TRADE RESTRICTIVENESS OF JAPANESE AGRICULTURAL IMPORT POLICIES

By

CHRISTOS J. PANTZIOS

A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1993

ACKNOWLEDGMENTS

My appreciation is extended to a number of people for their support during my doctoral studies. I would first like to express my gratitude to Dr. T. G. Taylor and Dr. E. Dinopoulos. As chairman of my supervisory committee, Dr. Taylor not only contributed to my education, but he also influenced my way of thinking and my ideas as an economist. His continuous encouragement, support, and friendship were important factors for me during my studies at the University of Florida and are deeply appreciated. Although the external member of my supervisory committee, Dr. Dinopoulos took a very close interest in my work and was instrumental in the inception and theoretical justification of my research. I would like to express my appreciation for his encouragement throughout my research effort, and also for his friendship.

My deep appreciation also goes to Dr. L. Polopolus and Dr. W. G. Boggess for recommending my application at the Food and Resource Economics Department (F.R.E.) at the University of Florida and effectively initiating my Ph.D. effort. Special thanks are also owed to Dr. Boggess for his unequivocal support as a member of my supervisory committee and also his friendship throughout my Ph.D. studies at the University of Florida. My sincere appreciation is also extended to the rest of the members of my supervisory committee, Dr. J. L. Seale Jr. and Dr. G. F. Fairchild, for their contribution to my research.

I would also like to express my thanks to the staff of the System Support Center, and the secretarial personnel at the F.R.E. for their help and support during my studies. Last but not least, I would like to extend my thanks to my friends in Gainesville FL, for their concern and support during the last two years of my studies and especially to Ms Trinidad Reyes for her help, encouragement, and moral support.

TABLE OF CONTENTS

Abstract of Dissertation Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Doctor of Philosophy

TRADE RESTRICTIVENESS OF
JAPANESE AGRICULTURAL IMPORT POLICIES

By

Christos J. Pantzios

December 1993

Chairperson: Timothy G. Taylor
Major Department: Food and Resource Economics

This study is an attempt to re-evaluate existing measures of trade protection and empirically investigate new ones in search of measures that aggregate satisfactorily diverse sets of trade distortions and provide a valid estimation of trade restrictiveness across countries and over time. A review of the existing literature reveals that, from a methodological point of view, the Trade Restrictiveness Index (TRI), has some clear advantages over the rest of the trade protection measures.

The study implements the TRI by investigating the overall restrictiveness of a subset of Japan's agricultural policies. The level of trade protection is measured, *ceteris paribus*, by means of the TRI for the following farm products: (1) beef, (2) pork, (3) poultry, (4) wheat, (5) rice, and (6) fresh oranges. The computed index indicates a dramatic rise in trade protection in the early 1970s, followed by a slow process of easing

price and quantity restrictions so that a slight trade liberalization trend appears towards the end of the examined period.

This study also attempts a generalization of the standard TRI by deriving the index in the presence of different sets of traded goods over time. Under the maintained assumption of a C.E.S. welfare function, it is shown that when newly traded goods are introduced over time, the standard TRI is adjusted by a factor that depends on the relative expenditure value of the new goods, and the elasticity of substitution of the underlying C.E.S. welfare function. This generalized version of the TRI is empirically investigated by calculating a partial TRI pertaining to Japanese meat imports under the maintained hypothesis that beef imports are differentiated products, distinguished by origin (supplier country). The standard TRI is adjusted in 1969 to account for the introduction of U.S. beef in the Japanese meat market. This exercise shows that the TRI may be shaped by both policy changes and cross-commodity effects and as a result the adjustment in the generalized TRI may be either upwards or downwards.

CHAPTER 1
PROBLEM STATEMENT AND OBJECTIVES OF THE STUDY

Introduction

The rapid growth of international trade during the last two decades has resulted in an increasing interdependence of the world's economies. The globalization of markets, however, has been often accompanied by heavy government intervention. This is especially true in agricultural trade where government intervention is the rule rather than the exception. In attempting to insulate their farm sectors from the variability of world markets, governments have devised national agricultural policies whose diversity and complexity obscures the global interdependence of agricultural markets.

Nowhere is this clearer than in the contrast between the agricultural policies of the European Community (EC) countries and the U.S. and the resulting declining export power of the US farm sector. To resolve this conflict, trade in agricultural products has been included for the first time in the Uruguay round of the General Agreement on Tariffs and Trade (GATT) negotiations. A major objective of the negotiations is to achieve a progressive reduction of government assistance to agriculture in developed countries.

Given the complexities and regulated environment of agricultural sectors, evaluation of the level of protection (overall trade restrictiveness) poses a challenge for both theorists and applied economists. In principle, a straightforward way to carry out such an evaluation is through an aggregate scalar measure (one that combines the various types of distortions and interventions). The resulting index would provide a useful and relatively simple means for international and intertemporal comparisons of trade protection.

However, the use of an such an aggregate measure may easily result in miscalculations of the degree of protection. In order to quantify the effects of diverse and often overlapping policies one must cope with a number of methodological and practical issues. Schwartz and Parker (1988) outline at least four criteria that an ideal aggregate measure of trade protection should satisfy. First, the measure should be a consistent aggregation across products, countries, and over time so that the resulting measurements can be meaningfully ranked and compared. Second, the measure should be relatively simple so that it is easily understood. Third, it should be flexible enough to capture the effects of diverse policies. Fourth, it should make the effects of trade distorting policies transparent, thus separating trade distortions from inefficiencies in resource allocation.

Measuring the magnitude of the distortions which government policies inflict on the trade flows of a country has long been a concern for economists. Over the years, researchers have developed various measures designed to quantify in a scalar measure the level of trade distortion. At the same time, there has been a continuous evolution of trade policies as global economic interdependence has progressed and the importance of the international marketplace was recognized.

In agriculture, one may observe two major evolutions related to trade policy tools. First, there has been a shift towards quantitative restrictions instead of tariffs, as the predominant means of protection. These range from quotas to various supply control schemes and marketing orders. Second, government assistance to the farm sector has taken numerous forms ranging from direct income transfers to structural policies such as research and extension expenditures. While some of these cause distortions to trade others cause distorting effects only to the domestic market. Thus any particular good may be affected by a number of different policies.

This evolution of trade policies and the inclusion of agricultural issues in the GATT negotiations have revitalized the interest of economists and trade negotiators in obtaining reliable indicators of trade protection. A comprehensive quantification of trade restrictiveness can provide a sound basis for trade negotiations and subsequently a consistent monitoring of the trade liberalization process. Thus an examination of the relevant existing measures on trade protection has been initiated in recent years, along with a search for new ones which can better cope with the new realities of agricultural protection.

Separately, the growth in international trade has revived the importance of the 'new goods-problem' as trade among the world's economies involves different sets of goods over time. Indeed, observed trade patterns suggest that new products play an increasingly important role in international trade. Product differentiation leads to the development of intra-industry trade and the importation of new varieties of goods across countries. It is also common practice for countries to change the trading status of goods by liberalizing old goods and protecting newly developed ones; thus the list of goods subject to trade restrictions differs over time. In addition, regional or global trade agreements (such as the North American Free Trade Agreement (NAFTA) or a possible future GATT agreement on liberalizing trade in farm products) are expected to facilitate the importation of goods which were not traded earlier (or were traded in negligible quantities) due to trade impediments.

In the area of agricultural trade, the 'new goods problem' can be linked to the Armington assumption (1969) which is often used in empirical work. The Armington assumption states that imports and domestically produced goods are imperfect substitutes in consumption or production. Also exports are imperfect substitutes for domestically consumed goods. Such differentiation is rationalized on the grounds of packaging, taste, safety requirements etc.--something which is very relevant in the case of trade in certain agricultural products. As the liberalization process of a particular country develops, agricultural imports from countries trading for the first time in certain products with the country in question can be viewed as a special case of the 'new goods problem'.

Problem Statement and Objectives

The preceding discussion makes clear that the empirical measurement of the size of trade distortions remains a complicated, but timely task. The intent of this study is to contribute to the attempts being made to evaluate and generalize aggregate measures that satisfactorily combine diverse sets of trade distortions and provide valid estimation of the trade restrictiveness across countries and over time.

Among the available aggregate measures of protection, the Trade Restrictiveness Index (TRI) developed recently by Anderson and Neary (1991) seems to be a particularly promising approach in evaluating trade distortions. This study reviews the existing measures of protection and subsequently focuses on the TRI approach in an attempt to examine empirically the performance of this newly developed protection index and furthermore investigate the effects of trading in new products on the measured level of trade protection.

The first objective of this study is an empirical implementation of the TRI approach. Given that the TRI is a recently developed concept in the measurement of trade protection, very few empirical constructions of the index exist (Anderson, 1991; Anderson and Bannister, 1991). In particular, this study applies the TRI approach in the agricultural sector of the Japanese economy in an attempt to

— subject the concept of the TRI to empirical testing and investigate its applicability;

— compute a measurement of trade restrictiveness which has a robust theoretical derivation and explicitly incorporates considerations missing from other standard measures, notably both production and consumption side interventions, cross commodity relationships, and quantity restrictions; and

— examine how various government interventions peculiar to agriculture can be modelled and subsumed in one parameter-measures.

The second objective of this study is to generalize the TRI to account for the fact that different sets of goods may be traded over time, in an attempt to incorporate the 'new goods-problem' in the measurement of trade restrictiveness.

An overview of this study is as follows. Chapter 2 provides a review of the literature on trade protection measures with particular emphasis on the TRI, and then a comparison of the available measures. Chapter 3 presents an empirical application of the TRI in Japan's agricultural sector. In particular, Japan's government policies on beef, pork, poultry, wheat, rice, and fresh oranges during the period 1970-87 are considered, and the respective partial equilibrium TRI is constructed. The index aggregates the government programs in all six commodities in a scalar measure and provides an estimation as how the overall level of protection on these commodities changed over the examined period.

Chapter 4 provides a discussion of the 'new goods' problem in index number theory and demonstrates how the standard TRI can be generalized to account for the presence of newly traded goods over time. Subsequently, it presents an empirical exercise on this generalization of the standard TRI. Specifically, a TRI pertaining only to Japan meat imports is constructed with the additional assumption that beef imports from the three major supplier countries (Australia, New Zealand, and the United States) are considered as different varieties of beef. Since U.S. beef imports were negligible in the 1960s, the meat TRI is computed for the period 1969-87, and adjusted in 1970 for the introduction of U.S. beef. Finally, conclusions and remarks are summarized in Chapter 5.

CHAPTER 2
MEASURES OF PROTECTION

The methodologies that have been used over the years to quantify the degree of trade protection reveals that the major protection measures can be classified into four groups: (a) the Average Tariff; (b) the Nominal and Effective Rate of Protection (NRP and ERP), and the Domestic Resource Cost (DRC); (c) the Producer/Consumer Subsidy Equivalent (PSE/CSE); and (d) the Trade Restrictiveness Index (TRI). A discussion of the merits and shortcomings of these measures is the objective of this chapter.

The Average Tariff - Measuring the Height of the Tariff 'Wall'

Early attempts to measure the effect of protection on trade flows focused on tariffs (League of Nations 1927, Crawford 1934). In particular, researchers devised various methods to compute the overall height of the individual tariff levels (in the sense of a tariff 'wall') for the purpose of international comparisons across countries or intertemporal comparisons of a particular country. The procedures which have been generally employed involve the calculation of the percentage of all import duties to a certain basis (e.g. the value of all imports) or equivalently, the calculation of weighted and unweighted averages of import duties.[1]

It was early recognized, however (Loveday 1929, Haberler 1936), that such computations have grave theoretical pitfalls and thus they can be quite misleading. When the height of the (aggregate) tariff is computed as the percentage of all duties collected over the value of total imports, one gets the rather absurd result that a more protective tariff regime yields a smaller percentage (i.e. a lower tariff 'wall'). This is because as duties become more protective, the value of total imports declines. In fact, if all duties became prohibitive, imports would be zero and the tariff 'wall' would be also zero. The same fallacy applies to the measurement of the tariff 'wall' as the percentage of imports subject to tariffs over all imports.

Calculations of a weighted average of all import duties faces the same grave objections. The basic difficulty is associated with choosing the proper weights of an average tariff rate. It is clear that weighing the various duties by the value shares of their own imports produces the same sort of distorting results. Low duties correspond to high relative levels of imports, thus they are given large weights; high duties are given small weights and prohibitive duties are given zero weights.

To circumvent these difficulties, various alternatives have been suggested (Haberler 1936, Lerdau 1957, Balassa 1965). A possible alternative would be the share

[1] Unweighted averages are obtained by computing a simple average of the import duties upon total imports. Weighted averages are obtained by assigning different weights on the duties of individual imports. For an empirical application see, Research and Policy Committee of the Committee for Economic Development, 1964.

of the imported good in total exports. Others include the share of the imported good in the volume of the world trade or its share in the volume of production (or consumption) in one or more countries. Nonetheless, even the weights based on these shares can be biased given the volume of world trade, and domestic production and consumption are influenced by the import duties already in place. On the other hand, the calculation of unweighted averages of import duties fails to take into account the relative importance of individual imports.

Besides the aforementioned difficulties in computing a reliable average of all import duties, there is a great deal of ambiguity surrounding the very concept of 'the height of the tariff'. In other words, even if all calculation problems are overpassed, it is still not clear what is to be established or indicated by such a measurement. It is only clear that an estimate of the average tariff alone by no means provides an assessment about the degree of a country's total protection.

Several reasons are cited in the literature (Bieda 1963, Towle 1956). First, there is a variety of other equally important measures upon which the protection of a country may rest (e.g. quantitative restrictions) that are not incorporated in the average tariff. Second, even if all trade restrictions were expressed in terms of a tariff, the true degree of a country's protection would still not be revealed. Different countries are expected to have different elasticity of demand for an imported good and different elasticity of domestic supply. Thus, any particular level of tariff will yield a less protective effect when the elasticity of domestic supply is low rather than high. In turn, elasticity of demand for imported goods depends on tastes, availability of close substitutes etc., while elasticities of domestic supply depend on a country's resources and technological constraints.

Third, the degree of protection of final goods may well be affected by protectionist measures imposed on the respective inputs (raw materials and intermediate goods). Consequently, there is a clear difference between nominal and *effective* rates of tariffs wherein the latter include all duties levied on inputs. This last consideration led researchers to develop the concept of the Effective Rate of Protection (ERP) which examines net or effective rather than nominal tariff rates.

The Nominal and Effective Rate of Protection, and the Domestic Resource Cost

The idea that a distinction should be drawn between the nominal and the effective protection of an economic activity was first developed by Barber (1955) and further elaborated by Johnson (1960), Humphrey (1962) and Corden (1963, 1966, 1971, 1985) among several others. Large-scale empirical contributions of the concept of effective protection are given in Balassa (1965) and Basevi (1966).

The effective rate of protection deals with the true or net rate of protection associated with an economic activity which produces a *final* or *value-added*[2] product by using purchased material inputs that are themselves traded, and thus may be subject to distorting government policies. In this case the question becomes: Does the nominal protection on the final product indicate the true protection rate of the associated economic

---

[2] Value added is the value of the final output less the cost of purchased intermediate inputs.

activity, and if not, how is the protection of the final product affected by government policies on its intermediate inputs?

Formally, the ERP is defined as the percentage change in the value-added per unit (or effective price) of an economic activity with and without the existing government intervention. Thus, algebraically the ERP of the jth economic activity is given by the ratio

$$ERP_j = \frac{v_j^D - v_j^W}{v_j^W} \qquad (2.1)$$

where

v^D_j = the value-added per unit of the final product under the existing protective structure,

v^W_j = the value-added per unit of the final product in the absence of any distortions (i.e. under free trade).

The ERP so defined is based on the following assumptions: (i) the ratios of intermediate inputs to output (i.e. what is often called the physical input-output coefficients) are fixed[3] and identical for all firms, (ii) a small country-framework is adopted implying the elasticities of demand for all exports and supply for all imports are

---

[3] The fixed input-output coefficients assumption needs to be interpreted with caution as it does not mean that there is a fixed coefficient production process. The basic idea is that the various value-added production functions are functions of purchased intermediate inputs, as well as, primary factors such as, capital labor and so on. Then assumption (i) still permits substitution among primary factors along isoquants but rules out substitution among intermediate inputs or intermediate inputs and primary factors. It is shown that calculation of ERPs always tends to *over*state the true effective rates, if there are indeed substitution relationships among the intermediate inputs or intermediate inputs and primary factors (Corden 1971, 1985).

infinite, (iii) all tradeable goods remain traded even after tariffs and other distortions have been imposed, so that the domestic market price of each importable is simply given by its international price plus tariff.[4]

The algebraic formula for the ERP of the jth economic activity can be further elaborated. Consider first the simple case of a traded final product j, which has a single intermediate input i, subject to a tariff, in its value-added production function. Let:

a_{ij} = the physical input-output coefficient of the intermediate input i, under free trade,

t_j = the nominal tariff rate on the final product,

t_i = the nominal tariff rate on the intermediate input,

p^w_j = the world price of the final product.

Then by definition, it holds

$$v_j^D = p_j^w(1 - a_{ij}) \tag{2.2}$$

$$v_j^w = p_j^w \, [(1 + t_j) - a_{ij}(1 + t_i)] \tag{2.3}$$

Combining equations (2.1), (2.2) and (2.3) yields

[4] Removing this assumption implies that part of a tariff may be redundant. Since a redundant tariff has no effect of any kind, all calculations should then be based on the *utilized* part of the tariff-this could require detailed price data not always available.

$$ERP_j = \frac{t_j - a_{ij} t_i}{1 - a_{ij}} = \left(\frac{1}{1 - a_{ij}}\right) t_j - \left(\frac{a_{ij}}{1 - a_{ij}}\right) t_i \qquad (2.4)$$

Thus the ERP is a combination of two effects. The first, given by the term $t_j/(1-a_{ij})$ is the proportional increase in effective price (value-added per unit) $v^D{}_j$, resulting from the nominal tariff on the final product. The second, given by $[a_{ij}/(1-a_{ij})]t_i$ is the proportional fall in the value-added per unit, resulting from the tariff on the intermediate input i. Clearly, an increase in the tariff rate imposed on input i reduces the rate of protection on the final product and vice versa. Furthermore, let

a'_{ij} = the physical input-output coefficient of intermediate input i, under the existing distortions.

Then

$$a'_{ij} = a_{ij} \frac{1 + t_i}{1 + t_j} \qquad (2.5)$$

and

$$ERP_j = \frac{1 - a'_{ij}}{\left[\frac{1}{(1 + t_j)} - \frac{a'_{ij}}{(1 + t_i)}\right]} - 1 =$$

$$= \frac{\frac{t_j}{(1 + t_j)} - \frac{t_i}{(1 + t_i)} a'_{ij}}{\frac{1}{(1 + t_j)} - \frac{a'_{ij}}{(1 + t_i)}} \qquad (2.6)$$

Equation (2.6) is a 'deflated' version of equation (2.4) expressing the ERP_j in terms of the distorted input-output coefficient a'_{ij} instead of the undistorted (free trade) a_{ij}. Its importance lies in the fact that it may be implemented more easily since input-output data are typically available in the presence of distortions.

Equation (2.4) can be readily extended to any number of inputs n, in which case

$$ERP_j = \frac{t_j - \sum_{i=1}^{n} a_{ij}\bar{t}_i}{1 - \sum_{i=1}^{n} a_{ij}}, \qquad \bar{t}_i = \frac{\sum_{i=1}^{n} a_{ij} t_i}{\sum_{i=1}^{n} a_{ij}} \tag{2.7}$$

that is, the tariff of the single intermediate input i is replaced by the weighted average of the tariffs on the individual inputs.

It must be noted that the ERP of a final product is not affected by any tariffs or other distortions imposed on the inputs of its intermediate inputs. In other words, one needs go only one step downward in the input-output structure. This is because for the producers of the jth final product only the cost of the inputs they themselves use, matters.

The ERP can be readily related to the much simpler concept of nominal rate of protection (or NRP). The NRP measures how nominal domestic prices for traded goods change in response to government policies and can be defined for either the producers (NRP_p) or the consumers (NRP_c).[5]

---

[5] The NRP that applies to producers may differ from that of the consumers since trade policies often affect producer prices differently than consumer prices.

The NRP_c measures the percentage difference (i.e. the 'wedge') between the domestic consumer price and the world (free-trade) price. Algebraically it is defined as the ratio

$$NRP_{c_i} = \frac{pc_i^D - p_i^W}{p_i^W} \qquad (2.8a)$$

where pc_i is the domestic consumer price.

Correspondingly, the nominal rate of protection to producers (NRP_p) measures the percentage difference between the domestic price received by the producers and the world (free-trade) price. Thus it is given by the ratio

$$NRP_{p_i} = \frac{p_i^D - p_i^W}{p_i^W} \qquad (2.8b)$$

Assuming ad valorem tariffs on final and intermediate goods, the ERP_i in equation (2.4) can also be expressed as

$$ERP_i = \frac{NRP_{p_i} - \sum_{i=1}^{n} a_{ij}\, NRP_{c_i}}{1 - \sum_{i=1}^{n} a_{ij}} \qquad (2.9)$$

Thus the ERP_i can be equivalently interpreted as a weighted average of the relevant nominal protection rates in the production of the final good j and the consumption of its intermediate inputs i=1...n.

Finally, the ERP bears also similarities with the concept of Domestic Resource Cost (or DRC). The DRC was developed by government planners in Israel during the 1950s as a means of project evaluation under conditions involving distorted official exchange rates and distorted prices of tradeable goods (Bruno, 1972). In a general sense, the Domestic Resource Cost per unit of the ith economic activity, DRC_i, is defined as the ratio

$$DRC_i = \frac{DC_i}{NVA_i} \qquad (2.10a)$$

where the numerator, DC_i, is the total value added of the domestic resources per unit of output employed in the ith activity, measured at *opportunity cost*. The denominator NVA_i is the value added per unit of output of the ith activity, measured at *world prices* (i.e. its international value added).

Originally, the DRC method was used as a normative ex ante criterion of social comparative advantage, in ranking development projects. That is, the DRC criterion was used as an indicator of ranking future investments according to the real cost of net foreign exchange earned or saved. However, the DRC can also be viewed as a measure of the opportunity cost that a country incurs in order to sustain its existing import substitutes. In this sense, the DRC can be interpreted as an index of the social cost of trade protection and a means for evaluating the magnitude of trade distortions.

From the definition of the DRC, it is clear that both the ERP and DRC involve value-adding activities in their measurement. A comparison between the two reveals that the ERP and DRC are in theory identical under only exceptional circumstances. In particular, it is shown (Krueger, 1972) that the following relationship is true

$$DRC_i = ERP_i + 1 \qquad (2.10b)$$

under these stringent conditions: (1) all goods are traded (or tradable), (2) there are no transportation costs, (3) resources are perfectly mobile within the domestic economy but perfectly immobile internationally, and (4) all domestic output/input markets are perfectly competitive.

It follows that the ERP may be a sufficient measure for economies where tariffs are the predominant impediment to trade and factor markets are fairly competitive. For economies where, in addition to tariffs, there are quantitative restrictions, institutional constraints (e.g. government involvement in trade-related sectors), and market imperfections (resulting in prices which do not reflect the true opportunity cost), the DRC has a conceptual advantage over the ERP. In these cases, evaluation of domestic resources at imputed shadow prices rather than market prices is a superior method to encompass as much as possible non-price distortions in measuring the cost of protection. This significant advantage comes, of course, at a higher information cost. Implementation of the DRC method requires besides input-output coefficients, shadow values for the domestic inputs which are usually estimated from programming models.

The Uniform Tariff Equivalent (UTE).

Based on the concept of ERP, Corden (1966) defines a single aggregate measure of the various individual tariffs, which he calls the Uniform Tariff Equivalent (UTE). The UTE is defined as the uniform tariff which (if applied) would keep the value of imports at the same level as the existing (nonuniform) tariffs. In other words, the UTE is the uniform tariff which is equivalent to the existing tariffs in its effect on the total value of imports.

By considering imports of two final goods and linear demand curves, Corden shows that the UTE is a weighted average of the ERPs on these two final goods; the respective weights are combinations of their demand elasticities, import values under free trade and input-output coefficients.

The UTE is then compared with average tariffs, calculated as weighted averages of all individual tariffs by using as weights either actual imports in the presence of distortions or domestic output. The diversion between the UTE and the average tariff is examined under various conditions on demand elasticities and input-output coefficients. These exercises provide a useful insight on the important factors ignored by the average tariff-approach - mainly, demand elasticities, traded inputs and the reference point of the comparison. An additional empirical application of the concept of the UTE appears in Balassa (1965).

The Producer (Consumer) Subsidy Equivalent (PSE and CSE)

Developed by Josling (FAO, 1973; FAO, 1975), the notions of the producer (consumer) subsidy equivalent (or PSE/CSE approach) are designed to provide an aggregate measure of government support policies in a particular sector of the economy.

The concept of the PSE is straightforward. It is the subsidy that would be necessary to replace all current government policies applied to the agricultural sector of a particular country in order to leave the producer's income unchanged. Thus the PSE measures total income transfer resulting from any policy that can be linked to incomes and it can be computed at any level of government--local, regional or national. The consumer subsidy equivalent (CSE) is defined in a symmetric fashion.

Several features of the PSE deserve particular attention. Unlike the measures mentioned above, the PSE combines both price and nonprice policies (ranging from import quotas to direct payments to farmers, disaster payments and so on). Like the previous measures, however, the PSE is commodity-specific, evaluated as the absolute sum of money received as support by the producers of that commodity. Then it can be expressed in relation to several bases:

(i) PSE per unit of output (i.e. PSE/volume of quantity produced)
(ii) PSE as a percentage of domestic production valued at domestic prices
(iii) PSE as a percentage of domestic production valued at world prices
(iv) PSE as a percentage of actual net farm income (thus serving as an indicator of income dependency).

The definition of PSEs and CSEs is inherently flexible. One may decide to include or exclude various government programs. Thus, while the first calculations of PSEs and CSEs included only commodity specific policies, a recent OECD study (OECD, 1987) broadened the policies covered in the PSE to include structural support programs, which are not necessarily commodity specific (e.g. research and extension). Additionally, the Economic Research Service (ERS) of the U.S. Department of Agriculture (USDA) has extended the OECD measurement of the PSE to include the effects of exchange rate distortions in the case of developing countries (USDA ERS, 1988).

