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Structure-Trade Links in Japanese Cereal Agriculture

by

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In Memory

of

"*Otoosan*"

Mr. Takashi Sumiyoshi

who inspired me to strive

for excellence in the pursuit of knowledge

Abstract

This study identified linkages between the structure of the Japanese cereal sector and Japanese wheat trading policies. A seven equation recursive econometric model was built to identify the linkages and to analyze the effects of changes in the cereal sector. Scenarios of static conditions and of increased rates of change in the exogenous variables from 1985 to 1991 were simulated.

The model linked the input structure of capital and labor use in rice and wheat production with costs of production. Estimation of the model showed that the input use of Japanese farmers does respond to economic stimuli. Rice and wheat prices are government-set based loosely on costs of production. Structural and policy variables were found to be important in determining costs of production and prices. Structural variables and non-economic factors were more effective than comparative advantage theory in explaining wheat trading behaviour.

From the results of the simulations, economic factors underlying the operation of the agricultural system, such as input prices, appear to have a greater influence on structural changes than do government policies.

The modelling approach used here appears to be more useful than the comparative advantage approach traditionally used in agricultural trade theory applied to Japan. Consequently there are many opportunities for further research to test this approach with other countries and commodities.

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"....and let us run with endurance the race that is set before us, fixing our eyes on Jesus, the author and perfecter of faith...."

Hebrews 12:1, 2.

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"I thank Christ Jesus my Lord, who has strengthened me."

I Timothy 1:12

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I. INTRODUCTION

A. Problem Definition

The present disarray of international agricultural trade has created many questions, not only about the future of agricultural trade, but also about the factors that affect agriculture and agricultural trade. Domestic policies are recognized as having an important role in agricultural trade. As the Organization for Economic Cooperation and Development (OECD) (1987) has said, "... *the border measures exist principally in support of domestic policies.*"[1] Japan is the world's largest net food importer (Anonymous, 1986) and has one of the most protected agriculture sectors in the world. For these reasons, knowledge of the linkages between domestic agriculture and agricultural trade is important. This thesis is intended to hypothesize and test for some of these linkages between the development of the structure of the Japanese cereal sector and agricultural trade.

B. Rationale for the Study

The availability of food (and hence agriculture) has been and is a concern in Japan. Until the 1960's, food shortages were a problem in Japan because Japan is an island country with a large population and a shortage of arable land. For food security reasons, the survival of a domestic agricultural industry is a priority for the government. Consequently, agriculture in Japan is treated differently from any other sector by the government.

Japanese agricultural policies are oriented toward the objective of ensuring food security for the country. This can be seen in the Japanese proposal regarding agriculture presented to the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) talks which said, "*Market forces must be harmonized with the need to guarantee food security.*"[2]

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[1] Organization for Economic Cooperation and Development (OECD), **National Policies and Agricultural Trade.** Paris, 1987.
[2] Reuters News Service, "Japan Submits Farm Trade Proposal to GATT Talks," January 4, 1988.

Food security has had many different definitions. Eicher and Staatz (1986) have defined it as "*the ability of a country or region to assure, on a long term basis, that its food system provides the total population access to a timely, reliable and nutritionally adequate supply of food.*"[3] Others (Lappe, 1978) define food security as self-sufficiency in food. Countries obtain food security through two means; one, self-sufficiency and the other, trade. Japanese agricultural policies show the importance of obtaining food security through self-sufficiency. To accomplish their food security policy, a goal for self-sufficiency levels was explicitly set from 1970 until 1985 (Roberts et al, 1981).

Agricultural policy objectives are usually intended to ensure the nation's food security and to retain agriculture as an industry for aesthetic, cultural and foreign exchange earning as well as food security reasons. Differences from country to country exist primarily in the priorities of these objectives and the means by which objectives are reached. The agricultural policy objectives combined with the definition of food security used in Japan, with the importance placed on self-sufficiency, have resulted in one of the most protected agricultural sectors in the world. Looking at the ratio of the domestic price to the international price (or net protection rate) of commodities in 1985 the protection levels for rice and wheat were 3.21 and 3.80, respectively (Table IV.1). The highly protected nature of Japanese agriculture, combined with the export success of Japanese industry, has become a source of friction in international trade relations.

The objective of retaining agriculture as an industry is synonmous with maintaining or shaping agricultural structure. This is because customarily the goal of retaining agriculture is actually a goal of retaining a certain agricultural structure. Analysis of structural change is necessary to determine the impact of agricultural policies on trade because of this connection between structure and domestic agriculture policies. Analysis of structural change involves analysis of all aspects of farm organization. Hence, the broad definition of structure, where structure is defined as the proportions of organization of output, inputs, markets, costs and

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[3]Eicher, Carl K. and John M. Staatz. "Food Security Policy in Sub-Saharan Africa" in **Agriculture in a Turbulence World Economy**, Gower Publishing Company, 1986, p. 216.

demographic factors, is used.

C. Area of Study

The Japanese goal of retaining agriculture is centered on retaining rice self-sufficiency. Because of this importance of rice in agricultural policies and the interdependence of rice and wheat production, rice and wheat were chosen for this study. The rice and wheat sectors are linked because:

1. they are two main food grains,
2. they compete for production on nearly the same land base,
3. the policies for the two sectors are interdependent.

The effects of domestic production on imports of cereals are very small in Japan due to the small percentage of yearly consumption that is accounted for by domestic production of wheat. But domestic production of cereals has a large effect on imports indirectly because of the interdependence of trade policies and domestic agricultural policies. As OECD (1987) has pointed out, "*The dismantling of border measures cannot, in principle, be disassociated from a reassessment of domestic policies and hence of the level of productive resources in agriculture.*"[4] For this reason, the rice and wheat sectors were used to test hypotheses about relationships between domestic policies, structural change and trade policies.

D. Hypotheses

The major question of this thesis is: "How do structural changes affect trading policies?" It is hypothesized that structural changes are a direct result of policies. Economic costs as measured by social opportunity cost measures, are hypothesized to be important in the determination of policies. Therefore if structural changes become less and less compatible with social opportunity costs, the policies creating those structural changes will be unsustainable in the long run. In the long run, domestic policies cannot overcome the

[4]Organization for Economic Cooperation and Development, **National Policies and Agricultural Trade**, Paris, 1987, p.23.

"*efficiency factor*" (here defined as social opportunity costs). This hypothesis implies that for a commodity which is increasing in opportunity costs, import restrictions would have to decrease in the long run. Costs would be too high (or become too high) to maintain import restrictions and the policies that encourage the shift towards higher opportunity costs. Conversely, those import restrictions would be maintained for a commodity which had relatively lower social opportunity costs or whose social opportunity costs were decreasing as the costs of import restrictions would be lower. With this hypothesis, simulations could be used to determine the future impacts resulting from the structure-trade relationship identified.

E. Objectives

There are three major objectives in this study. The first objective was to analyze the trend in social opportunity cost measures. The social opportunity cost measures are hypothesized to give an indication of trade possibilities. Social opportunity cost measures specific for the Japanese situation were developed because comparative advantage measures traditionally used were not suited to this analysis. The social opportunity cost measures were hypothesized to give an indication of trade possibilities. Historical data were used to accomplish the first objective.

The second objective was to explore likely future directions in the structural development of the Japanese cereals sector based on domestic policies. A simulation model was built to test hypothesized relationships between structural change and policies. The simulation model was run under different policy scenarios to simulate the possible future structural changes that could occur.

The third objective, to simulate the impact of various structural changes on trade, was also achieved through the use of different structural and policy scenarios in the simulation model.

F. Outline

The first chapter of this thesis describes the problem and the rationale of the approach used. Chapter II sets the framework for the study. It defines important terms and sets out the various aspects of economic theories needed as background for this work. The third chapter describes structural aspects of Japanese agriculture and the policies that affect those aspects. The fourth chapter presents the model methodology and data used. In Chapter Five, the final estimated structure-trade simulation model and the simulation results under different scenarios are discussed. The implications of the simulation results and conclusions are presented in the final chapter, Chapter VI.

G. Overview

The two interdependent sectors of wheat and rice were used in the structure-trade model. Each sector contained three equations specifying input, cost and price functions. An import function was used to model the link between structure and policies. Structural variables were the capital/labor ratio, production costs and the number of full-time farm households. Policies were represented by the acreage diverted under the crop diversion program, prices and imports.

The following conclusions resulted from the final specification of the model:

1. The behaviour of Japanese farmers does respond to economic stimuli as their utilization of inputs is determined by prices.
2. The K/N ratio was an acceptable proxy for technology, substitution and scale factors.
3. Factors other than costs of production are important in the setting of the wheat price.
4. The hypothesis that comparative advantage is the major determining factor of cereal trade and agricultural trade policies was rejected. The alternate hypothesis that non-quantifiable criteria are more important in determining agricultural trade policies was accepted. Domestic concerns and international pressures were found to be associated with agricultural trade protection and import policies.

II. BACKGROUND THEORY

A. Introduction

Economic theories of trade, production and development are necessary to study the impact of structural change in the cereals sector on agricultural trade. First, this chapter will define structure, structural change and the structural indicators that are used. Government policies are chosen after the performance of agricultural structure is evaluated. Thus evaluation of structural performance is a key link between structure and trade. For this reason, second, methods of evaluating structure and the links between structure and trade are briefly discussed. Third, economic trade theory, its development and its weaknesses, are reviewed. Comparative advantage is appealing logic in theory. However, the common methods of measuring comparative advantage are critiqued and found lacking for the scope of this study. Consequently, social opportunity cost measures are developed from basic trade theory. Fourth, economic production theory used in building the structural analysis portion of the simulation model is discussed.

B. Structure

1. Definition of Structure

The common definition of farm structure is "*the organization of productive units; the number and size distribution of firms*"[5]. This definition includes only farm size and scale. The definition of structure used here is much broader. Structure is used to describe the "*form; the mode of construction or organization* "[6]. This distinction between the two definitions is made because structure, broadly defined, is a criterion in agriculture policy decisions.

[5]Boehm, William T. "Farm Structure and a Changing Food Policy Environment." in **Structure Issues of American Agriculture**, USDA Economics, Statistics and Cooperatives Service, Ag. Ec. Report 438, November 1979, p. 263-268.
[6]**Webster's College Dictionary**. Springfield: G & C Merriam Co., 1981.

Brinkman and Warley (1983) have analyzed the proportions of agricultural organization (agriculture structure) using categories similiar to the following:

1. Input Structure: This category includes resource use, i.e. the structure of fixed factors of production (land, labor and capital).
2. Output Structure: The mix of commodities produced and economies of scale are included. The mix of commodities produced at the individual farm level is included as well as the mix of commodities produced nationally.
3. Cost Structure: The relationship of the various input cost shares as well as the shape of the cost function and of productivity are included here.
4. Organizational structure: Farm demographics, the form of tenure (renting vs. land-owning), ownership and control of resources and the type of business organization are covered.
5. Market Structure: This category includes the way in which products are sold and the types of markets operating for different commodities.

It is a large task to analyze agricultural structure completely or even just the structure of the cereals sector. Consequently, the following descriptive chapter of the Japanese cereals sector (Chapter 3), will touch only a few aspects of the structural categories. Only the output, inputs and organizational aspects of structure are incorporated in the model.

2. Definition of Structural Change

Structural change is defined as alteration in the various indicators that are used to describe structure. Structural change results in modification of the efficiency with which production activity can be carried out. For example, structural transformations are due to changes in technology, changes in the use of labor or in the accumulation of capital. Changes in efficiency over time in one aspect of structure, through feedback mechanisms cause adjustments in all other structural categories.

Structural changes can originate within the agricultural system. For example, labor-saving technological progress and the rise of farm wages relative to the prices of other inputs and output have been a factor in the decrease in labor use and in the increase of mechanization (Kuroda, 1985). Sources of structural change can also originate outside of agriculture. For example, the decline in labor use was influenced by increases in industrial wages outpacing increases in rural wages and increased employment opportunities in non-agricultural sectors *(Ibid)*. Forces of change may even originate outside of a country because of the international linking of economies through trading activities. These forces from inside and outside of agriculture may work together or in opposite directions.

3. Evaluation of Structure

Penn (1979) has stated that the actual structure of agriculture is not as important as the performance of that structure. Many different forms of structure may accomplish the same level of performance, but in different ways. Retaining a particular form for agricultural structure is a goal in itself in Japan. In this situation, Penn's statement about the unimportance of the actual structure of agriculture is false. Consequently, the criteria used to evaluate the performance of agricultural structure in Japan are different than those proposed by Penn (1979) because of the importance of the actual structure of agriculture in Japan.

The performance characteristics that are usually used to evaluate structural performance include economic as well as non-economic goals. The following performance characteristics have been proposed for U.S. agriculture by Penn (1979).

1. Quantity, quality and price of food available for domestic and foreign consumers.
2. Efficiency of resource use and contribution to national economic growth.
3. Care and preservation of the environment.
4. Relationship to rural communities.
5. Flexibility and adaptability.

The evaluation of the economic goals listed is usually straightforward. However the attainment of the non-economic goals is difficult to judge other than through the outcome of political processes.

The performance criteria used to evaluate agricultural structure in one country may be somewhat different than those used in another country. The difference will depend on the relative importance of different goals. The additional performance criterion of maintaining agriculture must be considered to adjust the above list to the Japanese situation. This non-economic criterion is one of the over-riding concerns in the evaluation of structural performance in Japan.

The non-economic performance characteristic of flexibility and adaptability is an important consideration. The concept of restructuring involves more than mere structural change as the United Nations Industrial Development Organization (UNIDO) (1981) has pointed out in the **World Industry in 1980 Report**. It also involves the adaptability, the willingness to change and the acceptance of change by the participants; i.e. the flexibility of the structure. Thus, the flexibility and adaptability of agricultural structure determine the amount of and the rate at which structural change can occur. The assumption is made that past trends are indicative of agriculture's capacity for change. Therefore from past trends, conclusions can be drawn about the present and future performance of Japanese agriculture structure.

In this thesis, non-economic criteria used in the evaluation of structure need to be considered because of the influence in Japan of the goal of maintaining an agricultural industry. The variables used in the model were chosen for their capacity to proxy for non-quantifiable and non-economic factors as well as for economic forces. Thus the hypothesis was formed that the economic measures chosen are important in the determination of policies because of their economic and non-quantifiable influences.

Usually the performance of trade (and hence the evaluation of structure) is measured through the efficiency of a country's use of its' factor endowments. Traditionally, this measurement is not done through economic variables such as costs and prices that are unadjusted for distortions. The quantitative economic measurement of "factor endowment" is difficult to accomplish (Chicholiades, 1978; Maskus, 1985). Hence, social opportunity cost measures were developed using economic variables (prices and costs) to evaluate the efficiency of resource use because of this measurement difficulty.

4. Structure-Trade Linkages

The Organization for Economic Cooperation and Development (OECD) (1987) has noted explicitly in **National Polices and Agricultural Trade** that domestic agriculture policies and agriculture trade are linked. Agriculture policies attempt to improve the performance of agricultural structure and to reach goals by the means of directing structural change. Policies, unless carefully orchestrated, can cause structural changes that may threaten the maintenance of agriculture. This pivotal role of policies creates a close link between structure and trade. As policies change, structure will change and trade will also change.

Factors other than domestic agricultural policies can cause structural changes. Structural changes initiated externally will cause a policy reaction and thus have an impact on trade. The interaction of policies, structure and trade is complicated and difficult to quantify. However, it is possible to hypothesize and to construct relationships between policies, structure and trade because of institutional arrangements in Japan that determine important economic variables (eg. cereal prices). Also production theory is explicit about the occurence of the most efficient use of resources when marginal returns (MR) are equal to marginal costs (MC) (Doll and Orazem, 1984). This concept of MR = MC has been used to develop the hypothesis that overall economic costs are weighed against policy returns in the determination of domestic agriculture and trade policies.

C. Trade Theory

1. Introduction

The basis of trade theory is the concept of comparative advantage. The theory of comparative advantage attempts to explain why and how in a competitive market world, mutually beneficial trade will occur whenever there are international differences in relative costs of production or utility (Kenen, 1985). In theory, structure is directly linked to trade via comparative advantage. The law of comparative costs or comparative advantage has been stated in many different ways. This research uses Kenen's (1985) definition: "*In a world of competitive markets, trade will occur and will be beneficial whenever there are international differences in relative costs of production*".[7]

The following critique of trade theory discusses the development of trade theory. First, Ricardian theory with its assumptions and limitations is discussed. The Heckscher-Ohlin (H-O) theory emerged from the Ricardian theory of trade. So, secondly, the H-O theory with its assumptions and limitations is evaluated. The third section critiques the methods of measuring comparative advantage that have developed from the two trade theories. The comparative advantage measures were found to be lacking, prompting the development of social opportunity cost measures. The theoretical basis of the social opportunity cost measures composes the last portion of the trade theory used in this study.

2. Ricardian Theory

The Ricardian theory of trade was the first theory to explain why trade was advantageous. The Ricardian argument for trade was that differences in labor productivity gave different relative costs of production. It is better for each country to produce the product for which relative cost is the lowest (ie. production is the most efficient), and to trade for the products they produce at a higher cost. Ricardo speculated that differences in technology resulted in cost differences (Abbott & Thompson, 1987). Ricardo assumed a single-factor (labor), constant returns to scale, two goods, two-country model. The assumption of one factor of production was a limiting factor in the Ricardian model.

3. Heckscher-Ohlin Theory

The H-O trade model used some of the same assumptions as Ricardo's model (constant returns to scale, two goods, two countries). However, Heckscher and Ohlin assumed two factors of production (capital and labor) instead of only the one factor of labor. In the

[7]Kenen, Peter B. **The International Economy.** Englewood: Prentice-Hall, 1985, p. 17.

Ricardian model, production functions were allowed to differ, while identical production functions were assumed in the H-O model. Other additional assumptions were: identical production functions among countries for identical commodities, homogeneity of labor supplies and the international immobility of resources (Baldwin, 1979). As a result of these changed and additional assumptions, the relative factor endowments of capital and labor in each country determined the production possibility frontiers. Consequently, the H-O model concluded that in addition to differences in technology propounded by the Ricardian theory to drive trade, that relative factor endowments were important determinants of trade.

Problems were discovered in the empirical application of the H-O theory. Leontief found that United States trade did not use the factor proportions predicted by the H-O trade theory. Attempts to explain the Leontief paradox prompted the discovery of the following inconsistencies in H-O theory. It was found that the presence of reversals of factor intensity in production resulted in biased findings (Minhas, 1962). The definition of factor abundance used was discovered to alter the results of an analysis (Chicholiades, 1978). This definition is very important because in H-O trade theory, factor abundance determines the goods in which a country will have a comparative advantage. The version of the Hecksler-Ohlin theory tested (factor-content or commodity version) was found to change the application of the Heckscher-Ohlin theory (Chicholiades, 1978). Natural resource based industries were also found sometimes to cause inconsistent results (Ball, 1966 and Naya, 1967). Differences in the quality of factors (such as the difference in labor quality due to education) were found to be important. Thus the conclusions from H-O theory were found to be valid only under strict assumptions.

4. Empirical Applications of Trade Theory

The Heckscher-Ohlin theory has been used empirically in two ways. The theory can be tested or comparative advantage can be measured. These two applications of trade theory and their limitations will be described in the following section.

a. Testing H-O Theory

Three independent measures of a country's trade, factor intensities in production and the factor endowment of a country and of the world, are needed to test the Hechschler-Ohlin theory. All three measures must be independent for a logically complete test (Maskus, 1985). One limitation in attempting a test of H-O theory is that these three kinds of data are difficult to gather and measure. A second limitation is that a test of the H-O theory requires data from two or more countries (Leamer and Bowen, 1981). Thus a test of the Heckscher-Ohlin theory was not found applicable for this study because of the difficulty in collecting the three types of data for one country.

b. Measurement of Comparative Advantage

The second empirical application of trade is in the measurement of comparative advantage. The two ways used to study comparative advantage are revealed comparative advantage measures and domestic resource cost measures. These two methods of measurement stem from differing assumptions on the link between comparative advantage and trade. The revealed comparative advantage measure assumes trade occurs according to comparative advantage and thus that there is a direct link between comparative advantage and trade. In contrast, the assumption underlying direct resource cost analysis (DRC) is the opposite. It is assumed that trade might not occur according to comparative advantage and therefore it is necessary to measure production costs before trade.

i. Revealed Comparative Advantage Measures

The difference between empirical data and theory was one of the reasons why the measure of revealed comparative advantage was developed (Hillman, 1980). It was to include non-price factors such as differences in quality and reputation and servicing. In the UNIDO (1982) study of revealed comparative advantage, three comparative advantage measures are outlined.

The first is the distribution of exports of manufactures among commodity groups or the share in total exports of manufactures (2.1). This share can be described by:

$$(2.1)\ S_j^i = (X_j^i / X_m^i \times 100)$$

where:

S_j^i = share in country i's total exports of commodity j (%)

X_j^i = value of country i's exports of commodity j.

X_m^i = value of country i's total exports of m manufactures.

The second comparative advantage measure (NX_j^i) examines the relationship between exports and imports of a commodity or commodity group and gives net exports as a percentage of total trade.

$$(2.2)\ NX_j^i = (X_j^i - M_j^i / (X_j^i + M_j^i) \times 100$$

where:

NX_j^i = net exports of commodity j in country i (%)

M_j^i = value of country i's imports of commodity j.

X_j^i = value of country i's exports of commodity j.

The third comparative advantage measure (E_j^i), the revealed comparative advantage measure developed by Bela Balassa (1965), is an export performance indicator. This method of comparative advantage measurement was hypothesized by Belassa (1965) to eliminate the difficulties in quantifying factor inputs, differences in efficiency and non-price factors in the production process because the structure of exports includes the effects of all of these factors. An index of the revealed comparative advantage of an industry in different countries is created by examining the specific commodity's share of a country's exports (X^{ij}/X^{im}) in relation to the commodity's share of world exports (X_{wj}/X_{wm}).

$$(2.3)\ E_j^i = \frac{X^{ij}/X^{im}}{X_{wj}/X_{wm}}$$

where:

E_j^i = export-performance ratio

X^{ij} = value of commodity j exports in country i

X^{im} = total (m) exports of country i

X_{wj} = value of commodity j exports in the world (w)

X_{wm} = total (m) exports in the world (w).

The revealed comparative advantage measure has been used for exports of manufactured goods. It would be difficult to support its' use for agricultural goods for a number of reasons. For some agricultural commodities, (e.g. rice), the production traded on the world market is only a small percentage of world production (Slayton, 1983). Sometimes domestic agricultural production is not exported (e.g. Japan). Using import levels in measures of comparative advantage is not done frequently, if at all, because *import levels are greatly influenced by the system of protection used in a country.*[1] These facts can create a bias in the revealed comparative advantage measure.

The implicit assumption in Belassa's revealed comparative advantage measurement is that the theory of comparative advantage does hold in reality and thus there is a direct link between comparative advantage and trade. Belassa's measurement does not consider the effects of trade barriers, domestic support measures or domestic preferences on a country's export mixture. If the term comparative advantage is used to be synonymous with trade, then Belassa's measurement is an accurate index of a country's success (or lack of it) in the development of an exporting industry in relation to other countries. But it is not a measure of Ricardian comparative advantage which relates to structure. Also this traditional approach of analyzing revealed comparative advantage has been found to have biased results and produce an incorrect ordering of countries (Yeats, 1985). The greatest strength of the revealed comparative advantage measure is the relatively light data requirements.

[1]United Nations Industrial Development Organization. **Structural Changes in Industry**, United Nations, New York, 1981, p. 24.

ii. Direct Resource Cost Measurement

The second method of measuring comparative advantage, resource cost analysis, also called net social profitability or domestic resource costs analysis, attempts to measure the Ricardian concept of comparative advantage. It measures the comparative cost of producing a commodity measured in pretrade relative prices. It is the traditional method of comparative advantage measurement used in agricultural studies.

Resource cost analysis tries to correct for distortions (e.g. externalities, government intervention) from the ideal economic situation. Net social profitability analysis attempts to measure the production cost of a commodity in social prices which reflect the social opportunity costs of production. Net social profitability has been defined as:

"the net gain (or loss) associated with the economic activity when all commodity outputs produced and material inputs and factors of production employed are evaluated at their social opportunity costs (through the use of shadow prices) and when all external effects on the domestic economy are given a social valuation and included directly in the measure." [9]

The domestic resource cost measure of comparative advantage has weaknesses that stem from the assumptions that must be made before the measure may be calculated. The measure's assumption of a perfectly competitive, undistorted market is unsupportable. A second problem with assumptions is that in reality, market prices do not equal shadow prices. Therefore, shadow prices must be estimated. To estimate shadow prices all inputs must be classified into tradeable or primary domestic factors. Often it is difficult to make a distinct classification of inputs because to classify inputs into these two categories requires knowledge of the input-output production chain of each non-tradeable non-primary domestic factor input, that requires large amounts of data. If not enough is known about the factor production process an assumption about the

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[9] Pearson, Scott R., Narongchai Akrasanee, and Gerald C. Nelson. "Comparative Advantage in Rice Production: A Methodological Introduction," **Food Research Institute Studies**, Vol. XV, No.2, 1976, p.,128.

shadow price valuation must be made. This assumption can weaken the robustness of the resulting measure of comparative advantage. Also, shadow prices may not account for market problems and social policy distortions. The third problematic assumption is that "*all external effects on the domestic economy*"[10] must be given "*a social valuation*",[11] which is difficult and sometimes a nearly impossible task. It has also been argued by Yeats (1985) that resource cost analysis, like revealed comparative advantage measures, can be biased and produce an incorrect ordering of countries.

