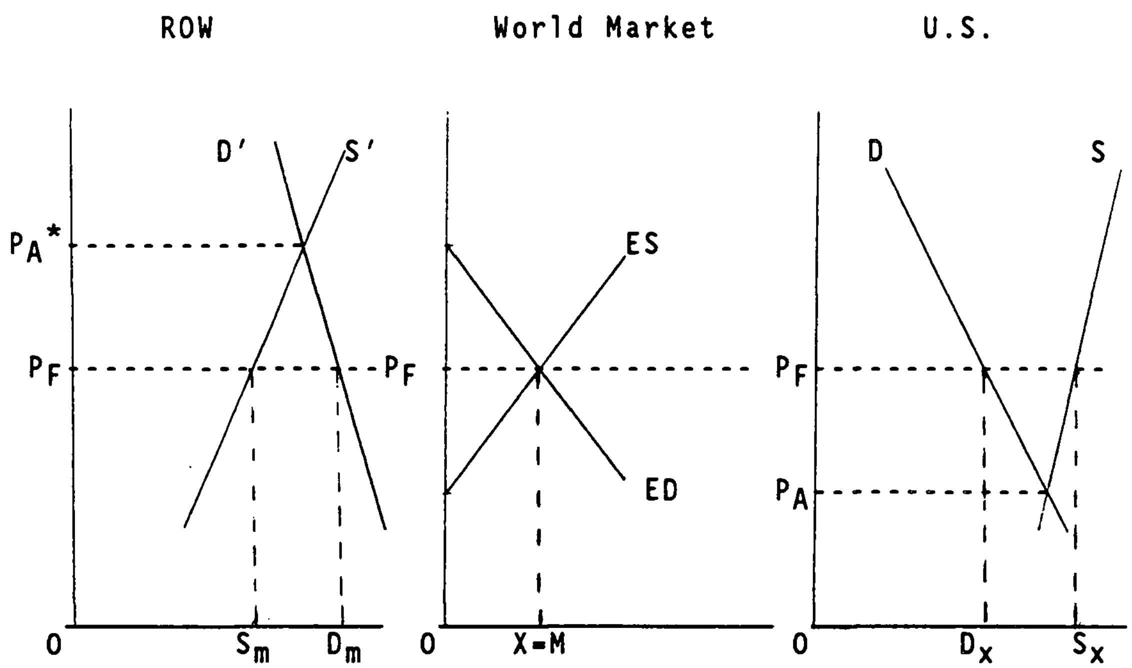

Figure 4. Derivation of Excess Demand and Supply Functions

Elasticity of Demand

Elasticity is an integral component of demand analysis. The elasticity of demand measures the change in the quantity demanded of a good due to a change in a demand determinant. These include the price of the good, prices of related goods, consumer incomes, and number of consumers.

Mathematically, the elasticity of demand is calculated as:

$$E = \frac{\text{\% Change in Quantity Demanded}}{\text{\% Change in Any Demand Determinant}}$$

The elasticity coefficient (E) is always calculated in relative or percentage terms rather than absolute or unit terms. This permits comparisons of demand sensitivity for different products irrespective of their units of measurement. Elasticity, is therefore a pure number, free of any unit identification with variables used [55].

Price Elasticity

The price elasticity of demand is the responsiveness of demand for a good to a change in its price, holding other factors constant. Economists measure the degree of price responsiveness by the price elasticity coefficient:

$$E_p = \frac{\text{\% Change in Quantity Demanded}}{\text{\% Change in Price}}$$

The coefficient on E_p is always negative since price and quantity demanded are inversely related. When price declines, the quantity demanded increases and vice-versa.

The elasticity of a good is:

1. "Elastic" if a given percentage change in price results in a greater percentage change in quantity demanded and the absolute value of E_p is greater than 1.

2. "Inelastic" if a given percentage change in price results in a smaller change in quantity demanded and the absolute value of E_p is less than 1.

3. "Unitary elastic" if a given percentage change in price results in the same percentage change in quantity demanded and the absolute value of Ep is equal to 1.

Price elasticity has an important relationship with total revenue (TR), which is the product of price and quantity sold of the good. The relationship is as follows:

1. If demand is price elastic, then an increase (decrease) in price will decrease (increase) TR.

2. If demand is price inelastic, then an increase (decrease) in price will increase (decrease) TR.

3. If demand is unitary elastic, an increase or decrease in price leaves TR unchanged.

Whether the demand for U.S. exports is price elastic or inelastic is important for international trade policy decisions and marketing programs due to this relationship with total revenue. The degree of price elasticity for agricultural exports needs to be determined in order to answer questions such as: How much will the demand for exports of a commodity vary when a price changes? If the U.S. lowered nonrecourse loan rates for grains and other commodities, which allows export prices to decrease, how much will exports increase and will TR for producers expand or decline? [18] What would be the impact on TR from grain exports due to cropland set-aside program? [54]

Recent Debate on Price Elasticity for U.S. Wheat Exports

During the 1980s there has been disagreement among agricultural economists regarding the degree of price elasticity of U.S. wheat exports.

Schuh [50] believes that the price elasticity for U.S. wheat exports is elastic or greater than 1, meaning lower prices would benefit U.S. producers. He notes that the rise in the dollar's value in the early 1980s coupled with the inaction of commodity programs damaged U.S. agriculture. Loan levels for wheat commodity export programs were held at a constant value but the dollar rose 25 percent in value during the same period against foreign currencies. This meant U.S. prices to foreign importers were "on the average 25 percent higher than they otherwise would have been" [50]. These higher export prices reduced foreign demand, made the U.S less competitive versus other exporting countries, and encouraged production in other countries. A possible solution, Schuh suggests, is adding "more price flexibility to commodity programs so that prices can decline when the value of the dollar rises" [50].

Schmitz, McCalla, Mitchell, and Carter dispute Schuh by inferring that the price elasticity of U.S. grain exports are inelastic [49]. They point to government policies for several importing countries which insulate domestic producers and consumers from external price fluctuations. Bredahl, Meyers, and Collins [5] note that these policies cause the transmission elasticity (response of the importing country's price to changes in the U.S. or world price) to have a value approaching zero in many cases.

A possible solution Schmitz et al. pursue is the formation of a grain export cartel composed of the three leading grain producing countries in the world (Australia, Canada, and the U.S.). With these countries as members, sufficient control over supply can be achieved and total revenue increased by raising prices, since Schmitz et al. assume grain export demand to be inelastic.

Income Elasticity

One of the main objectives of this study is to confirm the hypothesis regarding the income elasticity for imports of Hard Red Winter and Western White wheats. Income elasticity (E_I) is similar to price elasticity (E_p), only that the measurement of the responsiveness of quantity demanded is with respect to consumer income rather than price of the good.

When E_I is:

1. Positive, the quantity demanded of a good increases with a rise in income and it is called a "normal good".

2. Negative, the quantity demanded of a good falls with a rise in income and it is called an "inferior good".

When E_I is:

1. Greater than 1, demand for the good is income elastic.

2. Less than 1, demand for the good is income inelastic.

Normally, products which are necessities (light bulbs, dairy products, aspirin) have low income elasticities and products which are luxuries (jewelry, art objects, caviar) have high income elasticities. The interpretation of a given income elasticity, such as 0.59 is as follows: A one percent increase in consumer's incomes will result in a 0.59 percent increase in quantity demanded of a good. Since 0.59 is positive and less than 1, the good is normal and inelastic.

Literature Review

The literature concerning international wheat trade is vast and diversified, this section is not intended to be an exhaustive review but rather a survey of recent work pertinent to this thesis.

The implicit supposition in several of the articles cited is the small-country assumption. That is, the importing country has a very small share of the world wheat market and therby faces a perfectly elastic demand curve. This is known as the "small-country case" [21] where the importing country is a price-taker and cannot influence price.

Gallagher, Bredahl, and Lancaster [16], 1979, used an Ordinary Least Squares (OLS) model to estimate U.S. commercial wheat exports to six lesser developed countries, who were major U.S. wheat importers.

The variables found to have the largest influence on commercial sales were domestic wheat supplies and concessional imports under Public Law 480. Their respective elasticities were -2.69 and -4.44. However, several of the estimated coefficients had low t statistics, a symptom of high correlations between explanatory variables. Wheat price and income were among the statistically insignificant coefficients.

Gallagher et al. [17], 1979, again used OLS in a later article to estimate U.S. wheat export demand for two major developed country markets: Japan and Western Europe.

After attempting several preliminary regressions, the authors found the "best" equation representing Japanese per capita wheat import demand consisted of the following variables: (1) Japanese Food Agency wheat resale price, (2) Japan's wheat supply, (3) per capita income, and (4) a dummy variable representing the 1971 West Coast dock strike. Wheat price elasticity and wheat supply were both statistically significant with elasticities of -0.97 and -0.43, respectively. Despite its insignificant coefficient, Gallagher et al. contended that the negative sign for income showed that wheat was probably an inferior good in Japan.

Estimating U.S. wheat export demand in Western Europe, proved more difficult than Japan since single-equation estimates offered "very limited success". Food and feed demand equations were instead estimated separately along with a relationship for the U.S. share of the Western European market. Wheat was also found to be an inferior good in Western Europe as indicated by an income elasticity value of -0.233.

Martin, Gonarsyah, Oliveira, and Knowles [39], 1981, estimated wheat import demand with OLS for a single country (South Korea) and a single wheat class (Western White).

Different combinations of explanatory variables were attempted along with the linear and logarithmic functional forms. The linear form yielded the best results and South Korean rice production was found to be the principal domestic production variable rather than wheat production. All of the final four models chosen each had a negative income elasticity. The authors noted this was possibly due to the South Korean government's policy of food self-sufficiency rather than the demand for final products derived from Western White wheat (noodles, sponge cake, crackers) being inferior goods.

Wagenblast [63], 1982, again modeled Western White wheat import demand for South Korea using Ordinary Least Squares. The objective of this study was to empirically prove that the import demand for Pacific Northwest White wheat was not similar to the import demand for all classes of U.S. wheat in South Korea. Explanatory variables were added to each equation to assess their explanatory power and correlation with the dependent variables. The price and income elasticities for South Korean White wheat import demand (0.74 and 3.18, respectively) were found to differ in magnitude relative to the price and income elasticities of aggregate South Korean wheat import demand (0.35 and 1.83, respectively). The coefficient for wheat price was not statistically significant in both equations despite having the opposite sign of _a priori_ expectations.

Gonarsysah [19], 1983, estimated three sets of models for import demand and/or export supply of U.S. white wheat. These were: a single-country model, using

Japan and South Korea; a two-country model, with Japan - U.S. and South Korea - U.S.; and a three-country model, consisting of Japan - South Korea - U.S.

The single-country equations were estimated using OLS, while the two and three-country equations utilized a system of equations with two-stage least squares (2SLS) estimation.

The single-country results for Japan indicated that the import demand for white wheat was affected by domestic (soft) wheat production and imports of Australian standard (white) wheat, both statistically significant at the one percent level. Per capita income, supplies of rice, and exchange rate were not significant coefficients.

The results for South Korea indicated that the statistically signifcant variables included per capita income, P.L. 480 sales, and rice supplies. Domestic wheat production and exchange rate were not significant coefficients.

Capel and Rigaux [7], 1974, investigated the primary determinants of Canadian wheat exports. The import demand functions for 11 countries and the European Community were estimated using OLS. The price elasticity of the average annual price of wheat imported by each country from all suppliers was estimated with three approaches: the direct, the substitution, and the market share.

Transportation costs were excluded in the estimation since Capel and Rigaux anticipated data problems and because they assumed that unit transportation costs would be constant.

Four APR countries were used in the study: Hong Kong, Japan, Philippines, and Taiwan. Their respective price elasticities under the direct model were -0.79, 0.03, -1.43, and -5.93. These elasticities were greater with the substitution model, with the values for Japan, Philippines, and Taiwan being -1.46, -3.20, and -6.39, respectively.

The authors noted that several of the price elasticities were greater than unity (in absolute terms), meaning that possible gains could be derived by Canada through wheat price reductions. However, this must be interpreted with caution due to the insignificance of many of the price elasticities.