Concerning the estimation of PSEs (and CSEs), it must be emphasized that different countries have quite different sets of policies in their agricultural sectors. Thus a standard framework is needed for comparisons across countries and across commodities[6].

Several important points must be noted on the use and the interpretation of PSEs and CSEs. By aggregating a variety of government policies into a single measure, the PSE and CSE allow comparisons of government support across countries, commodity markets and types of policies. Additionally, they can indicate which forms of government support are most important in different countries and, when examined over time, they can indicate the intertemporal changes of government support.

As mentioned earlier, international comparisons of the PSE and CSE require a standard procedure and a common set of the policies covered. To the extent that policies excluded from this common framework provide a significant amount of support, the resulting comparisons may well be biased. Additionally, in intertemporal comparisons a country may change its government policy profile towards (or away from) the set of policies covered by the PSE (CSE). Therefore interpreting comparisons of PSEs (CSEs) requires consideration of these issues.

It is erroneous to conclude that, if all governmental programs were removed, incomes would decline by the value of the transfers estimated by the PSE. Income in

---

[6] In addition to estimating PSEs and CSEs for each commodity, 'pooled' PSEs and CSEs are also calculated and compared across countries (USDA ERS, 1987). Theses are weighted averages of the individual PSEs weighted by each commodity's share with the total production value of the covered commodities.

the absence of the existing government programs would depend on the new levels of prices, production, consumption and trade. PSEs only measure the total transfer to producers under current policy and market conditions.

The PSE and CSE measures do not capture the large-country effects on the world prices (i.e. they are implicitly based on a small-country framework). Additionally, PSEs and CSEs do not reveal the distributional effect of government programs within a particular sector (e.g. PSEs cannot show whether total transfers in the dairy industry are received equally by all dairy producers).

Changes in the PSEs and CSEs can be merely due to changes in the world reference prices or controlled exchange rates--both of which may be quite variable over time. Almost all traded goods are priced in U.S. dollars; thus when the dollar appreciates, the world reference price observed by countries other than the U.S. rises (and vice versa). Then for countries supporting the producer price above the world price, the price 'wedge' is now narrower than it would have been under constant U.S. exchange rates (unless their agricultural policies are responsive to world prices). Therefore changes in the magnitude of the PSE (CSE) can be markedly affected by controlled fluctuations in exchange rates.

The PSE does not directly measure the effect of supply control policies (e.g. uncompensated acreage reduction programs). An effective supply-control program reduces production from what it would have been in the absence of such program; therefore total government transfers (and thus the PSE) are lower under the program.[7]

Finally and most importantly, government policies which yield the same PSE/CSE across countries do not necessarily imply that these countries have the same degree of trade distortions. Different types of government policies produce different trade effects,[8] while the effect of government programs on trade depends on the country's share in international trade. Additionally, producers and consumers across countries respond differently to the same type of government intervention due to political and social factors, market characteristics, and resource and technology constraints.

PSE and Trade Distortions

Given the fact that the link between government support policies and the impact of that support on trade can be very weak,[9] the use of the PSE/CSE as a yardstick of trade liberalization has come under criticism. It is argued that if the PSE/CSE is used in trade negotiations, countries may try to achieve lower levels of PSEs (CSEs) by

---

[7] However, supply control programs may be implicitly taken into account in the PSE/CSE measures. For example, if a country is large enough to affect world prices, its supply-control programs will raise world prices. The price-effect of the supply-control program is then captured in the PSE/CSE calculations if the corresponding price data are used. Tangermann et al (1987) propose practical ways for countries employing supply-control programs to receive negotiating 'credits' on the PSEs for the commodities concerned.

[8] For example, deficiency payments stimulate domestic production but leave consumption unaffected; import quotas also raise domestic production but, at the same time, reduce demand.

[9] An illustrating diagrammatic exposition of the differences between support measures and measures of trade distortion appears in Roningen and Dixit (1991).

merely eliminating government programs which bear little relationship to trade, thus leaving their trade barriers intact.

To cope with this deficiency, economists have suggested versions of the PSE including only policies which are likely to affect trade. Thus Schwartz and Parker (1988) proposed the *modified* PSE as a more appropriate measure of trade distortion. The modified PSE includes only policies with well-defined price effects which are more likely to reflect on trade; it excludes policies with ambiguous price effects such as structural programs.

Rondingen and Dixit (1991) proposed a more direct measure of trade distortion, termed the Trade Distorted by Support-Index (or TDS). The TDS index is a volume measure[10] of distorted trade. In particular, it measures the change in the volume of the existing net trade, if a country eliminates completely all support to a commodity. The TDS in volume terms is generally expressed as

$$TDS_i = [q_s e_s s_m - q_d e_d s_m] + [q_s e_s s_p - q_d e_d s_c] + q_s e_s s_i - sso =$$

= [domestic market support] + [direct payments to farmers/consumers] + [other farmer support] - [offsets to support] (2.11)

where

e_s, e_d = own-price supply and demand elasticities, respectively,

[10] However, the TDS can be readily expressed in percentage form (i.e. TDS/[volume of production (consumption)]) or in value form (VTDS) by multiplying the TDS by the world (border) price.

q_s, q_d = observed production and consumption quantities, respectively,

s_m = market support ratio (i.e. the support level per unit of the commodity compared with domestic prices),

s_c, s_p = direct support rate to farmers and consumers, respectively,

s_i = support ratio for all other types of assistance to producers, and

sso = set-aside offset policies, usually policies that require production (consumption) discipline for farmers (consumers) to be eligible for direct payments.

The primary contribution of the modified PSE and the TDS is that they are more transparent measures of the trade distorting effects of government policies than the PSE. Methodologically however they share a lot in common with the PSE/CSE approach. Hence they may be viewed as 'trade-oriented' versions of the PSE[11].

The Trade Restrictiveness Index (TRI)

Unlike the previous protection measures which lack a clear theoretical basis, the TRI (Anderson and Neary, 1991a; 1991b; 1992) is explicitly based on the underlying economic structure of a trading economy.

Conceptually, the TRI is a general equilibrium distance function measure (Debreu,1951; Deaton,1979) for a trading economy. Conventionally the distance function is defined with some reference utility level u and an arbitrary quantity bundle

[11] The modified PSE is literally a trade version of the PSE; the TDS can be viewed as a volume-(trade) version of the PSE.

q as the factor by which the bundle q must be deflated (or inflated) in order to attain exactly utility u. Thus the distance function is a measure of the inefficiency of q relative to u.

The TRI utilizes the same notion in the space of trade distortions; in the case of only tariffs this space is the space of the domestic prices of the traded goods, while in the case of only quotas, it is the quantity space of the traded goods. Moreover, instead of a utility function, the starting point in the case of the TRI is the (general equilibrium) budget constraint of a trading economy. Such a function equates aggregate expenditure on traded goods to a gross revenue or GNP function and trade revenues (tariffs and quota rents). This permits the aggregate utility (welfare) level and the instruments of trade distortion (i.e. tariffs,quotas) to be subsumed conveniently in a single function called the balance-of trade function.

Based on the economy's balance-of-trade function, the TRI is defined as a compensating variation measure of the trade distortions towards a reference utility (welfare) level. Specifically, given a final period 1 and an initial period 0 the TRI is defined as the uniform rate by which the instruments of trade distortion (tariff rates, quota levels) must be deflated (or inflated) in order to take the economy back to the initial welfare level. Similar to the distance function therefore, the TRI can be viewed as a measure of the trade inefficiency associated with a set of trade distortions, relative to a reference welfare level.

Operationalization of the TRI

The TRI stems from the same theoretical reasoning as the cost-of-living-index or Consumer Price Index (CPI). To demonstrate this similarity a short digression on the concept of the CPI will first be presented. The CPI is the uniform rate of change in all consumer prices, which produces an equivalent rise in the expenditure required to maintain the same level of utility for a representative consumer. Formally the CPI is based on the consumer's expenditure function e(p,u) where p is the vector of consumer prices, u is the consumer's utility level and e(·) is the minimum level of income required to achieve the utility level u when the consumer faces prices p. Since e(p,u) is an optimal value-function, its gradient with respect to p gives the vector of the consumer's demands, X.

Given arbitrary changes in prices p, the level of income required to support utility u is X'∇p, where ∇p is vector of first order partial derivatives (i.e. the gradient vector) of the price vector, p. If the price vector p were proportional to its initial level by some factor α (i.e. $p = p^0\alpha$ where p^0 is the initial price vector) then the level of income required to support utility u, given a change in the prices p, is $X'p^0d\alpha$. Then the uniform rate of change in all consumer prices which creates the same rise in the required expenditure as the arbitrary change ∇p is

$$X'p^0 d\alpha = X' \nabla p \quad \Rightarrow \quad d\alpha = \frac{X' \nabla p}{X'p^0} = \sum_{i=1}^{n} \left(\frac{X_i p_i}{X'p} \right) \hat{p}_i \qquad (2.12)$$

where a hat (^) over a variable denotes a proportionate change, i.e. ∇p/p. For an initial value of $\alpha=1$, $d\alpha$ is also a percentage change and represents the CPI.

At this point it must be stressed that the preceding formula of the CPI (bearing the opposite algebraic sign) can be obtained as a solution to the following problem: what is the (hypothetical) uniform reduction in consumer prices (instead of income transfer) which compensates the consumer (i.e. preserves initial utility u) given some arbitrary change in prices dp. As earlier

$$-X'p^0 d\alpha' = X' \nabla p \quad \Rightarrow \quad d\alpha' = -\frac{X' \nabla p}{X'p^0} = -\sum_{i=1}^{n}\left(\frac{X_i p_i}{X'p}\right)\hat{p}_i \qquad (2.13)$$

where the minus sign denotes the direction of the compensatory change in prices p.

The notion of the TRI is rooted in the same reasoning as the compensatory price change $d\alpha$'. This is however where the similarities between a consumer and a trading economy end. The budget constraint of a price taking consumer links his expenditure to his monetary income. By contrast the budget constraint of a trading economy links the aggregate expenditure on all goods (domestic and imported) to the value of the national product (GDP) and the government revenues resulting from trade intervention (i.e. tariff revenues and quota rents). Thus a change in the tariff vector causes not only a change in aggregate expenditure but also a change in government tariff revenue.

Consequently, the starting point in the derivation of the TRI is the economy's budget constraint. The specification of this budget constraint can be conveniently carried out using standard dual techniques (e.g. Dixit and Norman,1980). In particular, using dual functions the consumption and the production sectors of a trading economy can be modelled in terms of an aggregate expenditure function $e(\pi,u)$ and a revenue (or GNP) function $g(\pi,v)$, respectively (where π denotes the price vector of traded goods, u aggregate utility or welfare, and v the vector of resource endowments). Given the fundamental requirement that imports must be paid for (i.e. trade must balance), the budget constraint of a trading economy becomes

$$e(\pi, u) - g(\pi, v) = b \tag{2.14}$$

where b denotes the value of net imports; a positive b implies a trade surplus while a negative b implies trade deficit; for the purpose of this analysis, b is considered to be exogenous. Moreover, the above equilibrium condition can be re-written in terms of the function

$$B(\pi, u, v) = e(\pi, u) - g(\pi, v) - \beta = 0 \tag{2.15}$$

which is termed the balance-of-trade function. Essentially, this function represents the overall equilibrium condition of the economy in each time period and can be expressed as

$$B(\pi, u;\ z) = 0 \tag{2.16}$$

where z represents all exogenous variables, such as factor endowments, international prices of traded goods, tastes, etc.

The balance of trade function B(·) can be specified to take into account the fact that trading economies impose price restrictions, or quantity constraints, or both on their imports (exports). Below, the balance of trade function (and subsequently the TRI) is defined with respect to an economy imposing both tariffs and quotas (the cases of only imports or only quotas may be considered as special cases and can be found in Anderson (1991)).

The TRI in the Presence of Tariffs and Quotas

Consider a competitive trading economy imposing both tariff and quota restrictions, wherein all goods are tradeable (non-traded goods can be considered in the background as quota-constrained goods whose quota levels are set equal to zero). The vector of goods subject to tariffs is denoted by m and the respective price vector by π. Quota levels are denoted by Q and the price vector of quota-constrained goods is p. Finally, the world prices for the tariff-ridden goods and quota-constrained goods are p^* and π^*, respectively.

The economy under examination is assumed to be small (price-taking) so that p^* and π^* are exogenous to the analysis. To facilitate the analysis, one can define

$$E(p,\pi,U) = \min_{Q,m} [p'Q + \pi'm \mid U(Q,m) = u] \tag{2.17}$$

as the *trade expenditure function* $E(p,\pi,U)$. In words, $E(\cdot)$ is the expenditure of the aggregate consumer in the *traded* quantities (net imports) of all goods and has the standard properties of an expenditure function: it is linearly homogeneous and concave in (p,π) and its derivatives with respect to prices are the economy's excess demand functions i.e.

$$E_\pi(\pi, p, u) = m(\pi, p, u) \qquad E_p = Q(\pi, p, u) \qquad (2.17a)$$

However, assuming that the quotas are binding the aggregate consumer can be regarded as minimizing expenditure over the tariff-ridden goods only. Thus optimizing behavior can be described equally well by the *distorted* trade expenditure function, defined as

$$\tilde{E}(Q, \pi, U) = \min_m [\pi' m \mid U(Q, m) = u] \qquad (2.18)$$

Alternatively one may write

$$\tilde{E}(Q, \pi, U) = \max_p [E(p, \pi, u) - p'Q] \qquad (2.19)$$

and its first derivatives yield

$$\tilde{E}_\pi Q, \pi, u) = E_\pi [p(Q, \pi, u), \pi, u] =$$

$$= m[p(Q, \pi, u), \pi, u] \qquad (2.20a)$$

$$\tilde{E}_Q(Q, \pi, u) = -p(Q, \pi, u) \qquad (2.20b)$$

The derivative (2.20a) follows from Shephard's Lemma since the distorted expenditure function is the minimum-value function for tariff-ridden goods. The derivative (2.20b) implies that relaxing the quota by one unit reduces the expenditure of tariff-ridden goods by -p. Thus it gives the consumers' marginal willingness to pay for quota-restrained goods.

Turning to the quota rent(s) $(p - p^*)'Q$, it may be recognized that usually these rents are shared between the home country and its trading partners.[12] Let ω denote the fraction of the quota rents accruing to foreigners (supplying countries); then the quota rent retained in the home country is $(1 - \omega)(p - p^*)'Q$.

The budget constraint of such an economy (assuming away any trade balance-surplus or deficit) in domestic prices, is given by

$$\tilde{E}(Q,p,U) + p'Q = t'm + (1-\omega)(p-p^*)'Q \tag{2.21}$$

In words, the left-hand side equals the expenditure of the aggregate consumer in all goods. In equilibrium this must equal the revenues from the trade restrictions retained at home. These are given by the right-hand side.

More conveniently this equilibrium condition can summarized in terms of the balance-of-trade function, defined as

---

[12] The fraction ω may be interpreted as the fraction of quota licenses awarded to foreign importers. A common practice in international trade is to impose tariffs on goods already constrained by quotas. In this case ω is also equal to the tariff rate imposed on quota controlled goods, under the assumption that all imports are handled by foreign importers.

$$B(Q,\pi,u;\gamma) = \tilde{E}(Q,\pi,u) + p'Q -$$

$$- t'm - (1-\omega)(p-p*)'Q = 0 \tag{2.21a}$$

As noted earlier B($\cdot$) summarizes the equilibrium condition of the home economy. It may also be interpreted as the net foreign exchange requirement (in the sense of total income), necessary to support the utility level u for the aggregate consumer facing given levels of tariffs or quotas. Consider now a relaxation in both trade restrictions of this economy (i.e. the tariffs rates and the quota levels). Then the compensating income transfer required to move the aggregate consumer back to the initial utility u, is

$$-B_{\pi} d\pi + B_{Q} dQ \tag{2.22}$$

Assume now that the prices of tariff-ridden goods π, and the quota levels Q are proportional to their initial levels *at the same proportionality factor* β (i.e. $Q = Q^0\beta$, $\pi = \pi^0\beta$, where π^0, Q^0 are the initial levels of prices and quotas respectively). Then the compensating income transfer, described in (2.22) is written

$$-B_{\pi}'\pi^0 d\beta + B_Q' Q^0 d\beta \tag{2.23}$$

By setting (2.22) equal to (2.23), one can solve for the *uniform proportional* change in tariffs and quotas which offsets the arbitrary change in (π,Q) in the sense that it returns the aggregate utility (welfare) to the initial level u. Thus:

$$d\beta = \frac{B_Q^{\prime} dQ}{B_Q^{\prime} Q - B_\pi^{\prime} \pi} - \frac{B_\pi^{\prime} d\pi}{B_Q^{\prime} Q - B_\pi^{\prime} \pi} \tag{2.24}$$

Note that for the initial value $\beta = 1$, $d\beta$ is also a percentage change ($d\beta/\beta$). The above expression is a scalar measure of the change in the overall trade restrictiveness of the economy as a result of any arbitrary change in trade policies. In particular, the percentage change $d\beta$ has the interpretation of an index number of trade distortion: it is the *uniform* proportional change in trade distortions which returns the economy back to its initial welfare level, given some arbitrary change in these trade distortions. This index is due to Anderson and Neary (1991) and it is termed 'Trade Restrictiveness Index' (henceforward TRI).

It may be noted that the derivatives $-B_\pi$ and $-B_Q$ can be interpreted as the marginal cost of tariff-increases and the shadow price of quotas, respectively. Then the welfare costs associated with tariffs and quotas are $-B'_Q Q$ and $B'_\pi \pi$, respectively Accordingly, the term $(B'_Q Q - B'_\pi \pi)$ equals the negative of the total welfare cost of the initial trade structure, and it is termed the 'shadow value of distorted trade' (Anderson and Neary, 1991).

As seen in (2.24), the TRI equals the sum of the (percentage) changes in all trade restrictions (π,Q) where each component (π_i and Q_j) is weighted by its contribution to the total welfare cost of the initial trade structure. As mentioned above, the balance of trade function can be interpreted as giving the net foreign exchange required to support a certain welfare level u . Thus the TRI can also be thought of as measuring the uniform change in trade distortions which yields an offsetting change in the foreign exchange required to maintain the initial welfare.

A more formal definition of the TRI is given below:

$$\beta(\pi, Q, u^0) \equiv \left[\beta :\ B(\pi^1\beta, \frac{Q^1}{\beta}, u^0;\ z) = 0\right] \tag{2.25}$$

In words, the TRI is the uniform rate β by which the domestic prices of the tariff-ridden goods must be raised, and the levels of the quota-controlled goods must be reduced (tightened) so that the economy returns to the initial protective regime consistent with welfare level u^0. If the trade policies (π,Q) do not change between periods 0 and 1, $\beta=1$. As the prices of tariff-ridden goods get lower and quota levels expand, the rate of change $d\beta/\beta$ of the TRI (and subsequently its magnitude) rises. Thus, an increase in the size of the TRI indicates that the economy moves towards free trade.

Totally differentiating (2.25) for the reference welfare level u^0, yields:

$$B_\pi(\nabla\pi\cdot\beta + \pi\cdot d\beta) + B_Q(\nabla Q\cdot\beta - Q\cdot d\beta) = 0 \tag{2.26}$$

Converting to proportional changes yields

$$\frac{d\beta}{\beta} \equiv \hat{\beta} = \frac{\sum_j^M (B_j Q_j)\hat{Q}_j}{B_Q' Q - B_\pi' \pi} + \frac{\sum_i^N (B_i \pi_i)\hat{\pi}_i}{B_Q' Q - B_\pi' \pi} \tag{2.27}$$

where $B_i = \partial B/\partial \pi_i$, $B_j = \partial B/\partial Q_j$, and a hat (^) over a variable denotes a proportionate change, i.e. dQ_j/Q_j, $d\pi_i/\pi_i$.

If distortions (π,Q) decrease in period 1, then returning the economy to the initial protective regime associated with welfare u^0 implies lower quotas (so that dQ/Q is positive) but higher tariffs and consequently higher domestic prices (so that $d\pi/\pi$ is negative). In that case, (2.27) may be also written as

$$\frac{d\beta}{\beta} \equiv \hat{\beta} = \frac{\sum_{j}^{M} (B_j Q_j) \hat{Q}_j}{B_Q' Q - B_\pi' \pi} - \frac{\sum_{i}^{N} (B_i \pi_i) \hat{\pi}_i}{B_Q' Q - B_\pi' \pi} \tag{2.28}$$

Turning to the derivatives B_π, B_Q , differentiation of $B(\cdot)$ in (2.21a) with respect to π, Q (and recalling that m, p are themselves functions of (π,Q,u) from (2.20) yields

$$B_\pi' = - t' m_\pi + \omega Q' p_\pi \tag{2.29}$$

$$B_Q' = - t' m_Q + \omega Q' p_Q - (1-\omega)(p-p^*)' \tag{2.30}$$

Moreover, Anderson and Neary (1992) show that the derivatives of the import demand functions $m(\pi,Q,u)$ and the inverse demand functions $p(\pi,Q,u)$ can be expressed in terms of either the distorted or the standard trade expenditure function. Taking into account equations (2.17a) and (2.20) one may show that the following equations hold

$$m_Q = \tilde{E}_{\pi Q} = E_{\pi p} E_{pp}^{-1} \qquad m_\pi = \tilde{E}_{\pi\pi} = E_{\pi\pi} - E_{\pi p} E_{pp}^{-1} E_{p\pi} \tag{2.31}$$

$$p_Q = -\tilde{E}_{QQ} = E_{pp}^{-1} \qquad p_\pi = -\tilde{E}_{Q\pi} = -E_{pp}^{-1} E_{p\pi} \tag{2.32}$$

The derivative matrix E^{-1}_{pp} is generally expected to be negative definite. Finally, it may be noted that the TRI can be also extended to incorporate the effect on trade protection from policies applied to: (i) non traded goods and (ii) distortions in factor markets (Anderson and Bannister, 1991; Anderson and Neary 1992b). In particular, consider the case where some goods are not traded and their price vector is denoted by s. The TRI in this case is defined as

$$\beta(\pi, s, Q, u^0) \equiv \left[\beta:\ B(\pi^1\beta, \frac{Q^1}{\beta}, s, u^0;\ z) = 0\right] \tag{2.33}$$

Note that the index is still defined over (π,Q) only; however the price vector s is an additional variable in the analysis as it reflects the policies which may be applied on the non traded goods. The TRI can now be derived by total differentiation of (2.33) with respect to π, Q, and s

$$\frac{d\beta}{\beta} \equiv \hat{\beta} = \frac{\sum_j^M (B_j Q_j)\,\hat{Q}_j}{(B_Q' Q - B_\pi' \pi)} - \frac{\sum_i^N (B_i \pi_i)\,\hat{\pi}_i}{(B_Q' Q - B_\pi' \pi)}$$

$$- \frac{B_s' ds}{\beta\,(B_Q' Q - B_\pi' \pi)} \tag{2.34}$$

It may be noted that a new complication arises here as the *level* of the TRI appears in the third denominator of the right-hand side. This difficulty may be overcome by multiplying (2.34) by β and transforming it into a first-order differential equation in β, i.e.

$$\frac{d\beta}{dt} = D_1\beta + D_2 \tag{2.35}$$

where D_1 represents the first two terms on the right-hand side of (2.34) and D_2 represents the third term. Solving for β yields

$$\beta_t = \left[\beta_{t-1} + \frac{D_1}{D_2}\right] e^{D_1 t} - \frac{D_1}{D_2} \tag{2.36}$$

However in empirical applications of the index with discrete time-data, (2.35) can be approximated as simple difference-equation and be solved as

$$\beta_t = [(1 + D_1)\,\beta_{t-1} + D_2] \tag{2.37}$$

This formula can be applied to each period $t_2, t_3, \ldots$ with the normalization that $\beta = 1$ in the initial period t_1. The introduction of distortions in factor markets can be treated in an analogous fashion (Anderson and Neary, 1992).

Comparisons Among the Measures of Protection

In attempting comparisons among these protection measures, one should bear in mind that they do not include the same set of policies in their definitions. Additionally, some of these policies cause trade distortions while others do not.

The focus of the PSE/CSE approach on income-transfers makes it the least transparent measure of trade distortion. The ERP, by including government policies on intermediate input-prices, is a superior indicator of government intervention over the NRP_p which captures only border measures and measures taken at the level of the final products; quantity restrictions nonetheless, are considered only implicitly in the ERP. The NRP_c on the other hand, provides a good analytical measure of trade distortions for consumers.

The PSE/CSE measure is the most flexible as it covers a wide range of government policies. However its flexibility opens the possibility for policy changes which reduce the size of the PSE (CSE) without affecting the existing trade distortions. Similarly, the NRP_p, by focusing only on policies applied on the final goods, opens up loopholes though which trade distortions are manipulated while the level of NRP_p remains unaffected (e.g. by applying government intervention on inputs). The PSE does not include the effects of government policies on intermediate product prices. By contrast, the ERP by explicitly including policies affecting intermediate inputs, is a more reliable indicator in the sense that certain targets of ERP can be negotiated and attained via either input or output (final good) policies. Moreover, the DRC is superior to the ERP in capturing, at least implicitly, nonprice trade distortions.

In terms of calculation, the PSE (CSE) and the modified PSE are most easily calculated by adding up budget expenditures on income transfers. The ERP, on the other hand, requires explicit estimates of input-output coefficients. The DRC can be a more accurate measure than the ERP; it requires however estimates on both input-output coefficients and shadow prices for the domestic factors. The TDS and modified PSE are most appropriate analytical measures of trade distortion in production; however calculation of the TDS requires data on supply, demand elasticities.

Apart from the above mentioned differences, the ERP (NRP) approach, the DRC and the CSE/PSE approach share a number of common methodological traits. First, they all are partial equilibrium measures, meaning that the prices of non-traded goods and goods in other (e.g. non-agricultural) sectors are held constant. Cross commodity substitution effects for both producers and consumers are ignored. The small-country framework is maintained thus ignoring the (potentially) important effect government policies may cause on world prices. Supply-control programs and income stabilization programs are not modelled explicitly in any of the measures (the TDS is an exception by including set-aside policies, while the DRC may implicitly capture nonprice distortions via imputed shadow prices).