The three applications of comparative advantage reviewed here were inadequate to enable the application of comparative advantage theory to the Japanese situation. The data required are often unavailable for direct resource cost measures. Thus data and theoretical difficulties prevent a conclusive test of H-O theory. Revealed comparative advantage and direct resource cost measures have handicaps when used in agriculture. Revealed comparative advantage measures are not appropriate in Japan because of the self-sufficiency nature of Japanese agriculture. Social opportunity cost measures have been developed for this study for the above reasons.

5. The Applicability of Trade Theory to Agriculture

Agriculture has been an industry in which, historically, trade theory was thought not to apply. Most trade studies have been done for manufactured commodities. Agriculture exhibits many of the characteristics previously mentioned that tend to invalidate the predictions of trade theory. In the following paragraphs, the deviations of agriculture from theoretical assumptions are outlined.

The Japanese agricultural industry, which invariably has government interference, operates in a non-competitive market. The Japanese cereal sector is a prime example of government intervention in market operations. Other characteristics of agriculture that cause violations of the H-O theory are that agriculture is a resource-based industry and factor intensity reversals are common. Consequently, traditionally agriculture commodities have been

[10] *Ibid*, p.128.
[11] *Ibid*.

excluded from trade theory analysis (Abbott and Thompson, 1987).

The traditional trade model has two factors of production. In agriculture, the importance of land, a third factor of production, can not be overlooked. Three factor trade models are being developed (Abbott & Thompson, 1987), but have not yet been empirically tested. Also one of the major factors affecting production, weather, is always a stochastic variable. Hence it is not strictly true that in agriculture, factor abundance determines production.

Three conclusions may be drawn from this evaluation of the application of trade theory to agriculture in Japan. Firstly, although the theory of comparative advantages is intuitively appealing, the empirical application and evaluation of comparative advantage in Japanese agriculture is more difficult. Secondly, in Japanese agriculture, a test of trade theory gives inconclusive results because of agriculture's deviations from theoretical assumptions. Thirdly, the effects of policies are not considered in traditional analysis using trade theory. The causative forces (i.e. policies) behind Japanese trading behavior need to be studied because of the government controlled nature of the cereals sector.

6. Social Opportunity Cost Measures

The two social opportunity cost measures developed here do not attempt to measure the theoretical concept of Ricardian comparative advantage. Instead, they measure the relative efficiency of resource use and the production advantage of one agricultural commodity relative to another within Japan. One measure also estimates gains from trade. All of the measures used account for market and policy distortions by using components that reflect those distortions. All these measures originate within economic theory.

Social opportunity costs (SOC) may be defined as the foregone returns to society of the best alternative use of resources. The two social opportunity cost measures used in this study calculate the opportunity cost to the Japanese society of the production of wheat instead of rice.

The first measure of social opportunity costs is the collection of cost of production comparisons (SOC1). This measurement is used to establish the position of the production possiblity frontier (PPF) of commodity pairs in relation to the origin. The position of the production possibility frontier depends on factor endowments and the production functions of the two commodities (Chacholiades, 1978). Changes in the production possibility frontier (reflected in SOC1) show that either factor endowments and/or production functions have shifted.

SOC1 measures opportunity costs as it shows the difference in the amount of resources that each commodity requires. Input prices are subsidized in Japan. Hence, this cost of production measure reflects not only economic efficiency but also society's willingness to support agriculture. By comparing the cost of wheat to the cost of rice over time, it is possible to see if wheat has become more cost efficient, relative to rice.

If the PPF moves outward in a parallel fashion for a given factor endowment (Figure II.1), then costs have decreased equally for all commodities. But if the PPF moves disproportionately (Figure II.2), one commodity is becoming comparatively more expensive. Unequal advances in technology, different mixes of inputs and many other factors can cause disproportionate movement in the production possibility frontier.

The second social opportunity cost measure (SOC2) uses relative prices. It is assumed that the price of wheat relative to that of rice is a measure of opportunity cost. In Japan, rice is the crop prefered by producers, therefore, it was chosen as the numeraire crop. The amount of extra income from rice production that must be foregone to produce another unit of wheat is expressed in SOC2. This domestic price ratio is the opportunity cost of production for the farmer. The international price ratio is the opportunity cost for the country. By comparing the domestic price ratio to the international price ratio, the possible gains from free trade that Japan is foregoing by distorting its domestic price ratio away from the international price ratio are measured. Trade theory is explicit in its explanation that a country will gain from trade only if the international price ratio is different from the domestic price ratio. The domestic price ratio compared to the international price ratio is the second opportunity cost

Figure II.1: Effects of an Equal Cost Decrease with Equal Resource Endowments

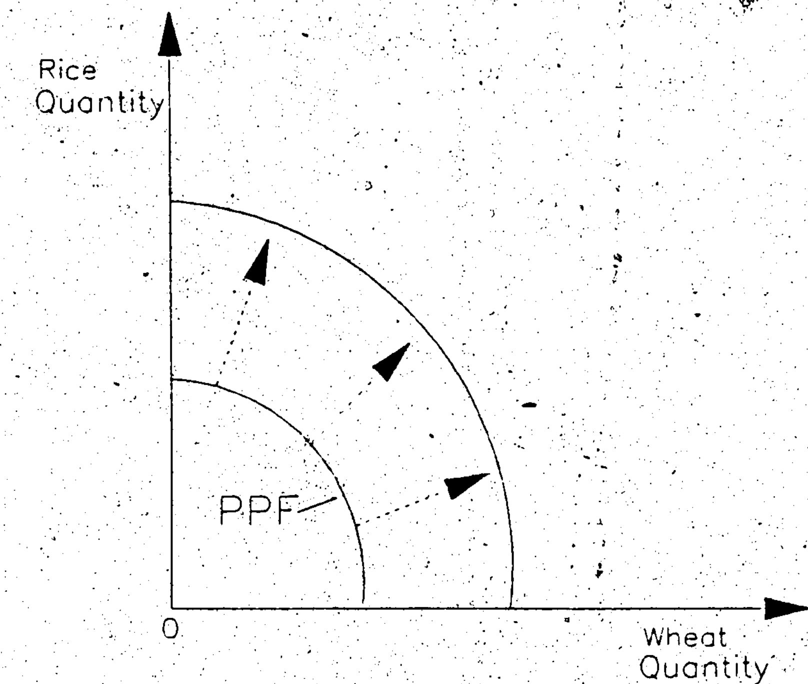
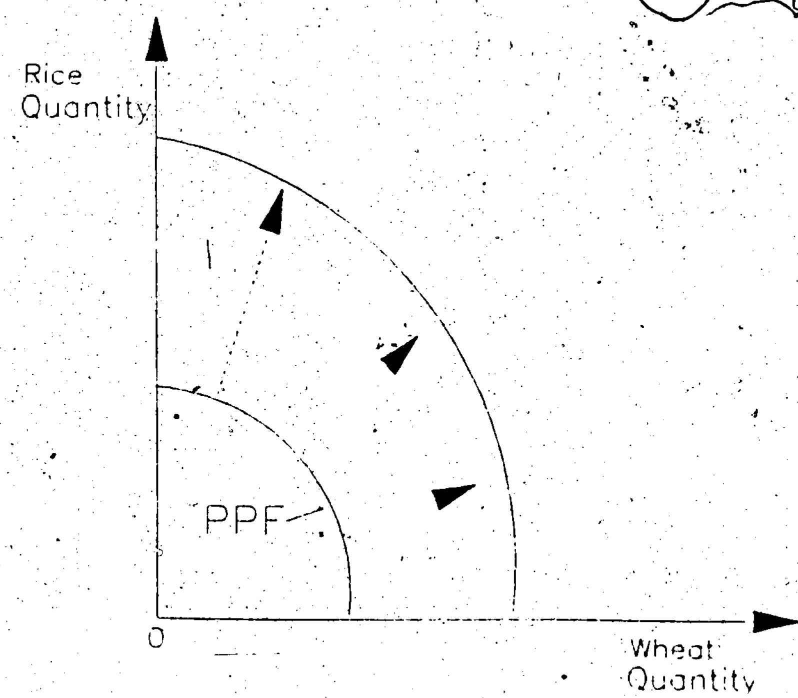


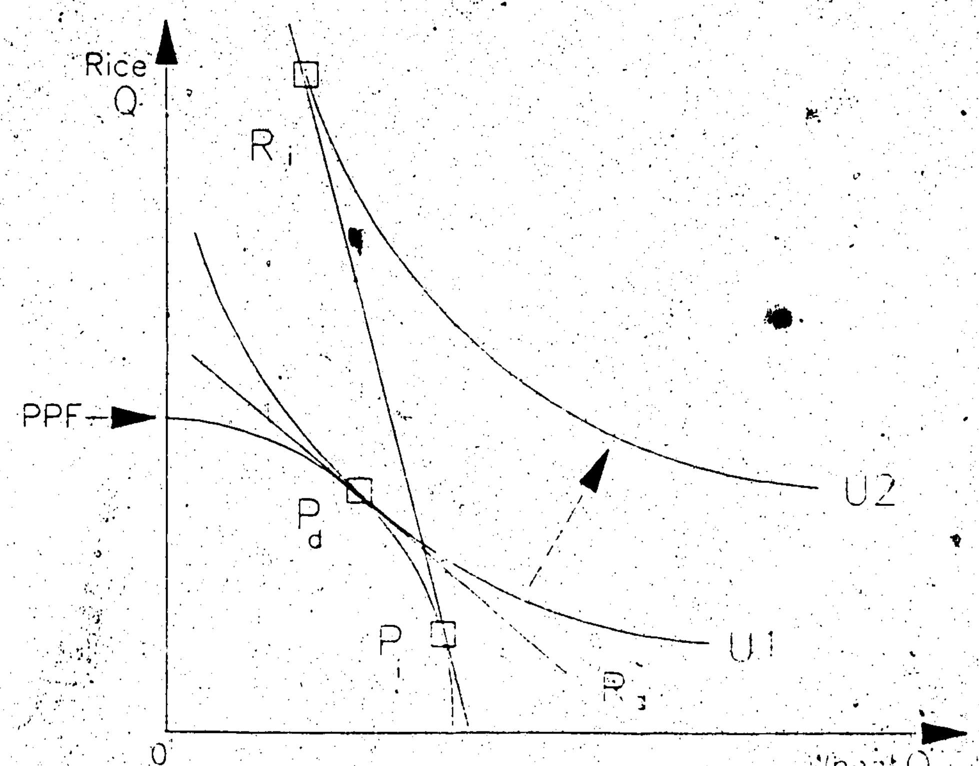
Figure II.2: Effects of an Unequal Cost Decrease with Equal Resource Endowments



measure (SOC2).

The economic rationale for this measure is illustrated in Figure II.3. The high relative domestic price of rice compared to wheat is shown by P_d. The international price ratio is represented by line P_i. Both P_i and P_d give the slope of the lines (R_d and R_i) that are tangent to the production possibility frontier (PPF) at P_d and P_i, respectively. The production possibility frontier (PPF) shows the combinations of rice and wheat that Japan can produce with her given resources. Given this production possibility frontier, Japan can move to a higher indifference curve by adopting the international price ratio rather than its domestic price ratio. This difference between indifference curves illustrates the distortion caused by the high internal price ratio.

Figure II.3: Social Opportunity Cost Measure 2



This second measure when calculated over time determines if social opportunity costs have been increasing or decreasing. If opportunity costs are increasing then Japan is misallocating more and more resources and production is becoming more costly. It is postulated that those policies that cause increasing opportunity costs will only be sustainable in the long run to the point where marginal social opportunity costs are equal to the marginal returns to society. This point cannot be identified. However, it is hypothesized that policies that cause increasing opportunity costs will become progressively less sustainable in the long run.

D. Model Choice and Production Theory

A simulation model was chosen to accomplish the objectives of this study. A simulation model accommodates the testing of linkages between structure and policies. Also, the individual effects of a change in a parameter on the entire system can be seen. Institutional relationships unique to the Japanese controlled cereal marketing system were used in the construction of the simulation model. Production theory has also been used to establish the relationships between structural variables and policies in the model.

A production possibility curve (also called opportunity curve) is derived from the production functions for the two commodities. A production function represents the relationship between inputs and an output. It specifies the quantity of an input required to produce a certain output. A typical production function is specified as:

$$Y = f(K, N, L)$$

where: Y is output, K are capital inputs, N is labor, L is land.

The production possibility curve uses information about the organization of inputs to determine the various combinations of products that can be produced with a given set of resources. Consequently, the production possibility frontier is affected by the same factors that affect production functions. These factors include such items as a change in productivity or a change in technology, or a change in the level of inputs. Changes in any of these circumstances have structural implications.

E. Conclusions

It is necessary to appreciate the economic theory behind the setting of this thesis topic and model construction. For this reason, broad definitions of structure and structural change were given to set the framework for the evaluation of structure and trade policies in Japan. The critique of theoretical and empirical developments in trade theory provided a background understanding for the two social opportunity cost measures developed here. The elements of production theory used in the construction of the model were outlined to complete the theoretical background for this study.

III. DESCRIPTION OF JAPANESE AGRICULTURE

A. Introduction

Along with the rapid growth of the Japanese economy in general, the structure of Japanese agriculture has changed in the last 25 years. Traditionally, agriculture is a sector that changes slowly. However, strong "pull" factors from the industrial sector and "push" factors from inside agriculture have accelerated the process of change (Kuroda, 1985). Agricultural policies have been instrumental in this rapid structural change.

The changes in the structure of Japanese agriculture will be described in this chapter using a systems analysis framework. A system has been defined as "*a complex set of related components within an autonomous framework*" [12] The underlying principle of systems analysis is holism which is the reasoning that the whole system explains more performance than does the sum of the individual system components.

Important parts of a system are the system boundaries, the interrelationships between the system components, and the environments surrounding the system. These parts of the Japanese agricultural system are identified in the general description of the Japanese agricultural system. Following this general description, the role of the Agricultural Basic Law and the resulting policies is outlined. The causal agricultural policies need to be known to understand the structural changes that have occurred. Thus this chapter attempts to describe the structural changes that have occurred in agriculture from 1960 until 1985, in light of the policies that have helped to cause these changes. The major policies in four of the structural categories (market, organizational, output and input) with the resultant structural features are detailed; first, in general and then in wheat production.

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[12] Dent, J.B. and M.J. Blackie. **Systems Simulation in Agriculture**. London: Applied Science Publishers Ltd., 1979.

B. The Japanese Agricultural System

All agricultural systems operate within economic, political, social and biological environments. But agricultural systems differ by the portion of each environment that is within the system's boundaries. Everything within a system's boundaries is controllable by the system.

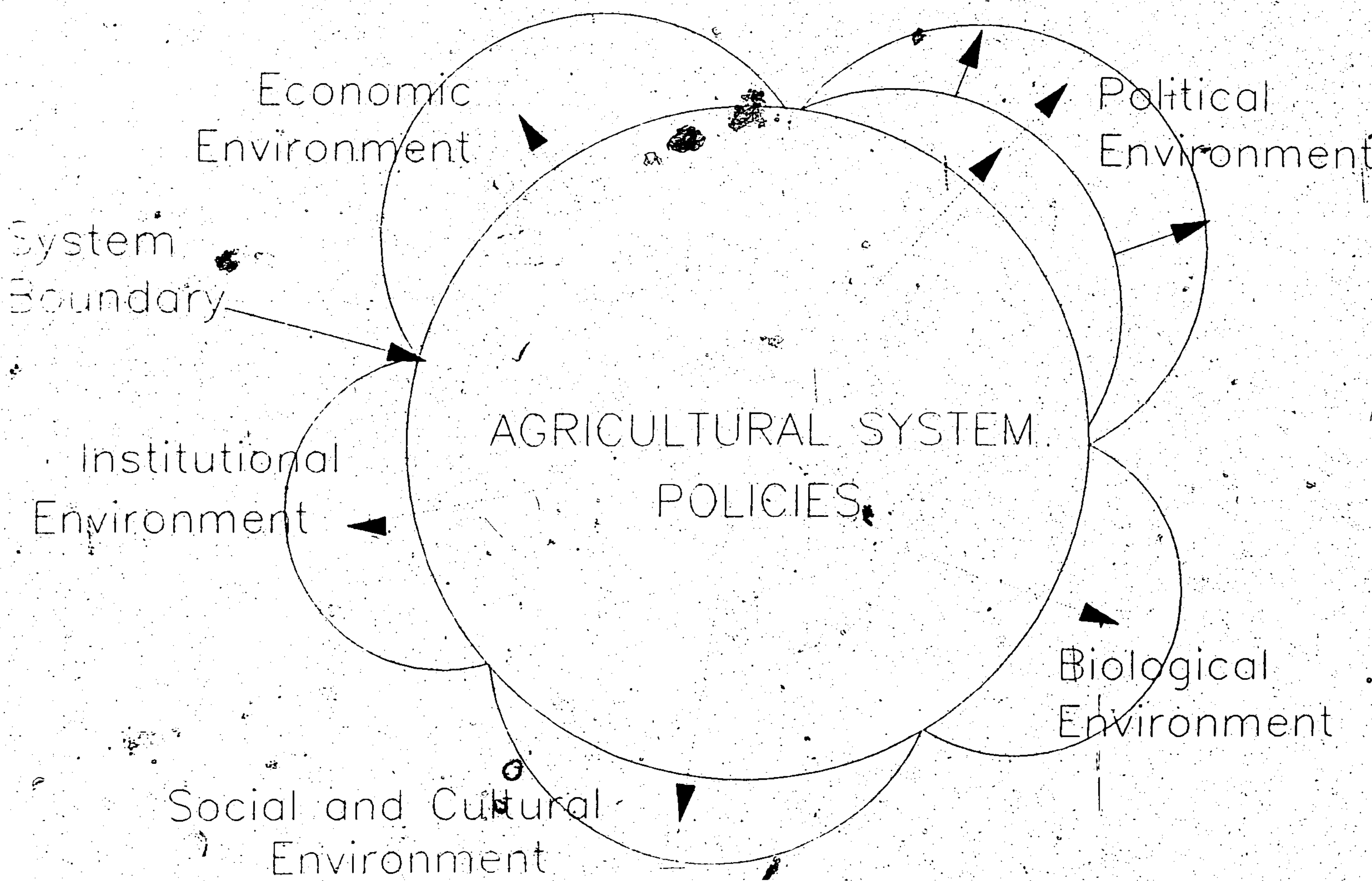
Rice holds a pivotal position for agricultural policies and most family farms. Rice holds this pivotal position in the agricultural system because rice producers have managed to expand the boundaries of the rice production system to control more of the cultural, biological, political and economic environments. The Japanese agricultural system, is represented in Figure III.1.

Historically, Japanese culture and basic survival have been tied to rice cultivation. Rice has been the primary food for the Japanese for many centuries. The Japanese realized their food security vulnerability because they lack natural resources. Consequently, the socio-cultural environment promotes the maintainence of agriculture and self-sufficiency. Rice is important for biological reasons. Rice has higher land productivity (yield/acre) than any other major cereal grain. Thus even with her shortage of land, it is possible for Japan to be self-sufficient in rice production. The rice production system has expanded into the biological environment with technological developments that improve control of growing conditions. Control over the political environment also has been achieved. Depopulation since World War II has caused a rural vote to have much more weight than an urban one because electoral districts are still mainly based on the post-War population distribution.

The expansion of the agricultural system boundary into the economic environment has been hypothesized. [13] The present agricultural structure with its dependence on rice production grew intertwined with industrial development. This interdependence is evident when the high percentage of the farming population working outside of agriculture is analyzed (Table III.1). The phenomenon of farm families who depend on off-farm income sources is much larger in Japan than in other industrialized countries (e.g. USA) (Kada, 1980). Consequently, the

[13] Interview with Dr. Junichi Sakai, professor, Department of Agricultural Economics, Tohoku University, Sendai, January 1987.

Figure III.1: Schematic Representation of the Japanese Agricultural System Policy Strategy of Gaining Control over Various Environments



agricultural structure based on rice is thought to be important for economic stability.

Agricultural policies operate within the agricultural system and affect the system's contents and the system's boundaries. Thus agricultural policies become more powerful as the boundaries are expanded into different environments because they have a wider base of operation. Agricultural policies are responsible for controlling the flow of materials, i.e. trade, across the system's boundaries.

Table III.1: Organizational Structure - Types of Farm Households, 1960-1985

Year	Total Number ('000)	Full-Time ('000)	Type I Part-Time ('000)	Type II Part-Time ('000)	Part-Time of Total (%)
1960	5985	1853	1890	2242	69.04
1961	5906	1613	1899	2394	72.69
1962	5829	1503	1945	2381	74.22
1963	5750	1379	1951	2420	76.02
1964	5667	1212	1965	2490	78.61
1965	5577	1149	1934	2494	79.41
1966	5498	1151	1833	2514	79.07
1967	5419	1151	1679	2589	78.76
1968	5351	1071	1666	2613	79.97
1969	5342	928	1740	2709	83.28
1970	5402	845	1814	2743	84.36
1971	5261	799	1566	2896	84.81
1972	5170	743	1404	3023	85.63
1973	5100	675	1303	3122	86.76
1974	5027	628	1222	3177	87.51
1975	4953	643	1112	3078	84.60
1976	4891	659	1002	3231	86.55
1977	4835	643	931	3261	86.70
1978	4788	620	884	3284	87.05
1979	4742	595	844	3303	87.45
1980	4661	587	837	3036	83.09
1981	4614	580	829	3205	87.43
1982	4567	599	774	3194	86.88
1983	4522	596	731	3195	86.82
1984	4473	605	689	3179	86.47
1985	4376	626	775	2975	85.69

Source: Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. **Statistical Yearbook of the Ministry of Agriculture and Forestry (Nourinshou Toukei Hyo).** Tokyo: various issues.

C. Agricultural Basic Law

After World War II, growth was more rapid in non-agricultural sectors than in agriculture, creating a gap in the standard of living between the rural farming population and the urban population. The Agricultural Basic Law was enacted in 1961 to assist in decreasing this rural-urban gap. The philosophy behind the Basic Law expressed by Ogura (1967) was that parity was important. However, Ogura did not define parity but the concept was related to incomes and living standards. In the Agricultural Basic Law, the government planned to implement policies to accomplish the following objectives:[14]

1. To adjust the production of agricultural commodities to the changing demand and selectively to expand agricultural production;
2. To increase agricultural productivity and agricultural production through effective use of land and the development of agricultural technology;
3. To improve the structure of agriculture through enlarged farm size and consolidation of farm land, the introduction of livestock and farm mechanization, and the improvement of farm management;
4. To rationalize the marketing of farm products;
5. To stabilize the prices of farm products and to protect agricultural income from unfavorable production conditions;
6. To rationalize the production and the distribution of agricultural inputs and to stabilize their prices;
7. To provide adequate alternative opportunities and training for employment outside of agriculture for those who wanted to leave agriculture and to develop the rural population by training them in modern methods of farm management;
8. To improve the welfare of the agricultural population.

Two main differences in the Agricultural Basic Law from previous agricultural policies was the selective expansion of agricultural production with the emphasis on equalizing supply

[14] This statement of the objectives of the Agricultural Basic Law was adapted from Inouye (1978) and Ogura (1967).

and demand, and the improvement of agricultural structure (Inouye, 1978). The agricultural products for which production was to be expanded/curtailed initially were chosen based on their income elasticity (Tsuchiya, 1976). These two new focuses of the Agricultural Basic Law were aimed primarily at changing the organizational and output aspects of structure. However, the policies enacted through the Agricultural Basic Law to achieve these goals have affected all aspects of the agricultural structure in Japan.

D. Policies and Their Effects on Organizational Structure

Many changes have occurred in the organizational structure of Japanese agriculture since 1960. Policies have attempted to direct these changes since 1970. These policies to change organizational structure have met with limited success. Policies to change farm demographics and policies to encourage different land tenure patterns have been relatively unsuccessful. Changes in farm organization have been more influenced by economic forces outside of agriculture than by specific agricultural policies. Some of the specific policies to change organizational structure are discussed in the following section.

Demographic Policies and Their Performance

The Japanese define the operation of farms to be by a "*farm household*" rather than by a "*farmer*". Appendix B contains the Japanese definition of part-time and full-time farm households. The change in the organizational structure of part-time farmers has been very rapid. There was a rapid decrease in full-time farm households until 1974 and there has been a slight reversal in the trend since then. Overall, full-time farm households have decreased 64.4% from 1960 to 1985. Part-time farming households have increased to 86% in 1985 of total farms from 69% in 1960 (Table III.1). From studies done on farming households, the conclusion is that many farms are run by the wife and grandparents with the head of the household having a full-time off-farm job (Kada, 1980).

In 1985, 21% of these part-time farm households earned the majority of their income from farming (classified as Type I part-time). The remainder of part-time households (Type II part-time) which comprise 79% of part-time, or 68% of total farm households, depend on off-farm sources for the majority of their income. However, some opinions are that approximately 70% of total part-time farm households need the supplemental income from agriculture to maintain an adequate standard of living.[15]

Policies did not differentiate between the part-time and full-time farm households from 1960 until the mid-1970's. Thus the organizational structure of Japanese agriculture became characterized by small farms (average size of 1.2 Ha in 1985) run by part-time owner-operator farm families. This structure resulted from the combination of the historical organization of agriculture and post-World War II land reforms.