Schuh [51], 1974, in a theoretical article, focused on the importance of the linkage between the exchange rate and U.S. agriculture. He noted that the exchange rate had been an significant omission in past interpretations of U.S. agricultural development and trade problems. Schuh demonstrated theoretically why changes in exchange rates were pertinent in contributing to the rise of North American agricultural prices during the early 1970s. This article produced empirical work which utilized exchange rates as variables.

Fletcher, Just, and Schmitz [14], 1977, estimated time-series data from 1949 through 1974 in an effort to explain the rapid rise in demand for North American grains during the early 1970s. Four importing regions were considered: USSR, Western Europe, Asia, and all other countries excluding U.S., Canada, Africa, Eastern Europe, and Australia.

Three equations were estimated: an export equation and two domestic equations for North America (U.S. and Canada). Ordinary least squares, 2SLS, and three-stage least squares (3SLS) techniques were used in the estimation.

In reporting only the 2SLS and 3SLS findings, the authors found that production and exchange rate coefficients were significant for the Western Europe and Asia export demand equations, although the sign of the exchange rate coefficient was positive for both regions, contrary to a priori expectations. Per capita income was insignificant except in Western Europe where the coefficient had a negative sign, meaning wheat was considered an inferior good.

Chambers and Just [10], 1981, used 3SLS to estimate 15 structural equations which explained disappearance, inventories, exports, and production of the three most important U.S. agricultural exports - wheat, corn, and soybeans. Their export equations included an exchange rate variable since they had argued earlier in a theoretical article [9] for the inclusion of exchange rate variable as a separate regressor. Special Drawing Rights (SDR) per U.S. dollar was used as the exchange rate variable. Chambers and Just noted that traditional work had either excluded exchange rates or only used them to adjust prices.

The results indicated that the exchange rate variable was statistically significant in all three reduced-form export equations with elasticities of -1.829 for wheat, -.072 for corn, and -0.776 for soybeans.

Konandreas, Bushnell, and Green [31], 1978, estimated export demand functions for five world regions: developed countries, Latin America, Asia, Africa, and U.S.S.R.-Eastern Europe.

Ordinary Least Squares was one of the three methods used in the estimation. The study noted that the OLS procedure caused the income variable to not agree with *a priori* expectations for three regions and be insignificant at a five percent level for all of the regions The authors cited this as an inability for OLS to incorporate "extraneous information". The efficiency of the income variable estimate improved when Conditional Least Squares and a mixed least-squares procedure were used in place of OLS.

Shalaby and Hassler [53], 1985, used the Seemingly Unrelated Regressions (SUR) procedure to estimate U.S. wheat import demand functions of seven South American countries. The SUR technique, unlike OLS, recognizes the correlation of disturbance terms across equations. Seemingly Unrelated Regressions is said to be "more efficient" than OLS since it utilizes this additional information.

The results of the study indicated wide ranges for the price and income elasticities; from -0.45 (Brazil) to -0.99 (Venezuela) for wheat price and from 0.64 (Brazil) to 3.29 (Bolivia) for income.

Jabara [27], 1982, pooled cross-sectional and time series data to estimate reduced form wheat import demand models for 19 middle-income developing countries. The models were estimated for wheat-producing and non-wheat producing countries.

Both equations appeared to fit the data quite well and most of the estimated coefficients were significant at the 10 percent level or higher. Non-wheat producing countries responded to the world wheat price while wheat-producing countries did not. However, the elasticity of world wheat price was low in either case,

-0.18 for non-wheat producers and -0.07 for wheat-producers.

The next chapter discusses the methodology used in this research and then specifies the actual model which will be implemented to test the stated hypothesis.

CHAPTER III

METHODOLOGY AND MODEL SPECIFICATION

This chapter describes the methodology attempted in this thesis, an econometric, least squares technique known as Pooled, Cross-Section, Time Series analysis. Before an explanation of the stated methodology is presented, Ordinary Least Squares and its properties are examined. The country selection is then described and the empirical model is given, including an explanation of the variables chosen and their respective sources.

Ordinary Least Squares

Ordinary Least Squares (OLS) was developed in 1821 by Carl Friedrich Gauss, a German mathematician [22]. It remains one of the most powerful and popular methods of regression analysis based on some very attractive statistical properties [22].

The objective of OLS is to fit a regression line which minimizes the sum of squared residuals or errors. This minimization produces estimated coefficients, $\hat{\beta}$ for the actual independent variable coefficients, β. These estimated coefficients are called estimators.

An important reason for implementing OLS in estimating linear regressions is the Gauss-Markov Theorem [42, 66]. The theorem recognizes linear estimators to be both efficient and unbiased. Efficiency means that $\hat{\beta}$ has minimum variance among all other estimators. Unbiasness denotes that $\hat{\beta}$ tend to neither overestimate or underestimate β in repeated samplings. Since $\hat{\beta}$ are linear estimators, they are often referred to as BLUE, Best Linear Unbiased Estimators. The mathematical proofs of the BLUE properties are discussed in [28, 29, 66].

The assumptions regarding OLS estimation are found in [22]. Briefly, they are: 1.) The residuals will have a value of zero on average, 2.) Successive residual values will be uncorrelated over time, 3.) The variance for the residuals will be a positive constant σ^2, 4.) The residuals and independent variables will be uncorrelated, and 5.) The independent variables are fixed in repeated samples. In other words, they are non-random or non-stochastic.

The assumption of non-stochastic independent variables is important in the estimation of import demand functions. It means that prices for the commodity are fixed and that the importing countries are said to be "price-takers". It also means that the commodity prices are determined exogenously to the importing countries actions.

However, if a country's imports of a commodity are sufficiently high, then they can possibly influence price. This means that the price variables are stochastic rather than being fixed. The result is that OLS estimators will be biased in small samples and inconsistent in large samples.

Pooled Cross-Section Time Series Analysis

Ordinary Least Squares linear regression models either utilize time-series or cross-sectional data for parameter estimation. Time-series data describe the movement of a variable over time in terms of daily, weekly, monthly, quarterly, or annual data. Cross-sectional data describe the movement of a variable across individuals, corporations, states, or countries.

The amount of useful information obtained through OLS can often be enhanced by combining or pooling cross-sectional and time-series data. In the estimation of wheat export demand coefficients for this research, a pooling procedure would likely provide additional information since it allows variation over time and across countries [27, 29]. For this reason, the regression technique initially chosen for this research is cross-sectional, time-series analysis.

Another advantage of the pooling technique is that is helps prevent multicollinearity, which occurs when two or more explanatory variables are highly or exactly correlated. In econometrics, this problem frequently arises with time series data, since prices, incomes, and other economic magnitudes tend to move together over time. This means that the information carried by one explanatory variable is not unique but similar or identical to another explanatory variable(s). The consequence is that the accuracy of the estimated coefficients cannot be determined because they are "unstable" due to their correlation with one another over time.

Koutsoyiannis notes that pooling remedies the problem of "the contemporaneous presence of multicollinear variables" [32]. This causes parameter estimates, under certain conditions, to be more reliable than OLS estimation on a time series sample [32].

A notable problem in pooling data is that the estimated intercept and slope terms may vary across cross-sections. Dummy variables are often used to permit the intercepts and slopes to vary. A hypothesis test procedure [28, 37] is then utilized to test the null hypothesis of the intercepts and/or slopes being equal across the cross-sections. The hypothesis is tested by the F statistic, which is:

$$F = \frac{(SSE_R - SSE_U) / r}{SSE_U / n - k} \sim F(r, n - k)$$

Where: SSE_R = Restricted error sum of squares

SSE_U = Unrestricted error sum of squares

r = Number of restrictions

n = Number of observations

k = Number of regressors (in unrestricted model)

The SSE_R is determined from the model which neither the intercept or slope terms are allowed to vary across the cross-sections. The SSE_U is calculated from the model that permits the intercept and/or slope terms to vary across the cross-sections.

In matrix notation, the pooled cross-section time-series equation can be written as:

$$Y = X\beta + e$$

where

$$Y = \begin{matrix} Y_{11} \\ Y_{12} \\ \vdots \\ Y_{1T} \\ Y_{21} \\ Y_{22} \\ \vdots \\ Y_{NT} \end{matrix} \qquad X = \begin{matrix} X_{11,1} & X_{11,2} & \cdots & X_{11,K} \\ X_{12,1} & X_{12,2} & \cdots & X_{12,K} \\ \vdots & \vdots & & \vdots \\ X_{1T,1} & X_{1T,2} & \cdots & X_{1T,K} \\ X_{21,1} & X_{21,2} & \cdots & X_{21,K} \\ X_{22,1} & X_{22,2} & \cdots & X_{22,K} \\ \vdots & \vdots & & \vdots \\ X_{NT,1} & X_{NT,2} & \cdots & X_{NT,K} \end{matrix}$$

$$e = \begin{bmatrix} e_{11} \\ e_{12} \\ \vdots \\ e_{1T} \\ e_{21} \\ e_{22} \\ \vdots \\ e_{NT} \end{bmatrix} \qquad \beta = \begin{bmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_K \end{bmatrix}$$

$n = 1, \ldots, N$ are cross sectional units

$t = 1, \ldots, T$ are time periods

Country Selection for Empirical Model

Six Asian Pacific Rim (APR) countries were selected for this research and they were grouped into two categories: developed and newly industrialized. The developed country (DC) group includes Japan, Hong Kong, and Singapore while the newly industrialized country (NIC) group consists of South Korea, Taiwan, and Malaysia.

This categorization is based on an analysis of the APR food consumption and imports by Martin [38], who classified APR nations on the basis of their 1985 per capita income in U.S. dollars. Four classifications were given: developed, newly industrialized, developing, and centrally planned.

Originally, this research intended to include some of developing countries of the APR such as Indonesia and the Philippines, who are primarily recipients of concessional sales. However, their inclusion proved difficult to justify since there was a lack of data separating cash and concessional sales.

Pooled cross-section time-series analysis will be employed to estimate import demand functions for HRW and WW wheat using the two country groups: developed and newly industrialized. The countries within each group are the cross-sections and the time-series is from 1970-71 through 1985-86. Therefore, four import demand functions are to be estimated: HRW developed, HRW newly industrialized, WW developed, and WW newly industrialized. These demand functions will be utilized to test the hypothesis stated in Chapter I.

General Form of Import Demand Function

In the analysis of imports of a commodity, a hypothesized behavioral relationship exists on the demand side between the level of imports of that commodity and several independent variables. This relationship is known as an import demand function.

The theory of demand suggests that the quantity of imports is the appropriate dependent variable for econometric investigation. Demand theory is also helpful in determining the independent variables chosen, based on how consumers allocate their incomes among commodities to derive maximum utility or satisfaction. Accordingly, the quantity of commodity imports purchased by consumers will depend on their income, commodity price, and prices of alternative commodities.

Additionally, the theory of excess demand discussed in Chapter II suggests that domestic supply of the commodity or a similar one will affect demand of the imported commodity. Hence, an import demand function should also include a domestic supply variable.

In summary, the general form of an import demand function is:

$$X = f(P, P_A, Y, S)$$

where

X = Level of imports

P = Price of imported commodity

P_A = Price of alternative imported commodities

Y = Consumer incomes in importing country

S = Domestic supply of commodity in importing country.