Last but not least, none of the aforementioned measures has any theoretical foundation. From a methodological point of view, this may be their most serious drawback. Aggregate measures should summarize the changes of their individual components in the sense of an index number. The change in value of an index number is generally a weighted average of changes in the components of the index while the respective weights are explicitly derived from the economic structure associated with the index. This makes the weights consistent with the underlying economic theory and the resulting index meaningful.

The TRI approach remedies some (but not all) of the above shortcomings. First, the TRI is defined in theory as a general equilibrium measure. Second, it is explicitly derived from the underlying economic structure gaining theoretical consistency. Third, the TRI incorporates explicitly both the consumption and production sector of the economy and also allows cross-commodity relationships (cross price elasticities are explicitly included in the formula that computes the TRI); this permits a theoretically consistent aggregation over commodities and (or) sectors. Fourth, by specifically incorporating expenditure and revenue functions in its definition, the TRI can potentially allow the explicit modelling of supply control policies (e.g uncompensated acreage reduction or production quotas). Fifth, the effect of purely domestic policies can be included in the definition of the TRI thus enhancing its comprehensiveness.

Nonetheless, the TRI approach still maintains the small country framework and has rather high information requirements (price elasticities are needed in its computation). Additionally, in its practical implementations, the TRI is still likely to be specified at a partial-equilibrium context unless the researcher has access to a complete general equilibrium model. Furthermore, the use of elasticities has been criticized as a practical means of trade negotiations. With respect to that, it must be stressed that elasticities can be viewed as weights that differentiate the importance of the various commodities included in the analysis and thus they can easily be interpreted even by non experts (Roningen and Dixit, 1991). Most importantly, the price elasticities in the formula of the TRI can be viewed as a theory-based means of aggregating the degree of trade protection across the commodities under examination.

CHAPTER 3
THE TRI APPROACH IN JAPAN'S AGRICULTURE

This chapter presents an empirical implementation of the TRI. The focus of this application is the farm sector of Japan and the respective policies affecting the trade flows of agricultural products. Japan provides a typical example of a country that protects the domestic agricultural sector predominantly by tight border measures along with a wide array of support programs within the farm sector itself. Indeed in recent years Japan, along with the European Economic Community (EC), have been charged with being two major world markets fairly closed to international trade in farm goods. In the subsequent sections the TRI pertaining to a subset of Japan's farm sector is first specified, the respective information requirements are then empirically estimated, and the index is computed for the period 1971-87.

Japan's Agricultural Trade Policies

With relatively poor endowments of natural resources and arable land, Japan is one of the world's largest net importers of farm products (OECD, 1987). It is also the largest and one of the most stable overseas markets for U.S. agricultural products. The U.S. consistently accounts for a significant share of the Japanese principal farm imports.

Despite the reliance on imported foodstuffs, the agricultural policies that Japan pursued in the 1970s and 1980s (as prescribed by the Agricultural Basic Law, enacted in 1961) have been policies of self-sufficiency. As a result, in the recent years Japan has persistently kept its agricultural markets closed to international trade.

To achieve import control, the government has used a complex intervention system comprised of a variety of policy instruments, administrative measures, and implementing institutions. These include conventional trade measures such as import tariffs and quantitative restrictions (import quotas), but also state trading and trade controlled indirectly by the government. In particular, trade in certain products (wheat, rice) is carried out directly by the Food Agency of the Japanese government. In other cases (livestock, sugar), trade is carried out by parastatal agencies - the Livestock Industry Promotion Corporation (LIPC), and the Japan Raw Silk and Sugar Price Stabilization Corporation (JRSSPSC), respectively. Participation of private traders in external trade is typically subject to strict licensing procedures and administrative guidance (Fitchett, 1988).

Due to insufficient information on certain policies and lack of data, this study does not provide a comprehensive representation of the trade policies and administrative programs in Japan's agriculture. In terms of import value the examined commodities, represent 20% to 30% of the value of Japanese imports in food and live animals during 1971-87. Nonetheless, this study investigates a subset of agricultural policies which comprises the most well known trade restrictions and have been most often criticized by Japan's trading partners (such as the beef and citrus quotas or the ban on rice imports).

In particular, this study measures *(ceteris paribus)* the level of protection by means of the TRI in the following farm products: (1) beef, (2) pork, (3) poultry, (4) wheat, (5) rice, and (6) fresh oranges. An outline of the domestic marketing policies and related border measures pertaining to these products during the period 1970-1987, (Australian Bureau of Agricultural and Resource Economics, 1988; Fitchett, 1988; OECD, 1987) is presented below and summarized in Table 3.1.

The Beef Industry

Although the beef industry is a minor sector in Japan's agriculture (in terms of production value), it attracts special attention because it is one of the industries the government wishes to expand and, at the same time, enjoys the support of the politically powerful cooperative movement (Australian Bureau of Agricultural and Resource Economics, 1988; Longworth, 1983).

For the period under examination[13] (1970 -1987), Japan's beef policy included two major instruments: a price stabilization scheme, and import quotas as a means to achieve the price stabilization objective. The implementation of these policies has been assigned to a quasi-governmental agency known as the Livestock Industry Promotion Corporation (LIPC).

The basic mechanism behind the beef price stabilization scheme is the following: every year the government, in consultation with the LIPC and other bodies (consumer groups, unions, etc.) determines a price band (i.e. a range between an "upper" and a

[13] In 1988, Japan agreed to abolish its beef quotas by April 1, 1991.

Table 3.1: Japan's agricultural policies, 1970-87.

COMMODITY	TYPE OF SUPPORT	TRADE POLICY	STATUTORY BODY
Pork	wholesale floor and ceiling price	variable levy on imports	L.I.P.C.
Chicken	private price stabilization band	20% tariff on imports	-
Beef	stabilization price band	(i) import quotas (ii) 25% tariff	L.I.P.C.
Wheat	Government sets purchasing and resale price	State trading	Food Agency
Rice	Government sets purchasing and resale price	State trading	Food Agency
Oranges	-	(i) import quotas (ii) 20% to 40% tariff	-

"base"stabilization price). This price band is set for representative beef categories (steer, wagyu herd, etc.) in the representative wholesale markets, Tokyo and Osaka. In addition, the government determines (usually twice a year) an import quota for beef; the quota is "global", in the sense that it is not directed towards any specific country. Suppliers however must be able to meet Japanese quarantine requirements.

With the beef price band and the quota levels predetermined, the LIPC intervenes in the market to keep the beef wholesale prices within the stabilization band. It does so by buying and storing beef when prices fall below the price band and releasing beef from its stock when prices move above the price band. The LIPC may stock and subsequently release both domestically produced and imported beef. In practice however, the LIPC manipulates the beef market by regulating the flow of imports via the quota levels (Australian Bureau of Agricultural and Resource Economics, 1988). The LIPC buys imported beef from licensed traders by competitive tender and releases it into the wholesale domestic markets by auction.

In addition to quota restrictions, Japanese beef imports are subject to a 25% ad valorem tariff. The associated tariff revenue is collected by the government (Ministry of Finance) and used for the development and assistance of the domestic livestock industry. More detailed presentations of the beef stabilization regime can be found in Australian Bureau of Agricultural and Resource Economics (1988), OECD (1987), and Longworth (1983).

The Pork and Poultry Industries

The government's support policies for the Japanese pork industry are similar to those on beef; in the case of pork however, the primary policy instruments are price-ridden rather than direct control over imports. As with beef, the government sets a stabilization price band for each fiscal year and assigns to the LIPC the role of supervising the pork market (i.e. absorbing from or releasing into the market the necessary quantities of pork and controlling imports).

However, in 1971 quantitative import control on pork was abolished. Since then, pork imports have been left to private traders (licensed and approved by the LIPC), while the LIPC keeps the price of pork within the stabilization price band by means of a flexible tariff system. In particular, pork imports are subject to the higher of either a 5% ad valorem tariff or a differential duty. This differential duty is applied when the import price is lower than the central price of the stabilization band and is defined as the difference between the central price of the stabilization band and the import price.

The key aspect of this tariff system is that the price of imported pork is always equal to or higher than the central price of the stabilization band. Additionally the tariff is equal to at least 5% (or higher) of the world price. A rather interesting side-effect of this mechanism is the preference of Japanese importers for higher quality (and higher price) pork cuts (loins, bucks, etc.) so as to subject their imports to the 5% duty rather than the differential duty (OECD, 1987).

In the poultry sector, direct government assistance is minimal. There are no conventional intervention forms of price stabilization or quantitative import restrictions. A price stabilization fund for broilers was set up in 1970 by the National sales Federation of Agricultural Cooperatives and the national Purchase Federation of Agricultural Cooperatives, without government participation; the government nevertheless assists poultry producers through research, and disease prevention programs (USDA, 1983). Additionally, poultry imports are subject to an ad valorem tariff with base rate of 20%.

The Rice Industry

For cultural, historical, and religious reasons, rice is the most significant agricultural crop in Japan. Rice farmers are known to be one of the most influential groups in Japanese politics. As a consequence, Japanese governments have intervened extensively in the rice market over the years influencing its production, marketing, and trade.

Today the rice policy regime in Japan is a comprehensive policy mix comprising (i) domestic supply control measures, (ii) state trading (import control), and (iii) pricing determined by the government. The government administers its programs in the rice sector through a governmental body, the Food Agency. The Food Agency buys rice directly from producers and sells it to wholesalers. Every year the government decides both the purchase price (price at which the Food Agency buys from rice producers) and the resale price (price at which the Food Agency sells to wholesalers). For most of the period under examination, the average purchase price has been set higher than the resale price generating considerable government deficits.

In addition to regulating the purchase and resale price for rice, the government also controls international trade on rice. Foreign trade in rice is carried out exclusively by the Food Agency; importers must apply for government permission and sell all rice imported to the government (Food Agency). As a result the domestic rice market is effectively insulated from the world markets. Japan has maintained a firm policy stance in rice - full self sufficiency. This means that the government would not import or permit rice to be imported as long as domestic production can meet domestic demand.

Practically, no imports have been permitted since 1970, except for small quantities of glutinous and cracked non-glutinous rice for particular processed products (OECD, 1987).

Rice exports have been made only occasionally to dispose of accumulated stocks. The only time that there were notable rice exports is the period 1979-83 when Japan exported to other Asian countries about 3 million tones of surplus rice at favorable repayment conditions (long term, low interest credit). The reaction of the U.S. however led to Japan terminating those export sales.

The high level of support to rice growers coupled with falling rice consumption, and increasing yields has resulted in considerable stockpiles of unwanted rice. To cope with rice oversupply, Japanese administrations have introduced two control schemes: (i) various rice land diversion programs designed to curtail domestic supply, and (ii) the voluntarily marketed rice program.

Concerning diversion of paddy fields to other uses, there have been four programs over the 1970-87 period designed to reduce rice supply and increase the production of other priority crops. In all four programs, an acreage reduction target was set annually, and diversion payments were offered to participant farmers. Participation in the programs has been voluntary. The focus of each program however has been different.

The *Rice production Control and Diversion Program* (1971-75) aimed primarily to reduce rice production and substitute other crops for rice. The *Comprehensive Paddy Field Utilization Program* (1976-78) aimed to reduce rice production but increase the self sufficiency of certain crops (with priority given to soybeans, feed crops, and vegetables).

The *Paddy Field Utilization Re-orientation Program* (1978-86) focused more on the reduction of the farm size than the reduction of rice surpluses. Finally, the *Paddy Field Farming Establishment Program* (1987-92) was designed to improve farm productivity and establish a regional crop rotation program, besides curtailing rice production.

The voluntarily marketed rice program was introduced in 1969 in order to provide an alternative channel for marketing rice (besides the Food Agency). The major difference between voluntarily marketed and government marketed rice is that the government does not fix the purchase price and lets the market mechanism work. Nevertheless subsidies and assistance are provided for the smooth marketing of voluntarily marketed rice. Because its purchase price is not fixed, the voluntarily marketed rice is usually of higher quality. Consequently, the price of voluntarily marketed rice brands are about 25% higher than the government marketed rice at the wholesale level and about 35% higher at the retail level (OECD, 1987). Thus the voluntarily marketed and government marketed rice complement each other in the preferences of the consumers for product differentiation and higher quality rice. It must be also noted that although the voluntarily marketed rice is subsidized the government expenses are still lower than they would have been if all produced rice was bought by the government (OECD, 1987).

The Wheat Industry

Besides rice, the wheat industry is also important in Japan, and a close relationship exists between the two crops as a result of policies aimed to reduce the excess rice production and encourage the cultivation of alternative crops. While wheat production was declining in the 1960s, the rice land diversion programs described earlier caused the production of wheat to rise and the level of wheat self sufficiency to increase in the 1970s. Nevertheless Japan imports about 80% of the wheat it consumes (Fitchett, 1988).

Similar to rice, the marketing of wheat is effectively controlled by the government via the Food Agency. The Agency purchases wheat from individual growers at a predetermined price and consequently sells it to wholesalers also at a fixed price. Although growers have the option of marketing their output privately, in practice the Food Agency buys almost all the wheat harvest, as it offers prices substantially higher than the international market. In addition the Food Agency fully controls all wheat imports; importers must seek government approval and sell all their importation to the Agency.

As in the case of domestically produced wheat, the government also sells imported wheat to domestic users at a fixed price. For domestically produced wheat the difference between the government purchase and resale price is substantially high, creating considerable deficits. By contrast, in the case of imported wheat the government resale price is usually above the international price at which the government buys imported wheat. Thus, the government gain from the sale of imported wheat helps offset the deficit created by paying high prices to domestic wheat growers; however this gain may fluctuate widely from year to year due to the fluctuations in world prices and exchange rates (e.g. the sharp appreciation of the yen over the period 1985-87 lowered considerably the prices paid by wheat importers).

The Fresh Citrus Industry

Japan's fruit industry is largely dominated by citrus fruits the major crops being oranges and lemons. Domestic orange varieties include tangerines (such as mikan, hassaku, and iyokan oranges), the summer-orange natsu-mikan, and the navel orange. The domestically produced mikans are the most important fruit in terms of area planted and volume of production (Australian Bureau of Agricultural and Resource Economics, 1988).

Contrary to the grain industry, the horticultural industry in Japan does not receive any direct price support. This is not to say, however, that the industry does not enjoy government assistance and protection. A variety of measures such as quotas, import licenses, blending requirements, import duties, quarantine regulations etc. are in place to assist domestic growers against foreign competitors.

In the case of mandarin oranges, evidence suggests (Baker and Mori, 1985) that imported oranges do not seriously affect the domestic industry because they are marketed mainly between April and September when only small quantities of the domestic mikans are marketed. Nevertheless, for the time period examined in this study, imports of fresh oranges from all sources were subject to import quotas. In addition, an ad valorem tariff was imposed on orange imports at a rate of 20% for the period from June 1, through

November 30, and 40% for the period December 1, through May 31.[14] Japan's persistence in protecting fresh citrus has been attributed to the fact that citrus growing was encouraged as an alternative to rice production. At the same time, there has been extensive financial involvement of the agricultural movement in the fruit industry; it was therefore feared that abandoning import controls would reduce demand for the domestic orange varieties (Australian Bureau of Agricultural and Resource Economics, 1988).

Japan's Balance of Trade Function on Farm Imports

As shown earlier, deriving the TRI for the aforementioned traded goods requires first the specification of a (partial equilibrium) budget constraint that relates the aggregate Japanese consumer expenditure to the sum of the GNP function and trade revenues, associated with these goods. Before specifying the relevant functions however the notation to be used is presented below. For notation convenience, let:

h: the price vector of tariff-ridden goods (pork price = h_{pk}, chicken price = h_{ch}),

p: the price vector of quota-controlled goods (beef price = p_{bf}, oranges price = p_o),

ρ: the producer price vector of state-traded goods (wheat price $=\rho_{wh}$, rice price = ρ_{ri}),

[14] In 1988 after negotiations with the U.S. Japan agreed to terminate import quotas on oranges and tangerines by April 1991 and retain the same tariff after the quotas are lifted.

s: the consumer (user) price vector of state-traded goods (wheat price = s_{wh}, rice price = s_{ri}),

σ^*: the international vector price of state-traded goods (σ^*_{wh} for wheat σ^*_{ri} for rice),

p^*: the international price for the quota controlled goods (p^*_{bf} for beef, p^*_{o} for oranges),

Q: the vector of quota levels (Q_{bf} for beef, Q_o for oranges),

A: the riceland diverted from rice production in each period,

c: the subsidy received by rice growers under the paddy field diversion programs.

On the production side, it is assumed that the farm products examined here are produced via production processes separable from each other. That is to say, from the producer's view-point the output level for each of these products depends only on its own price and on the prices of the respective inputs. This implies that joint production processes are assumed away and results in an additive GDP or revenue function expressed as

$$G(h,\ \rho,\ p;\ w, V) = g^{pk}(h_{pk}, w) + g^{ch}(h_{ch}, w) + g^{wh}(\rho^{wh}, w) + g^{ri}(\rho_{ri}, \ldots$$

$$+ g^{bf}(p_{bf}, w) + g^{o}(p_{o}, w) + w'V \tag{3.1}$$

The first six terms on the right hand-side of (3.1) are the profit functions for the tariff-ridden goods (pork and chicken), the quota controlled goods (beef), and the state-traded goods (wheat and rice), respectively. The last term to the far right represents payments to primary factors V employed in these agricultural sub-sectors. Since the analysis here is partial equilibrium, the prices w and supplies V of primary factors are considered exogenous.

The preceding GDP or revenue function can be equivalently written as the sum of returns to all factors associated with tariff-ridden, state-traded, and quota-controlled goods considered in this study, i.e.

$$G(h,\rho,p;\ w,V) = G^1(h_{pk},h_{ch},\rho_{wh},\rho_{ri},w) + w'\cdot V^1 + \\ + G^2(p_{bf},p_o,w) + w'V^2 \qquad (3.2)$$

where $G^1(\cdot)$, V^1 are returns to all factors associated with tariff-ridden and state-traded goods, while $G^2(\cdot)$, V^2 are returns to factors associated with the quota-controlled goods.

On the demand side, the aggregate expenditure function associated with these goods can be written as

$$e(\cdot) = e(h_{pk},h_{ch},s_{wh},s_{ri},p_{bf},p_o,u) \qquad (3.3)$$

Then the excess expenditure over the revenue function $G(\cdot)$ (i.e. the trade expenditure function) is given by the difference

$$E(\cdot) = e(\cdot) - G(\cdot) \qquad (3.4)$$

Given the fact that some of the goods under examination are subject to import quotas, the aggregate consumer minimizes expenditure only on the goods *not* subject to a quota. This implies that the trade expenditure function on goods other than those which are quota-controlled is conditional on the quota levels. This leads to the *distorted* trade expenditure function defined as

$$\tilde{E}(\cdot) = \tilde{e}(h_{pk}, h_{ch}, s_{wh}, s_{ri}, Q^{bf}, Q^{o}, u) -$$

$$- G^{1}(h_{pk}, h_{ch}, \rho_{wh}, \rho_{ri}; w) - w'V^{1} \qquad (3.5)$$

The excess (net) expenditure function of the aggregate consumer over all the goods under examination is then equal to

$$\tilde{E}(h_{pk}, h_{ch}, s_{wh}, s_{ri}, \rho_{wh}, \rho_{ri}, Q^{bf}, Q^{o}, u) +$$

$$+ (p_{bf}, p_{o})'(Q^{bf}, Q^{o}) \qquad (3.6)$$

or

$$\tilde{E}(h, s, \rho, Q, u) + p'Q \qquad (3.7)$$

By Shephard's lemma, the derivatives of E(·) with respect to h yield the (net) imports of tariff-ridden goods,

$$\tilde{E}_{h}(h, s, \rho, Q, u) = \tilde{e}_{h}(\cdot) - G^{1}_{h}(\cdot) = m(h, s, \rho, Q, u) \qquad (3.8)$$

With respect to the state-traded goods (wheat and rice), the vector of their production levels is given by the derivative vector of the relevant profit function, i.e.

$$G^1(\cdot)\nabla_\rho = Y(\rho) \tag{3.9}$$

while the vector of quantities demanded is given by the derivative vector of the distorted expenditure function e(·) i.e.

$$\tilde{e}_s\,(h, s,\, Q\, u) \;=\; X(h, s,\, Q\, u) \tag{3.10}$$

Additionally, the quota levels are defined as

$$Q = e_p(\cdot) - G_p(\cdot) \tag{3.11}$$

Separately, the government programs for the aforementioned agricultural products generate net government revenue (which may be positive or negative). In particular, this revenue consists of:

(i) the *portion* of the quota rents in beef and fresh oranges retained in Japan. These portions can be approximated by the number of quota licenses awarded to foreign importers. However given the restrictive trading status in beef imports (regulation of imports by the parastatal LIPC) the portion of beef quota retained abroad may be expected to be zero. The portion pertaining to fresh oranges is denoted below by ω^o.

(ii) the tariff duties and variable levies from the importation of chicken and pork,

(iii) the implicit subsidy (positive or negative) to consumers from fixing the consumer (selling) price in wheat and rice, and the implicit subsidy to producers from fixing the producer (purchase) price for wheat and rice.

More formally, the (net) government revenue is equal to the following sum:

$$(p_{bf}-p^*_{bf})\,Q^{bf} + (1-\omega^o)\,(p_o-p^o_o)\,Q^o$$

$$+ \tau_{pk}\, m^{pk}(\cdot) + \tau_{ch}\, m^{ch}(\cdot) -$$

$$- (\rho_{wh}-\sigma^*_{wh})\,Y^{wh}(\cdot) + (s_{wh}-\sigma^*_{wh})\,X^{wh}(\cdot) -$$

$$- (\rho_{ri}-\sigma^*_{ri})\,Y^{ri}(\cdot) + (s_{ri}-\sigma^*_{ri})\,X^{ri}(\cdot) \qquad (3.12)$$

The first line above denotes government revenues from quota rents. In particular, the first term is the quota rent on beef retained in Japan while the second term is the portion of the quota rent on fresh oranges. The second line is the government revenues from imposing tariffs and levies on chicken and pork imports, respectively. The third and fourth lines are the government revenues (positive or negative) from the policies applied on domestically produced wheat and on rice; the first terms are the implicit subsidy to producers (the difference between producer price and international price) while the second terms are the implicit subsidy (positive or negative) to the consumer (user).

In more compact notation these government revenues can be expressed as

$$(1-\omega)\,(p-p^*)'Q + \tau'\, m(h,s,\rho,Q,u) -$$

$$- (\rho-\sigma)'\,Y(\rho) + (s-\sigma)'\,X(h,s,Q,u) \qquad (3.13)$$

Further, it is assumed that the government trade revenues specified above are redistributed costlessly to the aggregate consumer, in a lump-sum fashion. In addition, the government funnels into the rice sub-sector subsidies for diverting paddy fields to other uses. The respective government outlay on rice diversion can be expressed as (c·A). By definition, the value of consumption expenditure in the farm sub-sectors examined here less the value of the respective domestic product must equal total transfers to these sub-sectors from the government. These total transfers are the sum of the relevant government trade revenues shown in (3.13) and the riceland diversion outlay. Thus the balance-of-trade function is defined as

$$B(h,s,\rho,Q,A,u) \equiv \tilde{E}(h,s,\rho,Q,u) \quad + \quad p'Q \quad -$$

$$- \quad (1-\omega)\,(p-p^{*})'Q \quad - \quad \tau' m\,(h,s,\rho,Q,u) \quad +$$

$$+ \quad (\rho-\sigma^{*})'Y(\rho) \quad - \quad (s-\sigma^{*})'X(h,s,Q,u) \quad - \quad c{\cdot}A \qquad (3.14)$$

To facilitate the discussion, the prices of all *price-constrained, traded* goods are henceforth denoted by π, i.e.

$$\pi \quad \equiv \quad \{h_{pk},\, h_{ch},\, s_{wh},\, \rho_{wh}\} \qquad (3.15)$$

Given the policy of self-sufficiency on rice and the fact that rice imports were zero in the period studied here while exports took place on exceptional basis (surplus disposal), rice may be treated as a (quasi) non-traded good. As discussed in Chapter 2, in such a framework - a trade regime involving price restrictions, quantitative import control, and intervention in factor markets (paddy field programs) - the TRI is defined as

$$\beta \equiv [\ \beta : B(h^1_{pk}\beta, h^1_{ch}\beta, s^1_{wh}\beta, s^1_{ri}, \rho^1_{wh}\beta,$$

$$, \rho^1_{ri}, \frac{Q^1_{bf}}{\beta}, \frac{Q^1_o}{\beta}, A^1, u^0) = 0\ ] \tag{3.16}$$

That is, the TRI is the proportionate factor β by which one must discount the prices of the *price-constrained, traded goods*, as well as, the quota levels in period 1 so that the farm sector described by the function B(·) in (3.14) returns to the welfare level u^0 of the previous period. Moreover the rate of change in the TRI is given by total differentiation of (3.14) with respect to the policy variables π, Q, s_{ri}, ρ_{ri}, and A:

$$\beta = \sum_j^m \frac{B_{Q_j} Q_j}{B'_Q Q - B'_\pi \pi} \hat{Q}_j + \sum_i^n \frac{B_{\pi_i} \pi_i}{B'_Q Q - B'_\pi \pi} \hat{\pi}_i +$$

$$\frac{B_{s_{ri}} s_{ri}}{\beta\,(B'_Q Q - B'_\pi \pi)} \hat{s}_{ri} + \frac{B_{\rho_{ri}} \rho_{ri}}{\beta\,(B'_Q Q - B'_\pi \pi)} \hat{\rho}_{ri} + \frac{B_A A}{\beta\,(B'_Q Q - B'_\pi \pi)} \hat{A} \tag{3.17}$$

where a hat (^) over a variable denotes a proportionate change, e.g. (dQ_j/Q_j).

The TRI, in other words, equals the sum of the percentage changes in all trade restrictions (i.e. tariff rates and quota levels) with each restriction being weighted by its contribution to the total welfare cost of the initial trade structure. At the same time, the policy changes in non-traded goods and their inputs are considered as seen in the second line of (3.17).