Part-time farm households are not segregated by commodity production in statistics. However from observation of farms, a higher percentage of farmers in rice production were part-time compared to farmers in wheat production. It is easier to be a part-time rice farmer than a part-time wheat farmer because of the machinery and labor requirements in relation to the financial returns of the two crops. Changes in the organizational structure have affected the output structure. The pattern of double-cropping of rice and wheat has switched to a single-crop of rice as the percentage of part-time farm households has increased.

Recently, policies have attempted to reverse or slow down the development of the part-time farming nature of farm organization. In 1976 the government introduced measures in its Crop Diversion Program to attempt to influence organizational structure. Subsidy payments that were an additional 18% of the basic crop diversion payment were offered to farmers that organized their production in a cooperative manner. This subsidy attempted to encourage the Japanese agricultural tradition of farmers working together. Not only the crop diversion program, but other policies (such as subsidized loans) offered extra subsidies for cooperative farmers.

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[15]Interview with Dr. Junichi Sakai, professor, Department of Agricultural Economics, Tohoku University, Sendai, January 1987.

Although there are two types of cooperative farming, joint machinery use and cooperative land use, government emphasis is on cooperative land use. It is hoped that through the extra incentives, cooperative land use may result in economies of scale and the encouragement of full-time farmers. The cooperative farming practiced is a type of rental system. Thus these policy incentives attempt to change the owner-operator tenure system, the operational size of farms as well as the demographics of organizational structure. Cooperative farming and other policy efforts to change farm demographics and land tenure to achieve economies of scale has had limited success even with the subsidy incentives.

The following is an example of how cooperative farming is organized. Part-time farmers and a full-time farmer form a business group. This business hires the full time farmer, paying him a wage and rental for his machinery. The part-time farmers pay for work done (similiar to custom contracting) and then receive all of the produce from their land. Since this business is the full-time farmer's livelihood, this situation encourages him to adopt the newest technology and to work to obtain the highest yields and the highest productivity. If yields would decrease and the part-time farmers feel they could produce more by working the land themselves, the cooperative group would disband and the full-time farmer's source of livelihood would disappear.

Farm Size Policies and Their Performance

Part of the problem in attempting to change the organizational structure of farms is that throughout history, farms in Japan have been small. This was a result of climatic and geographic factors and the subsistence nature of agriculture. Japan is generally characterized by a monsoon climate and mountainous topography. In this environment, paddy fields are able to conserve the large quantity of water that falls at one time for productive use and prevent land erosion. The small scattered paddy rice fields were a means of risk management but required all agricultural work to be done by hand. In either a flood or a drought, with plots of land varying distances from the permanent water source, a farmer was assured that some portion of his crop would be productive. The small field size also facilitated the achievement of maximum productivity by allowing transplanting and flooding in one day.

This historic organizational structure of small farms was made permanent by the land reform after the Second World War. Prior to World War II, the small farm size was a result of labor constraints, not land ownership. Land was mostly owned by landlords and farmed by tenants. The land reform was one of the most sweeping in the world's history as one-third of the cultivated land in Japan was affected (Ogura, 1980). Absentee landlords were eliminated and limits were placed on the amount of land a farmer could own and work. The maximum area of cultivated land was 12 hectares in Hokkaido and 3 hectares in the rest of Japan. As well as cementing in the small farm structure, the land reform left the fear that unless a land-owner farmed his land, the land could be lost.

Various policies have attempted to reverse these adverse effects of the land reform by encouraging the reorganization of the structure of land use in agriculture. The policies used have been the land improvement and consolidation program, changes in land laws and the encouragement of cooperative farming previously mentioned.

The land improvement and consolidation program, enacted in the Land Improvement Law in 1949 and amended greatly over the years has altered the dispersion and topography of land holdings. A Ministry of Agriculture, Forestry and Fisheries survey in 1977 reported that 25% of cultivated land had been consolidated into plots of 20 ares (0.2 Ha) or more (Sekiya, 1981). The concept behind the land improvement program is that land productivity is closely linked to the physical structure of land. Thus by enlarging field sizes, improving drainage, etc. land productivity would increase. This program has been used in conjunction with the crop diversion program. The changed topography of the land is evident in rural areas. The present land improvement program involves land reclamation, land improvements such as improving drainage and slope, and the rebuilding of fields into sizes and shapes that are more conducive to the use of machinery.

Of the total subsidies for the land improvement program, 20% are used for upland crop fields and 80% are used for rice paddy fields. Subsidies from various levels of government cover 80% of the cost of these land improvements, with the farmer paying the remaining 20%. Prefectural governments cover between 25-30% of the total cost of improvements with the national government contributing for 50-55% of the costs. The importance to the government of changing the organizational structure of agriculture can be seen from the large portion of the government budget devoted to the program. Land improvement subsidies currently comprise approximately 30% of the national government expenditures for agriculture.[16]

Because of the large benefits to the farmer with the limited costs, the land improvement program has met its objective of changing the organizational structure to consolidate land holdings. However the program has met with limited success in terms of altering the operating size of farms. Since the Agricultural Basic Law was implemented in 1960, average farm size has only increased from 1.0 hectares to 1.2 hectares in 1985.

The second policy change to reorganize land use was a change in the legislation governing land use. Previous to 1970, one obstacle hindering changes in organizational structure to attain economies of scale was strict laws pertaining to the rental and working of agricultural land. These laws were slightly changed in 1970 to ensure some of the rights of a landlord. However, laws were still too restrictive to encourage the spread of land rental. For example, until exemptions from the standard rent system were allowed in 1980, there was no possibility of any increase in rental income for landlords. Also cancellation of lending contracts was very difficult. It required the permission of the prefectural governor (equivalent to the premier of a Canadian province). Thus it is not surprising that in a Ministry of Agriculture, Forestry and Fisheries survey around 1978, only 5% of cultivated land was under lease (Sekiya, 1981). This percentage has not increased greatly in recent years.

[16]Interview with Dr. Taira Yori, professor, Department of Agricultural Economics, Kyoto University, Kyoto, January 1987.

Factors from outside of the agricultural sector have had a large effect on the organizational structure of agriculture. The forces of increased demand for land for housing and industrial uses, combined with the attractiveness of land as a tax shelter for landholders, encourage speculation on agricultural land. Thus many people hold agricultural land for benefits not related to agriculture. These motives combined with a declining labor force willing and able to work in agriculture (Kuroda, 1985), and inadequate economic incentives for agricultural production, in spite of the subsidies, have resulted in under-utilization of agricultural lands. Especially in areas remote from markets (such as the northern island of Hokkaido), it is sometimes uneconomic to produce any crops at all. Thus despite the focus of the Agriculture Basic Law on changing the organizational structure of agriculture, factors other than agricultural policies seem to have had and continue to have a great influence on organizational structure.

E. Polices and Market Structure

The market structure of the cereals sector has had a long history of government intervention. Historically in Japan, the major food grains were rice, wheat and barley. Barley was the substitute grain for rice in times of rice shortage. Barley was cooked in the same manner as rice, but considered a highly inferior substitute. In recent years, wheat has become much more important than barley as a food grain. The market structure is totally controlled by government policies because of the importance of the cereals sector to food security.

Rice

The history of the rice marketing policies that are in effect today began in 1921 with the enactment of the first Rice Law. This gave the government the power to operate the purchasing, sale, storage and processing of a set quantity of rice. Since that time, government involvement in rice commerce increased to the point where in 1942 the Food Control Law legislated that all rice was to be bought and sold by the government. The government monopoly over the marketing of rice remained until 1969. The 1969 change of the market structure to establish an independent rice market has had a large effect on the output structure. In the independent rice market there is a premium for high-quality and for popular varieties of rice. The price premium has affected rice production patterns by changing production to high quality rather the high yielding varieties. The importance of the independent rice market has been growing.

The government monopoly in rice marketing had been complemented by government control over the setting of rice prices. A two price system is used with the high producer price set separately from the lower consumer price. In recent years the government has been attempting to shift the costs of rice support to consumers by narrowing the gap between the two prices (Roberts *et al*, 1981).

The high and controlled producer price of rice is used as the main form of income support for farmers. The rice price is set at a level that is thought to "*secure the future production of rice*" (Ogura, 1980) for food security reasons. The rice price is set based on a cost and income compensation formula at a level to cover the production costs of 80% of farmers. The returns from rice have continually exceeded the actual costs on average (Roberts *et al*, 1981). The labor costs used in the calculation of the rice price are based on an average industrial wage rate. The problem with the calculation method is that various valuing methods for costs and industrial wages can be used. Thus the rice price is influenced as much by the strong political clout of farmers as by the actual formula (Balaam, 1987).

All forces that could affect the rice supply and demand situation are under government control. The government Food Control Agency is the only legal importer of rice. This total government control of both the type of market and pricing has given the government the ability to achieve structural changes through market forces. However in the past, marketing policies were not coordinated with other policies. For example, supporting the income of farmers through rice prices has encouraged the output structure to concentrate on rice production. At the same time, the crop diversion program was attempting to diversify output away from rice production. The government rice policy programs to support prices and to eliminate imports have accomplished their purpose of transferring income from consumers to producers (Otsuka & Hayami, 1985), even with this lack of coordination of policies.

Wheat

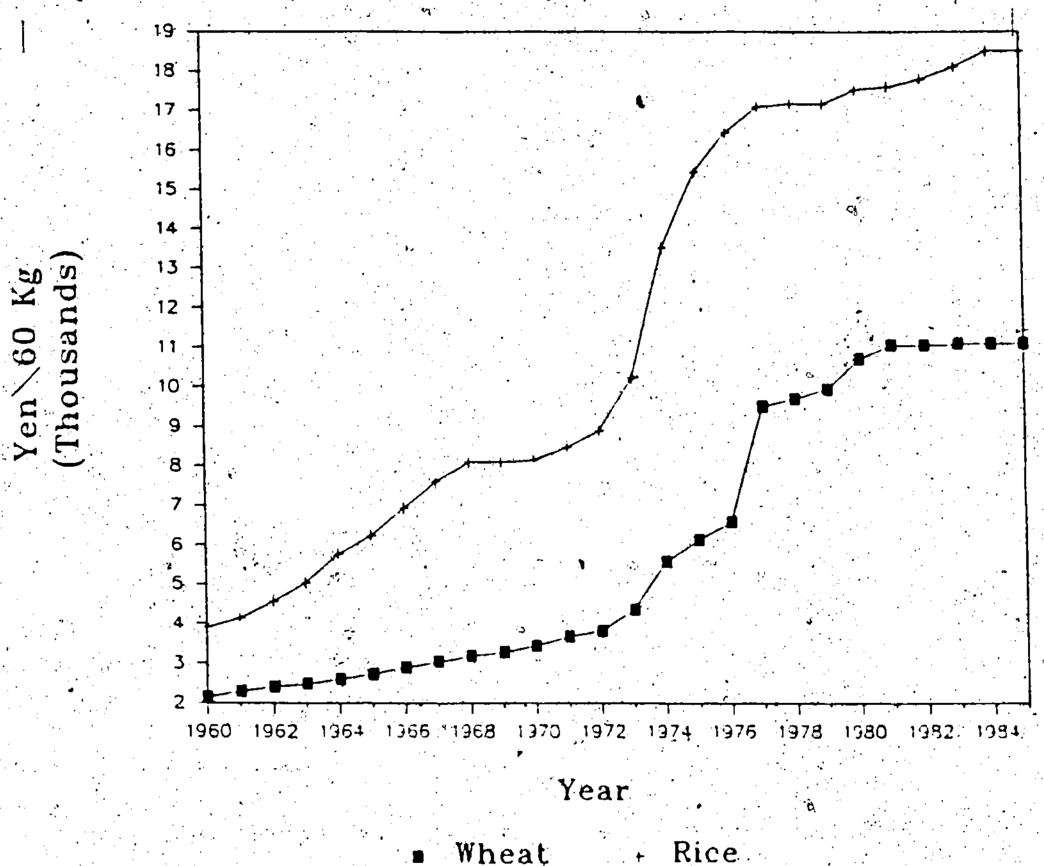
The marketing system for wheat is also government controlled. The government usually buys all wheat produced, sets producer and consumer prices and determines imports based on a demand and supply balance sheet approach. A global quota for imports is set after the import quantity is determined. The government Food Control Agency is the only legal importer of wheat.

The producer price for wheat is set by a formula different from that used for rice. Wheat prices were set using a cost of production formula to cover the costs of production for 50% of producers from 1960 until 1977. There has been no overt policy to include consideration of international price levels in the setting of domestic prices. As Figure III.2 shows, a large gap between rice and wheat prices quickly developed with the difference in the price setting formulas. A subsidy was added to the cost of production formula price in 1977 when increasing wheat production and decreasing rice production gained importance in the government policy agenda. This subsidy attempted to increase the economic incentives to produce wheat.

F. Policies and Their Effects on Output Structure

One of the main differences mentioned previously in the Agriculture Basic Law from previous policy statements was the emphasis on changing the output structure of agriculture to equalize supply and demand. The pricing and crop diversion policies used have been somewhat successsful in equalizing supply and demand. However, constraints to changing the output structure of rice and wheat have been encountered. The policies and the constraints encountered along with a summary of the changes in the output structure are discussed here.

Figure III.2: Domestic Rice and Wheat Price Gap



Data that describes the output structure of Japanese agriculture is contained in Appendix A.

Pricing Policies

In the 1960's and the early 1970's, pricing policies were not used to change output structure. Instead the rice pricing policies were the main income support measure to achieve the goal of the Agricultural Basic Law of income parity for farmers. This income support role of rice production was one of the constraints that has hindered changing of the output structure. In the southern part of the country, the production of rice is possible. In contrast, the north (Hokkaido) is borderline, temperature-wise, for rice production. However, attempts at rice production were prevalent until the crop diversion program pressured Hokkaido farmers to produce other crops.

Pricing policies were also a constraint to equalizing supply and demand because of their impacts on technology development and adoption. Rice yields increased so that in 1985 although acreage is only 70.8% of that in 1960, production is 90.7% of that in 1960. Wheat yields increased approximately 50% between 1960 and 1985 (Appendix A, Table A11). Despite the development of mechanical and biological technologies for both wheat and rice production, the technology developed and adopted favored rice production. For example, development of improved early varieties of rice and rice planting machines created an earlier rice season, causing fall crops (e.g. wheat) to overlap with spring crops (rice) (Roberts *et al*, 1981). Farmers choose to grow rice as rice is the more profitable of the two crops. Most new technology for wheat production is size-biased. The small size of Japanese farms, except in Hokkaido, is prohibitive to the adoption of this size-biased technology. This slower development of appropriate technology for Japanese wheat production caused the opportunity costs of wheat in terms of rice to increase greatly (Shinya, 1981). Consequently wheat area and production dropped drastically. This drop in wheat production was opposite to the increase in demand for wheat. Thus the pricing policies caused a further imbalance in supply and demand.

An attempt to use pricing policies to reflect the goal of equalizing supply and demand began in 1977. A subsidy was added to the wheat price determined by the cost of production formula to make wheat a more attractive substitute crop for rice. This subsidy narrowed the domestic price differential that had developed between rice and wheat.

A bias against wheat production was caused by pricing policies, and also by the lack of policies to direct changes in organizational structure such as the development of part-time farm households. Wheat production was primarily a second crop used in double-cropping. The increase in the industrial wage caused the opportunity cost of double-cropping to increase greatly (Shinya, 1981). Farmers chose off-farm jobs with the resulting organizational structure in agriculture of part-time farm households, rather than to double crop. Thus changes in other aspects of agricultural structure adversely affected the development of the output structure.

Crop Diversion Policies

The implementation of the crop diversion program signalled the beginning of the diversification of government policy targets. Until 1977, policies other than overt price policies, such as the crop diversion program, were used to direct the expansion of targeted crops to deal with supply and demand imbalances. The crop diversion policy was initiated because of the absence of changes in the output structure to keep pace with changes in demand. Beginning on a trial basis in 1969 and 1970, and fully implemented in 1971, a crop diversification programme was used to encourage the shifting of production from rice to other commodities such as: wheat, dairy and other livestock products, fruits, vegetables and other cereal crops. In conjunction with the crop diversion program until 1985, the government issued long term projections of demand and supply and targets for self-sufficiency for the major agricultural products.

In the first three years of the crop diversion program (1971-1973), cutbacks to rice production were successfully implemented because of the political pressure to decrease rice production. Production cutbacks were achieved by setting targets for diversion acreage for each region and encouraging farmers to divert land from rice to any other crop. The first three years of the program were successful enough to alleviate the urgent rice surplus crisis.

The change in output structure that was achieved was not a permanent change. With the rise in world grain prices that occurred in 1972, Japanese public concern about the "*food crisis*" developed. Farmers quickly adjusted and in 1975, there was an abundant harvest that increased government rice stocks to 6.7 million tons once again.[17]

In 1976 there was a restrengthening of the production adjustment program to deal with the increase in rice stocks. This time the program was focused on the diversion of lands

[17] Hokkaido Government Agriculture Department, Agriculture Programs Office. **Paddy Field Diversion Program Explanation (Suiden Riyou Saihen Taisaku)**. 1985.

to the production of specific commodities in which the self-sufficiency rate was low. The program was also integrated with the goal of increasing farm operating size. Acreage payments were changed to encourage selectively the diversion of certain lands to specific crops (e.g. wheat, soybeans, vegetables, etc.). The payment varied by land class and the diversion crop chosen. The integration of the crop diversion program with the drive to increase farm operating size came with the offering of an additional payment for land diverted from rice production that was farmed collectively. In 1977, another additional payment of 10,000 yen per ares[18] was offered to farmers that reached the government acreage target for the total of land converted to other crops and land used for land improvement.[19] In 1978, diversion payments were increased to 55000 yen per 10 ares.[20]

The crop diversion program has been successful in achieving a shift in production from rice to other crops. Wheat production responded to policy changes to encourage production (Appendix A, Table A10). There are many factors responsible for this success. One fact is that the development of the part-time organizational structure has decreased the importance of the income supporting role of rice production. Even though the acreage diversion program was expensive, it reduced the total government cost of rice policies (Otsuka and Hayami, 1985) and has been successful in changing output structure.

G. Policies and their Effects on Input Structure

In the Agricultural Basic Law, many of the goals outlined and their ensuing policies have had direct effects on the input structure of agriculture. Biological and mechanical research has been encouraged to increase agricultural productivity. The effects of government policies on the input structure of agriculture are more difficult to quantify, unlike policy effects in the output structure of agriculture. Consequently, only a general overview of policies is given with the discussion of the input structure.

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[18]An are is a hundred square meters.
[19]*Ibid.*
[20]*Ibid.*

Capital Use

Development of the agricultural sector was one of the important government objectives outlined in the Agriculture Basic Law. This goal was accomplished through the encouragement of technical progress. Agricultural mechanization occurred later in Japan than in western agricultures, so this encouragement was needed. As an indication of the recent nature of mechanization, until 1975 for rice and until 1973 for wheat, published average production costs included costs for draft animals. Historically an abundance of cheap rural labor combined with inappropriate technology hindered mechanization.[21] However with rapid industrialization and the development of appropriate paddy field technology, economic conditions encouraged mechanization.

The importance of capital to agriculture production from 1960 to 1985 is evident from analysis of capital data. The share of capital in rice production costs has increased from 4.9% in 1960 to 26.6% in 1985 when capital is defined in terms of the depreciation of machines, buildings and other capital goods (excluding land). In wheat production, the share of capital has increased from 10.8% in 1960 to 22.4% in 1985. The yearly net fixed investment, a measure of stock capital in rice production, increased by 542% in nominal terms over 21 years from 2965 yen in 1964 to 16079 yen in 1985 (Appendix A, Table A.5). In wheat production, yearly net fixed investment increased 144% from 2504 yen in 1960 to 6122 yen in 1985 (Appendix A, Table A.5). Machine hours per output unit, a third measure of capital, indicates a similiar upward trend in capital use (Appendix A, Table A.8).

Labor Use

Labor use per 10 ares declined 67.3% between 1960 and 1985 (Appendix A, Table A.7). The development of labor-saving technology may have been the most important factor within agriculture affecting the decrease in labor use (Kuroda, 1985). Of the forces generated within agriculture, the simultaneous adoption of mechanical technology (represented by

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[21] Interview with Dr. Junichi Sakai, professor, Department of Agricultural Economics, Tohoku University, Sendai, January 1987.

machine use) and biochemical technologies (represented by intermediate inputs, i.e. chemicals and fertilizers) were important in decreasing labor use (Kuroda, 1985). The relative labor-saving nature of technical change in agriculture followed the pattern of the demand for labor in the non-agriculture sector for two reasons. Firstly, industrial wage rates have increased faster than rural wage rates. Secondly, the rural labor was relatively higher priced than other agricultural inputs (Kuroda, 1985).

Policies to encourage technological improvements, along with other economic forces, have caused a reversal in the importance of labor and capital in the input structure of Japanese agriculture. This reversal in the importance of inputs has resulted in changes in capital and labor productivity. These changes in input use and productivity have slowed down in recent years. Increased productivity is thought to have been balkanized by the rationalization of the structure of the production and distribution of intermediate agricultural inputs and capital equipment (Kano, 1986).

IV. SIMULATION MODEL

A. Model Description

General

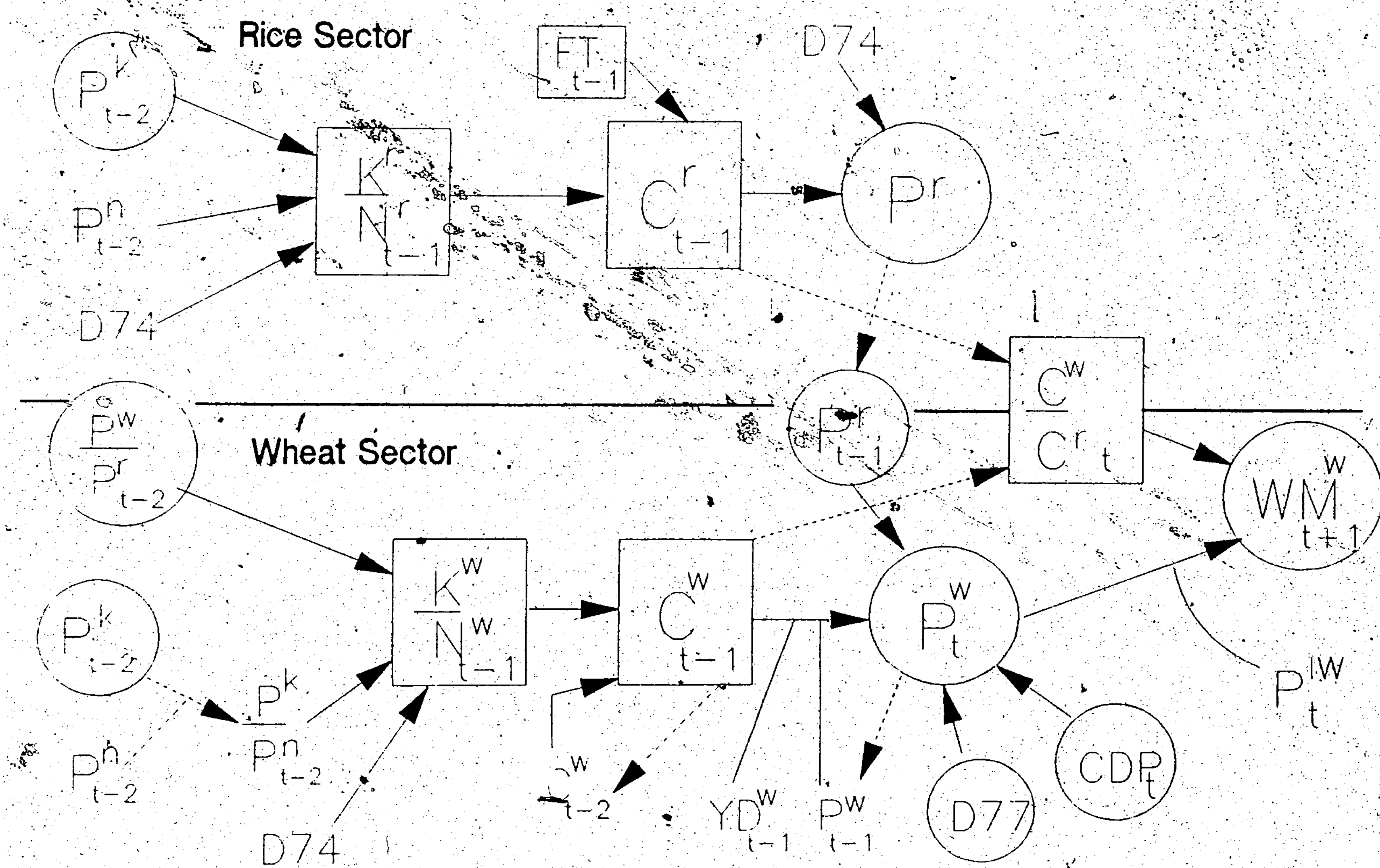
The purpose of this system simulation model was twofold. First it was to test various hypotheses about the relationship of structural change, policies and trading behaviour. The model hypothesizes that structure as well as domestic policies influence trade policy decisions. Under terms of the Agricultural Basic Law, policies in Japan have structural objectives. Attainment of those structural objectives impacts on future policy decisions regarding agriculture and trade. The model also hypothesizes that economic factors represented by social opportunity cost measures affect trading decisions.