Specific Form of Import Demand Functions

The specific form of the import demand equations for the two classes of wheat are hypothesized to be:

$$HRW_{nt} = f(P^{HRW}{}_{nt}, P^{DNS}{}_{nt}, P^{CWRS}{}_{nt}, GDP_{nt}, EX_{nt}, WHEAT_{nt}, e_{nt})$$

Where

n = 1, . . . , N represents countries

t = 1, . . . , T represents years

HRW_{nt} = Quantity of HRW wheat cash sales from the U.S. to country n in year t (1,000 metric tons per 1 million persons)

$pHRW_{nt}$ = Border price of HRW wheat in U.S. dollars per metric ton, deflated by the U.S. WPI

$pDNS_{nt}$ = Border price of DNS wheat in U.S. dollars per metric ton, deflated by the U.S. WPI

$pCWRS_{nt}$ = Border price of CWRS wheat in U.S. dollars per metric ton, deflated by the Canadian WPI

GDP_{nt} = Gross Domestic Product of country n in year t, deflated by country n's CPI (millions of U.S. dollars per one million persons)

EX_{nt} = Exchange Rate of country n in year t, deflated by country n's CPI (foreign currency units per U.S. dollar)

$WHEAT_{nt}$ = Domestic wheat production in country n in year t (1,000 metric tons per one million persons)

e_{nt} = Residual error term for country n in year t

Time Period = 1970-71 through 1985-86, Annual Data

$$WW_{nt} = f(P^{WW}_{nt}, P^{ASW}_{nt}, GDP_{nt}, EX_{nt}, RICE_{nt}, e_{nt})$$

where

WW_{nt} = Quantity of WW wheat cash sales from the U.S. to country n in year t (1,000 metric tons per one million persons)

P^{WW}_{nt} = Border price of WW wheat in U.S. dollars per metric ton, deflated by the U.S. WPI

P^{ASW}_{nt} = Border price of ASW wheat in U.S. dollars per metric ton, deflated by the Australian WPI

$RICE_{nt}$ = Domestic rice production in country n in year t (1,000 metric tons per one million persons)

All other variables previously defined

Time Period = 1970-71 through 1985-86, Annual Data

Dependent Variables

The dependent variables for the HRW and WW wheat import demand equations are dollar sales of HRW and WW wheat, respectively. The data are on a July-June basis and are listed in 1,000 metric tons. To reflect population changes, both dependent variables are stated in per capita terms. Gross Domestic Product and domestic grain production are also on a per capita basis.

The data source for dollar sales of HRW and WW wheat is from the USDA publication, Livestock and Grain Market News [60]. Population data are from the International Monetary Fund, International Financial Statistics [25], and Industry of Free China [11].

Specific Independent Variables for Hard Red Winter Wheat Import Demand Functions

Hard Red Winter Wheat Price

The HRW wheat price is in U.S. dollars per metric ton. The dollar was chosen since it is the most widely used international currency and because Bjaarnason et al. [4] stressed the need for a common currency when estimating national supply and demand equations.

The price is composed of a weighted average of the No. 2 HRW, ordinary protein f.o.b. Pacific and/or Gulf price plus the freight rate from U.S. Pacific and/or Gulf ports to the importing country. This is known as the "border price" concept. The sign for the estimated coefficient of HRW wheat price is expected to be negative.

Shalaby and Hassler [53] noted the importance of including ocean shipping costs when analyzing wheat export demand due to their influence on grain trade instability. The border price was originally devised by Schmitz and Bawden [48] and included all international marketing costs. In this research, as in the work of Shalaby and Hassler, the border price is simply defined as the wheat price and freight rate per metric ton.

The HRW border price is on a July-June basis and is deflated by the U.S. Wholesale Price Index (WPI) to remove the inflationary effects of money illusion. Meaning, doubling of all prices and incomes will leave the quantity demanded unchanged [35].

All wheat prices and freight rates used in this study are from World Wheat Statistics, International Wheat Council [26]. Wholesale Price Index data is from the International Monetary Fund, International Financial Statistics [25].

Dark Northern Spring Wheat Price

Dark Northern Spring (DNS), a subclass of Hard Red Spring wheat, was included as a substitute commodity since the high protein content allows both HRW and DNS to be used primarily in the manufacture of bread flour [24]. The sign of the estimated DNS wheat price coefficient is expected to be positive.

The border price of No.2 Dark Northern Spring, 14 percent protein, f.o.b. Pacific is on a July-June basis, in U.S. dollars per metric ton, and deflated by the U.S. WPI [25, 26].

Canadian Western Red Spring Wheat Price

The border price of Canadian Western Red Spring (CWRS) No. 1, 12.5 percent protein was included because Canada is a major competitor with the U.S. for the APR market and therby making CWRS wheat a substitute for U.S. HRW wheat.

Wilson et al. [65] noted that technically, Hard Red Spring is most comparable to CWRS rather than HRW wheat. However, it was felt that this research would not greatly be affected since CWRS and HRW are both high protein wheats. The estimated coefficient for CWRS wheat price is also expected to be positive.

The CWRS border price from Pacific Ports is on a

July-June basis, in U.S. dollars per metric ton, and deflated by the Canadian WPI [25, 26].

Per Capita Wheat Production

Domestic per capita wheat production is the supply variable for this equation. Since it reduces wheat imports, a negative sign of the estimated coefficient is expected.

Domestic wheat production in 1,000 metric tons for each country is on a calender-year basis and precedes import data by six months. For example, wheat production during January-December 1980 is used to explain U.S. Cash imports of wheat from July 1980 through June 1981.

Annual wheat production estimates for each country are obtained from the F.A.O. Production Yearbook [58] and Industry of Free China [11].

Specific Independent Variables for Western White Wheat Import Demand Functions

Western White Wheat Price

The border price of No. 2 Western White wheat, nine percent protein f.o.b. Pacific is on a July-June basis, in U.S. dollars per metric ton, and deflated by the U.S.

WPI [25, 26]. A negative sign is expected for the estimated coefficient.

Australian Standard White Wheat Price

The border price of Australian Standard White (ASW) wheat, ten percent protein was included since Australia raises predominantly soft white wheat and competes for basically the same markets in the APR as the Pacific Northwest [47]. Because ASW wheat is a substitute for WW wheat, its estimated coefficient is expected to be positive. The ASW border price from Australia's Eastern States is on a July-June basis, in U.S. dollars per metric ton, and deflated by the Australian WPI [25, 26].

Per Capita Rice Production

Domestic rice per capita production was included as an independent variable for WW wheat import demand rather than wheat production due to the close substitutability of rice for udon noodles. These are important food sources derived from WW wheat for APR countries. Both Gonarsyah and Wagenblast found rice and WW wheat to be closely related in their analysis of South Korean WW wheat import demand [64].

Since domestic rice production is the supply variable for this equation, its estimated coefficient is expected to have a negative sign.

Domestic rice production is in 1,000 metric tons for each country on a calender-year basis and precedes import data by six months.

Annual rice production estimates for each country are obtained from the F.A.O. Production Yearbook [58] and Industry of Free China [11].

Independent Variables for Both Wheat Classes

Per Capita Gross Domestic Product

Gross Domestic Product (GDP) is the income or activity variable used for this research. Gross Domestic Product is defined by the USDA "Dictionary of International Agricultural Trade" [15] as:

> "A measure of the market value of goods and services produced by the labor and property of a nation. Unlike gross national product, GDP excludes receipts from that nation's business operations in foreign countries, as well as the share of reinvested earnings in foreign affiliates of domestic corporations."

The GDP data are converted into U.S. dollars by exchange rates and deflated by the Consumer Price Index (CPI) of the respective importing country. The GDP is in calender-years, meaning 1980 real GDP was used to explain U.S. HRW or WW wheat exports from July 1980 through June 1981.

Since wheat is presumed to be a normal good in this research, the signs are expected to be positive for the estimated GDP per capita coefficients in both equations.

The GDP and CPI data sources are the United Nations Monthly Bulletin of Statistics [59], the International Monetary Fund, International Financial Statistics [25], and Industry of Free China [11].

Exchange Rates

The exchange rate is "the ratio of prices at which the currencies of nations are exchanged" [15]. In this research they are measured in foreign currency units per U.S. dollar. To account for inflationary effects not captured through exchange rate adjustments, the exchange rate variable is deflated by the CPI from each country.

Negative signs are expected for the exchange rate coefficients since the measurement is in foreign currency units per U.S. dollar. Therefore, when more foreign currency units are required for each U.S. dollar, less wheat can be obtained by the importing country.

The exchange rate data are from the International Monetary Fund, International Financial Statistics [25], Industry of Free China [11], and United Nations Monthly Bulletin of Statistics [59].

The next chapter reports the results from the estimated import demand equations for HRW and WW wheat.

CHAPTER IV

THESIS RESULTS

This chapter reports and interprets the empirical results of the estimation of import demand functions for HRW and WW wheat. A summary of the estimated coefficients for each demand function are presented in Tables I, II, III, and IV.

HRW Estimated Equations for NIC Group

The hypotheses tests mentioned in Chapter III for testing the equality of intercept and slope terms across countries were rejected for the NIC group (see Appendix 1). Therefore, the NIC group was subdivided on a single-country basis for estimating HRW wheat import demand.

The error terms or disturbances for each country's import demand represent factors that are omitted or unmeasured. These factors may have similar influences on the wheat import demand of a country group. Assuming that a particular country group would respond to these factors in a related manner, then the error terms would likely be correlated across countries. Zellner [67] found that gains in efficiency of coefficient estimates over OLS could be made by jointly estimating sets of equations assuming this contemporaneous correlation of error terms. Zellner called this technique Seemingly Unrelated Regression (SUR) estimation.

Ordinary Least Squares estimation will be as equally efficient as SUR if two conditions are met. The first is when all contemporaneous correlations of errors are zero. The second is that SUR will equal OLS if the independent variables in each equation are indentical [28].

Because per capita GDP, exchange rate, and wheat production data differ among South Korea, Taiwan, and Malaysia, the second condition does not hold. To test for the presence of contemporaneous correlation of error terms, Breusch and Pagan, [6] proposed a Lagrange Multiplier statistic be implemented. Where the statistic has an asymptotic Chi-Square distribution with M(M-1)/2 degrees of freedom and where M is the number of estimated equations.

Estimating the HRW import demand for the NIC group with SUR produced a Lagrange Multiplier statistic of 5.1018. The critical Chi-Square value with 3 degrees of freedom at 90 percent significance is 6.2514. Therefore, the null hypothesis of no contemporaneous correlation cannot be rejected and OLS will be as equally efficient as SUR estimation.

Thus, the HRW wheat equations for the NIC group were estimated using OLS and the results are given in Tables I(a), I(b), and I(c).

The outcomes of the OLS estimation for each NIC country indicated that South Korea provided the best results. This is in terms of the high adjusted R^2 value and overall statistical significance of the estimated coefficients. The equations for Taiwan and Malaysia produced lower adjusted R^2 values than South Korea, and insignificant own price and income coefficients. Therefore, these coefficients should be interpreted with caution.

The signs of the estimated coefficients for South Korea generally agree with economic theory, except for DNS wheat price and per capita GDP. Dark Northern Spring was assumed to be a HRW wheat substitute and thereby have a positive sign. However, its estimated coefficient was not statistically different from zero. Per capita GDP was expected to have a positive sign since HRW wheat consumption was hypothesized to rise with increasing incomes. Prevailing economic theory would imply that South Korean consumers perceive the end products from which the demand for HRW wheat is derived are "inferior goods." However, Martin et al. [39] also obtained negative income coefficients for South Korea when estimating the country's WW wheat import demand.