Computation of this TRI requires first specification and evaluation of the policy derivatives B_π, B_Q, B_{ri}, B_A. In this way one can calculate the weights by which the rates of change in policy variables π, Q,s, p, A are aggregated into a single measure - the TRI. To specify the policy derivatives B_π, B_Q, B_{ri}, B_A one needs to differentiate the balance of trade function B(·) in (3.14) with respect to all policy variables. A price (or a quota) appearing as a subscript in the following expressions denotes the partial derivative of the relevant function with respect to this price (or quota); for example the term

$$m^{pk}_{h_{pk}} \tag{3.18}$$

denotes the partial derivative of net pork imports $m^{pk}(\cdot)$, with respect the pork price h_{pk}.

Similarly, the term

$$p^{o}_{bf} \tag{3.19}$$

denotes the partial derivative of the price of fresh oranges p_o with respect to the beef quota Q_{bf}. Differentiation of the function B(·) with respect to policy variables yields

$$\begin{pmatrix} B_{h_{pk}} \\ B_{h_{ch}} \\ B_{s_{wh}} \\ B_{\rho_{wh}} \end{pmatrix} = - \begin{bmatrix} m^{pk}_{h_{pk}} & m^{ch}_{h_{pk}} & X^{wh}_{h_{pk}} & X^{ri}_{h_{pk}} & 0 \\ m^{pk}_{h_{ch}} & m^{ch}_{h_{ch}} & X^{wh}_{h_{ch}} & X^{ri}_{h_{ch}} & 0 \\ m^{pk}_{s_{wh}} & m^{ch}_{s_{wh}} & X^{wh}_{s_{wh}} & X^{ri}_{s_{wh}} & 0 \\ 0 & 0 & 0 & 0 & Y^{wh}_{\rho_{wh}} \end{bmatrix} \begin{pmatrix} \tau_{pk} \\ \tau_{ch} \\ s_{wh} - \sigma^{*}_{wh} \\ s_{ri} - \sigma^{*}_{ri} \\ -(\rho_{wh} - \sigma^{*}_{wh}) \end{pmatrix} +$$

$$+ \, \omega^{o} \begin{pmatrix} p^{o}_{h_{pk}} \\ p^{o}_{h_{ch}} \\ p^{o}_{s_{wh}} \\ 0 \end{pmatrix} Q^{o} \tag{3.20}$$

$$\begin{pmatrix} B_{Q_{bf}} \\ B_{Q_o} \end{pmatrix} = -\begin{bmatrix} m_{Q_{bf}}^{pk} & m_{Q_{bf}}^{ch} & X_{Q_{bf}}^{wh} & X_{Q_{bf}}^{ri} \\ m_{Q_o}^{pk} & m_{Q_o}^{ch} & X_{Q_o}^{wh} & X_{Q_o}^{ri} \end{bmatrix} \begin{pmatrix} \tau_{pk} \\ \tau_{ch} \\ s_{wh} - \sigma_{wh}^{*} \\ s_{ri} - \sigma_{ri}^{*} \end{pmatrix} +$$

$$+ \omega^{o} \begin{pmatrix} p_{bf}^{o} \\ 0 \end{pmatrix} Q^{o} - \begin{pmatrix} \frac{1}{1-\omega^{o}} \end{pmatrix} \begin{pmatrix} p_{bf} - p_{bf}^{*} \\ p_o - p_o^{*} \end{pmatrix} \tag{3.21}$$

$$B_{s_{ri}} = (m_{s_{ri}}^{pk}, m_{s_{ri}}^{ch}, X_{s_{ri}}^{wh}, X_{s_{ri}}^{ri}) \cdot \begin{pmatrix} \tau_{pk} \\ \tau_{ch} \\ s_{wh} - \sigma_{wh}^{*} \\ s_{ri} - \sigma_{ri}^{*} \end{pmatrix} + \omega^{o} p_{s_{ri}}^{o} Q^{o} \tag{3.22}$$

$$B_{\rho_{ri}} = (\rho_{ri} - \sigma_{ri}^{*})\, Y_{ri}^{ri}, \tag{3.23}$$

$$B_A = -\, w_R \cdot \frac{\partial R}{\partial A} - c = w_R - c \tag{3.24}$$

where w_R is the return to land in rice production, and R is the amount of land (paddy fields) employed in rice production. Given that A denotes riceland diverted from rice production, $(\partial R/\partial A)=-1$.

In more compact notation, expressions (3.20), (3.21) are written as

$$B_{\pi} = -\tilde{E}_{\pi\pi}\,\phi + \omega^{o}\,P_{\pi}\,Q \tag{3.25}$$

$$B_{Q} = -\tilde{E}_{\pi Q}\,\psi + \omega^{o}\,P_{Q}\,Q - (I-\Omega)\,(p-p^{*}) \tag{3.26}$$

where ϕ, ψ, are tariff vectors, I is the identity matrix and Ω is a diagonal matrix with the portions of quota rents on beef ($\omega^{bf} = 0$), and oranges (ω^{o}) retained abroad, on the main diagonal.

The evaluation of the derivatives B_{π}, B_{Q}, and B_{ri} can be carried out by using the equalities (2.31) and (2.32) shown in Chapter 2, which are reproduced here for convenience

$$m_{Q} = \tilde{E}_{\pi Q} = E_{\pi p}E_{pp}^{-1} \qquad m_{\pi} = \tilde{E}_{\pi\pi} = E_{\pi\pi} - E_{\pi p}E_{pp}^{-1}E_{p\pi} \tag{3.27}$$

$$p_{Q} = -\tilde{E}_{QQ} = E_{pp}^{-1} \qquad p_{\pi} = -\tilde{E}_{Q\pi} = -E_{pp}^{-1}E_{p\pi} \tag{3.28}$$

Specifically, one can compute

$$\tilde{E}_{\pi\pi} \equiv \begin{bmatrix} \overline{m}_{h_{pk}}^{pk} & \overline{m}_{h_{ch}}^{pk} & \overline{m}_{s_{wh}}^{pk} \\ \overline{m}_{h_{pk}}^{ch} & \overline{m}_{h_{ch}}^{ch} & \overline{m}_{s_{wh}}^{ch} \\ \overline{X}_{h_{pk}}^{wh} & \overline{X}_{h_{ch}}^{wh} & \overline{X}_{s_{wh}}^{wh} \end{bmatrix} -$$

$$\begin{bmatrix} \overline{m}^{pk}_{p_{bf}} & \overline{m}^{pk}_{p_o} \\ \overline{m}^{ch}_{p_{bf}} & \overline{m}^{ch}_{p_o} \\ \overline{X}^{wh}_{p_{bf}} & \overline{X}^{wh}_{p_o} \end{bmatrix} \begin{bmatrix} (Q^{bf}_{p_{bf}})^{-1} & 0 \\ 0 & (Q^{o}_{p_o})^{-1} \end{bmatrix} \begin{bmatrix} Q^{bf}_{h_{pk}} & Q^{bf}_{h_{ch}} & Q^{bf}_{s_{wh}} \\ Q^{o}_{h_{pk}} & Q^{o}_{h_{ch}} & Q^{o}_{s_{wh}} \end{bmatrix} \tag{3.29}$$

where m(·) denote the first derivatives of the standard (instead of the distorted) trade expenditure function E(·). The terms m_Q, p_π, and p_Q can be computed in an analogous fashion.

It may be noted that the evaluation of the policy derivatives B_π, B_Q, B_{ri}, and B_A requires information on:

(i) the respective price elasticities on import demand and supply,

(ii) domestic prices, international prices, and the imported quantities of the quota-controlled goods (beef, fresh oranges).

An empirical estimation of these elasticities is the task of the next section while the price and quantity data are discussed in Appendix C.

Demand Elasticities - A System-wide Approach

In estimating import demand elasticities for the farm products considered in this study the system-wide (or differential) approach developed by Theil (1967) is utilized. This focuses on systems of consumer demand equations rather than individual equations. Moreover, instead of initially selecting a particular functional form for the consumer's utility function to generate the demand system, one differentiates the first-order conditions of the standard utility maximization problem to obtain a system of differential demand equations (i.e. expressed in terms of changes in prices and quantities).

Specifically, manipulation of the utility maximization-first order conditions yields the following demand equation for the ith good:

$$w_i d(\log q_i) = \theta_i d(\log Q) + \phi \sum_{j=1}^{N} \theta_{ij} d(\log p_j - \log P') \quad (3.30)$$

where

$$w_i = \frac{p_i q_i}{M} \qquad i = 1, \ldots, N \quad (3.31)$$

is the respective budget share and

$$\theta_i = \frac{\partial (p_i q_i)}{\partial M}, \qquad \sum_{i=1}^{N} \theta_i = 1 \quad (3.32)$$

denotes its *marginal* share. Additionally, d(logQ) is a Divisia volume index of the form

$$d(\log Q) = \sum_{i=1}^{N} w_i d(\log q_i) \quad (3.33)$$

d(logP') is a Frisch price index defined as

$$d(\log P') = \sum_{i=1}^{N} \theta_i d(\log p_i) \quad (3.34)$$

and ϕ is the reciprocal of the income elasticity with respect to μ (the Lagrange multiplier),

$$\frac{1}{\phi} = \frac{\partial \log \mu}{\partial \log M} \quad (3.35)$$

Also, the following equalities hold

$$\sum_{i=1}^{N} \theta_i = 1, \qquad \sum_{j=1}^{N} \theta_{ij} = \theta_i, \qquad \sum_{i=1}^{N}\sum_{j=1}^{N} \theta_{ij} = \sum_{i=1}^{N} \theta_i = 1 \qquad (3.36)$$

In empirical implementation of the differential approach, based on the number and the similarity of goods examined, the assumption of (weak) separability is frequently utilized (Theil, 1980). This assumes that the various goods in the consumer's utility function may be divided into a number of commodity sub-groups, so that the overall utility function is some increasing function of the group sub-utilities. The consumer is assumed to first allocate the budget among the different groups and, in a second stage, the expenditure for each group is further allocated among the goods belonging to that group (multistage budgeting). Groups are assumed to be either strongly or weakly separable with each other; the terms *blockwise dependence* and *block independence* are also used. Within each group however the goods are no longer separable.

For estimation purposes, the general form-differential demand system can be parametrized in a number of ways; a particular parametrization is the Rotterdam model where the demand parameters are assumed constant over time. The Rotterdam specification assumes that the coefficients θ_{ij}, ϕ are constant over time, and w_i, $d(\log q_i)$, and $d(\log p_i)$ are approximated as

$$\overline{w}_{it} = \frac{1}{2}(w_{it} + w_{it-1}), \qquad d(\log q_{it}) \equiv dq_{it} = \log q_{it} - \log q_{it-1}$$

$$d(\log p_{it}) \equiv dp_{it} = \log p_{it} - \log p_{it-1} \qquad (3.37)$$

Then the corresponding discrete-time versions of the Divisia and Frisch indexes are

$$dP_t = \sum_{i=1}^{N} \overline{w}_{it} dp_{it}, \qquad dQ_t = \sum_{i=1}^{N} \overline{w}_{it} dq_{it} \tag{3.38}$$

and the differential demand equation of the ith good takes the estimable form

$$\overline{w}_{it} dq_{it} = \theta_i dQ_t + \sum_{j=1}^{N} \pi_{ij} dp_{jt} + e_{it} \tag{3.39}$$

where

$$\pi_{ij} = \phi(\theta_{ij} - \theta_i \theta_j) \qquad i,j=1,\ldots,N \tag{3.40}$$

and e_{it} is a random disturbance term which is assumed (Theil, 1980) to follow a multinormal distribution with zero mean and covariance

$$cov(e_{it}, e_{jt}) = \sigma^2(\theta_{ij} - \theta_i \theta_j) \qquad i,j=1,\ldots,N \tag{3.41}$$

The θ_{ij}'s account for the price effect on the quantity demanded, keeping the utility level constant (compensated effect) and are known as the *Slutsky coefficients* of the Rotterdam model. Note that given the linearity of (3.39) in its parameters, the income elasticity ζ_i and the compensated price elasticities ϵ_{ij} can be readily obtained as

$$\zeta_i = \frac{\theta_i}{w_i}, \qquad \epsilon_{ij} = \frac{\pi_{ij}}{w_i} \tag{3.42}$$

From (3.36) and (3.40) it can be seen that

$$\sum_{j=1}^{N} \pi_{ij} = 0 \qquad i=1,\ldots,N \tag{3.43}$$

This implies that the NxN Slutsky matrix $[\pi_{ij}]$ has rank N-1. Additionally, it is shown (Theil, 1980) that the covariances of the disturbance terms e_{it} are given by

$$cov(e_{it}, e_{jt}) = \sigma^2(\theta_{ij} - \theta_i\theta_j) = \frac{\sigma^2}{\phi}\pi_{ij} \tag{3.44}$$

that is, all disturbance covariances (and variances) are proportional to the corresponding Slutsky coefficients. Thus the disturbances $e_{1t},\ldots,e_{Nt}$ add up to zero and have a singular covariance matrix. This means that in implementing Rotterdam demand systems one equation may be dropped out and the other N-1 equations can be jointly estimated by maximum likelihood techniques.

The linearity of the Rotterdam model in its parameters allows us to impose on the demand equations the standard constraints of demand theory by means of linear restrictions. In particular, the properties of adding-up, homogeneity, and Slutsky symmetry can be imposed as follows:

(a) Adding-up

$$\sum_{i=1}^{N} \theta_i = 1, \qquad \sum_{j=1}^{N} \pi_{ij} = 0, \tag{3.45}$$

(b) Homogeneity

$$\sum_{j=1}^{N} \pi_{ij} = 0, \tag{3.46}$$

(c) Slutsky symmetry

$$\theta_{ij} = \theta_{ji} \tag{3.47}$$

and their compatibility can be checked by means of the likelihood ratio test (LRT).

In this study the absolute version of the Rotterdam model is used under the assumption that the farm products considered here are divided into two separable groups. The first group includes meat and grains (i.e. beef, pork, poultry, wheat, and rice). Fresh oranges are assumed to belong in a second group that includes all citrus fruit.[15] Moreover it is assumed that the aggregate consumer's welfare function on farm imports consists of the sub-utilities deriving from these two groups which are assumed to be separable from each other. Estimation of the demand systems generated from these two groups yields *conditional* price and expenditure elasticities (i.e. elasticities which depend upon only the prices, quantities and income expenditure allocated to the particular group).

Typically, the quantity and value of imports are used as data source for the estimation of import demand elasticities. In this study however, preliminary estimations using the reported import quantities and import value of the goods under examination (FAO-Trade Yearbook, various issues), produced unsatisfactory elasticity estimates. This may be attributed to the fact that the markets examined in this study are severely distorted-quantity restrictions imposed on beef imports combined with state trading in the

---

[15] Fresh oranges were separated from the rest of the goods, as preliminary estimations including all six goods in a single group showed that cross price relations between oranges and the rest of the goods are insignificant.

case of wheat and rice. Thus, using trade data on a model based on the implicit assumption of undistorted markets, such as the Rotterdam model, is likely to yield questionable estimates (e.g. positive own-price elasticities).

However this problem may be overcome by recalling that imports defined as the partial derivatives of the trade expenditure function E(·) are the difference between the quantity demanded and quantity supplied (see equations (3.8) and (3.11) in section 3.7 of this Chapter). Thus import demand elasticities can be computed as the difference between elasticities of demand and supply. Accordingly, the first group (meat and grains) was estimated for demand (rather than import demand) price elasticities. The price data used in this estimation are the respective domestic wholesale prices (reported for each commodity in Appendix C) while the quantity data are the respective total consumption volumes (gross food) reported in *OECD-Food Consumption Statistics* (1964-78, 1979-88).

The econometric estimates and test statistics for the first group (e.g. beef, pork, poultry, wheat, rice) are reported in Tables 3.2 and 3.3, respectively. Table 3.2 presents the estimated conditional price coefficients and expenditure coefficients with the standard constraints of demand theory (i.e. homogeneity and Slutsky symmetry) imposed. All own-price estimates are negative as expected. The own-price estimates of beef, pork, and rice are statistically different from zero at $\alpha=0.05$ level of significance while those of poultry and wheat are statistically different from zero at $\alpha=0.11$ level and $\alpha=0.14$ level, respectively. Concerning the cross-price Slutsky coefficients, a positive sign indicates substitutes, while a negative sign indicates complementary goods. Of the cross-

Table 3.2: Parameter estimates of a Rotterdam model on meat (beef, pork, poultry) and grains (wheat,rice), homogeneity and symmetry imposed, 1965-87.

	Conditional price coefficients π_{ij}					Expend. coeff.
	Beef	Pork	Poultry	Wheat	Rice	θ_i
Beef	-.0308	.0252	.0013	.0037	.0006	.4488
	(.012)[a]	(.009)	(.0055)	(.0020)	(.014)	(.056)
Pork		-.0446	-.0001	-.0038	.0233	.3565
		(.014)	(.0072)	(.0028)	(.018)	(.0582)
Poultry			-.0096	-.0062	.0146	.1619
			(.0073)	(.0027)	(.009)	(.0305)
Wheat				-.0034	.00976	.0003
				(.0031)	(.003)	(.010)
Rice					-.0483	.0329
					(.030)	(.0944)

[a] Asymptotic standard errors in parentheses.

Table 3.3: Hypothesis testing of the Rotterdam model.

Model	Log of likelihood function	Likelihood ratio test (LRT)	χ^2 (.05)
Unrestricted	389.852		
Homogeneity	386.889	5.926	9.49(4)[a]
Homogeneity and Symmetry	380.603	12.572	12.59(6)
Homogeneity and Symmetry vs. unrestricted		18.498	18.31(10)

[a] Numbers inside the parentheses indicate number of restrictions imposed.

price estimates, the wheat-rice term and the beef-pork term are statistically different from zero at α=0.01 level and positive; this implies that wheat and rice, as well as, beef and pork are substitutes. Additionally, the beef-wheat term and the poultry-rice term are statistically significant from zero at α=0.10 level and α=0.15 level respectively; they are also positive indicating substitutability between beef and wheat, and poultry and rice. Finally, the poultry-wheat term is significant from zero at the α=0.025 level and negative indicating complementarity between wheat and poultry.

The validity of homogeneity and symmetry restrictions is then checked by means of a likelihood ratio test (LRT). The relevant test statistic is

$$LRT = -2\,[\log L_R - \log L_U] \tag{3.48}$$

where L_R is the log-likelihood value of the model with the restriction(s) imposed and L_U is the log-likelihood value without the restrictions. The LRT statistic has an asymptotic $\chi^2(r)$ distribution, where r is the number of restrictions imposed (i.e. the degrees of freedom equal the difference between the number of parameters in the model without restrictions and with restrictions).

The computed values of the LRT statistic appear in the second column of Table 3.3. The following three hypotheses were tested: (a) the null hypothesis of homogeneity against the unrestricted version of the model, (b) the null hypothesis of symmetry against homogeneity, (c) the null hypothesis of both symmetry and homogeneity against the unrestricted model. The null hypotheses (a) and (b) cannot be rejected at the 0.05 significance level, while the null hypothesis (c) cannot be rejected at the 0.02 significance level. This implies that the estimated demand equation system complies with the properties of homogeneity and symmetry in prices as required by the standard consumer demand theory.

Conditional (and compensated) price elasticity estimates can be computed by dividing the relevant Slutsky price parameter by the budget share of good i, that is

$$\epsilon_{ij} = \frac{\pi_{ij}}{w_i} \tag{3.49}$$

However for the group tested here (meat,grains) this generates price elasticities of demand rather than imports. The conditional own-price elasticities of beef, pork, poultry, wheat, and rice are reported in Table 3.4, while Table 3.5 gives their conditional cross-price elasticities. Of the goods belonging to this group, the calculation of the TRI requires demand elasticities for grains (wheat and rice) but import demand elasticities for the three types of meat (beef, pork, and poultry). As mentioned earlier, import demand elasticities for meat can be obtained as the difference between demand and supply elasticities.

It may be noted that the differential approach used in demand analysis can be also used to generate a system of supply equations, since utility maximization and production maximization are mathematically identical optimization problems. Hence the Rotterdam model can be also utilized to estimate supply elasticities. However due to insufficient data on producer prices, no supply elasticities could be estimated. As an alternative, exogenous information on supply elasticities was used. In preparation for the Uruguay Round of GATT negotiations, the Economic Research Service (ERS) of the U.S.

Table 3.4: Conditional own-price elasticities of demand - Rotterdam model on meat (beef, pork,poultry) and grains (wheat, rice), 1965-87.

Year	Beef	Pork	Poultry	Wheat	Rice
1970	-0.270	-0.323	-0.172	-0.053	-0.077
1971	-0.242	-0.273	-0.142	-0.055	-0.084
1972	-0.224	-0.257	-0.152	-0.060	-0.085
1973	-0.167	-0.235	-0.140	-0.061	-0.097
1974	-0.201	-0.244	-0.138	-0.060	-0.090
1975	-0.200	-0.217	-0.150	-0.069	-0.092
1976	-0.187	-0.231	-0.146	-0.060	-0.093
1977	-0.173	-0.237	-0.166	-0.061	-0.093
1978	-0.160	-0.235	-0.176	-0.062	-0.095
1979	-0.175	-0.232	-0.152	-0.062	-0.094
1980	-0.182	-0.231	-0.143	-0.055	-0.095
1981	-0.196	-0.219	-0.134	-0.056	-0.096
1982	-0.182	-0.244	-0.143	-0.058	-0.093
1983	-0.171	-0.238	-0.142	-0.054	-0.096
1984	-0.166	-0.241	-0.138	-0.054	-0.098
1985	-0.157	-0.275	-0.147	-0.054	-0.094
1986	-0.147	-0.281	-0.149	-0.055	-0.096
1987	-0.135	-0.286	-0.171	-0.057	-0.097

Table 3.5: Conditional cross-price elasticities of demand - Rotterdam model on meat and grains (beef, pork, poultry, wheat, rice), 1965-87.

Year	Beef w.r.t. pork	Beef w.r.t. wheat	Poultry w.r.t. wheat	Poultry w.r.t. rice	Wheat w.r.t. rice
1970	0.221	0.032	-0.111	0.262	0.150
1971	0.198	0.029	-0.091	0.216	0.157
1972	0.183	0.027	-0.098	0.231	0.170
1973	0.137	0.020	-0.090	0.213	0.171
1974	0.165	0.024	-0.089	0.210	0.170
1975	0.164	0.024	-0.097	0.229	0.195
1976	0.153	0.022	-0.094	0.222	0.169
1977	0.141	0.021	-0.107	0.253	0.173
1978	0.131	0.019	-0.113	0.268	0.175
1979	0.143	0.021	-0.098	0.232	0.175
1980	0.149	0.022	-0.092	0.218	0.157
1981	0.160	0.024	-0.086	0.203	0.158
1982	0.149	0.022	-0.092	0.218	0.165
1983	0.140	0.021	-0.092	0.217	0.154
1984	0.136	0.020	-0.089	0.210	0.153
1985	0.129	0.019	-0.095	0.225	0.153
1986	0.121	0.018	-0.096	0.227	0.155
1987	0.111	0.016	-0.110	0.260	0.162

(continued)

Table 3.5 - continued.

Year	Pork w.r.t. beef	Wheat w.r.t. beef	Wheat w.r.t. poultry	Rice w.r.t. poultry	Rice w.r.t. wheat
1970	0.182	0.057	-0.095	0.023	0.016
1971	0.154	0.059	-0.099	0.025	0.017
1972	0.145	0.065	-0.108	0.026	0.017
1973	0.133	0.065	-0.109	0.029	0.020
1974	0.138	0.064	-0.108	0.027	0.018
1975	0.123	0.074	-0.124	0.028	0.019
1976	0.131	0.064	-0.107	0.028	0.019
1977	0.134	0.065	-0.110	0.028	0.019
1978	0.133	0.066	-0.111	0.029	0.019
1979	0.131	0.066	-0.111	0.029	0.019
1980	0.131	0.059	-0.099	0.029	0.019
1981	0.124	0.060	-0.100	0.029	0.019
1982	0.138	0.063	-0.105	0.028	0.019
1983	0.135	0.058	-0.098	0.029	0.019
1984	0.136	0.058	-0.097	0.030	0.020
1985	0.155	0.058	-0.097	0.029	0.019
1986	0.159	0.059	-0.098	0.029	0.019
1987	0.161	0.061	-0.102	0.029	0.020

Department of Agriculture (USDA) constructed a trade database known as the *Trade Liberalization Database* (TLIB) (USDA, 1989b). This database includes a set of price elasticities assembled from a survey of global agricultural models and commodity market studies. For developed countries such as Japan, the principal sources of these elasticities are: the Ministerial Trade Mandate (MTM) developed by OECD, the Grain Livestock, and Sugar model developed by Tyers and Anderson, and the Grain, Oilseed and Livestock model developed by the USDA (USDA, 1989b). The price elasticities of the TLIB have been used in numerous commodity models and comprise one of the most complete sets of price elasticities available. This study utilizes supply price elasticities on Japan developed by the OECD and reported in the TLIB. These elasticities which exclude cross commodity effects are reported as:

$$\epsilon(s)_{(beef)}=0.23,\ \epsilon(s)_{(pork)}=1.5,\ \epsilon(s)_{(poultry)}=1.5,\ \epsilon(s)_{(wheat)}=0.44,\ \epsilon(s)_{(rice)}=0.3$$

Table 3.6 reports import demand elasticities for beef, pork, and poultry computed by utilizing the preceding supply estimates, as well as, the conditional demand elasticities for wheat and rice. In summary, Tables 3.5 and 3.6 report the (estimated) information requirements which will be used next in the computation of the TRI.

Computing the Combined TRI for a Subset of Japan's Farm Imports, 1971-1987

In this section the calculation of the combined TRI of Japan imports of beef, pork, poultry, wheat, rice and fresh oranges is presented. The derivatives of the respective balance of trade function were evaluated for each period, utilizing the elasticity estimates reported above, along with information on imported quantities, domestic, and

Table 3.6: Own-price elasticities of imports for meat (beef, pork, poultry) and own-price elasticities of demand for grains (wheat, rice), 1970-87.