The second purpose of the model was to use the relationships established to simulate the effects of various policy changes. The effects of static conditions was simulated by setting an exogenous variable at its 1985 value for the entire prediction period. Also the effects of faster changes in the exogenous variables was simulated.

A recursive system of seven equations with two interdependent sectors, wheat and rice, was used to accomplish these objectives (Figure IV.1 and Figure IV.2). Each sector contained three equations to simulate the processes by which input, cost and price functions are determined. The seventh equation of the recursive system, determining wheat imports, uses the results from the wheat and rice sectors to give the final outcome of the system model.

Structure is represented by the capital/labor (K/N) ratio, production costs and the number of full-time farm households. These variables are represented by square boxes in Figure IV.1. These structural variables are hypothesized to cause changes in the whole system through the following mechanisms. The K/N ratios are one of the factors causing changes in the cost functions. The number of full-time farm households also affect the cost function in

Figure IV.1: Japanese Cereal Sector Simulation Model



rice. Costs of production determine domestic wheat and rice prices.

Policies are represented by the acreage diverted under the crop diversion program, prices and imports. These variables are represented in circles in Figure IV.1. Policies are created to obtain domestic structural goals and domestic self-sufficiency goals. All domestic policies whether directly or indirectly affect world commodity markets. These effects of domestic policies on international markets are not considered here.

Input Functions

The input functions (4.1, 4.2) are constructed to examine structural change in input use. They are based on production function theory. Input use is represented by the K/N ratio. An important factor of production, land, has been omitted because of the distortions in Japanese land values due to non-agricultural forces. The inclusion of land also tends to cause multicollinearity problems in equation estimation. As outlined previously, in production function theory, input prices and output prices affect optimum input use. As has been shown by Kuroda (1985) and Kako (1978), Japanese rice farmers have been fairly responsive to changes in input prices in varying their relative factor use. Here the assumption is made that since most wheat farmers also produce rice, farmers who produce wheat are also responsive to changes in relative input prices. The use of capital or labor decreases as the input's price increases.

The independent variables (input and output prices) are hypothesized to affect the optimum K/N ratio with a one year lag. This lag was used because capital investment occurs prior to the production year. Output prices are announced during the summer. Consequently, production decisions are based on the previous year's prices.

Farmers' investment in wheat production is a residual of their rice production decisions.[22] Production decisions are partly based on the possible returns from a crop. In Japan, farmers prefer to grow rice because rice production is more profitable than any other

[22]Interview with Dr. Yukio Hiromasa, instructor, Department of Agricultural Economics, Hokkaido University, Sapporo, May 1987.

Figure IV.2: Variable Definitions of Japanese Cereal Sector Simulation Model

Variables

- P – price (Yen/60 kg)
- K/N – capital/labor ratio (Yen/hr)
- C_r – costs of production (Yen/10 ares)
- YD – yield (kg/10 ares)
- CDP – Crop diversion program acreage (Ha)
- WM – World Imports (Thousand Tonnes)
- D74 – Oil shock dummy variable
- D77 – Pricing policy dummy variable

Superscripts

- k – capital
- n – labor
- r – rice
- w – wheat
- iw – International wheat

Subscripts

- t+n – time period

Symbols

- ◯ Policy Variables
- ☐ Structural Variables
- ——► Functional Relationships
- ◄······ Connection of Variables

field crop. Consequently, both rice and wheat prices are hypothesized to be factors influencing changes in input use in wheat production. The rice price is inversely related to input use because as the rice price rises, farmers will invest in rice production instead of in wheat production. The recent pressure from the crop diversion program for farmers to reduce rice production was not directly considered in this analysis.

$$(4.1)\ K/N^{w}_{t} = \beta_0 - \beta P^{k}_{t-1} + \beta P^{n}_{t-1} - \beta P^{r}_{t-1} + \beta P^{w}_{t-1} + \beta D + e$$

where:

K/N^{w}_{t} is the capital/labor ratio of wheat in time t,

P^{k}_{t-1} is capital price in time t-1,

P^{n}_{t-1} is labor price in time t-1,

P^{w}_{t-1} is wheat price in time t-1,

P^{r}_{t-1} is rice price in time t-1,

D are various dummy variables,

and e is assumed to be a normally independently distributed error term with mean equal to zero and constant variance.

In contrast to wheat production, the price of rice is the only output price hypothesized to affect input use in the rice production because rice is the preferred crop.

$$(4.2)\ K/N^{r}_{t} = \beta_0 - \beta P^{k}_{t-1} + \beta P^{n}_{t-1} + P^{r}_{t-1} + \beta D74 + e$$

where:

K/N^{r}_{t} is the K/N ratio used in rice production in time t,

P^{k}_{t-1} is capital price in time t-1.

P^{n}_{t-1} is labor price in time t-1, P^{r}_{t-1} is rice price in time t-1,

D74 is the oil shock dummy,

and e is assumed to be a normally independently distributed error term with mean equal to zero and constant variance.

Cost Functions

The concepts used to hypothesize the cost functions here are slightly different than those in the establishment of the traditional cost function. Costs are a function of output in a traditional cost function (Doll and Orazem, 1984). However, because the purpose here is to study structure, the cost functions (4.3, 4.4) are hypothesized to be a function of structural variables. The approach used can be justified by duality theory. In duality theory, the cost function is the inverse of the production function, assuming that the production function has an inverse. Thus the same factors that affect the production function can be said to affect the cost function.

The factors affecting production functions can be divided into three main categories: technology, substitution and scale (Kako, 1978). Substitution can be represented by the K/N ratio. Sometimes yield is used to capture changes in technology. However, as technology can be said to determine the optimum K/N ratio, the K/N ratio can also be hypothesized to represent technology. New technology which has a capital bias has been shown to have a scale bias. Thus the K/N ratio can also be used to account for economies of scale. All three factors affecting a production function can be captured by the K/N ratio. However, yield was tested separately as a measure of technology because of the importance of technical progress in structural change (Hayami and Ruttan, 1985).

$$(4.3)\quad C^{W}_{t} = \beta_0 + \beta K/N^{W}_{t-1} - \beta YD^{W}_{t} + \beta D74 + e$$

where:

C^{W}_{t} is average costs (Yen/60 kg) of wheat production in time t,

K/N^{W}_{t-1} is the K/N ratio used in wheat production in time t,

YD^{W}_{t} is wheat yields (kg/10 ares) in time t, D74 is a dummy variable for the oil shock in 1974,

and e is assumed to be a normally independently distributed error term with mean equal to zero and constant variance.

In the cost equation for rice production (4.4), the K/N ratio and yield are also hypothesized to influence costs of production. Costs will increase to cover the increased investment in capital and/or labor as the K/N ratio rises. Yield is inversely related to average costs of production because as yields rise, fixed costs per output unit decrease. Consequently, average costs per unit of output will decrease. Another structural variable, the number of full-time farming households, is postulated to be a factor determining costs of production. This variable is included for the following reason. In the optimum situation, a farmer uses additional inputs up to the quantity where the marginal cost of the input is equal to the marginal return from the extra output produced. This situation assumes that all inputs are available in limitless quantities. But part-time farmers can not minimize their costs of production because they have a personal labor constraint. The situation is created where as part-time farmers increase, there is less cost minimization and the average costs of production for the industry increase. Consequently, the decreasing number of full-time farming households is hypothesized to adversely affect costs of production. The production function approach could have been used. But the approach used included full-time farmers as they were representative of organizational structure.

$$(4.4)\ C^r_t = \beta_0 + \beta K/N^r_{t-1} - \beta YD^r_t + \beta FT^o_t + \beta D74 + e$$

where:

C^r_t is average costs (Yen/60 kg) of rice production in time t,

K/N^r_{t-1} is the K/N ratio used in rice production in time t,

YD^r_t is rice yields (kg/10 ares) in time t,

FT_t is the number of full-time farming households at time t,

D74 is a dummy variable for the oil shock in 1974,

and e is assumed to be a normally independently distributed error term with mean equal to zero and constant variance.

Price Functions

Wheat and rice prices are established by government. In 1960, the original purpose of the government-set rice price was to give farmers income parity with industrial workers. This parity was to maintain rural standards of living rather than allowing the adjustment costs of industrial development to fall entirely on the rural population (Hayami, 1986). The wheat price was set to cover production costs. Over the years, although the floor price function of both wheat and rice prices has remained, goals other than the original two have entered the government price-setting agenda.

The formulas by which prices are set are different because of the different goals for rice and wheat policy. For wheat, producer prices, which are floor prices, are set by a parity price formula based mainly on costs of production in the previous period. The wheat price is increased to cover increases in production costs. Changes in the rural cost of living index are taken into consideration. Since 1977, the pricing policy for wheat has changed to add a production incentive adjustment to the parity price. A dummy variable (D77) was used to test for the effects of this policy change.

The rice and wheat sector have totally different production structures. However, the policies of the two crops are linked. Since rice is the staple food in Japan, it is natural that rice policy is the most important in the policy agenda. However, because wheat is an alternative crop to rice, rice policies affect wheat production. For example, the accumulating rice surpluses with the concomitant budgetary costs were the incentive for the implementation of the crop diversion policy. This policy link between the sectors is represented by the lagged price of rice. As the price of rice increases, the price of wheat is hypothesized also to rise.

because policies are linked.

Changes in the price of wheat are one indirect method of achieving changes in agricultural structure. A direct method to change the production structure that has been used is the crop diversion policy. In Japan, the diverted rice acreage normally reaches or surpasses the government objectives. Thus the total area diverted in the crop diversion program can be used as an indicator of the importance to government of changing the structure of agriculture. Since both prices and the crop diversion progarm are means of changing structure, an increase in the overt method of changing structure (the crop diversion program) would logically be accompanied by a concurrent change in the covert means of changing structure (wheat pricing). This hypothesis was tested in the wheat price equation (4.5).

$$(4.5)\ P^{w}_{t} = \beta_0 + \beta P^{r}_{t-1} + \beta C^{w}_{t-1} + \beta\, CDP_t + \beta\, D77 + e$$

where:

P^{w}_{t} is the price of wheat in time t,

P^{r}_{t-1} is the price of rice in time t-1,

C^{w}_{t-1} is the average costs (Yen/60 kg) of wheat production in time t-1,

CDP_t is the total acreage diverted under the crop diversion program in time t,

D77 is a dummy variable for the pricing policy change,

and *e* is assumed to be a normally independently distributed error term with mean equal to zero and constant variance.

The rice price is set based on a formula of cost pricing for the purpose of income support. This formula includes costs of rice production with an income adjustment to give farmers income parity with industrial workers. An increase in costs or the industrial wage rate is followed by an increase in the rice price. The oil shock, through its effect on costs of production, is hypothesized to have had a positive effect on the rice price.

$$(4.6)\ P^{r}_{t} = \beta_0 + \beta C^{r}_{t-1} + \beta W^{i} + \beta D74 + e$$

where:

P^r_t is the price of rice in time t,

C^r_{t-1} is the average costs (Yen/60 kg) of rice production in time t-1,

W^i is an industrial wage index,

D74 is a dummy variable for the oil shock,

and e is assumed to be a normally independently distributed error term with mean equal to zero and constant variance.

Various dummy variables were tried to test for the effects of various policies and external events. In 1977, wheat pricing policies were changed to include a subsidy component as well as the cost of production adjustments in the price setting mechanism.[?] This subsidy component is hypothesized to not only have a positive effect on the wheat price equation, but also to have a positive effect on the wheat input equation through the increase of the profitability of wheat production. An increase in returns from wheat production would increase farmers' willingness to invest in wheat-specific capital.

The oil shock of 1974 is hypothesized to have had an effect on all six of the equations. The effect on the input equations is that of a disinvestment effect as the oil shock increased not only the prices of machinery, but also fuel costs as well. Through this mechanism, the oil shock is postulated to have had a direct role in shifting the cost functions upwards. An upward shift in the price functions is postulated as well because of the link between costs and prices.

Structure and Trade Linkages

It is difficult to quantify the aggregate effect of policies. This statement is especially true in this case where our interest is to measure the aggregate effect of domestic

[?]Interview with Dr. Toshio Kuroyanagi, professor, Department of Agricultural Economics, Hokkaido University, Sapporo, April 1987.

wheat policies on trade policies. In Japan it is known that agricultural trading behaviour does not follow that predicted by standard trade theory analysis. Non-economic considerations figure prominently in agricultural trading behaviour. The measurement of social opportunity costs was developed to overcome these difficulties. In this study, the hypothesis was that policies are a function of policy costs. Policy costs are evaluated here by social opportunity cost measures. Consequently domestic agriculture policies as well as trade policies are a function of social opportunity costs.

Trade policies are reflected in a country's imports, which can be an approximation of their "*willingness to import*". The first factor hypothesized to affect imports or the willingness to import is the nominal rate of protection. The nominal rate of protection is a conventional measure of protection of an industry. This is the ratio of the producer price to the border price. The nominal rate of protection is a result of internal policies vis-a-vis international events. The nominal rates of protection for rice and wheat are shown in Table IV.1. Japan is thought to decrease imports as the nominal rate of protection increases.

The second factor hypothesized to influence imports is the social opportunity costs of policies. The social opportunity cost indicators guage the impact of economic and non-quantifiable variables because the recursive system generating the social opportunity cost measures includes some non-economic variables such as full-time farmers and policy change variables. As costs of policies (social opportunity costs) increase, *ceteris paribus*, restrictions should be eased. Increased imports would decrease policy costs and increase government revenue.

The third factor hypothesized to affect imports is the objective of increasing wheat self-sufficiency to improve Japan's food security position. An increase in the importance of increasing wheat self-sufficiency is postulated to affect adversely Japan's imports. The hypothesized import function is as follows:

$$(4.7)\ WM^{W}_{t} = \beta_0 - \beta NP^{W}_{t} + \beta SOC1_{t-1} + \beta SOC2_{t-1} - + e_t$$

Table IV.1: Cereal Net Protection Rates, 1960-1985

Year	Rice	Wheat
1960	1.14	1.45
1961	0.91	1.50
1962	1.17	1.50
1963	1.18	1.61
1964	1.41	1.58
1965	1.55	1.71
1966	1.70	1.79
1967	1.78	1.77
1968	1.93	1.92
1969	1.90	2.02
1970	1.64	2.17
1971	1.72	2.32
1972	1.44	2.79
1973	1.23	2.12
1974	1.22	1.37
1975	1.72	1.61
1976	2.51	1.86
1977	2.19	4.04
1978	2.98	4.82
1979	2.63	3.82
1980	2.54	3.28
1981	2.17	3.25
1982	2.70	3.43
1983	2.82	3.72
1984	2.75	3.68
1985	3.21	3.80

Sources: Data tables in Appendix A

Notes:

1. Net Protection Rate $= \frac{P^i}{IP_i}$

   where:

   P^i is the domestic price of commodity i,

   IP_i is the international price of commodity i.

2. Price protection is nonexistent with a value of 1.

where:

WM^w_t is imports of wheat in time t,

NP^w_t is the nominal rate of protection in year t, which is $\frac{P^w}{IP_{w,t}}$

where:

P^w is the domestic price of wheat in time t,

$IP_{w,t}$ is the international price of wheat in time t.

$SOC1_{t-1}$ is the social opportunity cost of prices in year t-1, which is $\frac{P^{w}}{P_{r,t-1}} \times \frac{IP^{r}}{IP_{w,t-1}}$

where:

P^{w} is the domestic price of wheat in time t-1,

$P_{r,t-1}$ is the domestic price of rice in time t-1,

IP_{r} is the international price of rice in time t-1.

$IP_{w,t-1}$ is the international price of wheat in time t-1.

$SOC2_{t-1}$ is the social opportunity cost of production costs in year t-1, which is $\frac{C^{w}}{C_{r,t-1}}$

where:

C^{w} is total costs of wheat production in time t-1,

$C_{r,t-1}$ is total costs of rice production in time t-1,

SS^{w}_{t-1} is the self-sufficiency rate of wheat in year t-1,

and *e* is assumed to be a normally independently distributed error term with mean equal to zero and constant variance.

Model Validation and Simulation Method

The equations were estimated using Ordinary Least Squares (OLS) with the SHAZAM (White, 1978) econometrics program on an IBM personal computer. Then the equations were linked by the use of lagged independent variables into a recursive model. To run the simulation, the values of the exogenous variables for the entire time period and values of the lagged endogenous variables were entered in the first year. In the second and subsequent years, the model generated values for the lagged endogenous variables.

The model was run under different scenarios of structural and policy changes. The baseline scenario had structural changes continuing to occur at the same average incremental rate as in the historical estimation period from 1960-1985. The first set of scenarios that were simulated were changes in one variable at a time of the following structure and policy parameters: capital price, labor price, crop diversion acreage, wheat yields, full-time farm households and international wheat price. The second set of scenarios simulated the effects of an exogenous variable remaining at the 1985 level over the prediction period. The same exogenous variables as in the first set of scenarios were used.

Four methods of validation were used. First, the model was validated using 1960 data for the starting values and estimating from 1961 to 1985. A visual check was done by plotting the model results and actual data from 1961 to 1985. These graphs were inspected to determine how closely the predicted values followed the pattern in the actual values. Second, the root mean square error divided by the actual mean was calculated (Spriggs, 1981). This measure converges to zero with increasing perfection of prediction. The third validation method was a percentage error statistic (Boyle *et al*, 1982). The statistic, calculated yearly, is the difference between the actual and predicted values divided by the actual value. The yearly percentage errors were averaged over the prediction period. The absolute value of the percent error for each year was used in the calculation of the average percent error because our concern is with the total error over the time period, not with the direction of the error.

Lastly, the forecasting of the model was tested by inserting constant 1985 values for the exogenous variables from 1985 until 1991. After the three year lag works through the system, the endogenous variables are expected to stabilize at constant levels.

B. DATA DESCRIPTION

Input Functions

The price of capital is usually proxied by the interest rate. However, it is difficult to know the interest rate for farm capital investment due to different government programs to subsidize capital investment. Hence the price index of total aggregated capital inputs from the **Rural Area Price and Wage Statistics (Nouson Bukka Chingin Toukei)** was used as a proxy for the price of capital. This price index was chosen because of its suitability to the capital data used.

The capital data used were the aggregate total values of all depreciation items (including machinery, agricultural implements and buildings) in the cost of production statistics from the **Statistical Yearbook of the Ministry of Agriculture, Forestry and Fisheries**. This flow definition of capital was chosen to correspond with the flow definition of labor used for the capital/labor ratio. Transformation of the capital data was done to calculate a consistent data series in yen per 60 kilograms of output. The entire 26 year series was deflated by the index of large capital input prices to remove the effect of inflation and obtain a real investment figure. The index of large capital inputs was found in the **Rural Area Price and Wage Statistics**.

The price of labor is represented by an index of weighted male and female labor wage rates for rural hired labor taken from the **Rural Area Price and Wage Statistics**. A female labor hour was weighted as 0.8 of a male labor hour in the traditional Japanese manner.

The labor hour data were obtained from yearly issues of **Types of Wheat and Barley, and Other Field Crops Costs of Production (Mugirui Kougeisakumotsu Nado no Seisanpi)** from 1960 until 1972. After 1972, the statistical periodical was renamed as **Rice and Types of Wheat and Barley Costs of Production (Kome Oyobi Mugirui no Seisanpi)**. This data were also transformed to result in a consistent time series of labor hours per 60 kilograms of output.

Cost Functions

The data used for the cost functions were the total secondary costs of production obtained from the **Statistical Yearbook of the Ministry of Agriculture, Forestry and Fisheries.** Secondary costs of production are composed of the total costs of production less the value of by-products plus land rent and capital interest. The statistical method of estimating the labor cost of family members in the cost of production statistics was changed in 1976. Therefore the time series was adjusted to link the pre-1976 and post-1976 series in the following manner. The national average for total yearly expenditures for temporary hired labor was divided by the total yearly hours of temporary hired farm labor. Both of these data series were taken from the **Report on Farm Household Economy Survey (Nouka Keizai Chousa Houkoku)**. This calculated wage rate was multiplied by labor hours used for each commodity taken from the **Statistical Yearbook of the Ministry of Agriculture, Forestry and Fisheries** to obtain the adjusted cost of labor. The total secondary costs of production were adjusted by the difference between this calculated labor cost and the published post-1976 statistical series. All costs of production were adjusted to create a uniform series in yen per 60 kilograms of output basis. The cost of production statistics were deflated with the composite input index from the **Rural Area Price and Wage Statistics.**

There was a data problem for 1963. Only approximately 22% of the wheat crop was harvested because of an extra-long rainy season in 1963.[24] Thus cost of production figures were not collected. The average of 1962 and 1964 cost of production figures was used to replace this missing data point.

Farm household statistics (full-time and part-time) were collected from the **Statistical Yearbook of the Ministry of Agriculture, Forestry and Fisheries.**

[24] Ministry of Agriculture, Forestry and Fisheries. **Statistical Yearbook of the Ministry of Agriculture and Forestry (Norinsho Tokei Hyo)**, Explanatory Notes for the Cost of Production Statistics (Japanese), 1967, p. 167.

Price Functions

Domestic prices for rice and wheat were obtained from the yearly **Food Control Statistics Annual Report (Shoukuryou Kanri Tokei Nenpou)**. The standard price series was used. No adjustments were made for changes in the statistical collection procedure for rice prices in 1979 or for changes in the grading system of rice and wheat in 1979 and 1968, respectively.

Wheat Import Function

Import quantity and import value data for wheat from Canada, obtained from **Japan Exports and Imports**, were used to calculate the CIF price for wheat. Consequently the CIF price is the CIF price of wheat imported from Canada. An overall world wheat price was not felt to be as applicable as a CIF import price calculated using Canadian wheat prices because of the quality difference in Canadian wheat. Data was not available for 1963, so an average of 1962 and 1964 prices was used.

A proxy price for the international rice price was calculated because Japanese imports of rice have been minimal. Therefore an actual CIF rice price is unavailable. The data series calculated by Otsuka & Hayami (1985) was used for 1968 to 1973. The data series was extended with the same method used by Otsuka & Hayami (1985). The FOB price of Texas long grain rice, the highest quality rice of internationally traded rice varieties, was converted to a brown rice basis to allow for comparison to domestic Japanese prices (quoted on a brown rice basis). To approximate freight and other expenses, 15% of the original FOB price was added to obtain a CIF price. The original data source, **FAO Production Yearbook**, was consulted. The exchange rate used to convert the Texas rice price in U.S. dollars to Japanese yen was the yearly average published in **The Annual Report on National Accounts**.

Structure and Trade Linkages

Two time series were found for Japanese wheat imports and an interesting finding was made. The first time series was constructed from publications of the Japan Tariff Association that contained data from the Ministry of Finance. These publications were **Japan Foreign Trade Chronology (Nihon Gaikoku Boeki Nenpyo)** for 1960 data; **Japan Trade Chronology (Nihon Boeki Nenpyo)** for 1961, 1962 and 1964 data; and the December issues of **Monthly Japan Exports & Imports (Nihon Boeki Geppo)** for 1965 to 1985 data. As no copy of the **Japan Trade Chronology** could be found for 1963, this data point was estimated as the average of the 1962 and 1964 import figures. Because of the crop failure in 1963, this average figure is known to be inaccurate. However, it was the only estimate that could be made. The second time series was constructed from the **Food Control Statistics Annual Report (Shoukuryou Kanri Tokei Nenpou)** published by the Government Food Office.

The interesting finding that was made was the two series had an increasing difference over time. The statistics from the **Food Control Statistics Annual Report** were consistently lower than those from the export and import statistics. As shown in Table IV.2, the food control statistics varied from 20.7% to 36.7% lower than the trade statistics. The different calendar years used does not account for the consistent difference. The trade statistics were reported by the Ministry of Finance, while the food control statistics were reported by the Ministry of Agriculture.

Table IV.2: Wheat Imports (1,000 Tonnes), 1960-1985

Year	Ministry of Finance†	Ministry of Agriculture*	Percentage Difference (%)
1960	2678	2123	20.7
1961	2738	1856	32.2
1962	2665	1686	36.7
1963	3283	2492	24.1
1964	3646	2438	33.1
1965	3652	2525	30.9
1966	3917	3067	21.7
1967	4130	2937	28.9
1968	4073	2733	32.9
1969	4328	3285	24.1
1970	4685	3282	29.9
1971	4872	3360	31.0
1972	5145	3960	23.0
1973	5386	4060	24.6
1974	5377	4184	22.2
1975	5654	4434	21.6
1976	5827	4253	27.0
1977	5676	4339	23.6
1978	5564	4305	22.6
1979	5926	4231	28.6
1980	5682	4168	26.6
1981	5633	4120	26.9
1982	5714	4109	28.1
1983	5817	4171	28.3
1984	5979	4207	29.6
1985	5510	3968	28.0

Sources: 1. Government Food Office. **Food Control Statistics Annual Report (Shoukuryou Kanri Tokei Nenpou)**. Tokyo, various issues.

2. Japan Tariff Association. **Monthly Japan Exports and Imports (Nihon Boeki Geppo)**. Tokyo: December issues, 1965-1985.

3. ____. **Japan Trade Chronology (Nihon Boeki Nenpyo)**. Tokyo: 1961, 1962, 1964.

4. ____. **Japan Foreign Trade Chronology (Nihon Gaikoku Boeki Nenpyo)**. Tokyo: 1960.

Notes: 1. † - Calendar Year (Jan/Dec)

2. * - Fiscal Year (April/March)

V. RESULTS

A. Introduction

This chapter contains the specifications of the equations accepted for the final model. The results of the validation exercise for the recursive model are discussed. The simulation results under various policy and structural change scenarios are reported here.