Table I(a): Estimated per capita HRW Import Demand Equation for South Korea, 1970/71 - 1985/86

Independent Variable	Estimated Coefficient	t-statistic	Elasticity at Means
Intercept	62.367	5.5998 ***	4.6669
Price of:			
HRW Wheat ($/mt)	-0.1973	-3.8193 **	-2.8530
DNS Wheat ($/mt)	-0.0776	-1.5713	-1.2408
CWRS Wheat ($/mt)	0.1609	4.5164 **	2.9293
GDP/Capita (Millions of U.S. $)	-0.0069	-2.9402 **	-0.7741
Exchange Rate (Won/U.S. $)	-0.0228	-4.2688 **	-1.5359
Wheat Production /Capita (1,000 mt)	-0.8135	-2.5654 **	-0.1924

R-Square = .952 Adjusted R-Square = .921

Durbin-Watson = 2.4802

*** Significant at 1% Level
** Significant at 5% Level
* Significant at 10% Level

Table I(b): Estimated per capita HRW Import Demand Equation for Taiwan, 1970/71 - 1985/86

Independent Variable	Estimated Coefficient	t-statistic	Elasticity at Means
Intercept	16.1100	1.1271	1.1300
Price of:			
HRW Wheat ($/mt)	0.0737	0.7178	1.0026
DNS Wheat ($/mt)	-0.1824	-2.0322 *	-2.7330
CWRS Wheat ($/mt)	0.0863	1.9476 *	1.4741
GDP/Capita (Millions of U.S. $)	0.0034	0.8738	0.5087
Exchange Rate (NT $/U.S. $)	-0.0809	-1.1863	-0.3809

R-Square = .678 Adjusted R-Square = .517

Durbin-Watson = 1.9009 (Equation corrected for autocorrelation)

*** Significant at 1% Level
** Significant at 5% Level
* Significant at 10% Level

Table I(c): Estimated per capita HRW Import Demand Equation for Malaysia, 1970/71 - 1985/86

Independent Variable	Estimated Coefficient	t-statistic	Elasticity at Means
Intercept	-1.6504	-0.5158	-3.7153
Price of:			
HRW Wheat ($/mt)	0.0258	1.3138	11.2930
DNS Wheat ($/mt)	0.0056	0.3897	2.7337
CWRS Wheat ($/mt)	-0.0152	-1.7556	8.3908
GDP/Capita (Millions of U.S. $)	-0.0003	-0.2142	-0.8016
Exchange Rate (Ringgit/U.S. $)	-0.0175	-0.0425	-0.1189

R-Square = .481   Adjusted R-Square = .222

Durbin-Watson = 1.5965

*** Significant at 1% Level
** Significant at 5% Level
* Significant at 10% Level

They noted that the sign of the income coefficient was perhaps influenced by the South Korean government actively pursuing a food self-sufficiency policy, which countervailed the substantial growth in per capita income. They argued:

> "The negative relationship between income and consumption of white wheat may have been more a spurious result of government food import constraints than a reflection of consumer tastes and preferences."

Consequently, government policy could have caused the per capita GDP coefficient to be negative for South Korea's HRW wheat import demand.

The elasticities of these equations are calculated as the product of the estimated coefficients ($\hat{b}$) times the mean of the independent variable ($\bar{x}$) divided by the mean of HRW wheat cash sales ($\bar{y}$), $E = \hat{b} * (\bar{x}/\bar{y})$. These calculated elasticities are short-run since they represent the response to price and income changes at fixed production.

The price and income elasticities are interpreted as follows: the HRW price elasticity of -2.85 is elastic and indicates that a one percent decrease in price will increase cash imports of HRW wheat by South Korea by 2.85 percent, while the GDP elasticity value of -0.77 is inelastic and signifies that one percent decrease in per capita income will raise South Korean HRW wheat cash imports by 0.77 percent.

The per capita domestic wheat production coefficient is significant but its elasticity of -0.19 is low. It indicates that a 1 percent increase in domestic wheat production by South Korea will reduce HRW cash imports by only 0.19 percent. This is possibly a result of South Korea producing primarily soft wheats, which are suited for the manufacture of udon noodles rather than hard wheats. Accordingly, South Korea's domestic wheat production would be less substitutable for HRW wheat and possess a lower elasticity value.

Autocorrelation is a violation of an assumption for the OLS model stated in Chapter III. Sucessive error terms can either follow each other in a positive or negative pattern, known as positive or negative autocorrelation. This is a problem because it leads to large variances for the estimated coefficients, making them less reliable [66].

The Durbin-Watson (D-W) statistic is used to detect the presence of positive or negative autocorrelation. The range of the D-W statistic is from 0 to 4. A value close to 0 indicates positive autocorrelation, while a value near 4 means negative autocorrelation exists. If the D-W statistic is around 2, no autocorrelation is present.

The D-W statistic for South Korea is 2.4802 which shows positive autocorrelation is not present while testing inconclusive for negative autocorrelation. The D-W statistic for Taiwan is inconclusive for both positive and negative autocorrelation. The D-W statistic for Malaysia tests inconclusive for positive autocorrelation, while indicating that no negative autocorrelation is present.

Hausman's specification error test [23] was utilized to test the hypothesis of no misspecification in the OLS equations for each country. The test showed that all of the NICs were correctly specified under the null hypothesis of regressors and error terms being independent. Taiwan was originally misspecified but became correctly specified after removing the highly insignificant domestic wheat production variable. For the details and results of the Hausman test procedure, see Appendix 3.

The results for Taiwan are somewhat dissapointing and perhaps could be attributed to the high degree of correlations of the estimated variables in the equation. In econometrics, when two or more independent variables are highly correlated, then multicollinearity is present. This is a problem because it becomes difficult to interpret the separate effects of the independent variables accurately.

One method of detecting multicollinearity is to examine the correlation matrix of the estimated coefficients. In this case, the highest correlations were between per capita GDP and exchange rate (r = 0.86). Consequently, multicollinearity could have caused the statistical insignificance for the per capita GDP and exchange rate coefficients.

The poor results for Malaysia may be attributed to Malaysians maintaining a rice based diet [64]. This is reflected by the absence of HRW wheat cash sales to Malaysia in six out of the 16 years in the estimation. Hence, the paucity of data points for the dependent variable might have produced unfavorable results for Malaysia.

WW Estimated Equations for NIC Group

The hypotheses tests for equality of intercept and slope terms across countries for the NIC group suggested that pooling could be accomplished using separate intercepts for each country. The details of these tests can be found in Appendix 1.

However, the Hausman specification error test indicated that the pooling equation would be misspecified (see Appendix 3). Seemingly Unrelated Regression estimation was then attempted and the Lagrange Multiplier statistic of 6.9470 caused the null hypothesis of no contemporaneous correlation to be rejected at 90 percent significance (see Appendix 2). Therefore, SUR will be more efficient than OLS for estimating WW wheat import demand for the NIC group. The results of the SUR estimation are presented in Table II.

South Korea again provided the best statistical fit and most significant coefficients. The signs of all but one of the estimated coefficients were in accord with *a priori* expectations. The exception, as in the HRW equation, was per capita GDP. Its negative sign indicates it is also an inferior good, caused perhaps by the previously mentioned South Korean government food self-sufficiency policy rather than changing tastes and preferences. Martin et al. [39] also estimated the income coefficient to be negative and significant for South Korean WW wheat import demand. Their income elasticities ranged from -0.3275 to -0.3117 for the four models estimated.

The WW wheat price for South Korea had the expected negative sign and its elasticity of -2.58 is similar to the HRW value. However, the estimate is much greater (in absolute terms) than the South Korean WW wheat price elasticity estimates of Martin et al. [39], Gonarsyah [19], and Wagenblast [63]. Their estimates range from -0.09 (Gonarsyah) to 0.74 (Wagenblast).

Originally, per capita rice production was proposed as the domestic supply variable for the WW equation since previous work by Gonarsyah and Wagenblast had

Table II: Estimated per capita WW Import Demand Equations for Newly Industrialized Country Group, 1970/71 - 1985/86

SUR Estimation System R^2 = .996

Country = South Korea n = 16

Independent Variable	Estimated Coefficient	t-statistic	Elasticity at Means
Intercept	96.0600	4.9039 ***	4.0987
Price of:			
WW Wheat ($/mt)	-0.3177	-2.6751 **	-2.5843
ASW Wheat ($/mt)	0.1689	3.1126 **	1.5867
GDP/Capita ($)	-0.0101	-2.4847 **	-0.6474
Exchange Rate (Won/U.S. $)	-0.0314	-3.4883 **	-1.2032
Wheat Production /Capita (1,000 mt)	-1.8582	-2.8845 **	-0.2506

R-Square = .887 Durbin-Watson = 1.8108

Table II (Continued): Estimated per capita WW Import Demand Equations for Newly Industrialized Country Group, 1970/71-1985/86

Country = Taiwan n = 16

Independent Variable	Estimated Coefficient	t-statistic	Elasticity at Means
Intercept	0.8037	0.0910	0.1156
Price of:			
WW Wheat ($/mt)	-0.0955	-1.6723	-2.6189
ASW Wheat ($/mt)	0.0708	2.8048 **	2.2371
GDP/Capita ($)	0.0056	2.4944 **	1.7122
Exchange Rate (NT $/U.S. $)	-0.0495	-1.3181	-0.4782
Wheat Production /Capita (1,000 mt)	1.8756	0.1756	0.0323

R-Square = .823 Durbin-Watson = 2.8347

Table II (Continued): Estimated per capita WW Import Demand Equations for Newly Industrialized Country Group, 1970/71-1985/86

Country = Malaysia n = 16

Independent Variable	Estimated Coefficient	t-statistic	Elasticity at Means
Intercept	1.6005	0.3752	2.1921
Price of:			
WW Wheat ($/mt)	-0.0078	-0.2916	-2.0373
ASW Wheat ($/mt)	0.0017	0.1558	0.5118
GDP/Capita ($)	0.0008	0.5745	1.3923
Exchange Rate (Ringgit/U.S. $)	-0.2564	-0.5426	-1.0590

R-Square = .434 Durbin-Watson = 1.6135

*** Significant at 1% Level
** Significant at 5% Level
* Significant at 10% Level

indicated a strong relationship between WW wheat and rice [64]. However, rice production for this equation was found to be highly insignificant and possessing a positive sign, opposite of *a priori* expectations.

The elasticity of South Korea's domestic wheat production coefficient in the WW wheat equation was expected to be much greater than that for HRW equation. However, the difference was not large at all, -0.25 for WW versus -0.19 for HRW.

For Taiwan, the statistical fit and significance of the estimated coefficients improved when compared to its HRW import equation.

The GDP per capita coefficient is statistically significant and indicates that, unlike South Korea, WW wheat is income elastic for Taiwan. Meaning that for every one percent increase in per capita income, WW wheat cash imports will rise by 1.71 percent. The own price elasticity is close to that estimated for South Korea. Albeit, Taiwan's coefficient is marginally significant.

Malaysia again produced the poorest results. The rice based diet of the country again possibly influenced the outcome since Malaysia had no cash WW wheat imports in five out of the 16 years of the estimation.

The Hausman test for misspecification indicated that none of the NIC equations were misspecified (See

Appendix 3). The Durbin-Watson statistics for each NIC indicated the following: South Korea and Malaysia tested inconclusive for positive autocorrelation, negative autocorrelation was not present; Taiwan had no positive autocorrelation present and tested inconclusive for negative autocorrelation.

HRW Estimated Equations for DC Group

The hypotheses tests for equality of intercept and slope terms across countries for the DC group suggested that pooling was permissible (see Appendix 1). The pooling procedure, did however, produce misspecification according to the Hausman test (see Appendix 3). Seemingly Unrelated Regression estimation yielded a Lagrange Multiplier statistic of 2.3382. Therefore, the null hypothesis of no contemporaneous correlation could not be rejected at 90 percent significance. And estimating each developed country's HRW wheat import demand individually with OLS would be as efficient as SUR estimation. The OLS results are presented in Tables III(a), III(b), and III(c).