Year	Beef	Pork	Poultry	Wheat	Rice
1970	-0.500	-1.823	-1.672	-0.053	-0.077
1971	-0.472	-1.773	-1.642	-0.055	-0.084
1972	-0.454	-1.757	-1.652	-0.060	-0.085
1973	-0.397	-1.735	-1.640	-0.061	-0.097
1974	-0.431	-1.744	-1.638	-0.060	-0.090
1975	-0.430	-1.717	-1.650	-0.069	-0.092
1976	-0.417	-1.731	-1.646	-0.060	-0.093
1977	-0.403	-1.737	-1.666	-0.061	-0.093
1978	-0.390	-1.735	-1.676	-0.062	-0.095
1979	-0.405	-1.732	-1.652	-0.062	-0.094
1980	-0.412	-1.731	-1.643	-0.055	-0.095
1981	-0.426	-1.719	-1.634	-0.056	-0.096
1982	-0.412	-1.744	-1.643	-0.058	-0.093
1983	-0.401	-1.738	-1.642	-0.054	-0.096
1984	-0.396	-1.741	-1.638	-0.054	-0.098
1985	-0.387	-1.775	-1.647	-0.054	-0.094
1986	-0.377	-1.781	-1.649	-0.055	-0.096
1987	-0.365	-1.786	-1.671	-0.057	-0.097

international prices (a detailed description of price and quantity data is presented in Appendix C).

As shown in equation (3.17), the combined TRI is then calculated by weighing the percentage change of the policy variables (π,Q,A) in each period with their respective share in the total dead-weight loss due to trade distortions, given by ($B'_Q Q$ - $B'_\pi \pi$). The combined TRI for the period 1971-1987 assuming full quota rent retention[16] in the home country (Japan), is presented in Table 3.7. Inspection of the table reveals that the rate of change of the combined TRI is basically shaped by changes in the riceland diversion programs and the beef quota and, to a lesser extent, pork and poultry prices. In contrast, the contributions of rice and wheat are minimal reflecting the persistent policies of regulating the producer and consumer prices in both crops throughout the period under examination. The rate of change of the index increases with lower prices π for tariff-ridden and state-traded goods, higher quotas Q, and less land employed in rice production. Hence, the index rises as the trade distortions (π,Q), and the misallocation of resources (riceland) are getting reduced.

The level of the index can be computed by using the simple difference equation shown in Chapter 2. One can use either the *chain-principle* (i.e. in each period, use as basis the level of the TRI in the previous period, starting with β_0 = 1) or use $\beta_{(t-1)}$ = 1

[16] In the absence of any information on the portion ω of orange imports controlled by foreign importers, the values ω=0, ω=0.2, ω=0.4 were alternatively used to account for full quota retention in the home country, low quota retention abroad, and high quota retention abroad, respectively. Computations using ω=0.2, ω=0.4 produced little change in the estimated TRI, apparently due to the small contribution of fresh oranges in the overall index.

Table 3.7 The combined Trade Restrictiveness Index of Japan's agricultural imports, 1971-1987.

Year	Pork	Poultry	Wheat (demand)	Rice (demand)	Wheat (supply)
1970					
1971	-0.02459	-0.03309	-3.3e-06	0.000114	-0.00113
1972	-0.01698	0.02461	0.000022	-0.00074	-0.00068
1973	-0.01367	-0.0158	-0.00007	0.000029	-0.00117
1974	-0.0369	-0.03618	-0.00021	-0.00284	-0.00325
1975	-0.09505	-0.02049	-0.00002	-0.00294	-0.00142
1976	-0.00117	-0.0052	-0.00014	-0.0013	-0.00087
1977	0.006232	0.001564	-0.00003	-0.00112	-0.01491
1978	0.025769	0.013365	0.000001	0	-0.00057
1979	0.037185	0.007626	3.11e-07	-0.00072	-0.00102
1980	-0.00702	-0.00944	-0.00006	-0.00063	-0.00408
1981	-0.04444	-0.00927	-0.00002	-0.0005	-0.00143
1982	0.013591	0.009637	-4.2e-06	-0.00104	0
1983	-0.00216	0.004764	-0.00005	0	-0.00026
1984	0.004486	0.002236	0.000001	-0.00105	0
1985	0.031799	0.010745	-4.3e-07	-0.00113	0.000712
1986	0.006694	0.004628	-1.3e-06	-0.00035	0.002144
1987	0.012805	0.008617	0.000009	0	0.035188

(continued)

Table 3.7 - continued.

Year	Rice (supply)	Beef	Oranges	Paddy programs	TRI	TRI level
1970						1
1971	-0.00243	0.152008	0.002241	0.862268	0.955389	1.95539
1972	-0.004	0.119979	0.004022	0.101089	0.227323	2.30784
1973	-0.00598	0.367431	0.000886	-0.00698	0.324668	3.07404
1974	-0.02111	-0.54561	0.002035	-0.70616	-1.35023	0.43768
1975	-0.01334	-0.07086	0.000711	-0.0775	-0.2809	0.26200
1976	-0.00501	0.318762	0.000586	-0.06777	0.237889	0.26966
1977	-0.00305	-0.0596	-0.00038	0.017219	-0.05408	0.26460
1978	-0.00006	0.072784	0.005136	0.31105	0.427475	0.60641
1979	-0.00015	0.126254	0.000945	0.037107	0.207231	0.74634
1980	-0.00225	-0.02736	0.004886	0.166777	0.120817	0.87809
1981	-0.00035	-0.00084	0.001199	0.094097	0.038447	0.92321
1982	-0.00137	-0.00378	0.00375	0.006114	0.026898	0.94833
1983	-0.00223	0.059956	0.002609	-0.04552	0.017113	0.96209
1984	-0.00284	0.029695	-0.00012	-0.01438	0.018021	0.97874
1985	0	0.021505	0.009789	-0.01489	0.058526	1.03568
1986	0	0.113283	0.001288	0.009488	0.137174	1.17742
1987	0.004595	0.130345	0.001122	-0.00027	0.192411	1.40320

for each period. In the latter case, the level of the TRI coincides with its rate of change. Figure 3.1 shows the rate of change of the TRI, while Figure 3.2 shows the level of the TRI using the chain-principle.

The index shows considerable variation in the first half of the period under examination (1971-77) and a relatively smooth pattern in the second half (1978-97). In particular, during the period 1971-73 the index shows a positive but rapidly decreasing rate of change as beef quota, orange quota and riceland diversion all rise at a diminishing rate, while the domestic prices of pork and poultry rise, too. In 1974, the rate of the TRI turns negative implying a severe reduction in the magnitude of the TRI and therefore a dramatic increase in trade protection for that period. This severe drop of the index reflects the decision of the Japanese government to suspend the beef quota in late 1973 and to completely close the beef market to imports in 1974 until the second half of 1975 (Australian Bureau of Agr. and Res. Economics, 1987). This was coupled with an increase of almost 12% in the wholesale pork price, a 13.5% increase in the wholesale price of poultry, and a 79.5% reduction in the amount of riceland diverted from rice production.

In the period 1975-77 the index shows a recovery as its rate of change becomes less negative in 1975 and turns positive in 1976, almost zero in 1977 (reflecting stable policies during 1976-77) and again positive in 1978 reflecting higher beef imports, higher riceland diversion and lower pork and poultry prices. Thereafter the index shows a smoother variation. Specifically, for the period 1978-84 the index shows a positive but decreasing rate of change as the beef quota was slightly reduced in 1980, 1981, 1982,

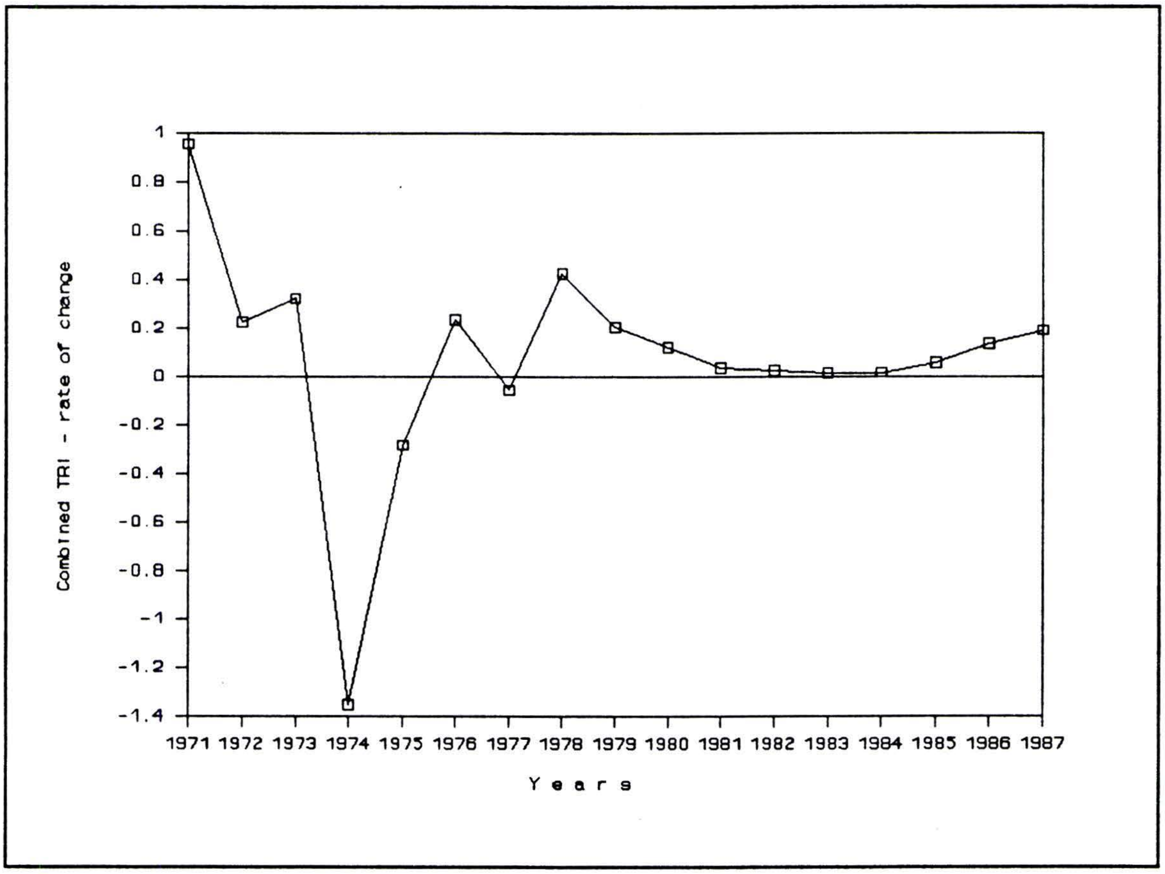

Figure 3.1 The rate of change of the combined TRI, 1971-87.

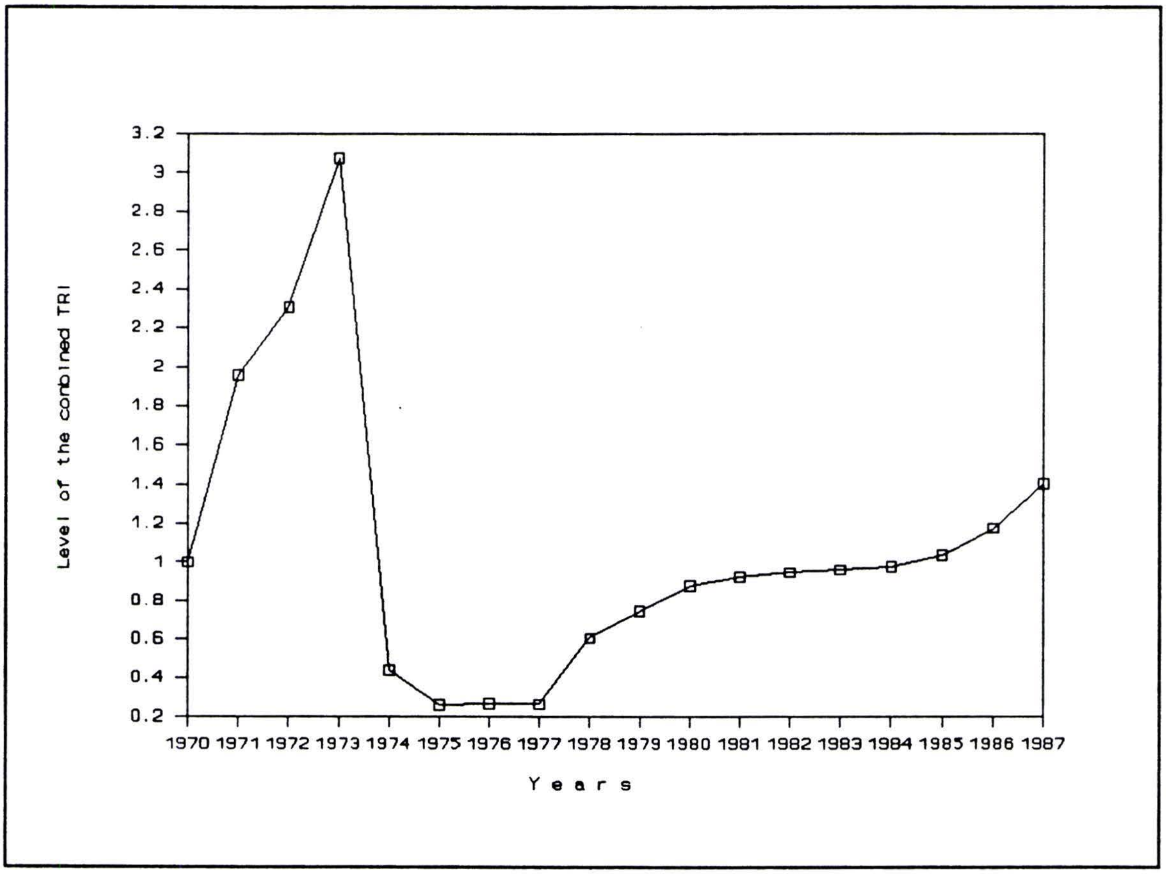

Figure 3.2 The level of the combined TRI (1970=1), 1970-87.

while pork and poultry prices rose and the diversion rate of riceland became smaller and even negative in 1983, 1984.

After 1984 the index rate of change shows a steady increase indicating a trade liberalization process at least for the period 1984-87. This is consistent with the so-called 1984 U.S.-Japan Beef and Citrus Understanding - in August 1984, Japan agreed to expand its import quotas for fresh oranges and grain-fed beef (mainly supplied by the U.S.) (USDA, 1986). It also reflects decreasing domestic prices on pork and poultry, stable or even decreasing domestic prices in wheat and rice, and very small variation in the riceland diversion programs.

Concerning the estimated *level* of the combined TRI, it may be noted that when this is computed according to the chain-principle, the dramatic drop of the index around 1974 affects the magnitude of the TRI in the subsequent years. As a result, the index shows a slow recovery which gains momentum after 1984. Levelwise the index in the last period (1987) is 40% higher than in the first period (Figure 3.2). This implies that using the trade regime of the initial period (1970) as reference-point, the regime of the last period (1987) is clearly less restrictive. Nevertheless, the magnitude of the TRI in 1973 is three times higher than in the first period. Therefore, one must also note that the lower distortions in the end of the examined period are still more strict compared to those in the beginning of the 1970s.

Comparing the TRI with the Respective PSE/CSEs

As explained in Chapter 2, the TRI is not directly comparable with other measures of trade protection. Nonetheless, Anderson and Neary (1992) suggest decompositions of the TRI which allow some comparison with the more conventional measures of producer and consumer subsidy equivalents. Specifically, one may define restrictiveness indexes separately for production and consumption distortions in an analogous fashion to the full TRI.

In the application considered here, one may define *a distortion index* β^P for *trade-related* production distortions as

$$\beta^P \equiv \left[\beta^P\colon\ B\left(h_{pk}^1 \beta^P, h_{ch}^1 \beta^P, \rho_{wh}^1 \beta^P, \rho_{ri}^1, \frac{Q_{bf}^1}{\beta^P}, \frac{Q_o^1}{\beta^P}, A^1;\ u^0\right) \right] \quad (3.50)$$

The rate of change of this index is computed analogously to that of the TRI, considering however only the policy variables related to production i.e. h_{pk}, h_{ch}, ρ_{wh}, Q_{bf}, Q_o, ρ_{ri}, A and ignoring policy variables related to consumption (i.e. s_{wh}, s_{ri}).

Hence β^P is interpreted as the equiproportionate change in trade-related production distortions (accounting, at the same time, for production distortions in non-traded goods) which is welfare-equivalent to policy-changes from period 0 to period 1.

A similar distortion index can be derived for trade-related consumption distortions, i.e. one may define a distortion index β^C as

$$\beta^C \equiv \left[\beta^C : B(h^1_{pk}\beta^C, h^1_{ch}\beta^C, s^1_{wh}\beta^C, s^1_{ri}, \frac{Q^1_{bf}}{\beta^C}, \frac{Q^1_o}{\beta^C}; u^0) \right] \tag{3.51}$$

The rate of change of β^C is calculated by considering only the policy variables related to consumption, i.e. h_{pk}, h_{ch}, s_{wh}, s_{ri}, Q_{bf}, Qo and ignoring production policy variables, i.e. ρ_{wh}, ρ_{ri}, A. Hence, β^C can be interpreted as the equiproportionate change in trade-related consumption distortions (considering however the effect of consumption distortions in non-traded goods) which is welfare-equivalent to these policy-changes from period 0 to 1. Since the distortion indexes β^P, β^C are defined similarly to the full TRI, an increase their magnitude implies less trade restrictiveness.

The distortion indexes β^P, β^C may be compared to the rate of change in the conventional PSEs, CSEs. The Economic Research Service (ERS) of the U.S. Department of Agriculture (USDA) has calculated PSEs, CSEs for a number of farm products in 27 countries for the period 1982-87. Table 3.8 presents the estimated Japanese PSEs, CSEs for beef, pork, poultry, wheat, rice, and mandarin oranges (USDA, 1990). These PSEs, CSEs are expressed as total income transfer per unit of output, i.e. yen per metric ton, (Y/MT). An aggregate PSE, CSE is then calculated by weighing the individual PSEs, CSEs by the respective production (consumption) value shares, i.e.

$$PSE^T = \sum_i^n \left(\frac{p_i y_i}{p'y}\right) PSE_i, \qquad CSE^T = \sum_i^n \left(\frac{q_i x_i}{q'x}\right) CSE_i \tag{3.52}$$

where i= beef, pork, poultry, wheat, rice, mandarin oranges, $p_i y_i$ is the production value of the ith product, and $q_i x_i$ is the consumption value of the ith product. The percentage

Table 3.8 A comparison of distortion indexes with PSE(CSE) measures.

Year	Agreggate PSE Y/MT	% change in PSE	% change in β^P	Agreggate CSE Y/MT	% change in CSE	% change in β^C
1982	310951	-	-	-263950	-	-
1983	342365	0.09175	0.01717	-305985	0.13737	0.06958
1984	336236	-0.0182	0.01908	-305721	-0.0008	0.03757
1985	328767	-0.0227	0.05964	-305535	-0.0006	0.07745
1986	391267	0.15973	0.13735	-387632	0.21179	0.13277
1987	396640	0.01354	0.19380	-403549	0.03944	0.15847

rate of change of these agreggate PSE, CSE is then reported along with the percentage change of the distortion indexes β^P, β^C.

The production distortion index β^P shows positive rates of change throughout the period 1982-87 thus implying diminishing production- related distortions. In contrast, the aggregate PSE shows negative rates of change (thus implying less distortions) only in 1984, 1985. For 1983, 1986 and, 1987 the aggregate PSE shows positive rates of change suggesting higher production distortions. Identical conclusions are drawn by inspecting the rate of change of the aggregate CSE relative to that of the distortion index β^C. It is therefore clear that the TRI approach leads to different conclusions on trade liberalization from the existing measures of PSE(CSE).

At least two reasons may be given for these contradictory results. First the PSEs, CSEs include policies which are not taken into account in the calculation of the trade-related distortion indexes β^P, β^C since they are not directly related to trade. Second, the aggregate PSEs, CSEs and the trade-related distortion indexes β^P, β^C are constructed in fundamentally different ways.

In estimating the aggregate PSE(CSE) one basically weights the price changes of the individual commodities by their value shares (in production or consumption). Hence, the overall rate of distortions is shaped by goods with high production (consumption) value. Such an aggregation is not derived from any theoretical basis; therefore the relative importance assigned to the price variations of the individual commodities is ad hoc and open to criticism. It must also be noted that the PSEs/CSEs consider the variation in price in both the cases of tariff-ridden and quota-controlled goods. However, in the case of quota-controlled goods, the variation in quantity is more relevant since the distortion is founded in the quantity available to the consumer rather than the price.

This is indeed the case in the distortion indexes β^P and β^C wherein the overall distortion rate is shaped by changes in the price or quantity of the individual goods depending on whether goods are price or quantity controlled. In addition, the distortion rate of each commodity is weighted by its contribution to the total welfare loss associated with all trade distortions in place. This aggregation of the individual distortions is explicitly founded in the underlying economic structure (balance of trade function) thus providing theoretical justification in the resulting distortion index. It follows that methodologically, the information on trade liberalization provided by the TRI approach, gains validity over more conventional ad hoc measures such as the PSEs/CSEs given its theoretically robust foundation.

CHAPTER 4
THE NEW GOODS PROBLEM AND THE TRI

A long time concern in index number theory has been accommodating for the disappearance of old commodities and the introduction of new ones into the market. The construction of a price index between two consecutive time periods requires data on the prices of the commodities in both periods. However in the case of a disappearing (new) commodity, its price is not observed in the second (first) period.

One theoretical explanation for the appearance (disappearance) of commodities in the marketplace is based on the concept of the reservation price. Conventionally the reservation price is defined as the price at which the consumer is just indifferent between purchasing or not purchasing a commodity. Hence, when a new good appears in the market it is inferred that its price in the previous period was at its reservation level resulting in quantity demanded equal to zero. Similar reasoning holds for the case of a disappearing good.

In practice, the problem of new (disappearing) goods has generally been circumvented either by setting the reservation prices equal to zero or by ignoring them in the period they appear for the first time (and including them into the index in the subsequent periods wherein price data become available). Diewert (1980) however showed that both practices result in Fischer price indexes which are upward biased. Moreover, the bias is more severe when the reservation price is arbitrarily set equal to zero than when the new (disappearing) goods are simply ignored when they first appear (disappear).

Theoretically, the correct procedure for treating new (disappearing) goods is to form an estimate of the reservation price and then use this estimate in the price index. One solution to this problem proposed by Griliches (1961) is the hedonic (or continuous characteristics) approach. According to this approach the price of a commodity is viewed as some function of certain continuous characteristics of the commodity (e.g. in Griliches' seminal work on automobiles these characteristics included horsepower, length, weight, etc). Estimates of the price of a new good can then be obtained from hedonic regressions using data on the characteristics of the good from the periods that it is available.

Abstracting from the statistical and theoretical difficulties associated with hedonic regressions, the major draw-back of the hedonic approach is the fact that it can be implemented only if data on the characteristics of a commodity are available. Although a set of continuous characteristics may be easily identified in such industries like automobiles or computers, in many other cases such as agricultural commodities, it is most likely that the relevant characteristics of a product are either not identified or not readily measured. In such cases alternative techniques are needed for the treatment of the new (disappearing) goods problem.

The TRI in the Presence of New Goods

This Chapter generalizes the standard TRI to account for new goods (in the sense of newly traded goods), by utilizing the work of Feenstra (1990), and Feenstra and Markusen (1991) who adjust price, quantity, and productivity indices in the presence of new goods.

Their approach to the 'new goods problem' starts with the presumption that data on the characteristics of the goods under examination are not available; this implies that no reservation price can be estimated. To circumvent this difficulty, it may be assumed that the reservation price of a new good is infinite in the period(s) wherein the good is not available, and falls to some finite price when the good first appears in the market.

Given the assumption of an infinite-reservation price, the underlying utility (welfare) function may be represented by a C.E.S. functional form with elasticity of substitution greater than unity. In this case, the reservation price for any good is infinity, since quantity approaches zero only for arbitrarily high prices.

This approach leads to an adjustment of price (quantity) indices by a factor which depends on the expenditure share of the new goods when they first appear, as well as on the value of the elasticity of substitution. Thus the 'opportunity cost' of this approach is that instead of estimating reservation prices (which are infinity by assumption), one must estimate the elasticity of substitution.

Drawing on the theoretical results of Feenstra and Markusen (1991), the standard TRI can be adapted to allow for different ranges of traded goods between any two periods of time. The basic idea of such a generalization is to alter the reference utility (welfare) of the standard TRI.

To start with, if the same range of goods is available to the consumers over time then the utility levels for periods 0 and 1 respectively, are written as

$$u^1(x;M^0) \qquad \text{and} \qquad u^0(x;M^0)$$

where x denotes the quantity vector of all goods (quota constrained and tariff-ridden goods) in the respective periods. The important point of this formulation is that welfare levels in periods 0 and 1 depend only on the quantities consumed (which may be different). However the number of goods in the welfare function remains constant.

In this situation, the appropriate TRI is that presented in Chapter 3. That is, taking the initial welfare $u^0(x;M^0)$ as the reference point, the TRI is defined as the factor of proportionality β by which period-1 policy vector (π^1,Q^1) would have to adjust in order to make the balance of trade function hold for the period-0 welfare $u^0(x;M^0)$. Formally this TRI is defined as

$$\beta \equiv \left[\beta : B(\pi^1\beta, \frac{Q^1}{\beta}, u^0(x;M^0)\,;\, z) = 0 \right] \tag{4.1}$$

Suppose however that the range of traded goods in period 1 is $M^1 \geq M^0$. Then the utility level in period 1 is $u^1(x;M^1)$. If the range M^1 were available in period 0, then the corresponding utility would be $u^0(x;M^1)$ instead of $u^0(x;M^0)$.