The structure-trade model is composed of seven equations in two sectors (wheat and rice). Each sector has three structural equations, and the trade equation links the two sectors. The functions were found to be well-fit with acceptable first order tests (Tables V.1, V.2, V.3, V.4, V.5, V.7). As illustrated in Figures IV.1 and IV.2, the model is a recursive system with exogenous variables added in each time period. In the first time period, the model starts with input and output prices. In the second time period, the K/N ratios are a function of lagged prices. The cost equations are a function of the input structure (K/N ratio) and other commodity specific structural variables in the same time period. Prices are set based on lagged costs of production in the third time period. In the fourth year, the import stance is determined by lagged costs and prices.

B. Model Equation Estimation

Various econometric problems were encountered in the estimation of the seven equations in the structure-trade model. Data transformations, new functional forms and additional variables were employed to solve the estimation problems in six of the equations. The logic of the equations did not change. The specification originally postulated for the trade equation was rejected. The new specification accepted for the trade equation is explained in this chapter.

Multicollinearity and misspecification problems were encountered in the estimation of the K/N functions. Data transformations to form price ratios (P^k/P^n, P^w/P^r) were used to solve the multi-collinearity problem. The misspecification in both equations was corrected with a double log functional form. The K/N function for wheat overall was significant at the 1% level with an F value of 449.765 and an R^2 of 98.25%. The variable coefficients of the ratio of lagged capital to labor prices (P^k_{t-1}/P^n_{t-1}) and the ratio of lagged wheat to rice prices (P^w_{t-1}/P^r_{t-1}) were significant at the 1% level, while the oil shock dummy was significant at the 20% level in the wheat K/N equation (Table V.1).

Table V.1: K/N Function for Wheat in a Simulation Model of Japanese Domestic Policies and Trade, 1960-1985

	β_0	βLog P^k/P^n_{t-1}	βLog P^w/P^r_{t-1}	βD74	R^2 Adj.	F-test
Log K/N^w_t	7.1573	-2.3264	0.80574	-0.14951	0.9825	449.765**
	(34.288)**	(-20.439)**	(3.966)**	(-1.2625)		

Source: Simulation Results

Note: Log: Natural log value of the variable indicated.

K/N^w_t: Capital/Labor ratio in wheat production in time t.

β_0: Natural log value of the constant

P^k/P^n_{t-1}: Relative price of capital to labor in time t-1.

P^w/P^r_{t-1}: Producer's price of wheat/producer's price of rice in t-1.

D74: Oil shock dummy variable

R^2 Adj.: The adjusted R^2 value.

Figures in parentheses are t values with significance of ** (1%) and (20%).

The price of rice was eliminated from the rice K/N equation because the rice price and the rural wage rate were virtually the same variable with a correlation of 99%. Hence the final variables in the K/N function for rice were the lagged price of capital (P^k_{t-1}), the lagged price of labor (P^n_{t-1}) and a dummy variable for the oil shock.[25] The K/N function for rice also was statistically significant at the 1% level with an F value of 2272.065, an R^2 of 99.65%

[25] Multicollinearity did not appear to affect the signs and the significance of the variables, similiar to the situation described in Johnson (1984, p.249).

and all variables significant at the 1% level (Table V.2).

Table V.2: K/N Function for Rice in a Simulation Model of Japanese Domestic Policies and Trade, 1960-1985

	β_0	βLog P^k_{t-1}	βLog P^n_{t-1}	βD74	R^2 Adj.	F-test
Log K/N^r_t	1.8384	-0.68200	1.7354	-0.28039	0.9965	2272.065**
	(2.953)**	(-3.541)**	(29.402)**	(-3.65)**		

Source: Simulation Results
Note: Log: Natural log value of the variable indicated.

K/N^r_t: Capital/Labor ratio in rice production in time t.

β_0: Natural log value of the constant

P^k_{t-1}: Price of capital in time t-1.

P^n_{t-1}: Price of labor in time t-1.

D74: Oil shock dummy variable
R^2 Adj.: The adjusted R^2 value.
Figures in parentheses are t values with significance of ** (1%).

The original specifications postulated for the cost functions required some modifications before well-fitting equations were obtained. The dummy variable for the oil shock was insignificant and not a factor influencing independence of the error term. Yield variables were replaced by the K/N ratios in both sectors. The final specification of the cost function for rice included only two independent variables in a log linear form. These two variables were the capital/labor ratio (K/N^r_t) to account for scale, technology and substitution and secondly, the number of full-time farming households (FT_t). The Cochrane-Orcutt procedure was used to correct the coefficient estimates for autocorrelation (Gujarati, 1988). The R^2 of the rice equation with adjusted coefficients was 96.61% and all variables were significant at the 1% level. (Table V.4) The final specification of the cost function in wheat had the two independent variables of lagged costs of production (C^w_{t-1})

and the wheat K/N ratio (K/N^W_t). The equation was significant with an F value of 43.465, and R^2 of 77.97%. All variables were significant at the 1% level (Table V.3).

Table V.3: Cost Function for Wheat in a Simulation Model of Japanese Domestic Policies and Trade, 1960-1985

	β_0	βC^W_{t-1}	$\beta K/N^W_t$	R^2 Adj.	F-test
C^W_t	17141	0.56021	10.690	0.7797	43.465**
	(2.623)**	(3.246)**	(2.342)**		

Source: Simulation Results

Note: C^W_t: Wheat costs of production in time t.

C^W_{t-1}: Wheat costs of production in time t-1.

K/N^W_t: Capital/Labor ratio in wheat production in time t.

Figures in parentheses are t values with significance of ** (1%).

Table V.4: Cost Function for Rice in a Simulation Model of Japanese Domestic Policies and Trade, 1960-1985

	β_0	$\beta K/N^r_t$	βFT_{t-1}	R^2 Adj.	Rho
†Log C^r_t	11.97	0.50514E-03	-0.57665E-03	0.9661	0.2767
	(72.710)**	(2.578)**	(-4.951)**		

Source: Simulation Results

Note: Log C^r_t: Natural log value of rice costs of production in time t.

K/N^r_t: Capital/Labor ratio in rice production in time t.

FT_{t-1}: Number of full-time farm households in time t-1.

† These coefficient values are corrected by the Cochrane-Orcutt iterative procedure. Figures in parentheses are t values with significance of ** (1%).

Many econometric problems were encountered with the original specification of the wheat price equation. Various data transformations were attempted to respecify the equation. A net margin variable was calculated to eliminate the multicollinearity problems from correlation between the variables of lagged costs of production and lagged output price. The net margin variable was calculated by taking the difference between price per 60 kg and costs of production per 60 kg in the same time period. The logic behind the use of the net margin as one independent variable was the same as in the original specification of the equation. Prices for wheat and rice in Japan are set by government to cover costs of production. If the net margin in the previous year decreased, the decrease in net margin would cause an increase in the wheat price. Use of the net margin variable eliminated the multicollinearity problem and resulted in a well-fitting equation. The three variables of net margin, rice price and total crop diversion acreage and a pricing policy dummy were all significant at the 1% level. The total equation was significant at the 1% level with an F value of 1410.233 and an R^2 of 99.58% (Table V.5).

The dummy variable to test for the effect of the pricing policy change was highly significant. The average wheat price subsidy from 1977-1983 calculated in a Japanese study was 2497 yen per 60 kilograms (Kitade, 1985). The equation results over a two year longer period (1977-1985) are 89% of the study results.

Net margin was expected to be always positive because the government sets prices. However with the new variable, measuring achieved net margin, an interesting discovery was made. Despite the high level of Japanese support prices, in actual and in real terms, prices have not consistently been successful in covering total secondary production costs.[26] Even allowing for statistical errors due to the small sample in the cost of production survey for wheat, as noted in the **Statistical Yearbook of the Ministry of Agriculture, Forestry and Fisheries**, there are many years when net losses occurred (Table V.6). The effect of the change in the wheat pricing policy in 1977 to add a subsidy component to the wheat price determined by the cost of production formula can also be seen.

[26] Secondary production costs are the total costs of production less the value of by-products plus land rent and capital interest.

Table V.5: Price Function for Wheat in a Simulation Model of Japanese Domestic Policies and Trade, 1960-1985

	β_0	βPFT^{W}_{t-1}	βP^{r}_{t-1}	$\beta\ CDP_t$	$\beta D77$	R^2 Adj.	F-test
P^{W}_{t}	1609.2	0.12244	0.30806	0.26874E-02	2220.5	0.9958	1410.233**
	(5.568)**	(3.726)**	(12.605)**	(5.673)**	(9.354)**		

Source: Simulation Results

Note: P^{W}_{t}: Price of wheat in time t.

β_0: Value of the constant.

PFT^{W}_{t-1}: Net margin = Wheat price - Cost per 60 kg.

P^{r}_{t-1}: Producer's price of rice in t-1.

CDP_t: Total acreage diverted under the crop diversion program.

D77: Pricing policy change dummy variable

Figures in parentheses are t values with significance of *(10%) and **(1%).

Table V.6: **Wheat Net Margin*, 1960-1985**

Year	Wheat (Yen/60 kg)
1960	-4641
1961	-4230
1962	-4781
1963	-5439
1964	-6213
1965	-5573
1966	-5914
1967	-5629
1968	-4737
1969	-6560
1970	-7576
1971	-7443
1972	-6710
1973	-3305
1974	-1634
1975	-2712
1976	-2236
1977	-198
1978	923
1979	2114
1980	1976
1981	394
1982	2328
1983	-849
1984	1979
1985	2349

Source: *Calculated from price statistics in Appendix A, Table A.12 and cost statistics in Appendix A, Table A.1.

Problems in specifying the price function for rice arise because of the political nature of the price-setting process. As Balaam (1986) has noted, politics dominate the rice price-setting arena. Consequently the final equation was specified with only rice costs of production (C^r_{t-1}) and the oil shock dummy variable (D74). With this specification, the overall equation was significant at the 1% level with an F value of 840.250 and an R^2 of 98.59%. The variables were significant at the 1% level, while the constant was significant at the 10% level (Table V.7). The error term accounts for the effects of all the political factors that enter into price-setting.

Table V.7: Price Function for Rice in a Simulation Model of Japanese Domestic Policies and Trade, 1960-1985

	β_0	βC^r_{t-1}	$\beta D74$	R^2 Adj.	F-test
P^r_t	1106.4	0.067721	6456.0	0.9859	840.250**
	(2.0208)*	(11.538)**	(16.251)**		

Source: Simulation Resu[illegible]

Note: β_0: Value of the co[illegible]

P^r_t: Producer's [illegible] in time t.

C^r_{t-1}: Costs of rice production in time t-1.

D74: Oil Shock dummy variable.

Figures in parentheses are t values with significance of *(10%) and **(1%).

The specification originally hypothesized for the relationship between structure and trade where imports are a function of the net protection rate, social opportunity costs and wheat self-sufficiency, was rejected. Rejecting this specification means rejection of the hypothesis that policies are dependent mainly on economic costs. An alternate hypothesis was postulated to explain relationship between structure and trade. This hypothesis, opposite to the first, postulates that other forces are more important than economic costs in determining agricultural trade policy. This view is compatible with the assumption that Japan wishes to maintain an agricultural industry irrespective of the cost.

Variables to proxy for economic and non-economic factors were chosen to test the new hypothesis. The first variable chosen was the comparison of the costs of production in wheat to those in rice, before labelled as SOC1. This cost comparison can be a proxy for economic and non-economic forces if it is given a different interpretation. The variable is a measure of the cost of producing a marginal unit of wheat in terms of foregone rice production. As this measure decreases, less resources are required to produce an unit of wheat and the efficiency of domestic wheat production (relative to rice production) is increasing.

The difficulties in the specification of the price equations in the structure-trade model supported the observation that politics play an important role in government decisions. The final specification of the trade equation resulted in the same conclusion; that non-quantifiable forces play a major role in policy decisions. The role of politics appears unlikely to decrease in the future. However, with Japan's increasing prominence in international affairs and her dependence on trade, external political factors as well as domestic policies may emerge to influence agricultural policy.

Japan appears destined always to support domestic agriculture for food security reasons. Thus her agriculture system could never be completely open. But this structure-trade model shows that both economic and non-economic costs have a role in the policy-setting process. Therefore to adjust to domestic and international economic and non-economic forces, agricultural policies may be forced to become more selective in terms of the commodities and the part of the farm sector that is supported. Japan appears to be recognizing the importance of becoming selective in focusing agricultural programs.

D. Simulations

The hypothesis that economic factors do affect Japanese trading policies was confirmed by the scenarios of changed input prices. However economic factors appear to influence policies only indirectly through the structure of agriculture. The estimation of the import function did not support a direct link between economic factors measured in terms of the social opportunity cost measures and trading policies.

The number of full-time farm households, after going through a period of rapid changes from 1960 to the late 1970's, has stabilized. Full-time farm households represent the organizational structure of agriculture. If any further change in organizational structure is to occur, it will require considerable government encouragement. This conclusion is supported by examples in other aspects of organizational structure. For example, farm size has increased very slowly from 1960 to 1985, even with many government programs to encourage an increase in farm size.

Changes in economic factors such as input prices, appear to have the largest effect on the structure of agriculture. In the simulations, input prices had a greater effect than government programs to change agricultural structure. One possible explanation for these results is that prices are able to impact on structure directly while policies have many indirect impacts. These indirect impacts on structure were not included in the model. Another possible explanation is that economic forces actually have a greater effect than government programs.

Permanent changes in the structure of agriculture appear to be based mainly on the economics underlying the operation of the agricultural system rather than on government policies. Government policies can encourage short-run changes in structure, but these results indicate that unless these changes are in accordance with economic principles the results will not last. For example, acreage diverted to cereal crops under the crop diversion program reached an all-time high in 1982. However, the diversion of large areas did not continue, even with the same level of diversion payments. The possible future direction in the structural development of the Japanese cereal sector will be based mainly on economic forces.

The simulations seem to indicate that it will be very difficult to increase Japan's self-sufficiency much by changing the output structure. In the simulation, even if the importance to the government of changes in the output structure was doubled, the effects on wheat trade are small. This result is due to the present low wheat self-sufficiency which was 11% in 1983.[30] Domestic production would have to increase by a large amount to change the wheat self-sufficiency level. This lack of response of self-sufficiency (imports) to changes in the output structure may be wheat-specific. Changes in the output structure would most likely have different effects for other commodities depending on the productivity increases that are possible and the intensity of land use of the commodity. The self-sufficiency level of other commodities could increase with changes in the output structure if the self-sufficiency level of the commodity was higher than that of wheat. Then productivity increases outpacing the population growth rate could increase the self-sufficiency level. Increases in self-sufficiency levels of commodities that are more land-intensive than wheat are realistic.

[30]OECD. Prepublication version of **National Policies and Agricultural Trade: Country Study, Japan,** 1987.

The result of constant imports under the validation scenario of constant 1985 values for all exogenous variables indicates that the present policy and economic conditions are balanced to maintain the status quo of the boundary conditions in the Japanese agricultural system. Static conditions in input prices for full-time farming households resulted in predictions of lower imports. These results indicate that any disturbance of the present mix of policy and economic factors moves to close the system boundary and to protect agriculture. These results give further evidence that policies are balanced to maintain the present closed nature of the boundary of the Japanese agricultural system. Thus, it will require definite government decisions to achieve an opening of the Japanese agricultural system to trade because of the present state which tends toward closing of the system.

E. Overall

One of the unusual features about agricultural development and structural change in Japan is the rapidity of changes. Within 25 years, the input structure has changed from a labor-intensive agriculture to a capital-intensive one. There has been a rural-urban migration of laborers that has changed the organizational structure of agriculture. The output structure has changed so that products other than rice are beginning to play a major role in agriculture. (Appendix A, Table A15) The debate is whether these rapid changes will continue in the future. Recent trends of structural changes exhibit a slowing in the rates of change. Thus large structural changes will be difficult to achieve unless other forces such as international pressures, budgetary restrictions, etc. change drastically to produce pressure on the agricultural structure.

The modelling approach used here appears to be more useful than the approach traditionally used in trade theory. The traditional approach evaluates trade flows based on resource endowments and the quality of those resources. The specification rejected for the trade equation was based on comparative advantage with comparative advantage being determined by resource endowments. The usefulness of the approach used here stems from its departure from the analysis of resource endowments and its inclusion of more easily measurable factors. In this approach recognition is made that distortions from the theoretical situation always exist. Therefore trade was modelled attempting to include those distortions in the model.

F. Limitations

The objective of this study was to analyze the effects on trade of the supply side changes in Japanese agricultural structure and in domestic agricultural policies. With this focus a necessary assumption was that demand would remain constant. Therefore the present analysis gives import projections based on only half of the equation, the supply side. The analysis would be enriched if the effects of demand changes could be incorporated.

A second limitation is that a small number of scenarios were analyzed. Other scenarios such as changes in endogenous variables or more drastic shocks to endogenous variables would have added to the analysis.

One limiting constraint in the model specification was the exclusion of land from the input function. Land is an important factor of agricultural production and thus is important in production decisions. Despite the complexity and distortions that exist with land valuation in Japan, land should be included.

The R^2 of all of the equations are high. This result could stem from possible autocorrelation in some of the equations. With these results, the R^2 of the equations is a measure of policy consonance rather than dissonance.

There may be some misspecification of the relationship between prices and costs due to the long history of market intervention in Japan. As Yoshikazu Kano (1987) has propounded, the traditional cause-and-effect relationship between costs and prices has been reversed in Japan. Farmers expect price increases when costs increase because of the price-setting formulas based on costs of production. Therefore there is little incentive to decrease costs. The market competition that normally prevents input suppliers from setting their prices above the no-profit equilibrium level is conspicuously absent.

G. Further Research

Non-economic factors were found to be important in the determination of wheat imports. Other non-economic factors that possibly play a role in Japanese willingness to trade could be tested. For example, the reliability of the supplier has been mentioned as an important trade criterion. Further research is needed to identify and measure the effects of other non-economic factors on the trade function.

In this analysis, rice was the numeraire commodity. Rice may be used as the numeraire commodity for any agricultural commodity in Japan. The policies for all agricultural commodities, even livestock products, to some extent, are conditional on rice policies. Thus, although this model analyzes wheat, the format of this simulation model could be adapted to other commodities. The structural part of the simulation model would be different for other commodities. The format of the final trade equation in the model would probably be similiar and allow the monitoring of the direction and rate of change in trade possibilities. Farmers in the cereals sector have the most protectionist attitude among farmers in all agricultural sectors. Farmers in other sectors of agriculture are more international in their outlook on technology and markets. Thus similiar studies in other agriculture sectors would give useful results.

Bibliography

Abbott, Philip C. "The Role of Government Interference in International Commodity Trade Models." **American Journal of Agricultural Economics**. Vol. 61, No. 1, 1979, p. 135-140.

Abbott, Philip C. and Robert L. Thompson. **On the Dynamics of Agricultural Comparative Advantage**. Unpublished working paper, 1986.

____. "Changing Agricultural Comparative Advantage." **Agricultural Economics**. No. 1, 1987, p. 97-112.

Adelman, Irma; Peter Berck, and Kathryn Gordon. **Food Security: A Mean Variance Approach**. Working Paper No. 251, California Agricultural Experiment Station, Giannini Foundation of Agricultural Economics, March 1983.

Anderson, Kim. "Economic Growth, Comparative Advantage & Agricultural Trade of Pacific Rim Countries." **Review of Marketing & Agricultural Economics**. Vol. 51, No. 3, 1983, p. 231-248.

Anderson, Kym and In-Chan Ahn. "Protection Policy and Changing Comparative Advantage in Korean Agriculture." **Food Research Institute Studies**. Vol. 19, No. 2, 1984, p. 139-151.

Anonymous. "Focus on Japan," **World Grain**, Vol. 4, No. 4, May 1986, p. 27-28.

____. "Zen-Noh's U.S. Elevator." **Milling and Baking News**. July, 1983, p. 45-49.

____. "Japan's Fear of Food Dependence," **Farmline**. Vol. 7, No. 5, May 1986, p.7.

Arrow, K.J., H.B. Chenery, B.S. Minhas and R.M. Solow. "Capital-Labor Substitution and Economic Efficiency." **Review of Economics and Statistics**. Vol. 63, No. 3, August 1961, p. 225-250.

Babb, E.M. "Some Causes of Structural Change in U.S. Agriculture." in **Structure Issues of American Agriculture**, United States Department of Agriculture (USDA); Economics, Statistics & Cooperatives Service (ERS); Ag. Ec. Report 438, November 1979, p. 51-60.

Balaam, David N. "Self-Sufficiency in Japanese Agriculture: Telescoping and Reconciling the Food Security-Efficiency Dilemma." **World Food Policies Toward Agricultural Interdependence**. Edited by William P. Browne and Don F. Hadwiger, Lynne Rienner Publishers, Boulder, CO., 1986, p. 91-105.

Balassa, Bela. "Trade Liberalization and 'Revealed' Comparative Advantage." **Manchester School of Economic and Social Studies**. Vol. 2, May 1965, p. 99-123.

Baldwin, Robert E. "Determinants of the Commodity Structure of U.S. Trade. **American Economic Review**, Vol 61, March 1971, p. 131-146.

____. "Determinants of Trade and Foreign Investment: Further Evidence." **Review of Economics and Statistics**, Vol 61, No. 1, 1979, p. 40-48.

Bale, Malcolm D. and Ernest Lutz. "Price Distortions In Agriculture & Their Effects: An International Comparison." **American Journal of Agricultural Economics**, 1981, p. 8-22.

Bale, Malcolm D. and Bruce L. Greenshields. **JAPAN: Production and Imports of Food - An Analysis of the Welfare Cost of Protection.** USDA, ERS, FAER No.141, Washington, D.C., November 1977.

Ball, David Stafford. "Factor-Intensity Reversals in International Comparison of Factor Costs and Factor Use." **Journal of Political Economy**, Vol. 74, No. 1, February 1966, p. 77-80.

Bannock, Graham; R.E. Baxter and Ray Rees. **The Penguin Dictionary of Economics (2nd Edition).** Penguin Books, 1983.

Bertrand, Trent J. "An Extension of the N-Factor Case of Factor Proportions Theory." **Kyklos**, Vol. 25, 1972, p. 592-596.

Bigman, David and Shlomo Reutlinger. "National and International Policies Toward Food Security and Price Stabilization." **American Economic Review.** Vol. 69, No. 2, May 1979, p. 159-163.

Blabey, Richard J. "Japanese Agricultural Policy is Key to Future Imports." **Foreign Agriculture.** USDA, Foreign Agriculture Service, September, 1984, p.13-17.

Boehm, William T. "Farm Structure and a Changing Food Policy Environment." **Structure Issures of American Agriculture**, USDA Economics, Statistics and Cooperatives Service, Ag. Ec. Report 438, November 1979, p. 263-268.

Boulding, Kenneth E. "Agricultural Economics in an Evolutionary Perspective." AJAE Vol. 63, 1981, p. [illegible]-795.

Bowen, Harry P. "Changes in the International Distribution of Resources and Their Impact on U.S. Comparative Advantage." **The Review of Economics and Statistics.** Vol. 65, [illegible] 1983, p. 402-414.

_____. "On the Theoretical Interpretation of Indices of Trade Intensity and Revealed Comparative Advantage." **Weltwirtschaftliches Archiv (Review of World Economics).** Vol. 119, No. 3, 1983, p. 464-472.

Boyle, Kevin J.; Ronald A. Oliveira and James K. Whittaker. **An Econometric Model of Barley Acreage Response to Changes in Prices and Wheat Acreage in the Northwest.** Special Report 647, Agricultural Experiment Station, Oregon State University, Corvallis, January 1982.

Brinkman, G. L. and T. K. Warley. **Structural Change in Canadian Agriculture: A Perspective.** Paper prepared for Agriculture Canada, Ottawa, June 1983.

Bruno, Michael. "Domestic Resource Costs and Effective Protection: Clarification and Synthesis." **Journal of Political Economy.** Vol. 80, No.1, 1972, p. 16-33.

Byrne, Sally Breedlove. "Competition in the East Asian Farm Market." **East Asia and Oceania - Situation and Outlook Report.** USDA, ERS, April 1986, p. 46-52.

Carter, Colin A. "Japanese Agricultural Policy and Trade: Current Developments and Prospects." **Future Prospects for World Agricultural Policies and Trade: Implications for Western Canada.** Proceedings of a Conference at the University of Saskatchewan, November 1-2, 1984.

Caves, Richard E. **Trade and Economic Structure (Models and Methods).** Cambridge: Harvard University Press, 1960.

Chacholiades, Militiades. **International Trade Theory and Policy**. McGraw-Hill Book Co., 1978.

Chenery, Hollis B. "Comparative Advantage and Development Policy." **American Economic Review**. Vol. 51, March 1961, p. 18-51.

Christensen, Laurits R. "Concepts and Measurement of Agricultural Productivity." **American Journal of Agricultural Economics**. December, 1975, p. 910-915.

Deardoff, Alan V. "The General Validity of the Law of Comparative Advantage." **Journal of Political Economy**. Vol. 88, No. 5, 1980, p. 941-957.

Debertin, David L. and Angelos Pagoulatos. **Contemporary Production Theory, Duality, Elasticities of Substitution, the Translog Production Function and Agricultural Research**. University of Kentucky Agricultural Economics Research Report 40, June 1985.

deJanvry, Alain. "Integration of Agriculture in the National and World Economy: Implications for Agricultural Policies in Developing Countries." **Agriculture in a Turbulent World Economy**. Proceedings of the 19th International Conference of Agricultural Economists. Edited by Allen Maunder and Ulf Renborg, Gower Publishing Co., 1986, p. 73-82.