Japan produced the most pleasing research results of the DC group. Several of its estimated coefficients were statistically significant although the signs of some coefficients were the opposite of *a priori*

Table III(a): Estimated per capita HRW Import Demand Equation for Japan, 1970/71 - 1985/86

Independent Variable	Estimated Coefficient	t-statistic	Elasticity at Means
Intercept	3.2781	0.8169	0.2854
Price of:			
HRW Wheat ($/mt)	0.0015	0.0766	0.0249
DNS Wheat ($/mt)	0.0582	2.5072 **	1.0847
CWRS Wheat ($/mt)	-0.0325	-2.3495 **	-0.6885
GDP/Capita (Millions of U.S. $)	0.0005	1.4636	0.3558
Exchange Rate (Yen/U.S. $)	0.0065	2.0200 *	0.2123
Wheat Production /Capita (1,000 mt)	-0.7779	-3.1970 **	-0.2746

R-Square = .826 Adjusted R-Square = .710

Durbin-Watson = 2.9119 (Equation corrected for autocorrelation)

*** Significant at 1% Level
** Significant at 5% Level
* Significant at 10% Level

Table III(b): Estimated per capita HRW Import Demand Equation for Hong Kong, 1970/71 - 1985/86

Independent Variable	Estimated Coefficient	t-statistic	Elasticity at Means
Intercept	-0.1647	-0.0390	-0.2483
Price of:			
HRW Wheat ($/mt)	-0.0260	-1.0592	-7.5748
DNS Wheat ($/mt)	0.0107	0.6147	3.4395
CWRS Wheat ($/mt)	0.0056	0.5985	2.0635
GDP/Capita (Millions of U.S. $)	0.0006	1.1338	3.2594
Exchange Rate (Hong Kong $/U.S.$)	0.0247	0.1177	0.2784

R-Square = .396 Adjusted R-Square = .093

Durbin-Watson = 1.6306 (Equation corrected for autocorrelation)

*** Significant at 1% Level
** Significant at 5% Level
* Significant at 10% Level

Table III(c): Estimated per capita HRW Import Demand Equation for Singapore, 1970/71 - 1985/86

Independent Variable	Estimated Coefficient	t-statistic	Elasticity at Means
Intercept	3.9526	0.1254	1.3115
Price of:			
HRW Wheat ($/mt)	0.0831	0.3630	5.3622
DNS Wheat ($/mt)	-0.0833	-0.4686	-5.9449
CWRS Wheat ($/mt)	0.0212	0.1793	1.7213
GDP/Capita (Millions of U.S. $)	-0.0001	-0.0378	-0.1729
Exchange Rate (Singapore $/U.S.$)	-1.2760	-0.3731	-1.2773

R-Square = .147 Adjusted R-Square = -.280

Durbin-Watson = 2.2807

*** Significant at 1% Level
** Significant at 5% Level
* Significant at 10% Level

expectations. The adjusted R^2 of .710 was far greater than the values for Hong Kong and Singapore.

The insignificance and incorrect sign of Japan's HRW price coefficient can be rationalized by government policy actions of some countries regarding agricultural imports. Gallagher et al. [16] note that these policies "insulate domestic producers and consumers from external price fluctuations." This makes the elasticity of price transmission (response of the importing country's price to changes in the U.S. price) at or near zero [16].

Arnade and Davison [1] contend that much of the world wheat market over the past 20 years may have functioned as a contract market rather than an auction market. A contract market has been described by Okun [43] as:

> "one where steady relationships develop between customer and suppliers based on implicit trusts and a desire to avoid the disruption and cost of searching for the best deal."

For example, Japan may purchase U.S. HRW wheat even when a competitor's wheat price is slightly lower to prevent disrupting a relationship that goes beyond the wheat market.

The per capita GDP coefficient is marginally significant, while possessing the correct sign. Its elasticity value of 0.36 is inelastic and means that a one percent increase in per capita income will increase Japan's HRW wheat cash imports by 0.36 percent. This estimate is similar to the Arnade and Davison income elasticity estimate for Japan of 0.32 [1]. Their income coefficient was also statistically insignifcant.

Japan's exchange rate coefficient was significant but possessed an incorrect sign. This is possibly due to the high collinearity between the per capita GDP and exchange rate coefficients. The correlation matrix value for these two coefficients was 0.95.

The results for Hong Kong and Singapore were dissapointing since the adjusted R^2 values were extremely low and all of the estimated coefficients were insignificant. Several years of no cash HRW wheat imports for either country is a possible reason for these unfavorable results.

The Durbin-Watson statistics for each DC indicated the following: Japan and Singapore tested inconclusive for negative autocorrelation, positive autocorrelation was not present; Hong Kong had no negative autocorrelation present and tested inconclusive for positive autocorrelation. The Hausman test for misspecification indicated that none of the DC equations were misspecified (See Appendix 3).

WW Estimated Equations for DC Group

The hypotheses tests for equality of intercept and slope terms across countries for the DC group indicated that pooling could be done, using separate intercepts for each country (see Appendix 1).

The Hausman test suggested that the pooling equation was correctly specified (see Appendix 3), however, the equation itself produced abysmal results. The adjusted R^2 value was -0.0111 and all of the estimated coefficients were insignificant.

Seemingly Unrelated Regression estimation was then attempted and the Lagrange Multiplier statistic of 0.3418 meant that OLS would be as efficient as SUR estimation. Hence, the WW wheat import demand equations for the DC group were also estimated for each developed country using Ordinary Least Squares. The results are given in Tables IV(a), IV(b), and IV(c).

The results on the whole were better for WW wheat than HRW when estimating equations for the DC group. Japan possessed three signifcant coefffficients, albeit two with signs opposite of *a priori* expectations. Hong Kong improved dramatically when compared to its HRW wheat import demand equation. Singapore improved slightly but the results remained poor. Both of the wheat prices for Japan were significant, however each

Table IV(a): Estimated per capita WW Import Demand Equation for Japan, 1970/71 - 1985/86

Independent Variable	Estimated Coefficient	t-statistic	Elasticity at Means
Intercept	-0.8358	-0.1932	-0.0886
Price of:			
WW Wheat ($/mt)	0.0868	2.9988 **	1.7561
ASW Wheat ($/mt)	-0.0394	-2.9186 **	-0.9179
GDP/Capita ($)	0.0006	1.5611	0.4675
Exchange Rate (Yen/U.S. $)	0.0049	1.5766	0.1955
Wheat Production /Capita (1,000 mt)	-0.9607	-3.4387 **	-0.4127

R-Square = .710 Adjusted R-Square = .565

Durbin-Watson = 1.8866

*** Significant at 1% Level
** Significant at 5% Level
* Significant at 10% Level

Table IV(b): Estimated per capita WW Import Demand Equation for Hong Kong, 1970/71 - 1985/86

Independent Variable	Estimated Coefficient	t-statistic	Elasticity at Means
Intercept	27.0260	2.9597 **	3.5960
<u>Price of:</u>			
WW Wheat ($/mt)	-0.1231	-2.3814 **	-3.1233
ASW Wheat ($/mt)	0.0548	2.5862 **	1.6036
GDP/Capita ($)	0.0004	0.4366	0.1923
Exchange Rate (Hong Kong $/U.S. $)	-1.2731	-3.3268 **	-1.2687

R-Square = .785   Adjusted R-Square = .706

Durbin-Watson = 1.7913

*** Significant at 1% Level
** Significant at 5% Level
* Significant at 10% Level

Table IV(c): Estimated per capita WW Import Demand Equation for Singapore, 1970/71 - 1985/86

Independent Variable	Estimated Coefficient	t-statistic	Elasticity at Means
Intercept	-18.2650	-0.5714	-2.2845
<u>Price of:</u>			
WW Wheat ($/mt)	0.1995	0.4865	4.7880
ASW Wheat ($/mt)	-0.0575	-0.3227	-1.5760
GDP/Capita ($)	-0.0009	-0.2227	-0.4494
Exchange Rate (Singapore $/U.S. $)	22.4640	2.0831 *	0.5218

R-Square = .375 Adjusted R-Square = .147

Durbin-Watson = 1.4686

*** Significant at 1% Level
** Significant at 5% Level
* Significant at 10% Level

sign was incorrect since WW was the own price and ASW wheat was assumed to be a substitute. The correlation matrix showed that the correlation between these two coefficients was -0.96, possibly causing their signs to switch.

Similar to Japan's HRW import demand equation, the per capita GDP coefficient was bordering on statistical significance. The WW income elasticity of 0.47 was greater than the 0.36 value for HRW wheat. This was not expected since HRW was hypothesized to be more "income elastic" than WW wheat for this research.

Japan's exchange rate coefficient sign was the opposite of a priori expectations but it was marginally significant. The correlation between the exchange rate and per capita GDP coefficients was relatively high (r = 0.86) possibly causing the sign to change.

Domestic wheat production was also used as the domestic supply variable for the DC group since the rice production coefficient was highly insignificant and possessing a positive sign. The elasticity value of -0.41 is greater than that of -0.27 estimated for Japan's HRW import demand domestic wheat production coefficient. Potentially this is due to the higher degree of substitutability of Japan's wheat and WW over HRW wheat.

The coefficients for Hong Kong were significant with the exception of per capita GDP. All of the signs were in agreement with _a priori_ expectations. The own price elasticity was similar to South Korea's estimate for WW wheat. These favorable results must be tempered with the fact that the Hausman test showed that this equation was misspecified (see Appendix 3).

All of Singapore's coefficients had signs opposite of _a priori_ expectations but only the exchange rate variable was significant. The correlation matrix indicated that some multicollinearity was present, possibly causing the poor results. Another reason may have been Singapore having five years of zero cash sales of WW wheat in the 16 years used in the estimation.

The Durbin-Watson statistics for each DC indicated the following: Hong Kong and Singapore tested inconclusive for positive autocorrelation, negative autocorrelation was not present; Japan tested inconclusive for positive and negative autocorrelation. The Hausman test for misspecification indicated that the import demand equations for Japan and Singapore were correctly specified but Hong Kong was misspecified, as mentioned earlier (See Appendix 3).

The next chapter summarizes the thesis and concludes the research by discussing the economic implications of the findings.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The first chapter of this thesis notes that the Asian Pacific Rim (APR) is a major outlet for wheat produced in the Pacific Northwest (PNW). Western White wheat is currently grown primarily in the PNW region. However, PNW wheat grower organizations have funded agronomic research toward developing a Hard Red Winter (HRW) wheat to be grown in the Pacific Northwest. One reason is that prices of HRW wheat have been historically higher than that of WW wheat. Another is that perhaps longer-term export demand will greater for HRW that WW wheat.

Cross-sectional studies have indicated changing dietary patterns as countries move from agrarian to industrialized societies. Food consumption tends to shift from cereals into fruits and vegetables and finally towards meat products, as incomes rise. Western white wheat end products are cereal-based and are often used as dietary staples, i.e. noodles. On the other hand, HRW wheat can be transformed into end products that are meat related, i.e. hamburger buns and sandwich breads.

Since WW and HRW wheats each have differing end uses, the hypothesis of this research is to confirm whether the industrialization of several APR countries has made HRW wheat more income sensitive or elastic than WW wheat over time. This information is necessary to determine whether PNW wheat producers would benefit by shifting some acreage into HRW wheat. Currently, a paucity of research exists in analyzing the import demand for the two wheat classes.

Import demand functions for U.S. HRW and WW wheats were estimated for the following APR countries: Japan, Hong Kong, Malaysia, Singapore, South Korea, and Taiwan. The data period was from 1970-71 to 1985-86. Seemingly Unrelated Regressions and Ordinary Least Squares estimations were utilized after pooling of cross-sectional and time-series data was found to be either not valid or misspecified.

The results were statistically pleasing for Japan, South Korea, and Taiwan. These countries were consistent, substantial importers of both HRW and WW wheat on an annual basis. Hong Kong, Malaysia, and Singapore were sporadic wheat importers, perhaps producing the poor results for these countries. Consequently, salient inferences can only be derived from the large-scale importing countries of Japan, South Korea, and Taiwan. The elasticities of the estimated coefficients of these countries are presented in Tables V and VI.

For South Korea, own price coefficients were significant for each equation with similar elasticities, -2.85 for HRW and -2.58 for Western White. The own price coefficients were both insignificant for Taiwan while Japan's HRW coefficient was also insignificant. A reason suggested for this was the government policy of insulating domestic consumers from external price changes in some countries. A second reason was that much of the world wheat market acted as a contract market rather than an auction market in the 1960s and 70s. Japan's WW coefficient was significant but its sign was contrary to a priori expectations. This was possibly due to its high collinearity with the ASW wheat price coefficient.