Under this setting, the TRI may now be defined as a compensating measure in which the trade restrictions (π^1,Q^1) of the goods which are common in both periods change so that $u^0(x;M^1)$, not $u^0(x;M^0)$, is attained. To be more explicit, suppose that there are M^0 goods in period 0 and just one new imported good in period 1 (so that $M^1 = M^0 + 1$). Then the TRI can be defined as the equiproportionate change in the vectors (π^1,Q^1) of the goods M^0, so that the economy returns not to the initial utility level $u^0(x;M^0)$, but to the hypothetical level $u^0(x;M^1)$.

For notational convenience let $u(x^0;M^1) \equiv \tilde{u}$ and $u(x^0;M^0) \equiv u^0$. Following the same reasoning as in defining the standard TRI, one can derive the offsetting *uniform* change in trade distortions (π,Q) required to return the aggregate consumer to the utility level $\tilde{u}$ (instead of the initial level u^0). Indeed, one may write

$$\beta' \equiv \left[\beta' : B\left(\beta'\pi^1, \frac{Q^1}{\beta'}, \tilde{u}; z\right) = 0 \right] \qquad (4.2)$$

This expression should be interpreted as follows: first, it equalizes the change to the foreign exchange requirement $B(\cdot)$ - due to an arbitrary change in π, Q, and u - *to a hypothetical proportionate change in π and Q*. Then, starting in period 1 it asks the question: what is the hypothetical proportionate change in (p,π) which returns the economy to welfare level $\tilde{u}$ rather than the actual level u^0?

This hypothetical proportionate change, which may be termed the *generalized* TRI, is determined by totally differentiating (4.2) and then solving for the rate of change $(d\beta'/\beta')$:

$$\frac{d\beta'}{\beta'} = \frac{B_Q' dQ}{B_Q' Q - B_\pi' \pi} - \frac{B_\pi' d\pi}{B_Q' Q - B_\pi' \pi} + \frac{1}{\beta'} \cdot \frac{\tilde{u} B_{\tilde{u}}}{B_Q' Q - B_\pi' \pi} \cdot \frac{d\tilde{u}}{\tilde{u}} \qquad (4.3)$$

This generalized version of the TRI suggests that the change of rate of the proportionality factor β' equals the sum of the percentage changes in the trade policy variables (π,Q) (each one weighted by its contribution to total welfare cost). Furthermore, it is adjusted by the percentage change in the hypothetical welfare level $\tilde{u}$, with the respective 'weight' being the ratio of the utility-derivative of the balance of trade function to the total welfare cost. Mathematically, the new features are the numerator $\tilde{u}B_{\tilde{u}}$, and the utility rate of change ($d\tilde{u}/\tilde{u}$) on the far right-hand side of (4.3). Making this generalized TRI operational is the objective of the following section.

Operationalizing the TRI in the Presence of New Goods

Assume that the preferences of the aggregate consumer are homothetic. Such preferences generate consumer expenditure functions e(π,p,u) which can also be written as $u\bar{e}(\pi,p)$ where $\bar{e}(\pi,p)$ is the unit-expenditure function. Additionally, given the fact that the measurement of utility is ordinal there is no loss of generality in representing preferences via linearly homogeneous utility functions. Then one may write

$$E(\pi,p) = u\bar{e}(\pi,p) - g(\pi,p) \tag{4.4}$$

$$Q = E_p = u\bar{e}_p(\pi,p) - g_p(\pi,p) \tag{4.5}$$

$$m = E_\pi = u\bar{e}_\pi(\pi,p) - g_\pi(\pi,p) \tag{4.6}$$

and the balance of trade function B(·) pertaining to utility level $\tilde{u}$ can be written as

$$B(\cdot) = \tilde{u}\,\bar{e}(\cdot) - g(\cdot) - t'[\tilde{u}\,\bar{e}_\pi(\cdot) - g_\pi(\cdot)] -$$

$$- (1-\omega)(p-p^*)'[\tilde{u}\,\bar{e}_p(\cdot) - g_p(\cdot)] = 0 \tag{4.7}$$

Differentiating with respect to ũ and premultiplying with ũ yields

$$\tilde{u}\,B_{\tilde{u}} = \tilde{u}\,\bar{e}(\cdot) - t'\tilde{u}\,\bar{e}_\pi(\cdot) - (1-\omega)(p-p^*)\tilde{u}\,\bar{e}_p(\cdot) \tag{4.8}$$

Rearranging the Balance of trade function in (4.7) gives

$$\tilde{u}\,\bar{e}(\cdot) - t'\tilde{u}\,\bar{e}_\pi(\cdot) - (1-\omega)(p-p^*)\tilde{u}\,\bar{e}_\pi(\cdot) =$$

$$= (\pi - t)'g_\pi(\cdot) + [p^* + \omega(p - p^*)]'g_p(\cdot) \tag{4.9}$$

Note however that the left-hand side of (4.9) is the derivative $\tilde{u}B_{\tilde{u}}$. Thus the term $\tilde{u}B_{\tilde{u}}$ can be evaluated as

$$\tilde{u}\,B_{\tilde{u}} = (\pi - t)'g_\pi(\cdot) + [p^* + \omega(p - p^*)]'g_p(\cdot) \tag{4.10}$$

The rate of change ($d\tilde{u}/\tilde{u}$) can be estimated by drawing on the work of Feenstra and Markusen (1991). They show that given a constant-returns-to-scale, C.E.S. production function

$$u(x;M) = \left[\sum_{i=1}^{M} a_i x_i^\theta\right]^{1/\theta}, \qquad 0 < \theta < 1 \tag{4.11}$$

and two different but overlapping ranges of inputs denoted by $M^0 \leq M^1$, the respective output levels $y = f(x; M^0)$ and $y' = f(x;M^1)$ are related by

$$f(x;M^1) = f(x;M^0)\cdot\rho \qquad \rho = \left[\frac{\sum_{i=1}^{M^1} w_i x_i}{\sum_{i=1}^{M^0} w_i x_i}\right]^{1/\theta} \tag{4.12}$$

where w's denote input prices, x's denote input quantities, and θ is the exponent coefficient of the underlying C.E.S. function.

Drawing on the similarities between the formal structure of the firm's cost minimization problem and the consumer's expenditure minimization problem, an analogous result can be stated in the context of consumption theory.

Specifically, given the expenditure minimization problem of the individual consumer

$$Min_{(x)}\ E \equiv \sum_{i=1}^{M} p_i x_i \qquad s.t. \qquad u^0 = u(x;M) \tag{4.13}$$

where p_i is the (exogenously given) price of the ith good, M denotes the set of goods available to the consumer, and $u^0 = u(x;M)$ denotes a certain utility level, the following proposition can be stated.

Proposition: Given a linearly homogeneous C.E.S. utility function,

$$u(x;M) = \left[\sum_{i=1}^{M} a_i x_i^{\theta}\right]^{1/\theta}, \qquad 0 < \theta < 1 \tag{4.14}$$

the utility levels achieved with two different ranges of goods M^0 and M^1 with $M^0 \cap M^1 \neq \varnothing$ are related as

$$u(x;M^1) = u(x;M^0)\cdot\rho \qquad \rho = \left[\frac{\sum_{i=1}^{M^1} p_i x_i}{\sum_{i=1}^{M^0} p_i x_i}\right]^{\frac{1}{\theta}} \tag{4.15}$$

In other words, the ratio of these two utility levels equals the expenditure ratio on the respective sets of goods M^0 and M^1 raised to the power $(1/\theta)$. The proof of this proposition is given in Appendix A.

Given this proposition, the utility levels $u^0(x;M^0) \equiv u^0$ and $u^0(x;M^1) \equiv \tilde{u}^0$ can be related as:

$$\tilde{u} = \rho\cdot u^0 \tag{4.16}$$

where as noted earlier, ρ equals the expenditure ratio on the range of goods M^1 to the range $M^{0,}$ raised to the power $(1/\theta)$. Since $\tilde{u}$ is a multiple of u, its rate of change $d\tilde{u}/\tilde{u}$, keeping the initial u^0 constant, is

$$\tilde{u} = u^0\cdot\rho \;\rightarrow\; d\tilde{u} = u^0 d\rho \;\rightarrow\; \frac{d\tilde{u}}{\tilde{u}} = \frac{d\rho}{\rho} \tag{4.17}$$

Further, the term $d\rho/\rho$ can be viewed as the rate of growth of the ratio ρ between periods 0 and 1. Thus it may be approximated as

$$\frac{d\rho}{\rho} = \frac{\rho^1 - \rho^0}{\rho^1} \tag{4.18}$$

If the same range of traded goods exists in both periods then, of course ρ vanishes and $\beta \equiv \beta'$. Suppose however that $M^1 > M^0$ and let N denote traded goods existing only in period 1, so that it holds, $M^0 + N = M^1$.

Since the N new goods exist only in period 1, we have

$$\rho_0 = 1, \quad \rho_1 = \left[\frac{\sum_{i=1}^{M^1} p_i^1 x_i^1}{\sum_{i=1}^{M^0} p_i^1 x_i^1}\right]^{\frac{1}{\theta}} = \left[\frac{\sum_{i=1}^{M^0} p_i^1 x_i^1 + \sum_{j=1}^{N} p_j^1 x_j^1}{\sum_{i=1}^{M^0} p_i^1 x_i^1}\right]^{\frac{1}{\theta}} = R \quad (4.19)$$

In light of expressions (4.9) and (4.17), the rate of change ($d\beta'/\beta'$) can be finally written as

$$\frac{d\beta'}{\beta'} = \frac{d\beta}{\beta} + \frac{1}{\beta'} \frac{(\pi - t)' g_\pi(\cdot) + [p^* + \omega(p - p^*)] g_p(\cdot)}{B_Q' Q - B_\pi' \pi} \left(1 - \frac{1}{R}\right) \quad (4.20)$$

The TRI β' can be thought of as the generalized value-TRI when trade in new products occurs over time. Its rate of change ($d\beta'/\beta'$) in expression (4.20) consists of two parts: the standard TRI (although evaluated at a different reference equilibrium) and an adjustment factor - the second term on the right-hand side of (4.20) - which accounts for the presence of newly traded goods in the second time period.

With respect to this generalized value-TRI, one can make several observations. First, taking into account different ranges of traded goods over time the value of the standard TRI can change either upwards or downwards, depending on the shadow value of distorted trade. This can be seen by observing the adjustment factor on the right-hand side of (4.20). The numerator and the expression $(\rho_1 - \rho_0)/\rho_1$ are unambiguously positive. The shadow value of distorted trade (e.g. the denominator ($B'_Q Q - B'_\pi \pi$)) is generally expected to be negative as can be inferred from expressions (2.29)-(2.32)--the trade distortions in other words are welfare-reducing. Therefore the adjustment factor of the generalized TRI is generally expected to be negative, too. However, there may be situations (e.g., strong cross commodity effects) that render the denominator ($B'_Q Q$ - $B'_\pi \pi$) positive. In this case, the adjustment factor becomes also positive thus enlarging the value of the standard TRI.

Intuitively, this change in the size of the standard TRI may be interpreted along the following lines. When only the traded goods, common in both time periods are considered, a certain degree of trade restrictiveness is measured via the standard TRI. If some newly traded goods appear in the second period, the generalized TRI suggests the standard TRI underestimates[17] the level of protection, since it does not take into account the restrictiveness associated with the new goods--this restrictiveness is reflected on the fact that these 'new' goods were not traded at all in the previous period.

Second, the value of the generalized TRI depends on whether the 'new' goods are freely traded or restricted. This can be seen via the term (1-1/R) of the adjustment factor in (4.20). If the newly traded goods are priced at the world prices the adjustment factor reduces the standard TRI only in a definitional sense (i.e. the original TRI is evaluated at a different reference point). If however, the newly traded goods are subject to tariffs or quotas, their prices are even higher, and the adjustment factor increases accordingly. This, in turn, reduces the value of the TRI even further.

A third point of importance is that the significance of the adjustment factor depends on the value of the new imports. This can be seen by observing the ratio R in

---

[17] However, in situations where the shadow value of distorted trade is positive (i.e., overall, the distortions are welfare-improving) the generalized TRI implies that the standard TRI overestimates the level of protection.

expression (4.19); when the expenditure on new imported goods is large relative to that on the common set of goods M^0, the magnitude of R rises accordingly. This is indicative of a situation where lowering the tariffs (and thus the price) of old traded goods is combined with imposing very high tariffs on newly traded products. By contrast, a small expenditure on new imported goods relative to that on the common set M^0 may result in a factor R, near zero. In such a case, a restrictiveness measurement based on the standard TRI may be considered adequate.

An Application of the Generalized TRI - the Case of Japan's Meat Imports

In this section, some of Japan's agricultural trade policies discussed in the previous Chapter are used to empirically investigate the generalized TRI. This empirical exercise constructs a TRI pertaining only to Japanese meat imports (beef, pork, and poultry). The interesting feature about this partial index (termed here the meat-TRI) is that it provides an example for adjusting the standard TRI to account for the presence of 'new' goods (i.e. goods not previously traded).

In particular, the beef imports in this meat-TRI are considered to be differentiated products, distinguished by origin (supplier country). Inspection of the data on beef imports by origin (Table C.8 - Appendix C) reveals that in the 1970s Japan beef imports were dominated by Australian and New Zealand beef, while U.S. beef imports were negligible. In contrast, U.S. beef imports rose considerably throughout the 1980s. Therefore one can start the construction of the meat-TRI in the absence of U.S. beef imports and then adjust it to account for the introduction of a newly traded beef variety (U.S. beef).

Beef import differentiation could, of course, be used to compute a generalized TRI for all six products considered earlier. Nevertheless, the small import value of U.S. beef in the early 1970s relative to the total import value of the rest of agricultural goods (beef, pork, poultry, wheat, oranges) may yield a negligible adjustment in the standard TRI. Therefore testing the applicability of the generalized TRI is confined to a partial measurement of the trade restrictiveness of meat imports.

Following similar steps as in the case of the combined TRI in Chapter 3, a partial equilibrium balance of trade function is specified for Japanese imports on beef, pork, and poultry. Focusing on beef imports, the three major beef suppliers of the Japanese market are Australia, New Zealand, and the U.S.--all three supply more than 90% all beef imports. These suppliers however produce different types of beef. In particular, Australia and New Zealand specialize in the production of grass-fed beef while the U.S. specialize in grain-fed beef.

It is often argued (Mori and Gorman, 1985; Mori, Gorman, and Faminow, 1987) that, traditionally, Japanese consumers have a strong preference for tender beef with high a portion of intermuscular fat (beef marbling). Traditional Japanese dishes such as sukiyaki require highly marbled beef, and the Japanese beef grading system is chiefly determined by the extent of marbling. Given the importance of marbling in assessing beef quality, the beef imports may be differentiated by origin (the often called Armington assumption). In other words, Australian, New Zealand, and U.S. beef imports can be considered as different beef varieties and be treated separately in the balance of trade function on meat imports.

Following similar steps as earlier, the balance of trade function on meat imports (assuming complete quota rent retention at home) can be written as

$$\tilde{E}(h_{pk}, h_{ch}, Q_{AUS}, Q_{NZ}, Q_{US}) + (p_{AUS}, p_{NZ}, p_{US})'(Q_{AUS}, Q_{NZ}, Q_{US}) - t_{pk}m^{pk}(\cdot) -$$

$$t_{ch}m^{ch}(\cdot) - (p_{AUS} - p^{*}_{AUS})\,Q_{AUS} - (p_{NZ} - p^{*}_{NZ})\,Q_{NZ} -$$

$$- (p_{US} - p^{*}_{US})\,Q_{US} = 0 \tag{4.21}$$

where (p_{AUS},p_{NZ},p_{US}) is the price vector of Australian , New Zealand, and U.S. beef, and (Q_{AUS},Q_{NZ},Q_{US}) is the corresponding vector of imported quantities. The TRI on meat imports is then defined as

$$\bar{\beta} \equiv \left[\bar{\beta}:\ B\left(\bar{\beta}h^{1}_{pk}, \bar{\beta}h^{1}_{ch}, \frac{Q^{1}_{AUS}}{\bar{\beta}}, \frac{Q^{1}_{NZ}}{\bar{\beta}}, \frac{Q^{1}_{US}}{\bar{\beta}}, u^{0}\right) = 0\right] \tag{4.22}$$

and its rate of change can be derived by total differentiation of (4.22) with respect to the respective policy variables. The rate of change of the generalized-meat TRI *in the first period that U.S. beef is introduced (i.e. 1969),* is given by

$$\frac{d\bar{\beta}}{\bar{\beta}} = \sum_{j}^{m} \frac{B_{Q_j} Q_j}{B_Q' Q - B_\pi' \pi} \hat{Q}_j + \sum_{i}^{n} \frac{B_{\pi_i} \pi_i}{B_Q' Q - B_\pi' \pi} \hat{\pi}_i + $$

$$+ \frac{(h-t)' G_h}{B_Q' Q - B_\pi' \pi} \cdot \left(1 - \frac{1}{(V^I/V^{II})^{\frac{1}{\theta}}}\right) \tag{4.23}$$

where j=Australian beef, N. Zealand beef, and i=pork, poultry. The derivatives B_Q, B_π refer to the balance of trade function on meat imports (4.21), V^I is the expenditure on meat *including U.S. beef* in the first period it appears, and V^{II} is the meat expenditure *without U.S. beef* in the same period.

For the subsequent periods, wherein price and quantity data are available for all three types of beef imports, the TRI is computed using its standard form

$$\frac{d\bar{\beta}}{\bar{\beta}} = \sum_{j}^{m} \frac{B_{Q_j} Q_j}{B_Q' Q - B_\pi' \pi} \hat{Q}_j + \sum_{i}^{n} \frac{B_{\pi_i} \pi_i}{B_Q' Q - B_\pi' \pi} \hat{\pi}_i \tag{4.24}$$

where j=Australian beef, N. Zealand beef, U.S. beef, and i=pork, poultry.

It may be recalled that the adjustment factor of the generalized TRI is based on the assumption that the underlying welfare function (here the utility associated with meat consumption) has a linearly homogeneous C.E.S. specification. Then the information requirements for the computation of the meat-TRI include import demand elasticities on pork, poultry, Australian, New Zealand, and U.S. beef, as well as, an estimate for the exponent coefficient θ of the underlying C.E.S. welfare function. Information on these requirements can be obtained from empirical estimation of a C.E.S. utility function.

Estimation of a C.E.S. Aggregator Function

Feenstra (1990) demonstrated an econometric procedure for the empirical estimation of a C.E.S. aggregator (utility or production) function. His technique basically involves the stochastic specification of a model derived from demand and supply equations of a C.E.S. utility (welfare) function. Estimation of this model yields an efficient estimate of the elasticity of substitution σ; σ is, of course, linked to the exponent coefficient θ as $\sigma = 1 / (1 - \theta)$.

An outline of Feenstra's methodology is presented in Appendix B. Assuming a C.E.S. utility function which involves $i=1 \ldots N$ goods, (only a subset of which may be available in period t), the corresponding expenditure function is given by:

$$E(p, G_t, u_t) = u_t \cdot \left(\sum_{i \in S_t} \left(\frac{p_{it}}{b_{it}} \right)^{-\frac{1}{\beta}} \right)^{-\beta}, \qquad \beta = \frac{1-\theta}{\theta} \tag{4.25}$$

where $p=\{p_1, \ldots p_N\}$ denotes a vector of prices, b_{it} are taste parameters, G_t is the set of goods available to the consumer in period t, and $\beta=(1-\theta/\theta)$ where θ is the exponent coefficient of the C.E.S. utility function.

The demand equation for the ith good can be written as

$$\beta \Delta \log p_{it} = d_t - \beta \Delta \log s_{it} + \epsilon_{it} \tag{4.26}$$

where s_{it} denotes expenditure shares, and $\Delta\log\ m_{it}=(\log m_{it}-\log m_{i\ t-1})$ with $m=p_{it},s_{it}$. Further, $d_t=\log(e_t/e_{t-1})$ denotes the ratio of unit-expenditure in t and t-1 while $\epsilon_{it}=(\log b_{it}-\log b_{it-1})$ denotes the random change in the taste parameters b in t and t-1.

On the supply side, the supply curve for the ith good is specified in first differences, Δ, as

$$\Delta \log p_{it} = \eta \Delta \log x_{it} + v_{it} \tag{4.27}$$

where $\Delta\log\ m_{it}=(\log m_{it}-\log m_{i\ t-1})$ with $m=p_{it},\ x_{it}$, x_{it} is the quantity supplied, η denotes the inverse supply elasticity, and v_{it} is a random error.

Further, a good k (available to the consumer in all time periods can be used as numeraire and its demand and supply equations can be subtracted from the demand and supply equations, respectively, for all other goods $i=1...N$, $i\neq k$. The adjusted demand and supply equations for each good $i\neq k$ are then multiplied with each other to yield the following expression

$$Y_{it} = \gamma_1 X_{1(it)} + \gamma_2 X_{2(it)} + \omega_{it} \tag{4.28}$$

where

$$\omega_{it} = \frac{\epsilon_{it} v_{it}}{(1-\lambda)} \tag{4.29}$$

$$Y_{it} = (\Delta \log p_{it} - \Delta \log p_{kt})^2 \tag{4.30}$$

$$X_{1(it)} = (\Delta \log s_{it} - \Delta \log s_{kt})^2 \tag{4.31a}$$

$$X_{2(it)} = (\Delta \log p_{it} - \Delta \log p_{kt})(\Delta \log s_{it} - \Delta \log s_{kt}) \quad (4.31b)$$

$$\gamma_1 = \frac{\lambda\beta^2}{(1-\lambda)}, \qquad \gamma_2 = \frac{\beta(2\lambda-1)}{(1-\lambda)} \quad (4.32)$$

This expression relates the logarithmic difference of the price of the ith good, $i \neq k$ to the logarithmic difference of its expenditure share. Estimation of the two parameters γ_1 and γ_2, yields an estimate for β as can be inferred from (4.32). Subsequently, this estimated β can be used to calculate the elasticity of substitution since $\beta = 1/(\sigma-1)$.

In the empirical application considered here, Japan's meat imports are assumed to be associated with a C.E.S. utility function so that for each type of meat equation (4.28) holds. Further, New Zealand beef imports were used as numeraire. That is, the differences ($\Delta \log p_{it}$ - $\Delta \log p_{ik}$) and ($\Delta \log s_{it}$ - $\Delta \log s_{ik}$) were formed for Australian beef, U.S. beef, pork, and poultry with New Zealand beef being the numeraire good k. Accordingly, equation (4.28) was specified for the rest of meat imports i.e. (Australian beef, U.S. beef, pork, and poultry). As shown in Appendix B, stacking equation (4.28) for i=Australian beef, US beef, pork and poultry yields an estimable model of the form $Y = X\gamma + \omega$.

The data set used for the estimation of this model appears in Table C.8--Appendix C. These data are the reported quantity and value of total Japan imports of beef, pork and poultry covering the period 1962-87. Beef imports are dissagregated into three categories: Australian beef, New Zealand beef, and U.S. beef. (United Nations Trade Data Summary). Data on pork and poultry are total imports from all supplying countries

(FAO Trade Yearbook, various issues). In the case of beef, imports from each of the three major supplying countries (Australia, New Zealand, U.S.A.) are assumed to represent a different variety of beef, as explained earlier. Imports of Australian beef, New Zealand beef, and poultry are reported here for the whole sample period. Negligible imports of U.S. beef (less than 50 metric tons) are omitted so that data on U.S. beef imports start in 1969. For the same reason, pork imports are considered to be zero in 1965, and 1966. Finally, import prices for all five types of meat are calculated as import unit-values (i.e. the ratio of the import value to the respect import quantity).

The model $Y = X\gamma + \omega$ is estimated via instrumental variables (IV) using as instruments a matrix Z of dummy variables for each good $i \neq k$ (shown in equation (B.28)--Appendix B. The instrumental variable (IV) estimator γ of the model is consistent but not efficient because it introduces heteroscedasticity in the errors ω_{it}. Thus in a second stage, efficient estimates are obtained by using a weighted IV estimator γ^{*}. The respective weighing matrix is a diagonal matrix involving the computed residual from the initial IV estimator γ.

The estimation results of this model are presented in Table 4.1. The upper part of the table shows the estimated parameters along with their standard errors (in parentheses). The consistent estimates (γ_1, γ_2) (shown in the first row) are computed as in (B.29)--Appendix B. The efficient estimates (γ_1, γ_2) (shown in the second row) are computed as in (B.30)--Appendix B, and their variances are computed as in (B.32)-Appendix B. The estimates of λ and β and their variances are then obtained using the formulas (B.33) through (B.37) in Appendix B.

Table 4.1 Parameter estimates of a C.E.S. welfare function - Japan meat imports, 1962-88.

Coefficients:	γ_1	γ_2	λ	β
Consistent estimate	0.05417 (0.0298)[a]	-0.6681 (0.428)	0.0896 (0.0995)	0.7410 (0.3591)
Efficient estimate	0.0635 (0.0245)	-0.6668 (0.4142)	0.1011 (0.0964)	0.7513 (0.3425)
Autocorrelation test statistic	1.205		$\chi^2(3)_{0.05}$	7.81
Specification test statistic	0.814		$\chi^2(2)_{0.05}$	5.99
Observations[b]:	93			

[a] Numbers in parentheses denote standard errors.
[b] The number of observations over years and supplying countries.

It may be noted that, as expected, the standard errors of all the efficient estimates are reduced relative to those of the consistent estimates. Focusing on the efficient estimates, the estimated γ_1^* is statistically different from zero at $\alpha=0.01$ level, while the estimated γ_2^* is statistically different from zero at $\alpha=0.12$ level. Additionally, the estimated β^* is statistically different from zero at $\alpha=0.025$ level while the estimated λ^* is statistically different from zero at $\alpha=0.15$ level.

The lower part of Table 4.1 reports statistics used to test the existence of autocorrelation and mispecification in the estimated model. As in Feenstra (1990), the White and Domowitz (1984) test was used to test for the existence of autocorrelation. This test is carried out by first computing the residuals

$$\hat{\omega}_{it} = Y_{it} - \hat{\gamma}_1 X_{(1it)} - \hat{\gamma}_2 X_{(2it)} \tag{4.33}$$

and then performing the regression

$$(\hat{\omega}_{(it)} \hat{\omega}_{(it-1)}) = c_1 \hat{X}^2_{1(it)} + c_2 \hat{X}^2_{2(it)} + c_3 \hat{X}_{1(it)} \hat{X}_{2(it)} \tag{4.34}$$

where the computed X_1 and X_2 are obtained by regressing X_1 and X_2 on the instrument matrix Z. The existence of autocorrelation can be tested under the null hypothesis of no autocorrelation by using the statistic nR^2 which is asymptotically distributed as $\chi^2(k)$; k is the number of regressors, n is the number of observations, and R^2 is the coefficient of determination of the regression (4.34).