Dent, J.B. and M.J. Blackie. **Systems Simulation in Agriculture**. London: Applied Science Publishers Ltd., 1979.

Doll, John P. and Frank Orazem. **Production Economics - Theory with Applications**. Toronto: John Wiley and Sons, Inc., 1984.

Dowling, Edward T. **Schaum's Outline of Theory and Problems of Mathematics for Economists**. Toronto: McGraw-Hill Book Company, 1980.

Eicher, Carl K. and John M. Staatz. "Food Security Policy in Sub-Saharan Africa." **Agriculture in a Turbulent World Economy**. Proceedings of the 19th International Conference of Agricultural Economists. Edited by Allen Maunder and Ulf Renborg, Gower Publishing Co., 1986, p. 215-229.

Fajardo, Daniel; Bruce A. McCarl, and Robert L. Thompson. "A Multicommodity Analysis of Trade Policy Effects: The Case of Nicaraguan Agriculture." **American Journal of Agricultural Economics**. Vol. 63, No. 1, February, 1981, p. 23-31.

Food and Agriculture Organization of the United Nations. **Production Yearbook**. Rome, various years.

Forrester, Jay. W. **Industrial Dynamics**. MIT Press, July 1964.

Fox, Karl A.; Jati K. Sengupta, Erik Thorbecke. **The Theory of Quantitative Economic Policy**. Chicago: Rand McNally and Company, 1966.

Francks, Penelope. **Technology and Agricultural Development in Pre-War Japan**, Baltimore: Yale University Press, 1984.

Goodwin, John R. **Agricultural Economics**, Reston: Reston Publishing Company, 1977.

Government Food Office. **Food Control Statistics Annual Report (Shouku Ryoukanri Toukei Nenpo)**. Tokyo, various issues.

Griliches, Zvi. "Research Expenditures, Education and the Aggregate Agricultural Production Function." **American Economic Review.** Vol. 54, No. 6, December, 1964, p. 961-974.

Gujarati, Damodar N. **Basic Econometrics (Second Edition).** McGraw-Hill, Inc., 1988.

Haberler, Gottfried. "An assessment of the Current Relevance of the Theory of Comparative Advantage to Agricultural Production and Trade." **Proceedings of the 12th International Conference of Agricultural Economists.** Toronto: Oxford University Press, 1966, p. 17-55.

Hall, Arthur D. "Some Fundamental Concepts of Systems Engineering," **Systems Analysis.** Edited by Stanford L. Optner, Baltimore: Penguin Books, Inc., 1973.

Hayami, Yujiro. "Poverty and Beyond: the Forces Shaping the Future in Asia." **Agriculture in a Turbulent World Economy.** Proceedings of the 19th International Conference of Agricultural Economists. Edited by Allen Maunder and Ulf Renborg, Gower Publishing Co., 1986, p. 37-48.

____. "Chapter 10: Adjustment Policies for Japanese Agriculture in a Changing World." **U.S. - Japanese Agricultural Trade Relations.** Edited by Castle, Hemmi, Skillings, 1982, p. 368-392.

____. "Trade Benefits to All: A Design of the Beef Import Liberalization in Japan." **American Journal of Agricultural Economics.** Vol. 61, No. 2, May 1979, p. 342-347.

____. "Rice Policy in Japan's Economic Development", **American Journal of Agricultural Economics,** Vol.54, No. 1, 1972, p.19-31.

Hayami, Yujiro and Vernon W. Ruttan. **Agricultural Development.** Baltimore: The Johns Hopkins University Press, 1985.

Hayami, Yujiro; Vernon W. Ruttan and Herman M. Southworth (editors). **Agricultural Growth in Japan, Taiwan, Korea and the Philippines.** Honolulu: The University Press of Hawaii, 1979.

Hayami, Yujiro and Masayoshi Honma. (in Japanese) **The Agricultural Protection Level of Japan in an International Comparative Perspective,** The Forum for Policy Innovation Research Report No. 1, November 1983.

Helpman, Elhanan. "International Trade in the Presence of Product Differentiation, Economies of Scale and Monopolistic Competition." **Journal of International Economics.** Vol. 11, No. 3, August 1981, p. 305-340.

Hemmi, Kenzo. "Chapter 18: A Japanese Perspective." **Agriculture in the Twenty-First Century.** Edited by John W. Rosenblum. New York: John Wiley & Sons, Inc., 1983, p. 319-328.

Higashi, Chikara. **Japanese Trade Policy Formulation.** New York: Praeger Publishers, 1983.

Hillman, A. L. and S. Hirsch. "Factor Intensity Reversals: Conceptual Experiments with Traded Goods Aggregates." **Weltwirtschaftliches Archiv (Review of World Economics).** Vol. 115, No. 2, 1979, p. 272-283.

Hindley, Brian and Alasdair Smith. "Comparative Advantage and Trade in Services" **The World Economy.** Vol 7, No. 4, December 1984, p. 369-389.

Hokkaido Government Agriculture Department, Agriculture Programs Office. **Paddy Field Diversion Program Explanation (Suiden Riyou Saihen Taisaku)**. March 1985.

Intriligator, Michael D. **Econometric Model, Techniques, and Applications**. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1978.

Inouye, Y. "Case Study of Japan" **Growth and Adjustment in National Agricultures**. Edited by J.P. O'Hagan. Rome: FAO, 1978.

Islam, Tariq Saiful. **Input Substitution and Productivity Change in Canadian Agriculture**. Unpublished Phd thesis, University of Alberta, Spring 1982.

Jabara, Cathy L. and Robert L. Thompson. "Agricultural Comparative Advantage under International Price Uncertainty: The Case of Senegal." **American Journal of Agricultural Economics**. Vol. 62, No. 2, May 1980, p. 188-198.

Japan Tariff Association. **Monthly Japan Exports and Imports (Nihon Boeki Geppo)**. Tokyo: December issues, 1965-1985.

____. **Japan Trade Chronology (Nihon Boeki Nenpyo)**. Tokyo: 1961, 1962, 1964.

____. **Japan Foreign Trade Chronology (Nihon Gaikoku Boeki Nenpyo)**. Tokyo: 1960.

Jensen, Harald R. "Farm Management and Production Economics, 1946-70." A **Survey of Agricultural Economics Literature, Vol. 1**. Edited by Lee R., Martin. Minneapolis: University of Minnesota Press for the American Agricultural Economics Association, p. 3-89.

Johnson, D. Gale. "The Nature of the Supply Function for Agricultural Products." **AEA Readings in the Economics of Agriculture, Vol. XIII**. Edited by Karl A. Fox and D. Gale Johnson. Homewood: Richard D. Irwin, Inc., 1969, p. 247-285.

Johnston, J. **Econometric Methods, 3rd Edition**. McGraw-Hill Book Co., 1984.

Johnson, James D.; Milton H. Ericksen; Jerry A. Sharples; David H. Harrington. "Price and Income Policies and the Structure of Agriculture." **Structure Issues of American Agriculture**, USDA Economics, Statistics & Cooperative Service, Ag. Ec. Report 438. November 1979, p. 174-184.

Johnson, Aaron C. Jr.; Marvin B. Johnson and Rueben C. Buse. **Econometrics: Basic and Applied**. New York: Macmillan Publishing Company, 1987.

Jones, Ronald W. **'Two-Ness' in Trade Theory: Costs and Benefits**. Special Papers in International Economics No. 12, International Finance Section, Princeton University, April 1977.

____. "The Structure of Simple General Equilibrium Models." **Journal of Political Economy**. Vol 73, No. 6, December 1965, p. 557-572.

____. "Factor Proportions and the Heckscher-Ohlin Theorem." **Review of Economic Studies**. Vol. 24, 1956-57, p. 1-10.

Jordan, N. "Some Thinking About 'System'," **Systems Analysis**. Edited by Stanford L. Optner, Baltimore: Penguin Books, Inc., 1973. p.53-72.

Judge, George G., Carter R. Hill, William E. Griffiths, Helmut Lutkepohl and Tsoung-Chao Lee. **Introduction to The Theory and Practic of Econometrics.** New York: John Wiley & Sons, Inc., 1982.

Kada, Ryohei. "Trends and Characteristics of Part-time Farming in Post-war Japan." **Geojournal.** Vol. 6, No. 4, 1982, p. 367-372.

____. **Part-time Family Farming.** Tokyo: Center for Academic Publications, Japan, 1980.

Kako, Toshiyuki. "Decomposition Analysis of Derived Demand for Factor Inputs: The Case of Rice Production in Japan." **American Journal of Agricultural Economics.** Vol. 60, 1978, p. 628-635.

Kalmbach, Paul M.; John W. Sharp and Francis E. Walker. **The Japanese Food and Feed Grain Economy.** Ohio Agricultural Research and Development Center Bulletin 1262, Wooster, Ohio, June 1981.

Kanazawa, Natsuki. "Core Farms," **Agriculture and Horticulture.** (In Japanese), Vol. 60, No. 3, 1985.

Katayama, Sei-ichi; Kazuhiro Ohtani and Toshihisa Toyoda. "Estimation of Structural Change in the Import and Export Equations: An International Comparison." **The Economic Studies Quarterly,** Vol. 38, No. 2, June 1987, p. 148-158.

Kenen, Peter B. **The International Economy.** Englewood Cliff: Prentice-Hall, Inc., 1985.

Kitade, Toshiaki. "Agricultural Products Price Policies (Nousanbutsu Kakaku Seisaku no Genjou to Hatten Hokou)," **Studies of Agriculture and Forestry Issues (Noringyo Mondai Kenkyuu).** Vol. 78, March 1985.

Kmenta, Jan. **Elements of Econometrics.** New York: Macmillan Company, 1971.

Koo, Won W. **Modelling Comparative Advantage for Agricultural Products.** North Dakota Agricultural Experiment Station Staff Paper Series, Department of Agricultural Economics, September 1986.

Koutsoyiannis, A. **Theory of Econometrics (Second Edition).** London: Macmillan Publishers Ltd., 1977.

Kuroda, Yoshimi. **The Production Structure and the Demand for Labor in Postwar Japanese Agriculture, 1952-82,** Institute of Socio-Economic Planning, Discussion Paper Series No. 270, University of Tsukuba, Sakura, Japan, July 1985.

____. "The Production Structure and Demand for Labor in Postwar Japanese Agriculture, 1952-82," **American Journal of Agricultural Economics.** 1987 p. 328-337.

Kuroyanagi, Toshio. "Economic Effects of Government Investment in Farm Mechanization - A Japanese Experience." **Journal of the Faculty of Agriculture,** Hokkaido University, Vol. 60, Part 4, 1981, p. 353-383.

Labys, Walter C. **Dynamic Commodity Models: Specification, Estimation and Simulation.** Toronto: Lexington Books, 1973.

Lappe, Francis Moore and Joseph Collins. **Food First.** Toronto: Random House of Canada, 1978.

Leamer, Edward E. "The Commodity Composition of International Trade in Manufactures: An Empirical Analysis", **Oxford Economic Papers**. Vol. 26, 1974, p. 350-374.

Leamer, Edward E. and Harry P. Bowen. "Cross Section Tests of the Heckscher-Ohlin Theorem: Comment", **American Economic Review**, Vol. 71, No. 5, December 1981, p. 1040-1043.

Lee, Jae-ok. "Japanese Agricultural Policies and Import Demand for Wheat." **Journal of Rural Development**. Vol. 8, No. 2, December 1985, p. 151-196.

Li, Ying. **Simulation of Economic Effects of Mechanical Technology Transfer in Cereal Agriculture**. M.Sc. Thesis, Department of Rural Economy, Edmonton, Spring 1987.

Maskus, Keith E. "A Test of the Heckscher-Ohlin-Vanek Theorem: The Leontief Commonplace," **Journal of International Economics**. Vol. 19, 1985, p.201-212.

Mayes, David G. **Applications of Econometrics**. London: Prentice-Hall International, Inc., 1981.

McGrath, Joseph E., Peter G. Nordlie, W.S. Vaughan, Jr. "A Descriptive Framework for Comparison of System Research Methods", **Systems Analysis**. Edited by Stanford L. Optner, Baltimore: Penguin Books, Inc., 1973. p. 73-86.

Ministry of Agriculture, Forestry and Fisheries, Agricultural Production Bureau, Sericulture Planning Office. **Report on the Survey of the Results of the Rice Conversion Program (Inasaku Tenkan Taisaku Jisseki Chosa Kekka Hyou)**. Tokyo: 1974-1975.

____. **Report on the Survey of the Results of the Rice Diversion and Control Program (Inasaku Tenkan Taisaku Jisseki Chosa Kekka Hyou)**. Tokyo: 1972-73.

Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. **Statistical Yearbook of the Ministry of Agriculture and Forestry (Nourinshou Toukei Hyo)**. Tokyo: various issues.

____. **Report on the Survey of the Farm Household Economy (Nouka Keizai Chousa Houkoku)**. Tokyo: various issues.

____. **Rural Area Price and Wage Statistics (Nouson Bukka Chingin Toukei)**. Tokyo: 1985.

____. **Rice, Wheat and Barley Costs of Production (Kome Oyobi Mugirui no Seisanhi)**. Tokyo: 1973-1985.

____. **Wheat and Barley and Field Crops Costs of Production (Mugirui Kougei Sakumotsu Tou no Seisanpi)**. Tokyo: 1960-1972.

____. **Pocket Agriculture, Forestry and Fishery Statistics (Poketto Nourinsuisan Toukei)**. Tokyo: various issues.

Ministry of Agriculture, Forestry and Fisheries, Sericulture and Vegetable Office, Planning Department. **Report on the Survey of the Results of the Paddy Field Diversion Program (Suiden Riyou Saihen Taisaku Jisseki Chosa Kekka Hyou)**. Tokyo: 1976-1985.

Ministry of Agriculture, Forestry and Fisheries, Technology Investigation Bureau. **Cold Weather Damage and Agriculture Technology 1980 Cold Weather Damage and Future Plans for Farm Operation (Reigai to Nouhyou Gijyutsu - 55 Nen Reigai to Kongo no Gijyutsu Einou Taisaku)**. Tokyo: 1981.

Ministry of Agriculture, Forestry and Fisheries, Research Section, Minister's Secretariat. **Agriculture White Paper - Additional Statistics (Nougyou Hakusho Fuzoku Toukei Hyou)**. Tokyo: 1982-1985.

Ministry of Finance, Economic Planning Agency. **Annual Report on National Accounts (Kokumin Keizai Keisan Nenpou)**. Tokyo: Ministry of Finance Printing Office, 1967, 1972, 1975, 1985, 1987.

Ministry of Foreign Affairs. "Agriculture in Japan," **Facts About Japan**. Tokyo: 1981.

____. **The Japan of Today**. Tokyo: The International Society for Educational Information, 1985.

Motono, Moriyuki. "World Trade Issues Require More than a Piecemeal Approach." **The World Economy**. Vol. 7, No. 31, September 1984, p. 229-239.

Nevison, John M. **The Little Book of Basic Style**. Don Mills, Ont.: Addison-Wesley Publishing Co., 1978.

Nakamura, Takafusa. **Nakasone Program Lecture: Japan in the World Economy**. Lecture series, University of Alberta, Department of Economics, March 30-April 3, 1987.

Naya, Seiji. "Natural Resources, Factor Mix and Factor Reversal in International Trade," **American Economic Review**. Vol. 57, May 1967, p. 561-570.

Niimi, Reiko. "Chapter 8: The Problem of Food Security" **Japan's Economic Security**. Edited by Nobutoshi Akao, Gower Publishing Co., 1983, p. 169-196.

Ogura, Takekazu. **Agrarian Problems and Agricultural Policy in Japan**. The Institute of Asian Economic Affairs, Tokyo, 1967.

____. **Can Japanese Agriculture Survive?** Agricultural Policy Research Center, Tokyo: Kyodo Printing Co., Ltd., 1980.

Ogura, Takekazu B. **Toward Structural Reform of Japanese Agriculture**. Food and Agriculture Policy Research Center, Tokyo, 1983.

Organization for Economic Cooperation and Development (OECD). **National Policies and Agricultural Trade**. Paris, 1987.

Otsuka, Keijiro and Yujiro Hayami. "Goals and Consequences of Rice Policy in Japan, 1965-80", **American Journal of Agricultural Economics**. Vol. 67, No. 3, 1985, p. 529-538.

Packer, Keir John. **Structural Changes in Alberta Cereal Agriculture Systems Between 1971 and 1981**. M.Sc. Thesis, Department of Rural Economy, Edmonton, Spring 1986.

Pearson, Scott R. and Ronald K. Meyer. "Comparative Advantage Among African Coffee Producers," **American Journal of Agricultural Economics**. Vol. 56, No. 2, May 1974, p. 310-313.

Pearson, Scott R.; Narongchai Akrasanee and Gerald C. Nelson. "Comparative Advantage in Rice Production: A Methodological Introduction." **Food Research Institute Studies**. Vol. XIV, No. 2, 1976, p. 127-137.

Penn, J. B. "The Structure of Agriculture: An Overview of the Issue," **Structure Issues of**

American Agriculture. United States Department of Agriculture (USDA); Economics, Statistics & Cooperatives Service (ERS); Ag. Ec. Report 438, November 1979, p. 2-23.

Pindyck, Robert S. and Daniel L. Rubinfeld. **Econometric Models and Economic Forecasts**. McGraw-Hill, Inc., 1976.

Rausser, Gordon C. and Richard E. Just. "Chapter 22: Principles of Policy Modeling in Agriculture," **New Directions in Ecconometric Modeling and Forecasting In U.S. Agriculture**. Edited by Gordon C. Rausser. New York: North Holland, 1982.

Reuter-Kyodo. "OECD agreement brings farm reform to reality: GATT talks next step," **Japan Times**, May 15, 1987.

Reuters News Service. "Japan Submits Farm Trade Proposal to GATT Talks," January 4, 1988.

Roberts, I. M.; R. A. Bain and E. A. Saxon. **Japanese Agricultural Policies: Their Origins, Nature and Effects on Production and Trade**. Bureau of Agricultural Economics, Policy Monograph No. 1, Canberra: Australian Government Publishing Service, 1981.

Ruttan, Vernon W. "Induced Institutional Change," in **Induced Innovation**, Binswanger, Hans P.; Vernon W. Ruttan and others (eds.), Baltimore: The Johns Hopkins University Press, 1978.

Sarris, Alexander H. "Grain Imports and Food Security in an Unstable International Market," **Journal of Development Economics**. 1980, p. 489-504.

Sarris, Alexander H. and John Freebairn. "Endogenous Price Policies & International Wheat Prices," **American Journal of Agricultural Economics**. Vol. 65, No.2, May 1983, p.214-24.

Schmitt, Gunther. "The Role of Institutions in Formulation of Agricultural Polcy: Their Repercussions on the Challenges of an Agriculture in a Turbulent World Economy," **Agriculture in a Turbulent World Economy**. Proceedings of the 19th International Conference of Agricultural Economists. Edited by Allen Maunder and Ulf Renborg, Gower Publishing Co., 1986, p. 390-403.

Sekiya, Shunsaku. "Agricultural Land System in Japan." **Japan's Agricultural Review**. Vol.81-4, March 1981, Ministry of Agriculture, Forestry and Fisheries, p. 1-32.

Sharples, Jerry A. **Estimating the Gains from Less Distorted Agricultural Trade**. Working Paper No. 87-1, International Agricultural Trade Research Consortium.

Sherbiny, Narem A. and Makhlis Y. Zaki. "Interregional Comparative Advantage Models in Developing Agriculture," **Journal of Development Studies**, Vol. 12, No.1, October 1975, p. 3-17.

Shibata, Tokue (editor). **Public Finance in Japan**. Tokyo: University of Tokyo Press, 1986.

Shinya, Masahiko. "Chapter 11: The Supply Response of Cereal Crops. (Mugirui no Kyoukyuu Hannou)," **Functional Analysis of Japanese Agricultural Production (Nihon Nouhyo no seisan Kansuu Bunseki)**. Tokyo: Daimeidou, 1981.

Slayton, Thomas. "Covering the Rice Market," **Foreign Agriculture**. December 1983, p. 14-17.

Smith, Lee. "Divisive Forces in an Inbred Nation," **Fortune**. March 30, 1987, p. 21-49.

Smith, Matt. "A Conditional Approach to Projecting Future Farm Structure," Unpublished draft submitted for consideration as an USDA ERS Staff Report, June 2, 1987.

Sorenson, Vernon L. **International Trade Policy: Agriculture and Development**. East Lansing, MI: Michigan State University Graduate School of Business Administration, 1975.

Spriggs, John. **An Econometric Analysis of Canadian Grains and Oilseeds**. USDA, ERS, Technical Bulletin No. 1662, December 1981.

Srinivasan, T. N. and Jagdish N. Bhagwati. "Shadow Prices for Project Selection in the Presence of Distortions: Effective Rates of Protection and Domestic Resource Costs," **Journal of Political Economy**, Vol.86, No. 1, February 1978, p. 97-116.

Susumu, Yamaji. "Agriculture," **Politics and Economics in Contemporary Japan**. Tokyo: Kodansha International Ltd., 1983.

Taylor, Jared. **Shadow of the Rising Sun**. Tokyo: Charles E. Tuttle Co., Inc., 1983.

Trebilcock, M.J. et al. **The Choice of Governing Instrument**. Ottawa: Economic Council of Canada, 1982.

Tsubota, K. "Agricultural Policy in Japan", **Journal of Agricultural Economics**. Vol. 36, No. 3, 1985, p. 365-375.

Tsujiro, Hiroshi. "A Quantitative Model of the International Rice Market and Analysis of the National Rice Policies, with Special Reference of Thailand, Indonesia, Japan and the United States," **Agricultural Sector Analysis in Asia**. Edited by Max R. Langham and Ralph H. Retzlaff, Bangkok: Singapore University Press, 1982.

Tweeten, Luther. "Impact of Domestic Policy on Comparative Advantage of Agriculture in the South", **Southern Journal of Agricultural Economics**. Vol. 18, No.1, July 1986. p. 67-74.

Tyner, Fred H. and Luther G. Tweeten. "Simulation as a Method of Appraising Farm Programs," **American Journal of Agricultural Economics**. Vol. 50, No.1, 1968, p. 66-81.

United Nations Industrial Development Organization (UNIDO). **Industry and Development Global Report 1985**. New York: United Nations, 1985.

____. **Changing Patterns of Trade in World Industry: An Empirical Study on Revealed Comparative Advantage**. New York: United Nations, 1982.

____. **World Industry in 1980**. Industrial Development Survey - regular biennial issue 1981. New York: United Nations, 1981.

____. **Structural Changes in Industry**. New York: United Nations, 1981.

Vanek, Jaroslav "The Factor Proportions Theory: The N-Factor Case", **Kyklos**. Vol. 21, 1968, p. 749-756.

Vollrath, Thomas. **Dynamics of Comparative Advantage and The Resistance to Free Trade**. USDA, ERS, Foreign Agricultural Economic Report No. 214, August 1985.

Webster's College Dictionary. Springfield: G. & C. Merriam Co., 1981.

White, K. J. "A General Computer Program for Econometric Methods - SHAZAM."

Econometrica. January 1978, p. 239-240.

Yamada, Saburo. **Country Study on Agricultural Productivity Measurement and Analysis: JAPAN 1945-1980**. Tokyo, Oct. 2-8th, 1984.

Yamashita, ~~Katsuhiko. "Public~~ Investment in Agricultural Development in Hokkaido" **Changing Agriculture and Rural Development: The World and Japan**. Edited by H. Ishida, R.D. Hill, R. Hough et al. Tokyo, 1981.

Yeats, Alexander J. "On the Appropriate Interpretation of the Revealed Comparative Advantage Index: Implications of a Methodology Based on Industry Sector Analysis," **Weltwirtschaftliches Archiv (Review of World Economics)**, Vol. 121, No. 1, 1985, p. 61-73.

Yoshikazu, Kano. "Opening the Way to an Agricultural Renaissance," **Japan Echo**. Vol. XIV, No. 1, Spring 1987, p. 9-13.

Appendix A

Data Tables

Table A.1: Undeflated Secondary Costs of Production (Yen/60 kg), 1960-1985

Year	Rice	Wheat	Six-Row Barley	Malting Barley
1960	2374	2261	2205	NA
1961	2673	2260	2230	2169
1962	2842	2529	2539	2504
1963	3190	2880	2754	2653
1964	3645	3231	2969	2801
1965	3939	3190	3395	3288
1966	4233	3544	3122	3278
1967	4823	3630	3099	3159
1968	5375	3416	3290	3355
1969	6249	4255	3874	3858
1970	6587	4909	4440	4377
1971	7344	5133	4033	4086
1972	7320	5081	4306	4358
1973	7883	4651	4285	5293
1974	10329	5499	5623	5097
1975	11706	7161	7490	7072
1976	13747	7462	8970	7741
1977	13871	8404	8764	8596
1978	14655	7410	9082	7953
1979	16139	6989	7539	8180
1980	17795	8728	9014	9448
1981	18580	10994	9104	10919
1982	19143	8972	10262	10074
1983	19749	12228	9398	10556
1984	17621	9359	11706	10040
1985	18512	8813	13241	10857

Source: Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. **Statistical Yearbook of the Ministry of Agriculture and Forestry (Nourinshou Toukei Hyo).** Tokyo: various issues.

Note: NA - Data was not available.