Canadian Western Red Spring (CWRS) wheat and Australian Standard White (ASW) wheat were proposed as the international substitutes for HRW and WW, respectively. For South Korea and Taiwan, both CWRS and ASW were significant and had signs in accord with a priori expectations. This indicates that Canada and Australia are viable competitors with the U.S. for the markets of South Korea and Taiwan. Canadian Western Red Spring and ASW were also significant for Japan but each sign was opposite of expectations. Their negative signs

Table V: Estimated HRW Import Demand Elasticities for Japan, South Korea, and Taiwan

Independent Variable	Japan	South Korea	Taiwan
Intercept	0.2854	4.6669 *	1.1300
Price of:			
HRW Wheat ($/mt)	0.0249	-2.8530 *	1.0026
DNS Wheat ($/mt)	1.0847 *	-1.2408	-2.7330 *
CWRS Wheat ($/mt)	-0.6885 *	2.9293 *	1.4741 *
GDP/Capita (Millions of U.S. $)	0.3558	-0.7741 *	0.5087
Exchange Rate (Foreign Currency /U.S. $)	0.2123 *	-1.5359 *	-0.3809
Wheat Production /Capita (1,000 mt)	-0.2746 *	-0.1924 *	-------
Adjusted R-Square	.710	.921	.517
Durbin-Watson	2.912	2.480	1.901

* At least statistically significant at the 10 percent level

Table VI: Estimated WW Import Demand Elasticities for Japan, South Korea, and Taiwan

Independent Variable	Japan	South Korea	Taiwan
Intercept	-0.0886	4.0987 *	0.1156
Price of:			
WW Wheat ($/mt)	1.7561 *	-2.5843 *	-2.6189
ASW Wheat ($/mt)	-0.9179 *	3.1126 *	2.2371 *
GDP/Capita (Millions of U.S. $)	0.4675	-0.6474 *	1.7122 *
Exchange Rate (Foreign Currency /U.S. $)	0.1955	-1.2032 *	-0.4782
Wheat Production /Capita (1,000 mt)	-0.4127 *	-0.2506 *	0.0323
R-Square	.710	.887	.823
Durbin-Watson	1.887	1.881	2.835

* At least statistically significant at the 10 percent level

indicate that CWRS and ASW are compliments rather than substitutes for the HRW and WW wheats in Japan.

Per capita Gross Domestic Product (GDP) was chosen as the income variable for this research and it was used to test the following hypothesis:

The import demand of APR countries for HRW wheat will be more income elastic than the import demand for WW wheat.

South Korea was the only country to have both wheat classes statistically significant for the income coefficient. However, there was a conspicuous discrepancy since per capita real GDP had a negative sign for both equations. This indicates that South Koreans viewed the final products from which the demand for each wheat are derived as inferior goods. The food self-sufficiency policy of South Korea was presented as a reason for this rather than a diminishing marginal propensity to consume food items caused by income growth. What is not known at the present time, is whether these self-sufficiency programs impact both wheat classes equally. Nevertheless, WW was found to be less inferior algebraically than HRW wheat for South Korea. Western white wheat was found to be more income elastic than HRW wheat for both Japan and Taiwan. This is contrary to what was stated in the hypothesis, although the income coefficient for Taiwan's HRW import equation was not significant and both of Japan's income coefficients were marginally significant.

Exchange rates were deflated by each country's CPI to give a real exchange rate variable. For South Korea, the coefficient was significant and elastic for both wheat classes, -1.54 for HRW and -1.20 for Western White. Both coefficients were insignificant for Taiwan while each possessed the correct (negative) signs. Japan's exchange rate coefficients were significant but both had signs contrary to a priori expectations. Collinearity between the exchange rate coefficient and per capita GDP was advanced as a reason for this.

Per capita wheat production was utilized as the supply variable in each equation. Despite its similarity in end use with WW wheat, rice was consistenly found to be highly insignificant and possessing an incorrect sign as the supply variable for Western White. For Japan and South Korea, the wheat production coefficient had the correct (negative) signs for each country's HRW and WW equations.

Conclusions

The objective of this research was to confirm whether the economic development of selected APR countries measured by growth in per capita GDP would cause HRW wheat to be preferred over WW in terms of greater income elasticity values. Due to the mixed results, complete policy implications for HRW and WW wheat can only be derived from South Korea, the only country whose income coefficients were significant in both equations. South Korea is currently the second largest importer of the APR region, possessing promising income and population growth. Therefore, these conclusions are important for the future.

First, the price elasticities are elastic for HRW and WW indicating lowering of prices by the U.S. will raise total revenue when importing wheat to South Korea on a cash basis. Hard Red Winter was more elastic than WW wheat, meaning greater revenue will be generated for HRW through lowering of prices than Western White. This conclusion is made on the assumption that South Korea is a price-taker and cannot influence price (small country assumption).

Second, Canada was found to be a competitor with the U.S. for South Korea's hard wheat market through Canadian Western Red Spring wheat while Australian Standard White wheat was found to compete with the U.S. for the soft wheat market of South Korea.

Third, each wheat was found to be exchange rate elastic, meaning that devaluation of the U.S. dollar will cause cash imports of wheat to increase for both classes. Hard Red Winter wheat was more exchange rate elastic (-1.54) than Western White (-1.20).

Fourth, U.S. and PNW agricultural policy makers have little direct control over wheat production in South Korea, which was a significant variable in both import demand equations. Nevertheless, South Korean wheat production has declined in recent years, possibly making this demand determinant less important for the future.

Finally, the continued income growth of South Korea would appear to cause the cash imports of both wheats to decline, based on conventional economic theory. However, if wheat imports are influenced by South Korean government policy rather than income, the effect may be ameliorated through bilateral trade negotiations.

Suggestions for Future Research

This study was an attempt to empirically estimate and evaluate the import demand by Asian Pacific Rim countries for Hard Red Winter and Western White wheat. To possibly improve on this research and provide more decisive results, the following steps could be implemented:

1.) Hard Red Winter wheat and Hard Red Spring (HRS) have similar protein levels and end uses. Since examination of the data indicates that HRS wheat is more consistently imported by the APR countries, perhaps using it as the high protein wheat for this type of research would result in better overall estimates.

2.) If the researcher possibly can obtain concessional sales data for a sufficient time series, then developing countries (Thailand, Philippines, Indonesia) can be added. This could increase the amount of information available to the researcher. A possible source for this data is the USDA Foreign Agricultural Service.

3.) Using the prices paid in the importing countries rather than the border prices would possibly give more accurate wheat price estimates. This is an elusive objective since this price information is not widely available from the importing countries.

4.) The exchange rate variable could be represented in a more sophisticated manner, utilizing forms attempted in previous and current research focusing on exchange rates. This may produce better overall results for the exchange rates in terms of significance and correct (negative) signs.

The continued growth of the Asian Pacific Rim countries and the importance of wheat in the Pacific

Northwest economy make it imperative that further research of this type be pursued.

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APPENDICES

APPENDIX 1

Hypotheses Tests for Intercept and Slope Terms

I (a). Hard Red Winter Import Demand: Newly Industrialized Country Group

i.) Test for equality of intercept terms across countries

Stated Hypothesis

H_0: β_0(S.Korea) = β_0(Taiwan) = β_0(Malaysia)

H_a: H_0 is not true

Test Statistic

$$F^* = \frac{(SSE_R - SSE_U) / r}{SSE_U / n - k} \sim F\ (r,\ n - k)$$

Where: SSE_R = Restricted error sum of squares

SSE_R = Unrestricted error sum of squares

r = Number of restrictions

n = Number of observations

k = Number of regressors (in unrestricted model)

Critical F Value

At 95 percent significance: F (.05; 2,39) = 3.23

Decision Rule

Reject H_0: If $F^* > 3.23$ Do Not Reject H_0: If $F^* < 3.23$

Calculated F*

$$F^* = \frac{(928.37 - 262.87) / 2}{262.87 / 39} = 49.37$$

Conclusion

Reject H_0, Intercepts are not equal across the Newly Industrialized Country Group ii.) Test for equality of slope terms across countries, given that their intercept terms are not equal.

Stated Hypothesis

H_0: β_1(S.Korea) = β_1(Taiwan) = β_1(Malaysia)

H_a: H_0 is not true

Test Statistic

$$F^* = \frac{(SSE_R - SSE_U) / r}{SSE_U / n - k} \sim F\ (r,\ n - k)$$

Critical F Value

At 95 percent significance: F (.05; 12,27) = 2.13

Decision Rule

Reject H_0: If F* > 2.13 Do Not Reject H_0: If F* < 2.13

Calculated F*

$$F^* = \frac{(262.87 - 85.20) / 12}{85.20 / 27} = 4.69$$

Conclusion

Reject H_0, Slope coefficients are not equal across the Newly Industrialized Group.

II (b). <u>Hard Red Winter Import Demand</u>: Developed Country Group

i.) Test for equality of intercept terms across countries

<u>Stated Hypothesis</u>

H_0: β_0(Japan) = β_0(Hong Kong) = β_0(Singapore)

H_a: H_0 is not true

<u>Test Statistic</u>

$$F^* = \frac{(SSE_R - SSE_U) / r}{SSE_U / n - k} \sim F\ (r,\ n - k)$$

<u>Critical F Value</u>

At 95 percent significance: F (.05; 2,39) = 3.23

<u>Decision Rule</u>

Reject H_0: If $F^* > 3.23$ Do Not Reject H_0: If $F^* < 3.23$

<u>Calculated F*</u>

$$F^* = \frac{(527.94 - 454.98) / 2}{454.98 / 39} = 3.13$$

<u>Conclusion</u>

Do not Reject H_0, Intercepts are equal across the Developed Country Group.

ii.) Test for equality of slope terms across countries, given that their intercept terms are equal.

Stated Hypothesis

H_0: β_1(Japan) = β_1(Hong Kong) = β_1(Singapore)

H_a: H_0 is not true

Test Statistic

$$F^* = \frac{(SSE_R - SSE_U) / r}{SSE_U / n - k} \sim F\ (r,\ n - k)$$

Critical F Value

At 95 percent significance: F (.05; 12,29) = 2.10

Decision Rule

Reject H_0: If $F^* > 2.10$ Do Not Reject H_0: If $F^* < 2.10$

Calculated F*

$$F^* = \frac{(527.94 - 392.71) / 12}{392.71 / 29} = 0.83$$

Conclusion

Do Not Reject H_0, Slope coefficients are equal across the Developed Country Group.

III (a). Western White Import Demand: Newly Industrialized Country Group

i.) Test for equality of intercept terms across countries

Stated Hypothesis

H_o: β_0(S.Korea) = β_0(Taiwan) = β_0(Malaysia)

H_a: H_o is not true

Test Statistic

$$F^* = \frac{(SSE_R - SSE_U) / r}{SSE_U / n - k} \sim F\,(r,\ n - k)$$

Critical F Value

At 95 percent significance: F (.05; 2,40) = 3.23

Decision Rule

Reject H_o: If $F^* > 3.23$ Do Not Reject H_o: If $F^* < 3.23$

Calculated F*

$$F^* = \frac{(1713.90 - 366.40) / 2}{366.40 / 40} = 73.55$$

Conclusion

Reject H_o, Intercepts are not equal across the Newly Industrialized Country Group.

ii.) Test for equality of slope terms across countries, given that their intercept terms are not equal.

Stated Hypothesis

H_0: β_1(S.Korea) = β_1(Taiwan) = β_1(Malaysia)

H_a: H_0 is not true

Test Statistic

$$F^* = \frac{(SSE_R - SSE_U) / r}{SSE_U / n - k} \sim F\,(r,\ n - k)$$

Critical F Value

At 95 percent significance: F (.05; 10,30) = 2.16

Decision Rule

Reject H_0: If $F^* > 2.16$ Do Not Reject H_0: If $F^* < 2.16$

Calculated F*

$$F^* = \frac{(366.40 - 229.50) / 10}{229.50 / 30} = 1.78$$

Conclusion

Do Not Reject H_0, Slope coefficients are equal across the Newly Industrialized Country Group.

IV (a). <u>Western White Import Demand</u>: Developed Country Group

i.) Test for equality of intercept terms across countries

<u>Stated Hypothesis</u>

H_0: β_0(Japan) = β_0(Hong Kong) = β_0(Singapore)

H_a: H_0 is not true

<u>Test Statistic</u>

$$F^* = \frac{(SSE_R - SSE_U) / r}{SSE_U / n - k} \sim F(r, n - k)$$

<u>Critical F Value</u>

At 95 percent significance: F (.05; 2,40) = 3.23

<u>Decision Rule</u>

Reject H_0: If $F^* > 3.23$ Do Not Reject H_0: If $F^* < 3.23$

<u>Calculated F*</u>

$$F^* = \frac{(2676.30 - 2671.50) / 2}{2671.50 / 40} = 0.36$$

<u>Conclusion</u>

Do not Reject H_0, Intercepts are equal across the Developed Country Group.

ii.) Test for equality of slope terms across countries, given that their intercept terms are equal.