In addition, the Hausman (1978) test was used to test for mispecification. This specification test contrasts an efficient estimator (such as γ^*) with an inefficient but generally consistent estimator (such as γ), under the null hypothesis of no mispecification. The test statistic has the quadratic form

$$(\hat{\gamma}^* - \hat{\gamma})'[Var(\hat{\gamma}) - Var(\hat{\gamma}^*)]^{-1}(\hat{\gamma}^* - \hat{\gamma}) \tag{4.35}$$

and is asymptotically distributed as $\chi^2(k)$ where k is the number of elements in the vector γ. The computed values of both the Domowitz-White, and Hausman statistics are below the relevant tabulated values at $\alpha=0.05$ level. Thus, both the null hypotheses of no autocorrelation and no mispecification cannot be rejected.

Given consistent estimates of β and λ, the elasticity of substitution σ and the exponent coefficient θ are then computed as

$$\hat{\sigma} = \frac{1 + \beta}{\beta}, \qquad \theta = \frac{\hat{\sigma} - 1}{\hat{\sigma}} \tag{4.36}$$

At this point it may be noted that, given the small estimated value of λ and its relatively large standard error, the parameter λ may considered to be zero. As explained in Appendix B, this implies a very flat (almost horizontal) supply curve for meat. This finding is interesting because it implies a meat sector consisting of relatively competitive producers, as one might expect. Furthermore, ignoring[18] the small value of λ the estimated values of β and σ are

$$\beta = 0.6668, \qquad \sigma = 2.499, \qquad \theta = 0.599 \tag{4.37}$$

These values are used in the next section for the computation of the TRI in Japan's meat sub-sector.

Specifically, the estimated exponent θ is used in the calculation of the adjustment factor of the TRI in 1969 as shown in (4.23). Additionally, it may be recalled that the TRI requires own-price and cross-price elasticities of demand for the five types of meat imports. It turns out that these elasticities can be conveniently computed given the estimated elasticity of substitution σ. This can be demonstrated by considering equation (B.12) from Appendix B which, for convenience, is repeated below

[18] Alternative computations taking into account the value $\lambda = 0.1011$ yield $\sigma = 2.33$ and $\theta = 0.570$ with insignificant numerical changes to the rest of the analysis.

$$\log x_{it} = \log(e_t^{\sigma} \cdot u_t) + \frac{1}{\beta}\log b_{it} - \sigma \log p_{it} \qquad (4.38)$$

Differentiating with respect to $\log p_{it}$ and $\log p_{jt}$ yields respectively

$$\frac{\partial \log x_{it}}{\partial \log p_{it}} = \sigma\left(\frac{\partial \log e_t}{\partial \log p_{it}} - 1\right) = \sigma\,(s_i - 1) \qquad (4.39)$$

$$\frac{\partial \log x_{it}}{\partial \log p_{jt}} = \sigma \frac{\partial \log e_t}{\partial \log p_{jt}} = \sigma\, s_j \qquad (4.40)$$

These formulas were used to compute own and cross price elasticities of demand for imports of Australian, New Zealand, and U.S. beef, pork, and poultry. Since a C.E.S. functional form is commodity-wise weakly separable, the estimated cross-price elasticities for any commodity i are identical across commodities. Additionally, all goods are price substitutes with each other. These elasticity estimates are reported in Table 4.2 and are utilized next in the calculation of the respective TRI on meat imports.

Calculating the TRI of Japan's Meat Imports

The TRI pertaining to Japanese imports of Australian, New Zealand, and U.S. beef, pork, and poultry is calculated in an analogous fashion to the combined index. However the TRI of meat imports differs from the combined index as the import demand elasticities for the five types of meat involved here are based on a C.E.S. specification of the underlying welfare function.

Concerning the calculation of the quota rents for the three types of beef, the domestic wholesale prices for Australian, New Zealand, and U.S. beef were not

Table 4.2 Own price-elasticities of import demand, assuming a C.E.S. utility function on meat imports, 1969-87.

	Austra lian	New Zealand	U.S.		
Year	beef	beef	beef	pork	poultry
1969	-2.125	-2.420	-2.487	-0.921	-2.042
1970	-1.612	-2.375	-2.432	-1.472	-2.105
1971	-1.457	-2.394	-2.466	-1.666	-2.013
1972	-1.603	-2.438	-2.473	-1.263	-2.219
1973	-1.415	-2.411	-2.350	-1.443	-2.377
1974	-1.521	-2.430	-2.249	-1.606	-2.191
1975	-2.182	-2.461	-2.402	-0.617	-2.334
1976	-2.028	-2.464	-2.346	-0.848	-2.310
1977	-2.013	-2.458	-2.398	-0.928	-2.199
1978	-1.967	-2.443	-2.334	-1.064	-2.189
1979	-1.790	-2.470	-2.263	-1.251	-2.222
1980	-1.692	-2.455	-2.223	-1.424	-2.202
1981	-1.992	-2.455	-2.283	-1.101	-2.165
1982	-1.954	-2.469	-2.191	-1.257	-2.124
1983	-1.951	-2.447	-2.208	-1.201	-2.190
1984	-1.995	-2.455	-2.211	-1.165	-2.169
1985	-2.024	-2.456	-2.154	-1.159	-2.202
1986	-2.123	-2.474	-2.180	-1.105	-2.114
1987	-2.141	-2.472	-2.125	-1.106	-2.152

(continued)

Table 4.2 - continued.

Year	w.r.t Austra lian beef	w.r.t New Zealand beef	w.r.t U.S. beef	w.r.t pork	w.r.t poultry
1969	0.374	0.079	0.012	1.578	0.457
1970	0.887	0.124	0.067	1.027	0.394
1971	1.042	0.105	0.033	0.833	0.486
1972	0.896	0.061	0.026	1.236	0.280
1973	1.084	0.088	0.149	1.056	0.122
1974	0.978	0.069	0.250	0.893	0.308
1975	0.317	0.038	0.097	1.882	0.165
1976	0.471	0.035	0.153	1.651	0.189
1977	0.486	0.041	0.101	1.571	0.300
1978	0.532	0.056	0.165	1.435	0.310
1979	0.709	0.029	0.236	1.248	0.277
1980	0.807	0.044	0.276	1.075	0.297
1981	0.507	0.044	0.216	1.398	0.334
1982	0.545	0.030	0.308	1.242	0.375
1983	0.548	0.052	0.291	1.298	0.309
1984	0.504	0.044	0.288	1.334	0.330
1985	0.475	0.043	0.345	1.340	0.297
1986	0.376	0.025	0.319	1.394	0.385
1987	0.358	0.027	0.374	1.393	0.347

available. Thus the total quota rent on beef was distributed among the three supplying countries using as weights the respective import value shares[19]. Additionally, inspection of the computed cross price-elasticities reveals that the cross price-elasticity with respect to pork imports is relatively high--indeed for half of the examined years, this elasticity is higher than the own price-elasticity of pork imports. This is due to the fact that the import value-share for pork is predominant, ranging from 40% to 60% of the value of all meat imports. Since own and cross price-elasticities are estimated via equations (4.39) and (4.40), this results in cross price-elasticities with respect to pork that are higher than the respective own price-elasticities of pork.

The high substitutability of the rest of meat types with respect to the price of pork renders the derivative with respect to price of pork $B_{h(pk)}$, negative. Intuitively, this implies that a rise in the price of pork reduces, instead of increasing, the income required to preserve a certain welfare level--in other words, it is welfare-improving. The reason is, of course, the high degree of substitutability of the other meat categories with pork.

---

[19] The total beef quota rent is

$$R^{bf} = Q_{bf}(p_{bf} - p^*_{bf})$$

where Q_{bf} is total beef imports. This rent is assumed to be distributed among Australia, New Zealand, and the U.S. according to their import value shares. Hence, for Australia

$$R^{AUS} = \left(\frac{V^{AUS}}{V^{bf}}\right)\left[Q_{bf}(p_{bf} - p^*_{bf})\right]$$

The rent per physical unit (i.e. Y/MT) is

$$\bar{R}^{AUS} = \left(\frac{p_{AUS}}{p_{bf}}\right)(p_{bf} - p^*_{bf})$$

Moreover, the shadow value of distorted trade associated with pork--the term $B_{h(pk)}h(pk)$--turns out to be larger than the shadow values associated with the other policy instruments (i.e., the poultry price and the beef quotas). As a result, the overall shadow value of distorted activity ($B'_Q Q$ - $B'_\pi \pi$) is positive for most of the examined years. This, in turn, adversely affects the performance of the TRI: now, the individual components of the index do not necessarily change in accordance with the changes in the policy instruments (domestic prices of tariff-ridden goods and quota levels). In other words, a relaxation of a quota (or a reduction of the price of tariff-ridden goods--pork, poultry) does not necessarily raise the index, as the algebraic sign of the 'weight' may reverse the change of the respective policy instrument.

The results of computing the TRI on meat imports for the period 1968-69 through 1986-87 appear in Table 4.3. Table 4.4 then presents the percentage changes in the respective policy instruments--pork prices, poultry prices, beef quotas--over the same period. It can be seen that with the exception of a dramatic variation in 1972-1974, this TRI shows relatively low change over time. Furthermore, the rate of change of the index is primarily shaped by the changes in domestic pork prices followed by changes in poultry prices and to a lesser extend by changes in beef imports. This is due to the fact that the shadow value of distorted activity associated with pork prices is the largest portion of the overall shadow value of distorted trade. Consequently, percentage changes in pork prices comprise the largest component of the index.

Upon close examination, the index captures the abrupt changes of agricultural import policies of Japan in the early 1970s-- especially the sharp rise of all beef imports

Table 4.3 The Trade Restrictiveness Index of Japan's meat imports, 1969-87.

Year	Pork	Poultry	Australian beef	New Zealand beef
1968				
1969	-0.19412	-0.06422	-0.02383	-0.00679
1970	0.595683	0	-0.02598	0.008347
1971	-0.3491	0.277394	-0.234	-0.07451
1972	-0.16791	-0.16796	-0.11402	0.002716
1973	2.607768	-2.25562	6.557446	0.85529
1974	-0.50446	0.321219	0.914166	0.206341
1975	-0.58578	0.098689	0.026548	-0.00509
1976	-0.03159	0.094805	-0.76237	-0.02262
1977	0.175971	-0.04749	0.166626	0.017643
1978	-0.11854	0.147654	0.113734	0.039707
1979	-0.88779	0.24539	0.788355	-0.1321
1980	-0.22296	0.409131	0.263379	-0.02411
1981	-0.70429	0.249391	0.139392	-0.07137
1982	0.538008	-0.28383	0.027766	0.103106
1983	-0.19043	-0.27208	-0.29371	-0.26449
1984	-0.53664	0.178829	0.077559	-0.01824
1985	-0.70198	0.161476	0.016868	-0.01342
1986	-0.0416	0.0256	0.088311	0.000273
1987	-0.02528	0.028785	0.075706	-0.00054

(continued)

Table 4.3 - continued.

Year	U.S. beef	TRI	TRI level	Adjusted TRI in 1969	TRI level
1968			1		1
1969	-	-0.28897	0.71103	-0.08517	0.914827
1970	-0.01216	0.565887	1.113393		1.432516
1971	-0.00868	-0.38889	0.680405		0.875424
1972	-0.00258	-0.44975	0.374392		0.481701
1973	2.358343	10.12322	4.164443		5.358063
1974	0.050074	0.98734	8.276162		10.64829
1975	0.072174	-0.39346	5.019839		6.458635
1976	-0.3551	-1.07688	-0.3859		-0.49651
1977	0.338734	0.651479	-0.63731		-0.81998
1978	0.230617	0.413174	-0.90063		-1.15878
1979	0.634138	0.647992	-1.48424		-1.90965
1980	0.07974	0.505185	-2.23405		-2.87438
1981	-0.15864	-0.54552	-1.01533		-1.30635
1982	-0.25787	0.127175	-1.14446		-1.47248
1983	-0.50784	-1.52854	0.604892		0.778267
1984	0.521979	0.223489	0.740079		0.952201
1985	0.101071	-0.43599	0.417414		0.537054
1986	0.175744	0.248324	0.521068		0.670418
1987	0.15782	0.236498	0.6443		0.828971

Table 4.4 Percentage changes in price and quantity distortions of Japanese meat imports, 1969-1987.

Year	% change in h_{pk}	% change in h_{ch}	% change in Q_{AUS}	% change in Q_{NZ}	% change in Q_{US}
1968					
1969	0.089	-0.060	0.334	0.254	-
1970	-0.212	0.000	0.252	-0.227	0.732
1971	0.079	0.103	0.456	0.373	0.286
1972	0.055	-0.106	0.299	-0.035	0.151
1973	0.075	0.119	0.509	0.591	0.937
1974	0.118	0.135	-1.533	-2.231	-0.235
1975	0.248	0.091	-0.141	0.166	-1.175
1976	0.005	0.034	0.513	0.213	0.685
1977	-0.020	-0.011	-0.061	-0.157	-0.551
1978	-0.059	-0.171	0.075	0.502	0.430
1979	-0.124	-0.076	0.228	-1.258	0.458
1980	0.019	0.074	-0.081	0.125	-0.049
1981	0.094	0.077	-0.069	0.361	0.152
1982	-0.055	-0.062	-0.011	-0.687	0.162
1983	0.011	-0.034	0.054	0.529	0.163
1984	-0.023	-0.017	0.010	-0.020	0.107
1985	-0.211	-0.098	0.012	-0.089	0.092
1986	-0.051	-0.065	0.116	-0.152	0.266
1987	-0.076	-0.198	0.132	0.232	0.257

in 1973 and their abrupt reduction in the next year. Indeed from Table 4.4 it can be seen that in 1973 Australian beef imports increased by 51%, New Zealand beef imports by 59%, and U.S. beef imports by 94% while in 1974 Australian imports plunged by 153%, New Zealand beef imports by 223% and U.S. beef imports by 23.5%. At the same time, pork and poultry prices rose by 7.5% and 12% respectively in 1973 and 12%, 13.5% in 1974. The severe variations in the beef quotas are due to the policies of the Japanese government which suspended the beef quota in late 1973 and completely closed the Japanese market to beef imports in 1974.

From the second half of the 1970s to the end of the examined period (1987), the index shows negative rates of change in the years 1976, 1981, 1983, and 1985 suggesting that in periods t = 1976, 1981, 1983, 1985 there was increased restrictiveness relative to the respective (t-1) periods. For the rest of this sub-period the index shows in general, low positive rates, suggesting slight liberalization on a year-to-year basis. Additionally, one may observe that during the 1980s the increasing U.S. beef quota is the main contributor of the index, among the three beef quotas. A graphical representation of the rates of change of the meat-TRI is given in Figure 4.1. It may be noted that this graph can also be interpreted as showing the level of the meat-TRI on a year-to-year basis--that is, the level of the index between any t and (t-1) periods.

Furthermore, the meat-TRI was adjusted in 1969 to account for the introduction of U.S. grain-fed beef. As demonstrated in Chapter 3, the adjustment term equals the ratio of the production value (evaluated at domestic prices, net of levies or tariff rates) of the tariff-ridden goods over the shadow value of trade distortion, times a factor

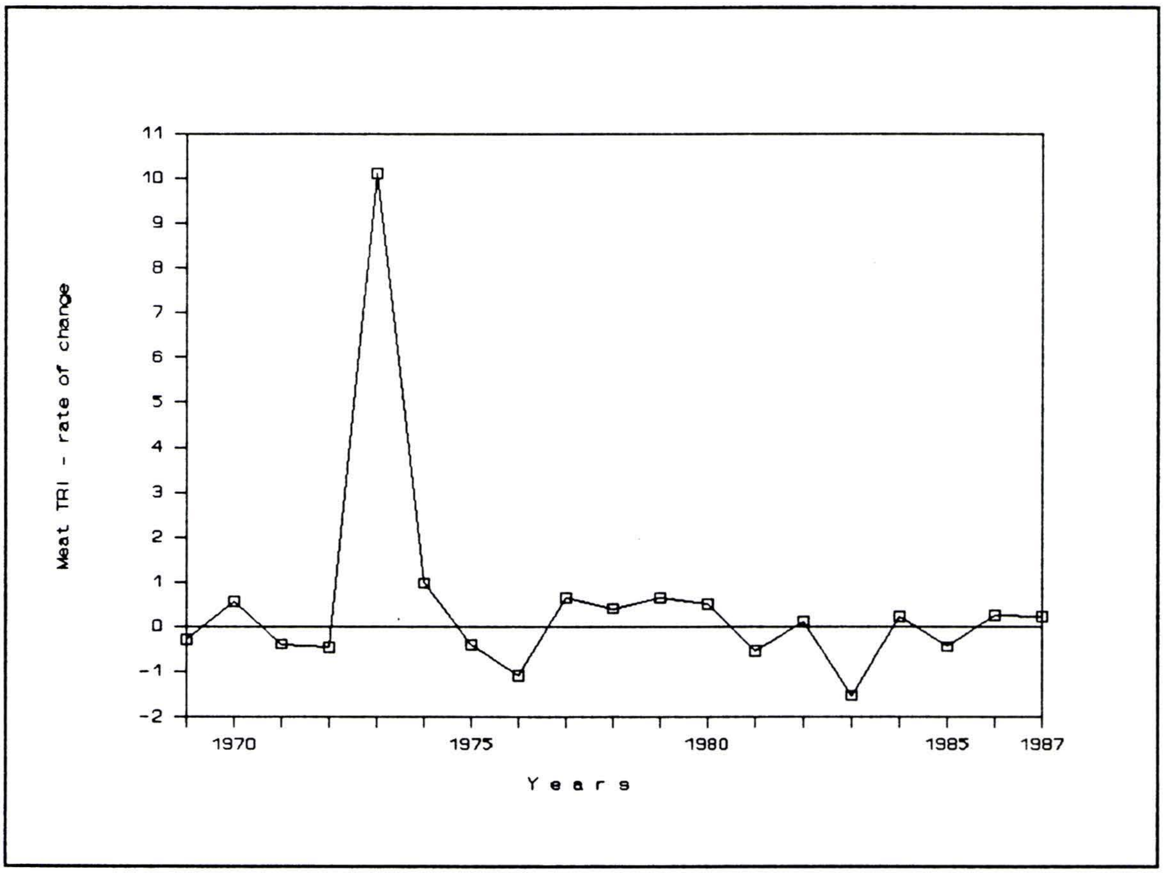

Figure 4.1 The rate of change of the TRI of Japanese meat imports, 1969-87.

involving the expenditure share of the 'new' good(s) relative to the expenditure of all goods in the index. The result of this adjustment is reported in the fifth column of Table 4.3. Given a positive shadow value of distorted trade, the adjustment reduced the negative rate of change of the standard meat-TRI by 70% implying a larger size meat index and therefore lower trade restrictiveness for meat imports in 1969.

Figure 4.2 plots the levels of the standard and the adjusted meat-TRI computed according to the chain-principle, against time. It may be recalled that when the level of the TRI is computed via the chain-principle, one compares the magnitude of the index in all subsequent periods with that of the initial period (here 1968) assuming that initially the index equals one.

Up to 1972, the level of the index is generally decreasing indicating rising protection. Then in 1973 and 1974 the index level is steeply raised implying a dramatic relaxation of trade protection. Nonetheless, the level of the index plummets from 1974 to 1980, assuming even negative values after 1976. In 1980, the index is at its lowest level relative to the initial (base) period. After 1980 however, the index level starts increasing as one moves towards the end of the period under examination. Yet, in 1987 the size of the index is 35.5% smaller than the size of the index in 1968.

One may conclude that, using the early 1970s as reference point, there has been increasing restrictiveness in Japan's meat sub-sector throughout the 1980s. Although this restrictiveness is somewhat counterbalanced after 1980, the degree of combined trade restrictiveness of meat imports, at the end of the period is still higher relative to that of the base period.

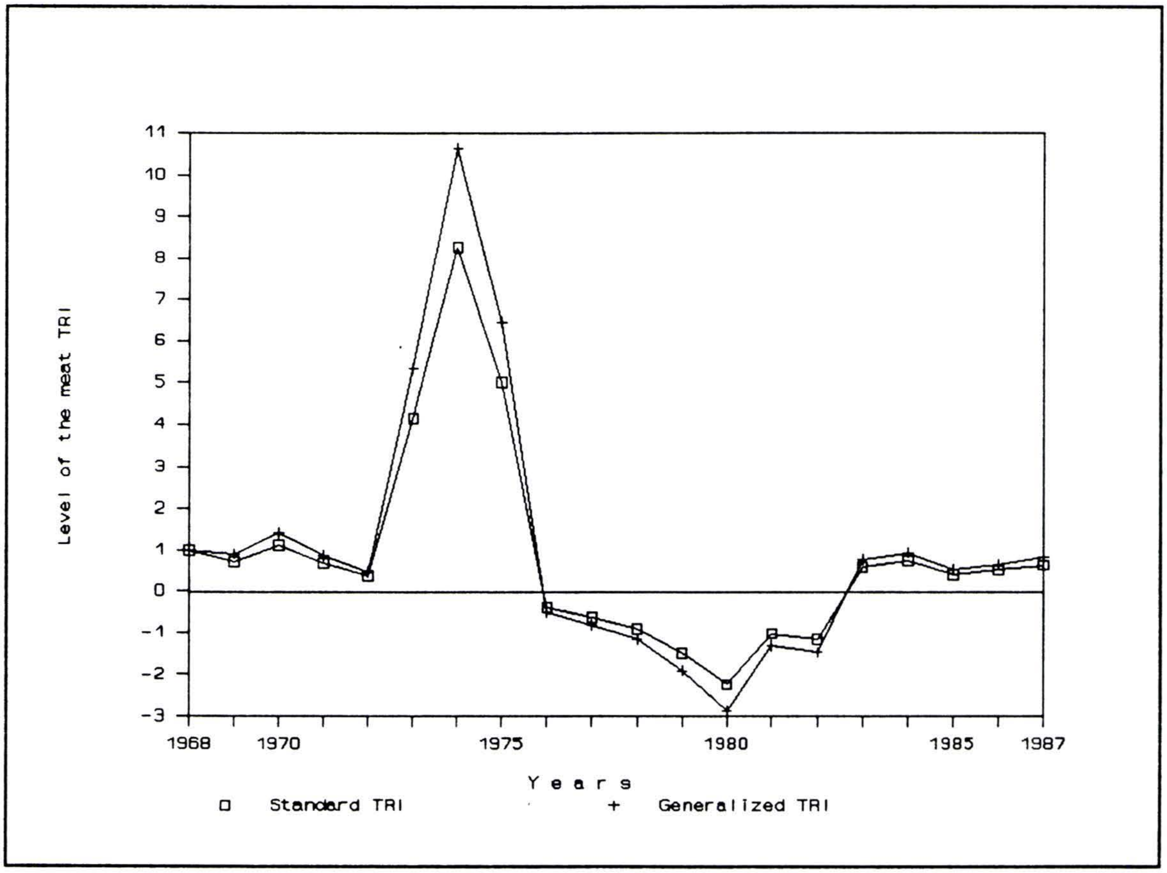

Figure 4.2 The level of the standard and the generalized TRI of Japanese meat imports (1968=1), 1968-87.

Moreover, the level of the generalized value-index, computed according to the chain-principle, is 28.7% higher than the level of the standard meat-index throughout the period 1969-87, due to the new-goods adjustment in 1969. As a result, the standard TRI suggests that relative to the initial period, the index level in 1987 is smaller by 35.5% while the generalized TRI suggests that the same level is smaller by 17.1%. In other words, although both the standard and the generalized TRI imply higher restrictiveness in the end relative to the initial period, the latter suggests that the magnitude of this restrictiveness is smaller than that suggested by the standard index.

It should be stressed nonetheless, that the new traded goods-adjustment does not alter the main conclusions on the pattern of trade protection over time provided by the standard TRI. This is because the introduction of a newly traded good occurred only once, in the beginning of the period under examination, resulting in a uniform adjustment in the size of the standard index throughout the examined period. Nevertheless, such an adjustment may be seen as a suggestive remark on how the magnitude of the standard index can change. The size and the importance of such a change would depend on whether the introduction of new goods occurs more than once, in the middle or in the beginning of the examined period, and the relative expenditure value of the newly traded good(s). Finally, the direction of such a change would depend on the algebraic sign of the total shadow value of distorted trade (as measured by the term $(B'_Q Q - B'_\pi \pi)$) at the period wherein the new goods-adjustment takes place.

CHAPTER 5
SUMMARY AND CONCLUSIONS

This study is an attempt to re-evaluate existing measures of trade protection and empirically investigate new ones, in search of measures that satisfactorily aggregate diverse types of trade distortions and provide a valid estimation of the magnitude of trade restrictiveness across countries and over time. A review of the existing literature on the measurement of trade protection shows that the major protection measures can be classified into four groups: (a) the Average Tariff, (b) the Nominal and Effective Rate of Protection, and the Domestic Resource Cost (DRC), (c) the Producer/Consumer Subsidy Equivalent (PSE/CSE), and (d) the Trade Restrictiveness Index (TRI).

Investigating the existing measures of protection reveals that they are not directly comparable; they differ in their definitions, and the sets of policies they cover may include indiscriminately, support policies with weak impact on trade. Additionally, nonprice distortions are either left out of the analysis or only implicitly taken into account (e.g. via shadow evaluation). Focusing on the theoretical robustness of the available protection measures and their ability to cover diverse sets of distorting policies shows that the TRI has some clear advantages over the rest of the measures. These include the robust theoretical derivation of the TRI which enhances the validity of the index, the fact that the index aggregates consistently the level of restrictiveness across a set of commodities, and most importantly, the fact that it explicitly incorporates both price and nonprice distortions thus allowing the modelling of a wide array of trade policies.