Table A.2: Undeflated Capital Costs of Production (Yen/60 kg), 1960-1985

Year	Rice	Wheat	Six-Row Barley	Malting Barley
1960	293	244	207	NA
1961	380	238	207	207
1962	413	353	317	331
1963	480	438	369	360
1964	583	522	421	389
1965	639	543	541	471
1966	699	616	487	464
1967	740	643	522	453
1968	876	697	640	634
1969	1033	884	741	783
1970	1309	1112	816	929
1971	1536	1145	760	917
1972	1642	1175	715	1047
1973	1784	1060	642	1029
1974	2130	1107	551	929
1975	2358	1339	971	1391
1976	3009	1438	1289	1495
1977	3251	1648	1455	1661
1978	3611	1348	1636	1579
1979	4127	1424	1554	1621
1980	4911	1808	1939	1762
1981	5166	2296	2173	2256
1982	5209	1831	2611	2412
1983	5517	2688	2580	2478
1984	5062	2176	2929	2636
1985	5347	2085	2724	3167

Source: Costs of Production statistics from Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. **Statistical Yearbook of the Ministry of Agriculture and Forestry (Nourinshou Toukei Hyo)**. Tokyo: various issues.

Note: NA - Data was not available.

Table A.3: Undeflated Labor Costs of Production (Yen/60 kg), 1960-1985

Year	Rice	Wheat	Six-Row Barley	Malting Barley
1960	1191	1087	1126	NA
1961	1361	1139	1179	1298
1962	1488	1298	1344	1409
1963	1697	1468	1481	1519
1964	1951	1638	1618	1721
1965	2105	1667	1823	1729
1966	2260	1830	1729	1705
1967	2334	1864	1707	1545
1968	2535	1544	1702	1803
1969	2788	1943	2078	2147
1970	2819	2423	2518	1817
1971	3058	2248	2200	1835
1972	2888	2166	2370	2334
1973	3033	1652	2553	1921
1974	3881	1913	3809	2338
1975	4130	2331	4523	3039
1976	4517	2240	4965	2236
1977	4368	2353	4532	2555
1978	4350	1768	4684	2145
1979	4818	1510	3738	2265
1980	4868	1712	4380	2417
1981	4963	2014	3927	2483
1982	5096	1454	4413	2503
1983	5204	1905	3688	2798
1984	4405	1385	3436	1969
1985	4592	1246	2957	2119

Source: Costs of production statistics from Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department, Statistical Yearbook of the Ministry of Agriculture and Forestry (Nourinshou Toukei Hyo), Tokyo: various issues.

Note: NA - Data was not available.

Table A.4: Deflated* Labor Costs of Production (Yen/60 kg), 1960-1985

Year	Rice	Wheat	Six-Row Barley	Malting Barley
1960	15090.2	13739.2	14245.8	NA
1961	14248.6	11793.8	12301.3	13587.1
1962	12509.3	10940.3	11360.6	11817.2
1963	12100.0	10461.3	10545.0	10832.7
1964	12439.2	10439.9	10347.5	11010.6
1965	12106.6	9582.4	10483.7	9931.7
1966	11850.6	9595.7	9058.9	8944.7
1967	10917.0	8729.9	8005.1	7233.4
1968	9781.2	5945.0	6568.7	6961.0
1969	9740.5	6790.0	7257.3	7495.3
1970	8752.0	7526.8	7817.9	5643.6
1971	8455.1	6215.9	6080.4	5071.1
1972	7116.5	5343.5	5844.8	5758.5
1973	6270.7	3415.7	5277.6	3972.3
1974	6063.7	2987.4	5951.0	3651.5
1975	5666.7	3198.1	6206.8	4169.5
1976	5832.8	2892.0	6412.9	2886.7
1977	5014.3	2702.1	5202.4	2932.6
1978	4759.2	1934.3	5125.0	2346.3
1979	5073.9	1590.0	3936.0	2386.2
1980	4868.0	1712.0	4380.0	2417.0
1981	4717.7	1914.2	3733.1	2360.4
1982	4664.0	1330.5	4039.5	2291.5
1983	4642.8	1699.0	3290.1	2496.4
1984	3837.8	1206.4	2993.4	1715.5
1985	3910.7	1061.2	2518.4	1804.7

Source: Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. **Statistical Yearbook of the Ministry of Agriculture and Forestry (Nourinshou Toukei Hyo)**. Tokyo: various issues.

Notes: 1. NA - Data was not available.

2. * Deflated using a weighted average wage index (1 Female labor hour = 0.8 male labor hour).

Table A.5: Undeflated Net Fixed Capital Investment (Yen/60 kg), 1960-1985

Year	Rice	Wheat	Six-Row Barley	Malting Barley	Naked Barley
1960	NA	NA	NA	NA	NA
1961	NA	NA	NA	NA	NA
1962	NA	NA	NA	NA	NA
1963	NA	NA	NA	NA	NA
1964	2965	2504	1864	1657	4041
1965	3075	2698	2360	1886	3603
1966	3324	2906	2115	1761	4201
1967	3429	3046	1998	1757	4006
1968	4139	3651	3387	3489	4400
1969	5901	4659	3750	4247	6353
1970	6736	5896	3944	4947	9923
1971	7692	5902	3780	4967	8511
1972	7084	5441	3275	5311	9658
1973	7030	4353	2674	4412	7520
1974	8724	4133	1843	3838	5724
1975	9604	4969	3674	5927	8571
1976	12203	5275	4818	5838	14035
1977	12914	5743	4420	6313	16629
1978	12659	4783	5603	6235	11838
1979	15092	4997	5925	6100	13214
1980	17154	5962	6543	6165	15195
1981	17147	7312	5980	7005	12487
1982	16598	5692	6210	6384	14152
1983	17050	8143	8619	6782	16678
1984	15364	8398	8649	6908	11909
1985	16079	6122	10100	8100	14062

Sources: 1. Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. **Rice, Wheat and Barley Costs of Production (Kome Oyobi Mugirui no Seisanhi)**. Tokyo: 1973-1985.
2. Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. **Wheat and Barley and Field Crops Costs of Production (Mugirui Kougei Sakumotsu Tou no Seisanpi)**. Tokyo: 1960-1972.

Note: NA - Data was not available.

Table A.6: Labor Use (Hours/60 kg), 1960-1985

Year	Rice	Wheat	Six-Row Barley	Malting Barley	Naked Barley
1960	26.1	23.1	24.9	NA	32.7
1961	25.5	20.1	22.1	18.4	32.4
1962	22.7	19.3	21.8	19.3	32.8
1963	21.6	23.9	27.6	32.1	154.7
1964	21.5	17.9	19.0	17.8	30.9
1965	20.6	16.1	19.2	16.6	18.8
1966	19.9	16.1	17.1	14.4	21.1
1967	17.9	14.5	15.7	12.8	23.1
1968	17.0	10.3	12.9	9.9	19.0
1969	16.8	11.5	13.3	10.5	21.9
1970	15.4	13.0	13.6	11.0	24.2
1971	15.0	10.6	11.4	8.3	16.4
1972	12.6	9.2	10.6	8.7	16.2
1973	11.4	6.7	9.9	8.5	12.2
1974	10.8	5.9	13.2	5.9	11.0
1975	9.7	5.8	12.2	5.4	11.7
1976	10.3	4.9	11.9	5.4	12.3
1977	9.0	4.7	9.2	5.8	10.9
1978	8.4	3.3	9.6	4.0	7.6
1979	8.4	2.5	7.9	3.7	6.5
1980	8.2	2.8	8.3	3.9	7.6
1981	8.2	3.2	8.9	3.5	6.9
1982	7.6	2.1	8.0	3.1	6.7
1983	7.9	2.8	6.8	3.8	7.0
1984	6.5	2.0	6.4	2.6	4.4
1985	6.5	1.7	3.8	2.5	4.8

Sources: 1. Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. **Rice, Wheat and Barley Costs of Production (Kome Oyobi Mugirui no Seisanhi).** Tokyo: 1973-1985.

2. Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. **Wheat and Barley and Field Crops Costs of Production (Mugirui Kougei Sakumotsu Tou no Seisanpi).** Tokyo: 1960-1972.

Note: NA - Data was not available.

Table A.7: Labor Use (Hours/10 ares), 1960-1985

Year	Rice	Wheat	Six-Row Barley	Malting Barley	Naked Barley
1960	172.9	107.6	126.5	NA	137.0
1961	167.0	104.3	118.7	91.6	136.8
1962	153.2	96.0	112.8	92.6	139.3
1963	146.3	87.3	106.3	86.8	118.6
1964	147.2	78.5	99.7	81.0	97.8
1965	141.0	77.3	97.4	77.9	91.0
1966	140.0	70.4	94.9	71.5	85.1
1967	139.4	67.8	90.8	65.3	95.6
1968	132.7	62.0	80.1	54.7	100.5
1969	128.1	57.0	73.2	51.6	91.6
1970	117.8	57.9	72.4	49.7	78.0
1971	110.3	47.3	64.4	43.9	75.0
1972	99.0	43.7	58.2	38.4	62.8
1973	92.7	33.4	55.0	36.9	50.1
1974	87.1	28.8	67.6	29.9	53.7
1975	81.5	26.5	67.7	24.9	52.7
1976	79.7	23.4	64.9	22.9	49.9
1977	73.8	22.6	51.3	24.2	47.4
1978	71.7	20.3	53.6	22.6	41.9
1979	69.4	17.6	45.[illegible]	21.5	37.9
1980	64.4	15.7	45.0	20.6	37.4
1981	63.9	15.7	42.5	18.5	37.4
1982	60.4	14.1	41.5	16.6	36.6
1983	61.2	13.4	38.9	18.8	34.1
1984	56.5	12.8	25.9	15.5	27.9
1985	56.5	12.8	25.9	15.5	27.9

Sources: 1. Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. Rice, Wheat and Barley Costs of Production (Kome Oyobi Mugirui no Seisanhi). Tokyo: 1973-1985.

2. Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. Wheat and Barley and Field Crops Costs of Production (Mugirui Kougei Sak[illegible] Tou no Seisanpi). Tokyo: 1960-1972.

Note: NA - Data was not available.

Table A.8: Machine Use (Hours/10 ares), 1960-1985

Year	Rice	Wheat	Six-Row Barley	Malting Barley	Naked Barley
1960	7.8	3.9	4.5	NA	3.6
1961	8.6	5.9	6.5	5.2	4.0
1962	9.9	6.5	8.3	7.2	5.0
1963	11.5	8.4	10.1	9.2	3.8
1964	13.6	7.9	10.9	8.1	6.8
1965	14.4	9.6	11.9	10.0	7.9
1966	15.6	10.2	13.6	9.9	9.0
1967	17.6	9.9	12.6	9.3	7.9
1968	18.1	11.6	16.6	13.0	9.7
1969	18.9	10.9	16.4	12.9	9.2
1970	18.5	14.5	17.1	14.0	10.2
1971	18.4	12.0	18.0	14.4	13.0
1972	18.2	10.9	16.3	12.8	11.7
1973	18.3	9.9	15.4	10.3	11.3
1974	16.8	9.9	12.8	6.3	11.3
1975	17.9	9.1	14.3	11.2	11.2
1976	17.8	8.2	13.6	10.5	10.5
1977	14.7	8.0	12.0	7.3	9.7
1978	14.9	6.7	11.4	8.4	10.7
1979	14.8	6.2	11.8	7.3	9.6
1980	14.2	5.7	12.7	6.7	10.4
1981	15.2	5.6	11.8	6.7	8.6
1982	14.6	4.9	11.5	5.3	9.2
1983	15.5	5.1	11.9	6.1	8.9
1984	15.0	5.3	7.3	5.2	9.6
1985	14.5	5.1	6.4	4.6	10.0

Sources: 1. Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department, **Rice, Wheat and Barley Costs of Production (Kome Oyobi Mugirui no Seisanhi)**. Tokyo: 1973-1985.

2. Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. **Wheat and Barley and Field Crops Costs of Production (Mugirui Kougei Sakumotsu Tou no Seisanpi)**. Tokyo: 1960-1972.

Note: NA - Data was not available.

Table A.9: Production Area (1,000 Ha), 1960-1985

Year	Rice	Wheat	Six-Row Barley	Malting Barley	Naked Barley	Total
1960	3308	602.3	319.3	82.7	435.9	6122
1961	3301	648.7	261.5	95.8	335.0	6136
1962	3285	642.0	223.3	113.8	275.7	6132
1963	3272	583.7	191.9	124.7	248.5	6060
1964	3260	508.2	160.5	112.1	205.7	6042
1965	3255	475.9	131.9	113.3	177.0	6004
1966	3254	421.2	115.2	110.2	162.5	5996
1967	3263	366.6	95.2	112.0	145.1	5938
1968	3280	322.4	81.1	108.3	126.5	5897
1969	3274	286.5	66.4	107.4	109.3	5852
1970	2923	229.2	46.3	99.3	80.2	5796
1971	2695	166.3	30.7	82.0	50.7	5741
1972	2640	113.7	21.3	68.0	31.9	5683
1973	2620	74.9	14.1	47.5	18.4	5647
1974	2724	82.8	12.0	48.0	17.5	5615
1975	2764	89.6	11.1	49.7	17.3	5572
1976	2779	89.1	10.6	53.2	16.5	5536
1977	2757	86.0	9.7	53.3	14.8	5515
1978	2548	112.0	11.1	69.8	15.2	5494
1979	2497	149.0	15.4	83.5	16.7	5474
1980	2377	191.1	19.3	84.9	18.0	5461
1981	2278	224.4	23.3	83.0	16.1	5442
1982	2257	227.8	26.4	81.9	14.7	5426
1983	2273	229.4	26.5	83.9	13.5	5411
1984	2315	231.9	24.1	81.5	11.1	5396
1985	2342	346.9	22.9	79.6	10.4	NA

Source: Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. Statistical Yearbook of the Ministry of Agriculture and Forestry (Nourinshou Toukei Hyo). Tokyo: various issues.

Note: NA - Data was not available.

Table A.10: Total Production (1,000 Tonnes), 1960-1985

Year	Rice	Wheat	Six-Row Barley	Malting Barley	Naked Barley
1960	12858	1531	974.8	230.8	1095
1961	12419	1781	841.1	286.1	849.1
1962	13009	1631	695.1	328.1	703
1963	12812	716	443.2	202.4	113.3
1964	12584	1244	506.5	305.9	390.4
1965	12409	1287	402.6	318.1	513.3
1966	12745	1024	383.9	327.0	394
1967	14453	996.9	329.5	343.4	359.4
1968	14449	1012	279.4	360.1	381
1969	14003	757.9	219.5	318.4	274.2
1970	12689	473.6	148.1	269.4	155
1971	10887	440.3	103.8	260.3	138.7
1972	11889	283.9	70.0	180.4	74.4
1973	12144	202.3	46.8	124.3	45.2
1974	12292	231.7	36.9	144.8	51.4
1975	13165	240.7	37.1	137.0	46.8
1976	11772	222.4	34.9	135.2	40.2
1977	13095	236.4	32.6	134.5	38.7
1978	12589	366.7	37.3	238.5	50.2
1979	11958	541.3	53.5	294.1	58.8
1980	9751	582.8	62.8	269.2	53.3
1981	10259	587.4	66.7	263.6	52.7
1982	10270	741.8	82.4	259.4	47.9
1983	10366	695.3	90.9	249.2	39.3
1984	11878	740.5	58.2	294.8	42.5
1985	11662	1252	75.7	263.8	38.1

Source: Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. **Statistical Yearbook of the Ministry of Agriculture and Forestry (Nourinshou Toukei Hyo).** Tokyo: various issues.

Table A.11: Cereal Yields (Kg/10 ares),1960-1985

Year	Rice	Wheat	Six-Row Barley	Malting Barley	Naked Barley
1960	448	285	305	279	251
1961	439	303	322	299	253
1962	450	292	311	288	255
1963	446	212	231	162	46
1964	446	266	315	273	190
1965	445	291	305	281	290
1966	455	265	333	297	242
1967	502	282	346	307	248
1968	497	360	345	333	301
1969	484	297	331	296	251
1970	487	268	320	271	193
1971	464	267	338	317	274
1972	495	285	329	265	233
1973	511	301	332	262	246
1974	503	295	308	302	294
1975	525	275	334	276	271
1976	486	288	328	254	244
1977	512	291	336	252	261
1978	533	371	336	342	330
1979	516	418	347	352	352
1980	489	339	325	317	296
1981	489	296	286	318	327
1982	495	405	312	317	326
1983	488	292	343	297	291
1984	544	392	241	362	383
1985	527	430	331	331	366

Source: Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. **Statistical Yearbook of the Ministry of Agriculture and Forestry (Nourinshou Toukei Hyo)**. Tokyo: various issues.

Table A.12: Domestic Producer Prices (Yen/60 kg), 1960-1985

Year	Rice	Wheat	Barley
1960	3902	2149	1904
1961	4129	2283	2001
1962	4562	2404	2107
1963	5030	2473	2167
1964	5772	2591	2271
1965	6228	2713	2378
1966	6936	2902	2544
1967	7592	3034	2658
1968	8088	3170	2778
1969	8090	3267	2864
1970	8152	3431	3008
1971	8482	3667	3214
1972	8880	3810	3340
1973	10218	4345	3808
1974	13491	5564	4877
1975	15440	6129	5372
1976	16432	6574	5762
1977	17086	9495	8628
1978	17176	9692	8804
1979	17176	9923	9016
1980	17536	10704	9700
1981	17603	11047	9994
1982	17797	11047	9994
1983	18112	11092	10039
1984	18505	11092	10039
1985	18505	11092	10039

Source: Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. **Statistical Yearbook of the Ministry of Agriculture and Forestry (Nourinshou Toukei Hyo)**. Tokyo: various issues.

Table A.13: International CIF Prices (Yen/60 kg), 1960-1985

Year	Rice (Yen/60 kg)	Wheat (Yen/60 kg)	Barley (Yen/60 kg)
1960	3420	1482	NA
1961	4560	1524	NA
1962	3900	1608	NA
1963	4260	1536	NA
1964	4080	1644	1308
1965	4020	1590	1344
1966	4080	1620	1470
1967	4260	1710	1410
1968	4200	1650	1368
1969	4260	1614	1062
1970	4980	1578	1176
1971	4920	1578	1404
1972	6180	1368	1188
1973	8280	2046	1776
1974	11040	4062	2992
1975	9000	3798	2700
1976	6540	3534	2556
1977	7800	2352	1992
1978	5760	2010	1536
1979	6540	2598	1770
1980	6900	3264	2376
1981	8100	3396	2604
1982	6600	3222	2262
1983	6420	2982	1962
1984	6720	3018	2148
1985	5760	2922	1878

Sources:
1. Japan Tariff Association. **Monthly Japan Exports and Imports (Nihon Boeki Geppo)**. Tokyo: December issues, 1965-1985.
2. ____. **Japan Trade Chronology (Nihon Boeki Nenpyo)**. Tokyo: 1961, 1962, 1964.
3. ____. **Japan Foreign Trade Chronology (Nihon Gaikoku Boeki Nenpyo)**. Tokyo: 1960.
4. Otsuka, Keijiro and Yujiro Hayami. "Goals and Consequences of Rice Policy in Japan, 1965-80", **American Journal of Agricultural Economics**, Vol. 67, No. 3, 1985, p. 529-538.
5. Food and Agriculture Organization of the United Nations. **Production Yearbook**. Rome, various years.

Notes:
1. See Chapter IV for the methodology used to construct the data series.
2. NA - Data was not available.

Table A.14: Input Price Indexes*

Year	Large Machinery Price Index	Overall Input Price Index	Composite Machinery Price Index†	Aggregated Wage Index
1960	51.7	33.3	47.1	10.4
1961	51.7	34.7	47.2	11.7
1962	52.0	35.2	47.6	14.5
1963	52.1	36.4	47.9	15.4
1964	52.0	36.7	[illegible]	17.0
1965	52.2	38.5	48.3	18.6
1966	53.1	40.2	49.4	20.0
1967	53.8	41.9	50.5	23.2
1968	53.8	43.2	50.6	26.0
1969	54.5	43.3	51.4	28.6
1970	56.0	44.6	53.1	32.3
1971	57.0	46.2	54.2	34.9
1972	58.5	48.3	57.0	39.9
1973	65.1	60.8	64.0	47.9
1974	81.9	76.4	80.6	59.3
1975	86.4	81.0	85.7	69.2
1976	88.7	84.7	88.3	74.5
1977	90.2	86.7	90.0	81.9
1978	92.3	84.5	92.0	87.5
1979	94.2	89.5	93.8	96.9
1980	100.0	100.0	100.0	100.0
1981	102.3	103.2	102.4	102.7
1982	104.7	102.9	104.8	113.0
1983	105.6	102.4	105.7	112.3
1984	108.3	102.7	108.2	114.8
1985	108.6	100.8	108.7	118.8

Source: Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. **Report on the Survey of the Farm Household Economy (Nouka Keizai Chousa Houkoku)**. Tokyo: various issues.

Notes: * 1980 = 100

†Used as proxy for capital price.

Table A.15: Aggregate Gross Income by Commodity Grouping (1,000 Yen), 1960-1985

Year	Aggregate Total	Crops Total	Rice	Wheat & Barley	Misc. Cereals	Vegetables	Industrial Crops	Livestock Total
1960	358.7	281.0	176.1	18.7	9.4	30.9	17.0	60.6
1961	391.6	302.6	181.1	18.7	9.2	40.6	19.6	70.6
1962	451.4	341.9	204.0	17.9	8.9	43.7	21.9	89.8
1963	499.6	363.9	220.8	7.5	10.0	46.6	24.8	112.6
1964	563.9	419.2	249.2	13.7	9.6	58.3	30.0	124.9
1965	638.8	466.8	274.2	15.7	11.5	64.2	32.5	149.6
1966	725.7	530.3	314.9	14.4	11.2	75.3	38.8	167.6
1967	869.6	646.6	387.0	15.8	13.7	94.9	44.0	187.6
1968	926.1	687.0	413.4	16.4	13.9	100.1	49.1	207.1
1969	969.2	715.2	409.2	11.9	14.6	117.0	46.5	222.7
1970	984.6	726.5	379.7	8.4	16.5	146.5	49.2	223.3
1971	961.4	695.1	339.7	7.8	17.5	143.9	51.1	235.2
1972	1127.5	806.6	393.5	5.7	20.0	169.5	62.9	285.5
1973	1410.7	1005.0	470.0	4.7	26.3	241.3	79.1	351.1
1974	1776.8	1322.1	662.5	9.4	29.2	299.4	96.7	409.1
1975	2080.6	1564.3	793.3	11.6	32.0	349.8	115.5	466.0
1976	2214.4	1632.1	783.9	11.9	40.9	382.6	126.5	526.1
1977	2331.5	1713.3	904.1	12.4	39.2	347.1	128.2	561.9
1978	2398.5	1756.9	867.6	24.0	44.4	359.5	148.1	580.1
1979	2446.7	1783.7	832.9	34.5	46.4	421.1	136.4	596.4
1980	2420.9	1723.1	721.8	35.2	50.6	441.5	138.6	631.5
1981	2551.9	1842.7	787.7	40.3	54.5	465.7	140.7	649.8
1982	2575.6	1852.8	802.5	46.0	27.2	463.3	157.0	660.1
1983	2691.1	1963.9	819.6	44.4	24.2	533.7	167.6	665.4
1984	2857.4	2127.4	973.1	49.8	26.5	483.8	174.2	675.9
1985	2896.8	2168.7	956.4	52.7	24.4	549.8	160.4	677.8

Source: Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department. Statistical Yearbook of the Ministry of Agriculture and Forestry (Nourinshou Toukei Ilyo). Tokyo: various issues.

Appendix B

Statistical Definitions of Farm Households[31]

Statistics on the number of farm households are based on the results of the annual Sample Survey of Agriculture.

Definition of Household:

A household consists of the total number of household members who consider the farm as their base of life. Therefore, household members who are temporarily working away from home, but return from time to time to the farm and use it as their base of life are considered part of the farm household.

Definition of Farm household:

1. In East Japan (14 prefectures of Hokkaido, Aomori, Iwate, Miyagi, Abita, Yamagata, Fukushima, Ibarabi, Tochigi, Gumma, Saitama, Chiba, Niigata and Toyama) - a household managing 10 ares or more of cultived land **OR**

2. In West Japan (the other prefectures) - a household managing 5 ares or more of cultivated land **OR**

3. A household having received 70,000 yen or more from the sale of its agricultural products during the year before the survey date, even though the household is managing less ares of cultivated land than the said minimums or is managing no cultivated land.

Definition of Full-Time Farm Household:

A farm household which has no household member engaged in work other than farming.

Definition of Part-Time Farm Household:

1. Part-Time Farm Household - Type I: A farm household which has one or more household members engaged in jobs other than farming (i.e. employed for 30 days or more off the farm or earning 50,000 yen or more from off-farm business) . However, more than 50% of the household's income comes from farming.

2. Part-Time Farm Household - Type II: A farm household which has one or more household members engaged in jobs other than farming and greater than 50% of the household's income comes from off-farm sources.

[31] Farm Household Statistics Explanation in the **Statistical Yearbook of the Ministry of Agriculture and Forestry (Nourinshou Toukei Hyo)** from the Ministry of Agriculture, Forestry and Fisheries, Economic Affairs Bureau, Statistics and Information Department.