Stated Hypothesis

H_0: β_1(Japan) = β_1(Hong Kong) = β_1(Singapore)

H_a: H_0 is not true

Test Statistic

$$F^* = \frac{(SSE_R - SSE_U) / r}{SSE_U / n - k} \sim F(r, n - k)$$

Critical F Value

At 95 percent significance: F (.05; 10, 32) = 2.14

Decision Rule

Reject H_0: If $F^* > 2.14$ Do Not Reject H_0: If $F^* < 2.14$

Calculated F*

$$F^* = \frac{(2676.30 - 1878.25) / 10}{1878.25 / 32} = 1.35$$

Conclusion

Do Not Reject H_0, Slope coefficients are equal across the Developed Country Group.

APPENDIX 2

Testing for Contemporaneous Correlation

If contemporaneous correlation is not present, then OLS estimation of each equation will be fully efficient and Seemingly Unrelated Regression (SUR) estimation will be unnecessary. Therefore, it is useful to test if the contemporaneous covariances are zero. The null and alternative hypothesis for this test are

H_0: $\sigma_1 = \sigma_2 = \ldots \sigma_n$

H_1: At least one covariance is nonzero

Breusch and Pagan proposed the Lagrange Multiplier test statistic for confirming contemporaneous correlation [28].

For M equations, the test statistic is

$$\lambda = T \sum_{i=2}^{M} \sum_{j=1}^{i-1} r^2_{ij}$$

where r^2_{ij} is the squared correlation

The test statistic has an asymptotic Chi-Square distribution with M(M-1)/2 degrees of freedom.

Results of Tests

Import Demand Equation	Lagrange Multiplier Value	Result
NIC HRW wheat	5.1018	Reject H_o
NIC WW wheat	6.9470	Do not Reject H_o
DC HRW wheat	2.3382	Reject H_o
DC WW wheat	0.3418	Reject H_o

The critical Chi-Square value of all estimated equations, at 90 percent significance, is 6.25139.

APPENDIX 3

Hausman's Specification Error Test

Let H_0 denote the null hypothesis that there is no misspecification and let H_1 be the alternative hypothesis that there is misspecification of a particular type.

$$y = \beta_0 + X\beta_1 + e$$

To be able to use OLS for the regression model stated above, the specification in this case will be that X is independent of e, a basic OLS assumption. Hence, the null and alternative hypothesis will be:

H_0: X and e are independent

H_1: X and e are not independent

In order to utilize Hausman's test, two estimators, $\hat{\beta}_0$ and $\hat{\beta}1$, must be calculated which have the following properties:

$\hat{\beta}_0$ is consistent and efficient under H_0 but is not consistent under H_1

$\hat{\beta}_1$ is consistent under both H_0 and H_1 but not efficient under H_0

Where: $\hat{\beta}_0$ are the coefficients estimated using OLS

$\hat{\beta}_1$ are the coefficients estimated using instrumental variable estimation

In matrix notation, the Hausman test statistic is:

$$m = \hat{q}'[\hat{V}(q)]^{-1}\hat{q}$$

Where: $\hat{q} = \hat{\beta}_1 - \hat{\beta}_0$

$V(\hat{q}) = V_1 - V_0$, the difference in variance-covariance matrices

The test statistic has a Chi-Square distribution with degrees of freedom equal to the number of parameters estimated.

Hausman test for HRW wheat import demand

Country /Group	m value	Chi-Square value at α=.05	df	Result
S.Korea	-1.0952	14.0671	7	Do not Reject H_0
Taiwan	0.7896	12.5916	6	Do not Reject H_0
Malaysia	1.5802	12.5916	6	Do not Reject H_0
DC Group	34.8409	14.0671	7	Reject H_0
Japan	2.2791	14.0671	7	Do not Reject H_0
Hong Kong	-1.0523	12.5916	6	Do not Reject H_0
Singapore	-3.6276	12.5916	6	Do not Reject H_0

Hausman test for WW wheat import demand

Country /Group	m value	Chi-Square value at α=.05	df	Result
NIC Group	22.6451	15.5073	8	Reject H_0
S.Korea	-10.8288	12.5916	6	Do not Reject H_0
Taiwan	2.4207	12.5916	6	Do not Reject H_0
Malaysia	-2.1903	11.0705	5	Do not Reject H_0

Hausman test for WW wheat import demand (Continued)

Country /Group	m value	Chi-Square value at α=.05	df	Result
DC Group	5.3215	12.5916	6	Do not Reject H_0
Japan	0.4461	12.5916	6	Do not Reject H_0
Hong Kong	26.4066	11.0705	5	Reject H_0
Singapore	-0.3422	11.0705	5	Do not Reject H_0

APPENDIX 4

HRW Wheat Data

COUNTRY= JAPAN

YEAR	DOLLAR SALES HRW 1,000 MT	HRW WHEAT BORDER PRICE / MT US $	DNS WHEAT BORDER PRICE / MT US $	CANADA W.SPRING WHEAT BORDER PRICE / MT US $	WHEAT PROD. 1,000 MT
70-71	1221	69.49587	74.26365	78.5266	474
71-72	1133	65.54912	69.90792	72.48164	440
72-73	1329	103.6444	105.229	111.9102	284
73-74	1331	209.9648	216.06	231.0896	202
74-75	1287	188.1066	221.1016	219.7541	232
75-76	1526	165.6196	199.5984	200.3089	241
76-77	1338	128.7224	150.9495	151.5841	222
77-78	1241	131.5442	143.3576	145.8927	236
78-79	1449	159.4849	168.9541	175.637	367
79-80	1213	203.8736	216.2362	228.4785	541
80-81	1371	213.8814	240.854	257.68	583
81-82	1310	194.5491	210.4915	225.2047	587
82-83	1274	180.773	191.6228	204.5752	742
83-84	1293	172.7161	196.1096	208.081	695
84-85	1290	171.7884	189.7123	204.3369	741
85-86	1241	152.9993	181.924	195.7156	874

COUNTRY= S.KOREA

YEAR	DOLLAR SALES HRW 1,000 MT	HRW WHEAT BORDER PRICE / MT US $	DNS WHEAT BORDER PRICE / MT US $	CANADA W.SPRING WHEAT BORDER PRICE / MT US $	WHEAT PROD. 1,000 MT
70-71	0	69.0431	74.26365	78.5266	357
71-72	133	64.75939	69.90792	72.48164	322
72-73	111	103.0244	105.229	111.9102	241
73-74	528	210.3529	216.06	231.0896	100
74-75	573	185.998	219.1114	217.764	74
75-76	500	162.7214	196.5679	199.1084	97
76-77	732	128.8505	151.0107	151.643	82
77-78	564	130.6644	143.1497	145.6882	45
78-79	521	158.6965	169.9401	176.6303	35
79-80	588	205.7766	218.5546	230.7868	41
80-81	607	211.0914	239.384	256.21	92
81-82	623	195.0287	212.6437	227.3646	57
82-83	645	182.3904	193.7956	206.7477	66
83-84	642	169.6061	193.4896	205.4575	115
84-85	644	166.3035	184.4696	199.0911	17
85-86	588	152.5364	181.924	195.7156	11

COUNTRY= TAIWAN

YEAR	DOLLAR SALES HRW 1,000 MT	HRW WHEAT BORDER PRICE / MT US $	DNS WHEAT BORDER PRICE / MT US $	CANADA W.SPRING WHEAT BORDER PRICE / MT US $	WHEAT PROD. 1,000 MT
70-71	51	69.0431	74.26365	78.5266	3.664
71-72	132	65.23503	69.90792	72.48164	2.346
72-73	233	103.1844	105.2053	111.9102	1.546
73-74	344	210.3529	216.06	231.0896	.921
74-75	189	193.2377	226.3511	225.0031	.738
75-76	240	164.3704	197.4829	200.0601	3.042
76-77	243	127.6265	149.5515	150.3546	1.224
77-78	270	127.8154	140.5471	143.0868	1.287
78-79	293	159.1279	168.0446	174.7284	2.395
79-80	331	201.1881	213.9661	226.2056	2.521
80-81	272	213.6214	240.714	257.54	2.839
81-82	224	194.8553	212.4703	227.1883	2.71
82-83	278	180.8384	191.681	204.6336	2.314
83-84	276	172.2861	193.8396	205.8081	1.57
84-85	230	171.2837	188.1776	202.8022	1.03
85-86	296	153.2432	181.924	195.7156	2.125

COUNTRY= HONG KONG

YEAR	DOLLAR SALES HRW 1,000 MT	HRW WHEAT BORDER PRICE / MT US $	DNS WHEAT BORDER PRICE / MT US $	CANADA W.SPRING WHEAT BORDER PRICE / MT US $	WHEAT PROD. 1,000 MT
70-71	1.09	69.0431	74.26365	78.5266	0
71-72	.6	64.75939	69.90792	72.48164	0
72-73	.54	103.0244	105.229	111.9102	0
73-74	1.06	210.3529	216.06	231.0896	0
74-75	1.06	193.2377	226.3511	225.0031	0
75-76	1.06	163.6701	199.3519	200.0601	0
76-77	5.82	127.5117	149.7178	150.3546	0
77-78	4.65	127.8154	140.5471	143.0868	0
78-79	4.33	156.801	168.0446	174.7284	0
79-80	3.48	201.1881	213.9661	226.2056	0
80-81	7.21	212.4214	240.714	257.54	0
81-82	0	194.8553	212.4703	227.1883	0
82-83	0	180.6322	191.681	204.6336	0
83-84	0	169.9561	193.8396	205.8081	0
84-85	8.41	170.0115	188.1776	202.8022	0
85-86	12.9	152.5364	181.924	195.7156	0

COUNTRY= MALAYSIA

YEAR	DOLLAR SALES HRW 1,000 MT	HRW WHEAT BORDER PRICE / MT US $	DNS WHEAT BORDER PRICE / MT US $	CANADA W.SPRING WHEAT BORDER PRICE / MT US $	WHEAT PROD. 1,000 MT
70-71	0	69.0431	74.26365	78.5266	0
71-72	0	64.75939	69.90792	72.48164	0
72-73	3.48	103.0244	105.229	111.9102	0
73-74	0	210.3529	216.06	231.0896	0
74-75	0	188.3712	221.4846	220.1342	0
75-76	0	163.6328	199.3146	200.0165	0
76-77	5.31	130.5488	152.7549	153.3957	0
77-78	5.17	132.0735	144.8052	147.345	0
78-79	1.99	159.776	169.9277	177.7083	0
79-80	1.06	208.9644	221.7424	233.976	0
80-81	21.26	215.1714	243.464	260.29	0
81-82	20.38	194.1107	211.7257	226.439	0
82-83	21.36	180.5837	191.6325	204.5752	0
83-84	9.28	169.7061	193.5896	205.5663	0
84-85	0	172.5556	190.7217	205.3308	0
85-86	10.26	152.5364	181.924	195.7156	0

COUNTRY= SINGAPORE

YEAR	DOLLAR SALES HRW 1,000 MT	HRW WHEAT BORDER PRICE / MT US $	DNS WHEAT BORDER PRICE / MT US $	CANADA W.SPRING WHEAT BORDER PRICE / MT US $	WHEAT PROD. 1,000 MT
70-71	0	69.0431	74.26365	78.5266	0
71-72	0	64.75939	69.90792	72.48164	0
72-73	3.95	103.0244	105.229	111.9102	0
73-74	22.13	210.3529	216.06	231.0896	0
74-75	0	188.3712	221.4846	220.1342	0
75-76	15.32	163.6328	199.3146	200.0165	0
76-77	7.35	130.5488	152.7549	153.3957	0
77-78	2.5	132.0735	144.8052	147.345	0
78-79	1.44	159.776	171.0196	177.7083	0
79-80	1.99	208.9644	221.7424	233.976	0
80-81	5.23	215.1714	243.464	260.29	0
81-82	51.03	194.1107	211.7257	226.439	0
82-83	1.69	180.5837	191.6325	204.5752	0
83-84	0	169.7061	193.5896	205.5663	0
84-85	0	172.5556	190.7217	205.3308	0
85-86	0	152.5364	181.924	195.7156	0