Appendix C

Validation Graphs

Figure C.1: Wheat K/N Ratio, 1960-1985

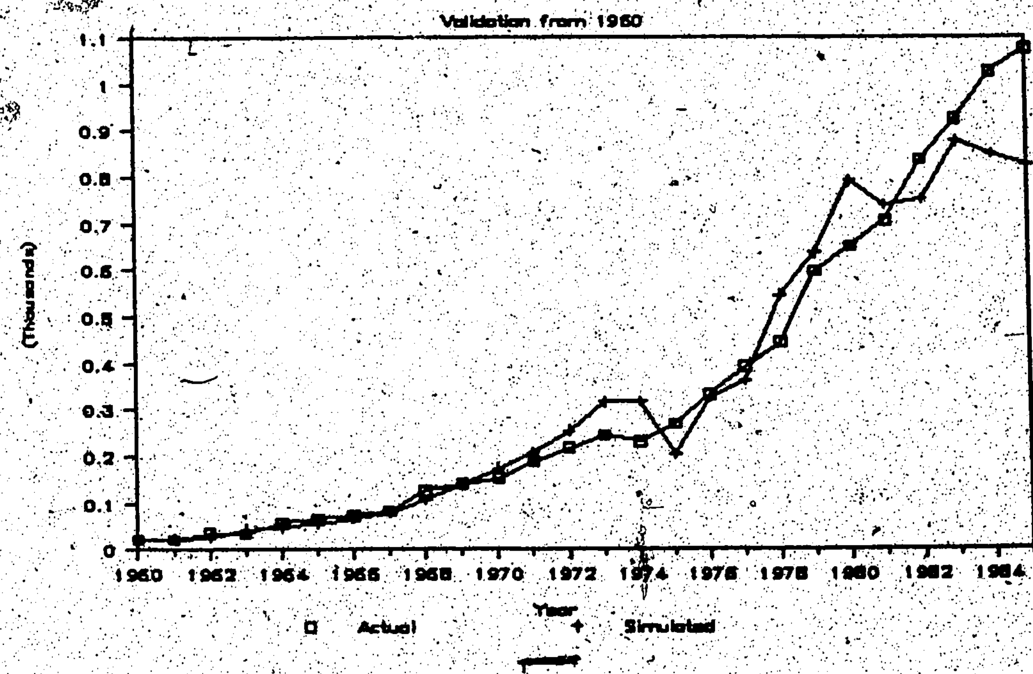


Figure C.2: Wheat Costs of Production, 1960-1985

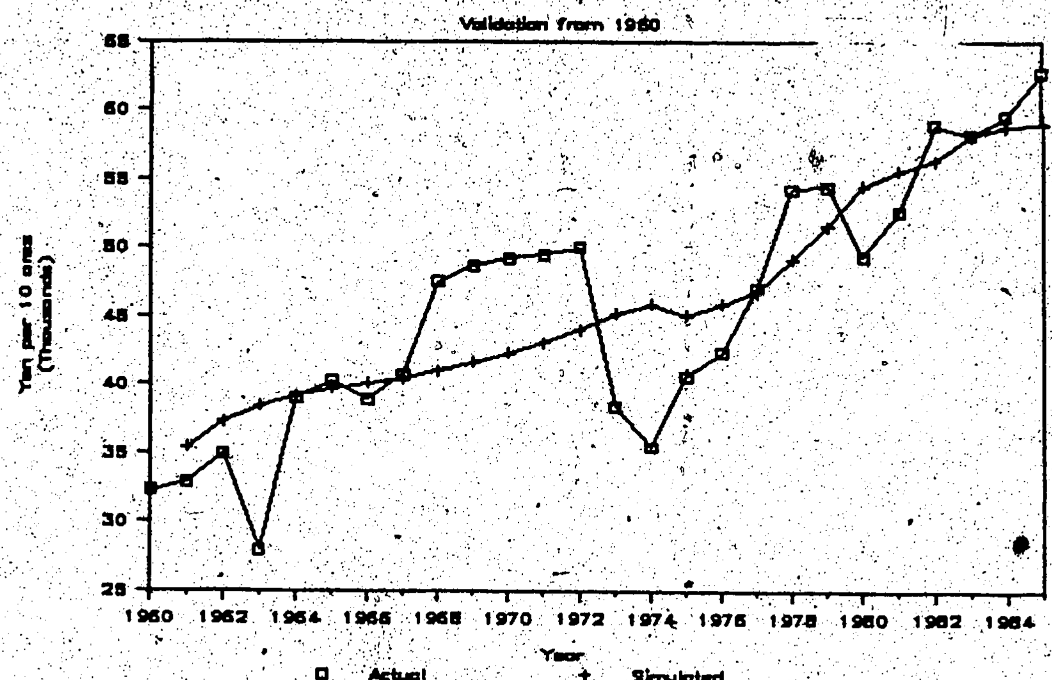


Figure C.3: Wheat Price, 1960-1985

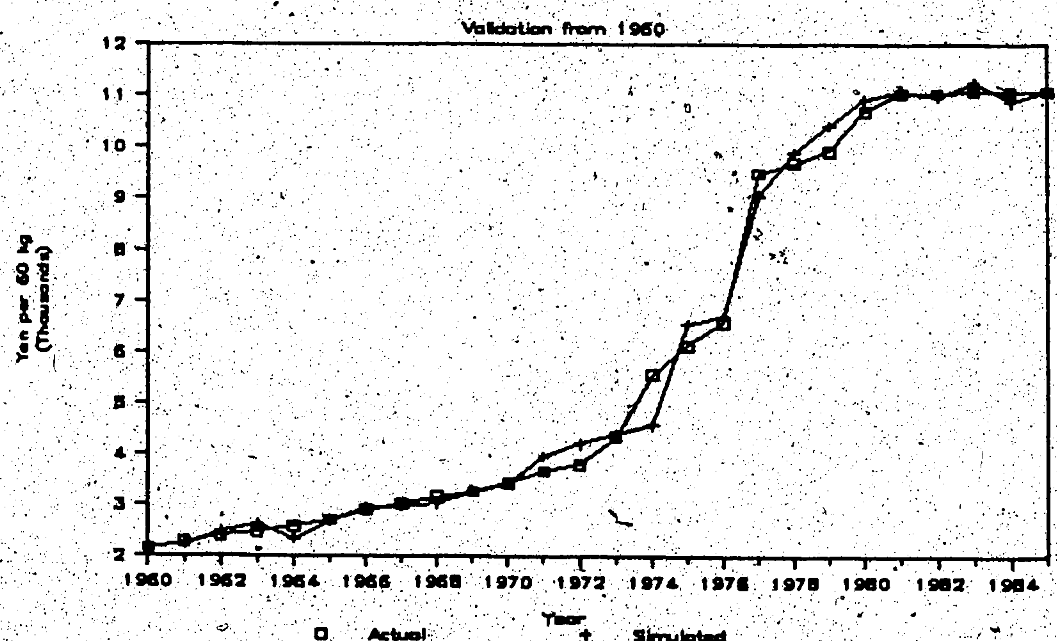


Figure C.4: Rice K/N Ratio, 1960-1985

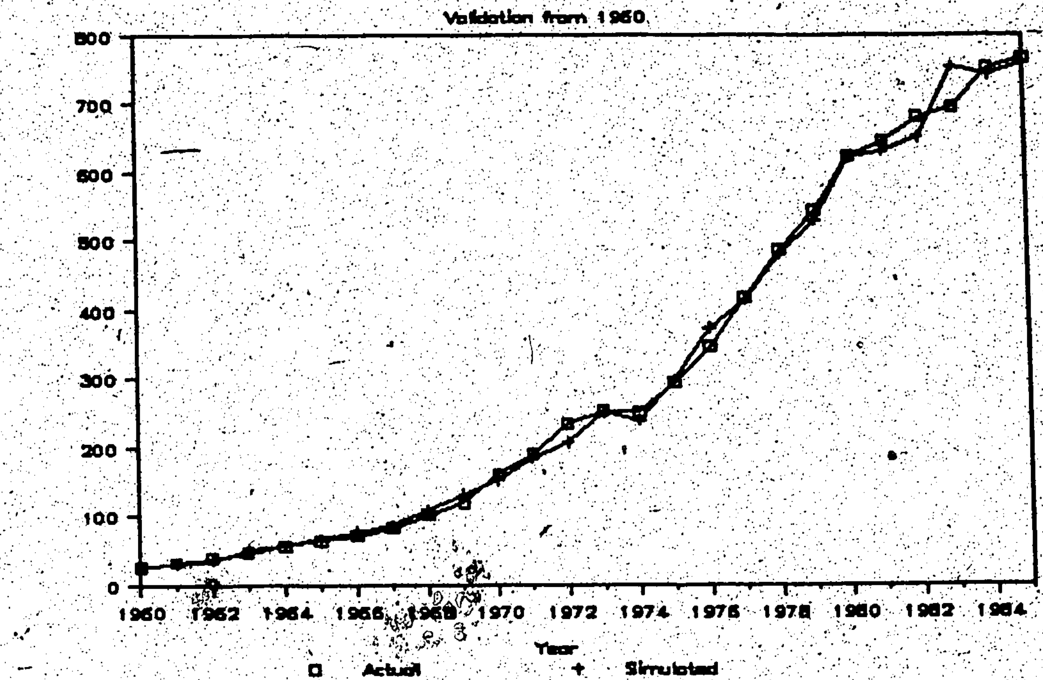


Figure C.5: Rice Costs of Production, 1960-1985

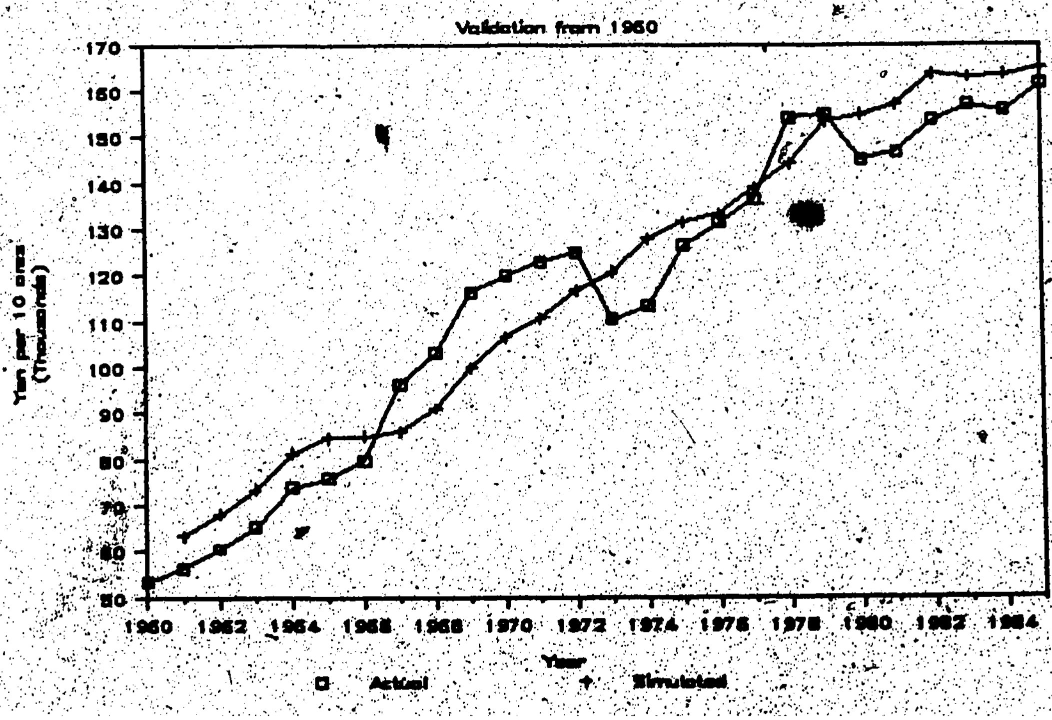


Figure C.6: Rice Price, 1960-1985

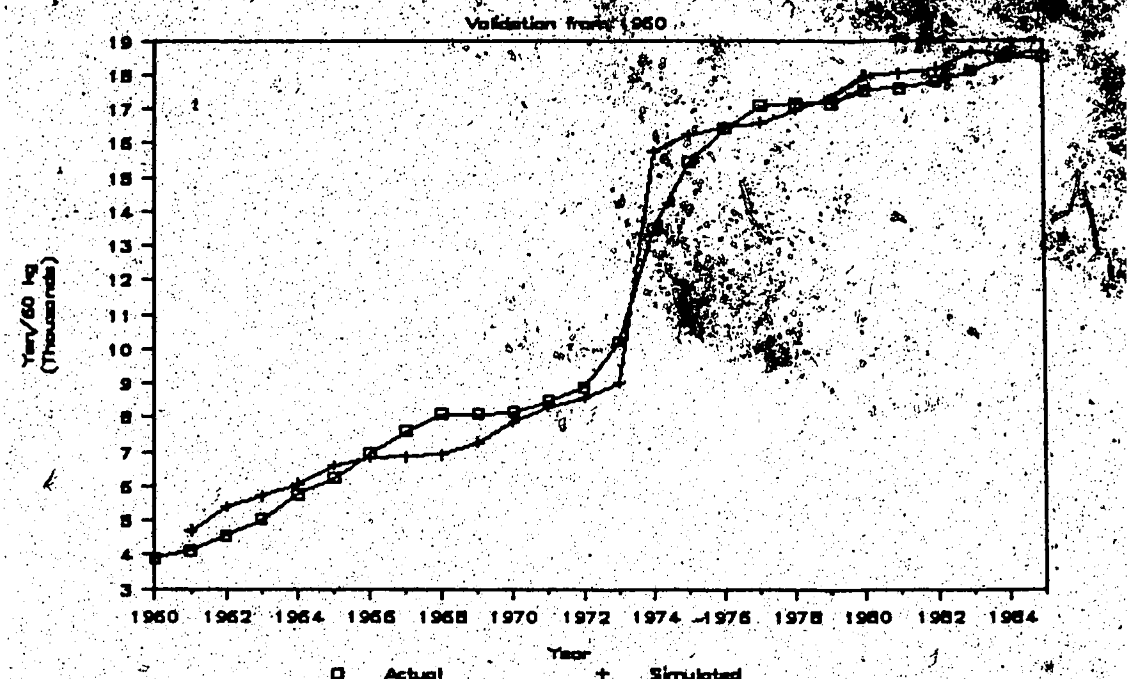
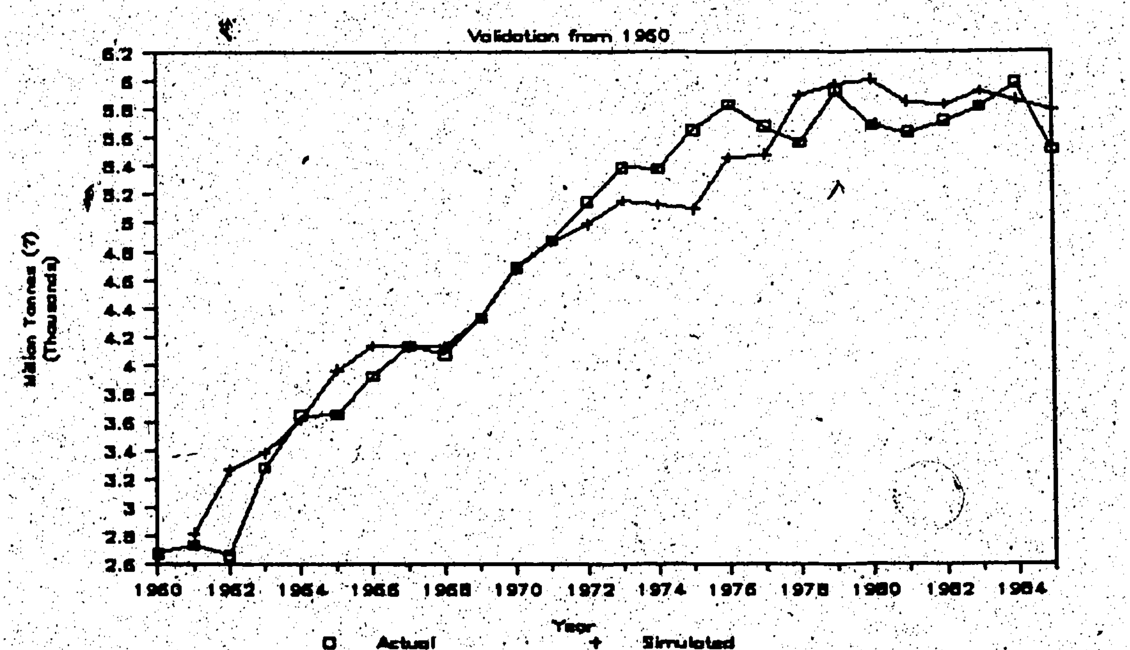


Figure C.7: Total Wheat Imports, 1960-1985



Appendix D

Graphs of Exogenous Variables

Figure D.1: Full-Time Farm Households, 1960-1985

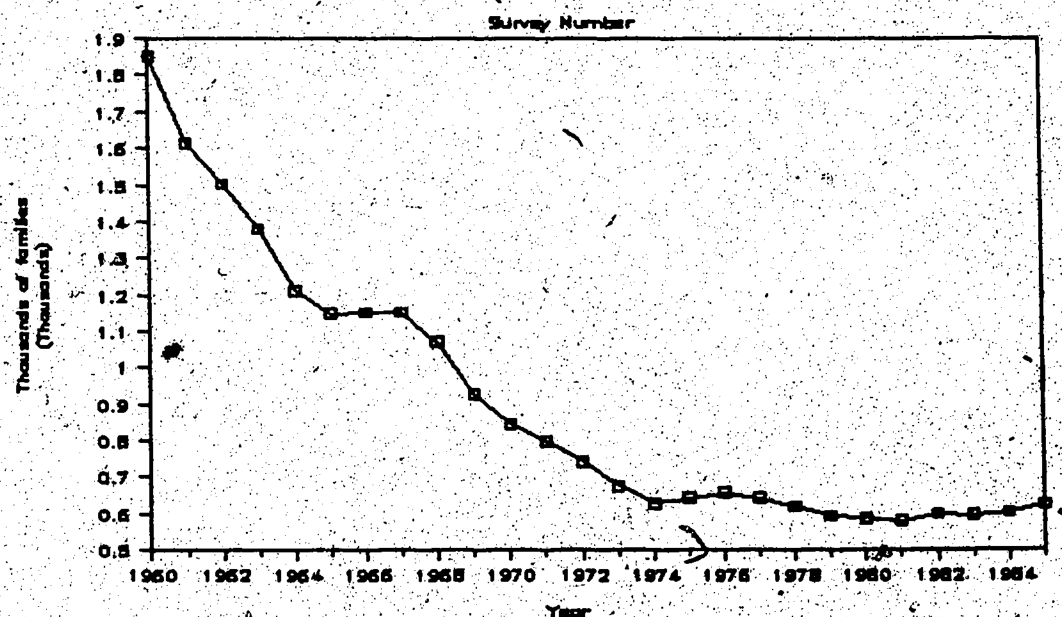


Figure D.2: Price of Capital, 1960-1985

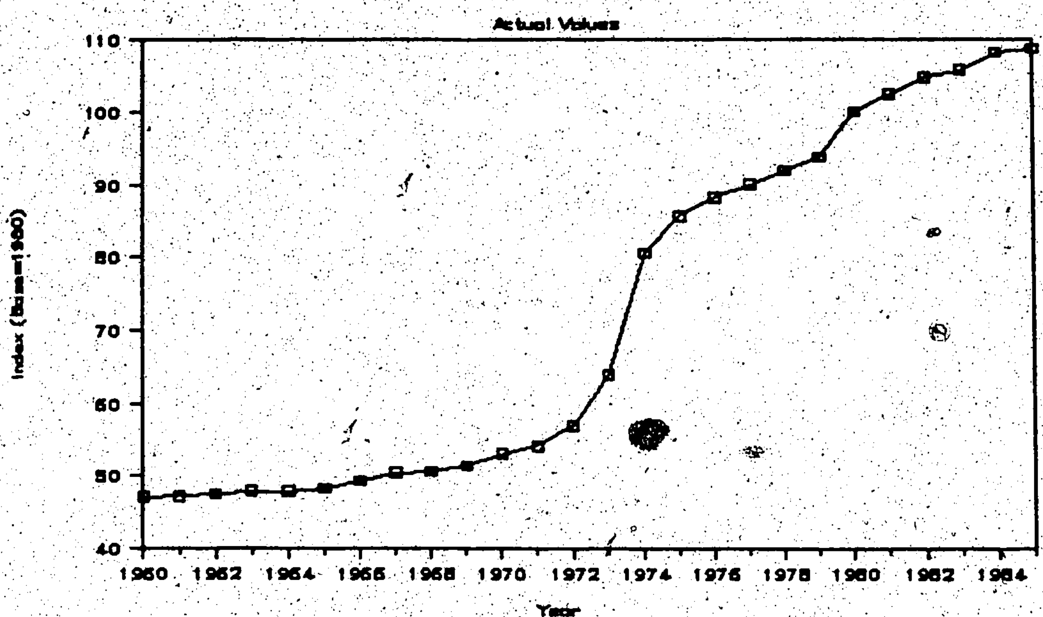


Figure D.3: Price of Labor, 1960-1985

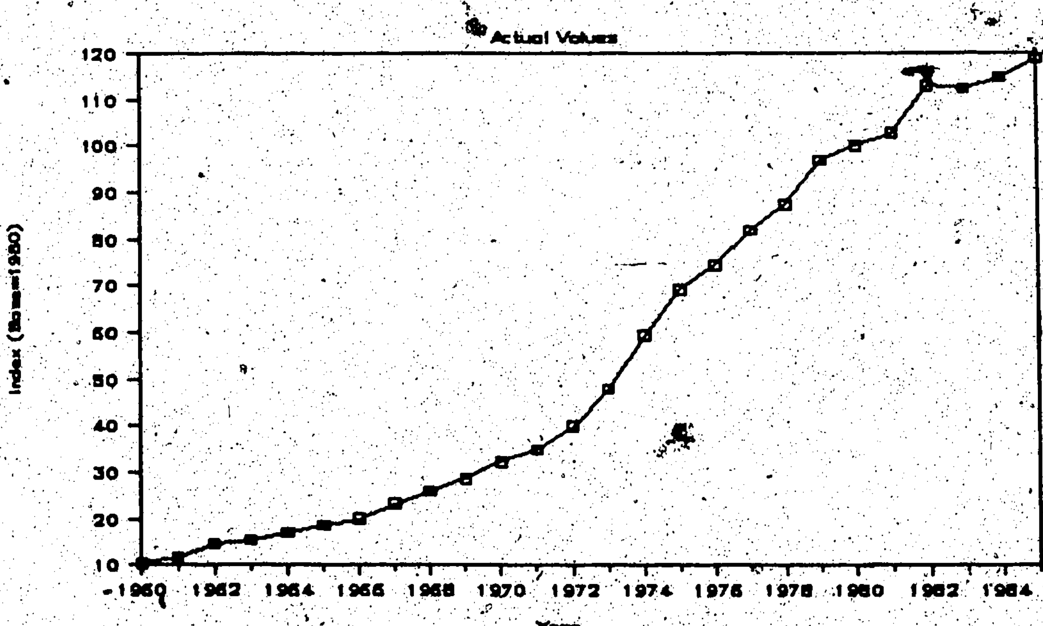


Figure D.4: International Price of Wheat, 1960-1985

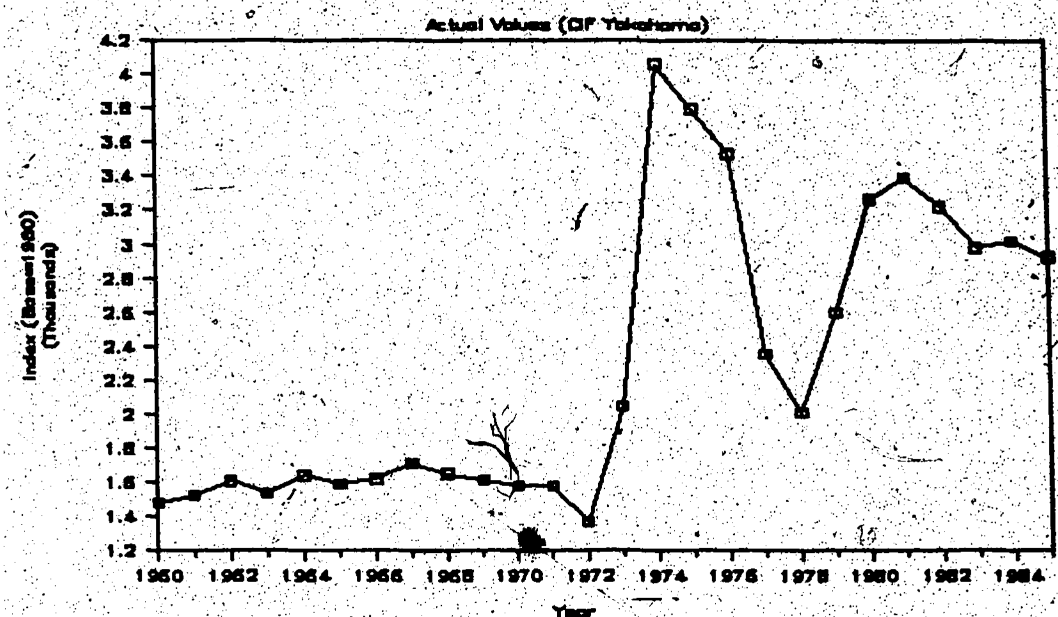


Figure D.5: Wheat Yields, 1960-1985