APPENDIX 5

WW Wheat Data

COUNTRY= JAPAN

YEAR	DOLLAR SALES WW 1,000 MT	WW WHEAT BORDER PRICE / MT US $	ASW WHEAT BORDER PRICE / MT US $	WHEAT PROD. 1,000 MT
70-71	860	69.36939	68.54484	474
71-72	729	65.42372	64.95288	440
72-73	1259	104.4941	102.912	284
73-74	1174	212.4282	221.557	202
74-75	1003	187.1603	189.58	232
75-76	1077	161.1719	161.4989	241
76-77	1127	128.7434	127.7128	222
77-78	1197	132.3235	133.2363	236
78-79	1077	160.2091	160.1573	367
79-80	1085	189.9704	201.8942	541
80-81	1228	197.4964	212.46	583
81-82	1222	185.006	189.5929	587
82-83	1107	182.7125	181.2833	742
83-84	1087	166.3472	172.727	695
84-85	966	160.5709	168.6579	741
85-86	957	153.9033	153.8607	874

COUNTRY= S.KOREA

YEAR	DOLLAR SALES WW 1,000 MT	WW WHEAT BORDER PRICE / MT US $	ASW WHEAT BORDER PRICE / MT US $	WHEAT PROD. 1,000 MT
70-71	0	69.36939	68.54484	357
71-72	112	65.42372	64.95288	322
72-73	195	104.4941	102.912	241
73-74	685	212.4282	221.557	100
74-75	1029	185.1702	189.58	74
75-76	910	159.9767	161.4989	97
76-77	1205	128.8046	127.7128	82
77-78	1145	132.1156	133.2363	45
78-79	975	161.1951	160.1573	35
79-80	1098	192.2888	201.8942	41
80-81	1299	196.0264	212.46	92
81-82	1011	187.1582	189.5929	57
82-83	1045	184.8853	181.2833	66
83-84	1146	163.7272	172.727	115
84-85	1121	155.3282	168.6579	17
85-86	1064	153.9033	153.8607	11

COUNTRY= TAIWAN

YEAR	DOLLAR SALES WW 1,000 MT	WW WHEAT BORDER PRICE / MT US $	ASW WHEAT BORDER PRICE / MT US $	WHEAT PROD. 1,000 MT
70-71	0	69.36939	68.54484	3.664
71-72	20.68	65.42372	64.95288	2.346
72-73	5.23	104.4941	102.912	1.546
73-74	236.86	212.4282	221.557	.921
74-75	109.08	192.4098	188.21	.738
75-76	103.85	160.9253	161.591	3.042
76-77	118.5	127.5117	128.4436	1.224
77-78	122.14	129.513	131.5137	1.287
78-79	125.46	159.2996	159.485	2.395
79-80	235.2	187.7003	202.2625	2.521
80-81	120.86	197.3564	213.29	2.839
81-82	137.6	186.9848	188.0522	2.71
82-83	163	182.7707	181.0115	2.314
83-84	130.14	164.0772	172.395	1.57
84-85	145.14	159.0362	167.8631	1.03
85-86	154.23	153.9033	153.8607	2.125

COUNTRY= HONG KONG

YEAR	DOLLAR SALES WW 1,000 MT	WW WHEAT BORDER PRICE / MT US $	ASW WHEAT BORDER PRICE / MT US $	WHEAT PROD. 1,000 MT
70-71	5.17	69.36939	68.54484	0
71-72	3.86	65.42372	64.95288	0
72-73	8.98	104.4941	102.912	0
73-74	27.49	212.4282	221.557	0
74-75	33.04	192.4098	188.21	0
75-76	32.52	160.9253	161.591	0
76-77	51.38	127.5117	128.4436	0
77-78	58.65	129.513	131.5137	0
78-79	56.28	159.2996	159.485	0
79-80	40.8	187.7003	202.2625	0
80-81	51.49	197.3564	213.29	0
81-82	42.86	186.9848	188.0522	0
82-83	46.73	182.7707	181.0115	0
83-84	42.29	164.0772	172.395	0
84-85	38.1	159.0362	167.8631	0
85-86	38.46	153.9033	153.8607	0

COUNTRY= MALAYSIA

YEAR	DOLLAR SALES WW 1,000 MT	WW WHEAT BORDER PRICE / MT US $	ASW WHEAT BORDER PRICE / MT US $	WHEAT PROD. 1,000 MT
70-71	0	69.36939	68.54484	0
71-72	0	65.42372	64.95288	0
72-73	1.58	104.4941	102.912	0
73-74	6.26	212.4282	221.557	0
74-75	4.06	187.5433	188.21	0
75-76	0	160.888	161.591	0
76-77	0	130.5488	128.4436	0
77-78	0	133.7711	131.5137	0
78-79	4.33	162.2746	159.485	0
79-80	6.72	195.4766	201.5521	0
80-81	6.5	200.1064	209.25	0
81-82	37.5	186.2402	185.2963	0
82-83	15.1	182.7222	179.9122	0
83-84	30.35	163.8272	171.0158	0
84-85	42.92	161.5803	167.8093	0
85-86	12.36	153.9033	153.8607	0

COUNTRY= SINGAPORE

YEAR	DOLLAR SALES WW 1,000 MT	WW WHEAT BORDER PRICE / MT US $	ASW WHEAT BORDER PRICE / MT US $	WHEAT PROD. 1,000 MT
70-71	0	69.36939	68.54484	0
71-72	0	65.42372	64.95288	0
72-73	0	104.4941	102.912	0
73-74	27.6	212.4282	221.557	0
74-75	0	187.5433	188.21	0
75-76	4.25	160.888	161.591	0
76-77	0	130.5488	128.4436	0
77-78	6.21	133.7711	131.5137	0
78-79	55.76	162.2746	159.485	0
79-80	87.42	195.4766	201.5521	0
80-81	97.4	200.1064	209.25	0
81-82	9.74	186.2402	185.2963	0
82-83	3.81	182.7222	179.9122	0
83-84	5.5	163.8272	171.0158	0
84-85	3.29	161.5803	167.8093	0
85-86	2.2	153.9033	153.8607	0

APPENDIX 6

Economic Data

CONSUMER PRICE INDEXES 1980 = 100

Year	Japan	S. Korea	Taiwan(1)	Hong Kong
1970	42.3	22.2	31.9	44
1971	44.9	25.2	32.8	45.3
1972	46.9	28.1	33.78	48.1
1973	52.4	29	36.54	56.8
1974	65.2	36.1	53.89	65.1
1975	72.9	45.2	56.71	66.9
1976	79.7	52.1	58.13	69.3
1977	86.1	57.4	62.22	73.2
1978	89.4	65.7	65.81	77.6
1979	92.6	77.7	72.23	86.7
1980	100	100	85.96	100
1981	104.9	121.3	100	114.1
1982	107.7	130.1	102.96	126.2
1983	109.9	134.5	104.36	138.6
1984	112.3	137.6	104.33	150
1985	114.6	141	104.16	154.7

(1) = 1981 is Taiwan's Base Year

Year	Australia	Canada	U.S.	Malaysia	Sing.
1970	36.4	39.7	44.4	56.4	50.6
1971	38.1	40.4	45.2	57.3	51.6
1972	40	42.2	50	59.2	52.6
1973	43.4	47	70.6	65.4	66.5
1974	50	55.9	75.1	76.8	81.4
1975	57.6	62.2	74.7	80.2	83.6
1976	64.1	65.4	76.5	82.3	81.9
1977	70.6	70.5	77	86.3	84.6
1978	76.4	77	85	90.5	88.6
1979	87.7	88.1	96.6	93.7	92.2
1980	100	100	100	100	100
1981	108.5	110.2	102	109.7	108.2
1982	118.2	116.8	97	116.1	112.4
1983	127.7	120.9	100	120.4	113.8
1984	134.7	125.8	103	125.1	116.8
1985	143.5	129.1	93	125.5	117.3

GROSS DOMESTIC PRODUCT (2)

Year	Japan	S. Korea	Taiwan	Hong Kong
1970	73660000	2672000	225695	19214
1971	81025000	3298000	262247	21873
1972	92748000	4044000	314301	25854
1973	113069000	5275000	407535	33964
1974	135312000	7398000	545024	38786
1975	148955000	9952000	584494	40574
1976	167451000	13357000	701117	51973
1977	186301000	17123000	820473	59615
1978	204405000	24017000	980318	81200
1979	221546000	31215000	1180522	107000
1980	240177000	37915000	1470175	137200
1981	257364000	47024000	1749447	165300
1982	269628000	52913000	1859665	186900
1983	280256000	61003000	2041370	208400
1984	297947000	68867000	2255111	250200
1985	316114000	74978000	2357106	266600

(2) = MILLIONS OF OWN COUNTRY CURRENCY UNITS

Year	Malaysia	Sing.
1970	10588	5805
1971	12955	6823
1972	14220	8156
1973	18623	10205
1974	22858	12543
1975	22332	13373
1976	28085	14575
1977	32340	15958
1978	37886	17830
1979	46424	20523
1980	53308	25091
1981	57613	29339
1982	62579	32670
1983	69565	36733
1984	79550	40048
1985	77547	38521

POPULATIONS (3)

YEAR	JAPAN	S.KOREA	TAIWAN	MALAYSIA	HONG KONG	SING.
1970	103.39	31.793	14.676	10.945	3.96	2.075
1971	104.66	31.849	14.995	11.16	4.045	2.11
1972	106.96	32.36	15.289	11.005	4.078	2.147
1973	108.35	32.905	15.565	11.306	4.16	2.185
1974	109.67	33.459	15.852	11.702	4.249	2.22
1975	111.566	35.28	16.15	12.308	4.396	2.25
1976	112.768	35.86	16.508	12.653	4.444	2.278
1977	113.216	35.953	16.813	12.961	4.536	2.319
1978	114.898	38	17.136	13.33	4.606	2.334
1979	115.692	37.814	17.479	13.137	4.965	2.361
1980	116.782	38.198	17.805	13.871	5.068	2.415
1981	117.645	38.88	18.136	14.2	5.154	2.444
1982	118.6	41.1	18.458	14.7	5.5	2.5
1983	119.2	41.3	18.733	15	5.2	2.5
1984	119.9	42	19.013	15.3	5.4	2.5
1985	120.8	42.7	19.258	15.7	5.5	2.6

(3) = MILLIONS OF PERSONS

EXCHANGE RATES (4)

Year	Japan	S. Korea	Taiwan	Hong Kong	Malaysia	Sing.
1970	358.07	310.57	40.05	6.06	3.0797	3.0942
1971	347.86	348.2	40.05	6.06	3.0202	3.0267
1972	303.17	392.9	40.05	5.735	2.8048	2.8092
1973	271.7	398.32	38.262	5.085	2.4426	2.4436
1974	292.08	400.43	38	5.08	2.4071	2.4369
1975	296.79	484	38	5.085	2.4016	2.3713
1976	296.55	484	38	4.78	2.5416	2.4708
1977	268.51	484	38	4.69	2.4613	2.4394
1978	210.44	484	37.054	4.83	2.316	2.274
1979	219.14	484	36.08	5.01	2.1884	2.1746
1980	226.74	607.43	36.06	5.13	2.1769	2.1412
1981	220.54	681.03	37.89	5.675	2.3041	2.1127
1982	249.05	731.13	39.96	6.495	2.3354	2.14
1983	237.51	775.75	40.32	7.78	2.3213	2.1131
1984	237.52	805.98	39.53	7.823	2.3436	2.1331
1985	238.54	870.02	39.9	7.811	2.483	2.2002

(4) = FOREIGN CURRENCY PER U.S. $