Further, this study investigates the TRI empirically, by implementing the index in Japan's agricultural sector. Japan is chosen as the typical example of a country that protects the domestic agricultural sector predominantly by tight border measures along with support programs within the farm sector itself. Although the coverage of trade policies and administrative programs is not comprehensive, this study examines a subset of agricultural policies which comprises the most well known trade restrictions in Japan's agricultural trade.

In particular, the level of trade protection is measured, *ceteris paribus*, by means of the TRI for the following farm products: (1) beef, (2) pork, (3) poultry, (4) wheat, (5) rice, and (6) fresh oranges. By estimating a set of price elasticities of imports and utilizing information on imported quantities, domestic, and international prices, the combined TRI of the aforementioned products is calculated for the period 1971-87. The computed index indicates a dramatic rise in trade protection in the early 1970s, followed by a slow process of easing price and quantity restrictions so that a slight trade liberalization trend appears towards the end of the examined period. It is worth noting that these conclusions are in contrast with more conventional ad hoc measures of protection. Specifically, a comparison of the TRI approach with some weighted averages of Japan's PSEs/CSEs computed by the USDA over the period 1982-87 shows that while the PSE/CSE approach implies diminish distortions only in two years (1984-85), the TRI approach suggests diminishing overall distortion throughout the 1982-87 period.

Moreover, this study attempts a generalization of the standard TRI by deriving the index in the presence of different sets of traded goods over time. Under the maintained assumption of a C.E.S. welfare function, it is shown that when newly traded goods are introduced over time, the standard TRI is adjusted by a factor that depends on the relative expenditure value of the new goods, and the elasticity of substitution associated with the underlying C.E.S. welfare function.

This generalized version of the TRI is then empirically evaluated by calculating a partial TRI pertaining to Japanese meat imports (beef, pork, and poultry) for the period 1969-87. Beef imports in the meat-TRI are considered to be differentiated products distinguished by origin (supplier country). Thus the meat-TRI comprises five types of meat (Australian beef, New Zealand beef, U.S. beef, pork, and poultry). Prior to 1970s U.S. beef imports to Japan were essentially zero. In contrast, U.S. beef imports rose considerably in the 1980s. Thus the calculation of the meat-TRI starts in the absence of U.S. beef imports (1968-69) and the index is adjusted in 1970 for the introduction of a newly traded beef variety (U.S. grain-fed beef).

For the computation of the meat-TRI, the utility associated with these five types of meat is assumed to have a C.E.S. functional form with elasticity of substitution greater than unity. This elasticity of substitution is empirically estimated via an instrumental variables technique suggested by Feenstra (1990). Estimation of the elasticity of substitution makes computable not only the adjustment factor of the generalized TRI but also the demand price elasticities of the goods involved.

The calculated index of Japanese meat imports shows considerable variation in the early 1970s (specifically, in 1973-74) but relatively low variation afterwards. The index suggests that the overall trade restrictiveness of Japanese meat imports increased throughout the 1970s and early 1980s followed by a slight trend of trade liberalization towards the end-period (1987). Furthermore, the adjustment of the standard TRI to account for the introduction of U.S. beef imports in the 1970s yields a 28.7% rise in the magnitude of the standard index throughout the examined period. Hence the main conclusions of analyzing the trend of combined protection on meat imports are not altered--except, of course, for the actual size of the index when computed relative to the initial period. This is because the adjustment of the index takes place only once in the beginning of the examined period.

More importantly, the empirical exercise of computing the standard and generalized meat-TRI yields some interesting findings about the performance of the index. Specifically, in the case of the meat-TRI, the computed import price elasticities of meat imports suggest high substitutability of all other meat types with respect to pork. This high degree of substitution implies that changes in the price of pork are welfare-improving rather than welfare-reducing (due to large cross-commodity effects). This means that in computing the (minus) total welfare cost i.e. the term $(B'_Q Q - B'_\pi \pi)$ welfare gains may cancel welfare losses, so that this term assumes a positive rather than a negative value. This is indeed the case with Japanese meat imports where pork welfare gains dominate over welfare losses in most of the examined years.

Such cases alter the performance of the TRI as follows: changes in the components of the index do not necessarily change according the changes in the policy instruments (domestic prices, quota levels). This is not true for 'normal' cases where all distortions cause welfare losses. It can be verified that in the case of the combined TRI in Chapter 3, the components of the index change in accordance with the changes in the policy instruments.

Thus, it must be stressed that for trade regimes involving both tariff and quotas, one should interpret the TRI more carefully. If changes in trade distortions result in both gains and losses, the index may register not only the restrictiveness due to changes in trade policies but also *implicit* restrictiveness arising from cross-commodity effects.

A corollary of this analysis is that the adjustment factor in the generalized TRI may raise or reduce the standard index depending on whether the shadow value of distorted trade ($B'_Q Q - B'_\pi \pi$) is positive or negative. In other words, the size of the standard TRI is increased or decreased, depending on whether the distortions in place are welfare-improving or welfare-reducing, respectively.

Concerning the calculations of tariffs and quota rents used in the computation of the TRI it is often argued that the use of Purchasing Power Parity (PPP) rates are preferable than the use of official exchange rates in converting world prices expressed in foreign currency to domestic currency. A recalculation of the combined TRI of Chapter 3 using PPPs changed only the actual values of the index in every period but left the pattern of change of the index unaffected. Thus the major conclusions drawn from this index remain robust to PPP conversions of the respective international prices. In the case of the meat-TRI however, the use of PPPs altered the pattern of the index. This is because the shadow values of distorted trade turned to be positive (or negative) in different periods when PPP conversions were used. As result, not only the value but also the pattern of change of the meat-index in the various years changed, too.

Summarizing, this study concludes that the TRI approach offers a particularly appealing tool in the empirical research to evaluate trade barriers across countries and over time. Nonetheless, it must be noted that the comprehensiveness of the TRI in the empirical context depends critically on the statistical information available on a country or period of time. Utilization of the flexibility of the index in modeling price restrictions, quantitative constraints, non-traded goods policies, and factor market distortions requires detailed data sets on protection policies that go well beyond the trade data on quantities and values, usually available. Information availability is also vital for the aggregation level of the TRI. Although the index consistently aggregates trade policy distortions across commodities, inclusion of all policies that significantly affect imports(exports) may not be feasible due to the lack of statistical information. Hence surveys on the protection policies pursued by various countries accompanied by detailed statistical information are critical in empirical implementations of overall trade restrictiveness.

Suggestions for Further Research

Future empirical work utilizing the TRI approach may focus on an indepth analysis of protection across countries provided that comprehensive data are available to the researcher. This may provide consistent aggregate measures of trade protection, that are free from the inadequacies inherent on commodity-based measures, and may allow useful inferences on how the level of trade restrictiveness develops across a set of countries, over time. On theoretical grounds, the TRI may be further refined to take into account the effect of exchange rate fluctuations on the international prices used in the computation of the index. In addition, research on how to incorporate empirically into the TRI, changes of international prices (thus eliminating the small-country framework) will improve the comprehensiveness of the TRI. Lastly, research on approximating the price elasticities of the TRI with nonparametric estimates will largely enhance the appeal of the index.

Turning to the calculation of the TRI in the presence of different sets of traded goods over time, future empirical work could produce particularly interesting results if there is recurrent introduction of high value, newly traded goods over the period under investigation. Finally, operationalizing this generalized TRI while relaxing the maintained assumption of a C.E.S. underlying aggregator function is definitely a desirable task.

APPENDIX A
PROOF OF THE PROPOSITION

Given a linearly homogeneous C.E.S. utility function, the minimization problem of consumer expenditure is stated as

$$Min_{(x_i)} \sum_{i=1}^{N} p_i x_i \qquad s.t. \qquad \bar{u} = u(x;M) \tag{A.1}$$

The first-order condition for the ith good is

$$p_i - \mu\left[\sum_{i=1}^{M} a_i x_i\right]^{\frac{1-\theta}{\theta}} a_i x_i^{\theta-1} = 0 \quad \Rightarrow \quad p_i x_i = \mu\left[\sum_{i=1}^{M} a_i x_i\right]^{\frac{1-\theta}{\theta}} a_i x_i^{\theta} \tag{A.2}$$

where μ represents the Lagrangian multiplier of the expenditure minimization problem (A.1).

In principle, the utility function u(x; M) includes all possible goods which may become available to the consumer. Suppose that the range M of all possible goods is split into two sets

$$M = M^0 + M^1 \tag{A.3}$$

Let only M^0 goods be available to the consumers; then summing (A.2) over M^0 yields

$$\sum_{i=1}^{M^0} p_i x_i = \mu \left[\sum_{i=1}^{M} a_i x_i^\theta \right]^{\frac{1-\theta}{\theta}} \left[\sum_{i=1}^{M^0} a_i x_i^\theta \right] \tag{A.4}$$

Suppose now that M^1 goods become also available to the consumers. Then, summing (A.2) over M^1 yields

$$\sum_{i=1}^{M^1} p_i x_i = \mu \left[\sum_{i=1}^{M} a_i x_i^\theta \right]^{\frac{1-\theta}{\theta}} \left[\sum_{i=1}^{M^1} a_i x_i^\theta \right] \tag{A.5}$$

Dividing equation (A.4) into (A.5), and raising to the power $(1/\theta)$ gives

$$\left[\frac{\sum_{i=1}^{M^1} p_i x_i}{\sum_{i=1}^{M^0} p_i x_i} \right]^{\frac{1}{\theta}} = \left[\frac{\sum_{i=1}^{M^1} a_i x_i^\theta}{\sum_{i=1}^{M^0} a_i x_i^\theta} \right]^{\frac{1}{\theta}} \tag{A.6}$$

or

$$\left[\frac{\sum_{i=1}^{M^1} p_i x_i}{\sum_{i=1}^{M^0} p_i x_i} \right]^{\frac{1}{\theta}} \equiv \rho = \frac{u(x;M^1)}{u(x;M^0)} \qquad Q.E.D.$$

APPENDIX B
STOCHASTIC SPECIFICATION OF A C.E.S. AGGREGATOR FUNCTION

Following Feenstra (1990), suppose that in general, the set $U=\{1,\ldots,N\}$ of goods may be available to the aggregate consumer. Let the total number of adjacent time-periods (i.e. t and t-1) be denoted by the set $H=\{2,\ldots,T\}$. The number of adjacent time-periods for good i is then denoted by $H_i \subset \{2,\ldots,T\}$ and T_i denotes the number of elements in H_i i.e. the number of adjacent periods for which the ith good is available. Furthermore consider a utility function for the aggregate consumer which has a C.E.S. functional form:

$$u(x_t, G_t, a) = \left(\sum_{i \in S_t} a_i x_i^{\theta}\right)^{\frac{1}{\theta}} \qquad a_i > 0, \qquad 0 < \theta < 1 \tag{B.1}$$

where u denotes aggregate utility or welfare, x_{it} denotes the demanded quantity of the ith good in period t, $G_t \subset \{1,\ldots,N\}$ denotes the set of goods available to the aggregate consumer in the same period, and a_i $i=1,\ldots,N$ are taste parameters.

It is convenient to rewrite the utility function as:

$$u(x_t, G_t, b) = \left(\sum_{i \in S_t} (b_{it} x_{it})^{\theta}\right)^{\frac{1}{\theta}}, \qquad b_{it} = a_i^{\frac{1}{\theta}} \tag{B.2}$$

Then it can be shown (e.g. Varian, 1984) that the corresponding expenditure function is given by:

$$E(p, G_t, u_t) = u_t \cdot \left(\sum_{i \in S_t} \left(\frac{p_{it}}{b_{it}} \right)^{-\frac{1}{\beta}} \right)^{-\beta}, \qquad \beta = \frac{1-\theta}{\theta} \tag{B.3}$$

where $p = \{p_1, \ldots p_N\}$ denotes a vector of prices; β is linked to the elasticity of substitution σ as $\beta = 1/(\sigma - 1)$. The unit-expenditure function of the ith good is given by:

$$e_t(p, S_t, u_t) = \left(\sum_{i \in S_t} \left(\frac{p_{it}}{b_{it}} \right)^{-\frac{1}{\beta}} \right)^{-\beta} \tag{B.4}$$

Differentiating and simplifying gives

$$\frac{\partial e_t}{\partial p_t} \cdot \frac{p_t}{e_t} = \left(e_t \cdot \left(\frac{b_{it}}{p_{it}} \right) \right)^{\frac{1}{\beta}} \tag{B.5}$$

or

$$s_{it}^{\beta} = e_t \cdot \frac{b_{it}}{p_{it}} \tag{B.6}$$

where s_{it} is the expenditure share, owing to the envelope theorem properties of the expenditure function.

Logarithmizing through, this expression is written in periods t and t-1 as

$$\beta \ln s_{it} = \ln e_t + \ln b_{it} - \ln p_{it} \tag{B.7}$$

$$\beta \ln s_{it-1} = \ln e_{t-1} + \ln b_{it-1} - \ln p_{it-1} \tag{B.8}$$

Letting Δ denote first-differences, one may write

$$\beta \Delta \ln p_{it} = d_t - \beta \Delta \ln s_{it} + \epsilon_{it} \tag{B.9}$$

where $d_t=(e_{it}/e_{it-1})$ denotes the ratio of unit-expenditure for the ith good in t and t-1 while $\epsilon_{it}=(\ln b_{it}-\ln b_{it-1})$ denotes the random change in the taste parameters b in t and t-1. Expression (B.9) will serve as a reduced form of the demand function for the ith good.

At the supply side, the supply curve for the ith good can be written in first differences as

$$\Delta \ln p_{it} = \eta \Delta \ln x_{it} + v_{it} \tag{B.10}$$

where η denotes the inverse supply elasticity and v_{it} is a random error. The quantity term x_{it} in (B.10) can be replaced by the expenditure share s_{it} as follows: Shephard's lemma yields

$$x_{it} = u_t \frac{\partial e_t}{\partial p_{it}} \tag{B.11}$$

Substituting (B.5) into (B.11), the expenditure-minimizing quantity x_{it} is written as

$$\ln x_{it} = \ln(e_t u_t^{\sigma}) + \frac{1}{\beta} \ln b_{it} - \sigma \ln p_{it} \tag{B.12}$$

and in first-differences the same expression is written as

$$\Delta \ln x_{it} = \Delta \ln(u_t e_t^{\sigma}) - \sigma \Delta \ln p_{it} + \frac{1}{\beta} \epsilon_{it} \tag{B.13}$$

recalling that $1/\beta=(\sigma-1)$. Thereafter (B.10) and (B.12) can be used to solve for the price and obtain

$$\Delta lnp_{it} = \kappa_t + \lambda \epsilon_{it} + \chi_{it} \tag{B.14}$$

where

$$\chi_{it} = \frac{v_{it}}{(1+\eta\,\sigma)}, \quad \kappa_t = \frac{\eta}{(1+\eta\,\sigma)} \Delta\ln(u_t e_t^{\sigma}), \quad \lambda = \frac{\eta\,(\sigma-1)}{(1+\eta\,\sigma)} \tag{B.15}$$

Equation (B.14) will serve as a reduced form for the supply function of the ith good. An interesting point about this equation is the coefficient λ. This coefficient accounts for the effect that a change in variable ϵ_{it} has on the supply price. Given that the variable ϵ_{it} is defined as the change in the taste parameters b_{it}, a positive value of ϵ_{it} implies an outward shift in the demand for good i when $\sigma > 1$. If $\lambda = 0$, this means that outward shifts in demand leave the supply price unaffected; in other words the supply curve is horizontal.

Thus far a stochastic demand and supply model has been generated consisting of equations (B.9) and (B.14). The estimator set in this model may be viewed as an application of the generalized method of moments (GMM) estimators developed by Hansen (1982). Thus ϵ_{it} and v_{it} are assumed to satisfy the following properties:

(i) ϵ_{it} and v_{it} are heteroskedastic and have zero means,

(ii) ϵ_{it} and v_{it} are stationary with asymptotic variances

$$\underset{H_i \to \infty}{plim} \frac{1}{H_i} \sum_{t \in H_i} \epsilon_{it}^2 = \sigma_{\epsilon i}^2 \qquad \underset{H_i \to \infty}{plim} \frac{1}{H_i} \sum_{t \in H_i} v_{it}^2 = \sigma_{vi}^2 \tag{B.16}$$

respectively, and

(iii) v_{it} is independent of ϵ_{jk} for all $t \in H_i$, $k \in H_j$ with

$$\underset{T\to\infty}{plim}\ \frac{1}{T}\sum_{t\in H_i\cap H_j} v_{it}\epsilon_{jk}=0 \tag{B.17}$$

This assumption implies that the error terms in the demand and supply equations are independent for all products i and j so that the model's parameters are identified.

A final simplifying step in the specification of the model is the elimination of the terms d_t and κ_t from (B.9) and (B.14), respectively. In particular, suppose that some good k is available to the aggregate consumer in all time periods T. Subtracting the demand (supply) equations for the kth good from the demand (supply) equations of all other goods $i \neq k$ yields

$$\overline{\epsilon}_{it} = (\Delta lnp_{it} - \Delta lnp_{kt}) + \beta(\Delta lns_{it} - \Delta lns_{kt}) \tag{B.18}$$

$$\overline{v}_{it} = (\Delta lnp_{it} - \Delta lnp_{kt}) - \lambda\overline{\epsilon}_{it} \Rightarrow \tag{B.19}$$

$$\overline{v}_{it} = (1-\lambda)(\Delta lnp_{it} - \Delta lnp_{kt}) - \lambda\beta(\Delta lns_{it} - \Delta lns_{kt}) \tag{B.20}$$

Multiplying these two equations and then dividing by (1-λ) yields

$$Y_{it} = \gamma_1 X_{1(it)} + \gamma_2 X_{2(it)} + \omega_{it} \tag{B.21}$$

where

$$\omega_{it} = \frac{\overline{\epsilon}_{it}\overline{v}_{it}}{(1-\lambda)} \tag{B.22}$$

$$Y_{it} = (\Delta lnp_{it} - \Delta lnp_{kt})^2 \tag{B.23}$$

$$X_{1(it)} = (\Delta lns_{it} - \Delta lns_{kt})^2 \tag{B.24}$$

$$X_{2(it)} = (\Delta lnp_{it} - \Delta lnp_{kt})(\Delta lns_{it} - \Delta lns_{kt}) \tag{B.25}$$

$$\gamma_1 = \frac{\lambda\beta^2}{(1-\lambda)}, \qquad \gamma_2 = \frac{\beta(2\lambda-1)}{(1-\lambda)} \tag{B.26}$$

Equation (B.21) holds for all goods $i \neq k$ and for all periods these goods are available i.e. $t \in H_i$. Thus an estimable equation system is formed by writing out (B.21) for all the adjacent periods T_i wherein the good i is available and then by stacking these equations for all goods $i \neq k$. This results in a system

$$Y = X\gamma + \omega \tag{B.27}$$

with total number of observations $M = \sum_{i \neq k} T_i$. Y is a Mx1 vector with elements Y_{it} ordered as: $Y_1 \; \forall \; t \in H_1$, $Y_2 \; \forall \; t \in H_2$ and so forth. X is a Mx2 matrix with rows $(X_{1(it)}, X_{2(it)})$ ordered in the same fashion, ω is a Mx1 vector with elements ω_{it}, and Γ is the 2x1 vector (γ_1, γ_2).

It may be readily observed however that the disturbance term ω_{it} is correlated with both the regressors $X_{1(it)}$ and $X_{2(it)}$ (equations (B.9), (B.14) and (B.22)). To cope with this, a matrix of instrumental variables must be introduced. Feenstra (1990) uses a Mx(N-1) matrix of the following form:

$$Z = \begin{pmatrix} I_1 & 0 & \dots & 0 \\ 0 & I_2 & \dots & 0 \\ \cdot & \cdot & \dots & \cdot \\ 0 & 0 & \dots & I_N \end{pmatrix} \tag{B.28}$$

where I_1 is a T_1x1 vector of ones, I_2 is a T_2x1 vector of ones etc. for each good $i \neq k$. Thereafter the parameter vector (γ_1,γ_2) can be estimated by using the standard instrumental variables (IV) estimator[20]

$$\begin{pmatrix} \gamma_1 \\ \gamma_2 \end{pmatrix} = (X'P_zX)^{-1}X'P_zY, \qquad P_z = Z(Z'Z)^{-1}Z' \tag{B.29}$$

The IV estimator however is not the most efficient one. Feenstra (1990) demonstrates that the rank condition for (γ_1,γ_2) to be identified results in heteroskedasticity in the error term ω_{it}. The efficient estimator Γ^* is obtained (White, 1982) as

$$\gamma^* = (\hat{X}'\hat{W}^{-1}\hat{X})^{-1}\hat{X}'\hat{W}^{-1}Y, \qquad \hat{X} = Z(Z'Z)^{-1}Z'X \tag{B.30}$$

where $\hat{W}$ is a MxM diagonal matrix with elements $\hat{w}_i^2$ *repeated T_i times on the diagonal* for $i=1,\dots,N$, $i \neq k$ and

---

[20] The variances of the IV estimators corrected for heteroscedasticity are computed as

$$(\hat{X}'\hat{X})^{-1}\hat{X}'\hat{W}\hat{X}(\hat{X}'\hat{X})^{-1}$$

where the diagonal matrix W is shown in (B.30).

$$\hat{W}_i^2 = \frac{\sum_{t \in H_i} \hat{\omega}_{it}^2}{T_i}, \qquad \hat{\omega}_{it} = Y_{it} - \hat{\gamma}_1 X_{1(it)} - \hat{\gamma}_2 X_{2(it)} \tag{B.31}$$

i.e. the computed residuals using the initial estimates γ. Moreover the covariance matrix of the efficient estimator γ^* is estimated as

$$\hat{\sigma}_{\gamma^*} = (\hat{X}'\hat{W}^{-1}\hat{X})^{-1} \tag{B.32}$$

Having obtained efficient estimates of (γ_1,γ_2) one can use equations (B.26) to solve for λ and β. At this point it must be stressed that a prerequisite for obtaining meaningful estimates of λ and β is that the estimated[21] $\gamma_1 \rangle 0$. Then estimates for λ and β are obtained as follows:

$$\hat{\gamma}_2 \gtrless 0 \rightarrow \hat{\lambda} = \frac{1}{2} \pm \left(\frac{1}{4} - \frac{1}{4 + (\hat{\gamma}_2^2/\hat{\gamma}_1)}\right)^{\frac{1}{2}} \tag{B.33}$$

$$\beta = \left(\frac{1 - \hat{\lambda}}{2\hat{\lambda} - 1}\right)\hat{\gamma}_2 > 0 \tag{B.34}$$

Moreover, the variances of β and λ can be computed by taking first order approximations around the expressions (B.33), and (B.34). In particular, it is shown (Feenstra, 1990, Appendix) that

[21] If the estimated $\gamma_1 \langle 0$ then the estimated λ and β are not in the ranges $\beta \rangle 0$ and $0 \langle \lambda \langle 1$ as expected. In such a case one should conclude that the data do not support the hypothesis of a C.E.S aggregator function with $\sigma \rangle 1$.

$$Var\hat{\lambda} = \frac{1}{4}\left(\frac{1}{4} - \frac{1}{4+\left(\frac{\hat{\gamma}_2{}^2}{\hat{\gamma}_1}\right)}\right)^{-1}\left(\frac{1}{4+\left(\frac{\hat{\gamma}_2^2}{\hat{\gamma}_1}\right)}\right)^4 \cdot$$

$$\left(\left(\frac{\hat{\gamma}_2}{\hat{\gamma}_1}\right)^4 var\hat{\gamma}_1 + 4\left(\frac{\hat{\gamma}_2}{\hat{\gamma}_1}\right)^2 var\hat{\gamma}_2 - 4\left(\frac{\hat{\gamma}_2}{\hat{\gamma}_1}\right)^3 cov(\hat{\gamma}_1, \hat{\gamma}_2)\right) \tag{B.35}$$

and

$$var\boldsymbol{\beta} = \left(\frac{1-\hat{\lambda}}{2\hat{\lambda}-1}\right)^2 var\hat{\gamma}_2 + \left(\frac{\hat{\gamma}_2^2}{(2\hat{\lambda}-1)^4}\right) var\hat{\lambda} -$$

$$-\left(\frac{2\hat{\gamma}_2(1-\lambda)}{(2\lambda-1)^3}\right) cov(\hat{\lambda}, \hat{\gamma}_2) \tag{B.36}$$

where

$$\hat{\gamma}_2 \gtrless 0 \quad \rightarrow \quad cov(\hat{\lambda}, \hat{\gamma}_2) = \pm\frac{1}{2}\left(\frac{1}{4} - \frac{1}{4+\left(\frac{\hat{\gamma}_2^2}{\hat{\gamma}_1}\right)}\right)^{-\frac{1}{2}} \cdot \left(\frac{1}{4+\left(\frac{\hat{\gamma}_2^2}{\hat{\gamma}_1}\right)}\right)^2 \cdot$$

$$\left(2\left(\frac{\hat{\gamma}_2}{\hat{\gamma}_1}\right) var\hat{\gamma}_2 - \left(\frac{\hat{\gamma}_2}{\hat{\gamma}_1}\right)^2 cov(\hat{\gamma}_1, \hat{\gamma}_2)\right) \tag{B.37}$$

APPENDIX C
DESCRIPTION OF THE DATA AND THEIR LIMITATIONS

Price and quantity data on each of the six goods considered here are reported in Tables C.1 through C.8 in this Appendix and are discussed below. The relevant data series are compiled from three sources: USDA(1983) for the 1970-78 period, OECD(1987) for the 1979-81 period and USDA(1990) for the 1982-87 period. When possible, price definitions, conversion factors etc. used in these studies were also used here.

Starting with beef, the respective international price is calculated as the ratio of total import value to total import quantity (import unit value). Then the quota rent is given as the difference between the domestic wholesale price and the import unit value. Finally, the reported quantities of total beef imports are used as the respective quota levels in each period.

In the case of pork imports, the unit import value is not an adequate international price as importers tend to import high quality and better cuts of pork in order to higher tariff rates (OECD, 1987). Consequently, using the actual unit import value may result in underestimation of the respective tariff rates. Alternatively, a possible international price for pork can be computed as the U.S. wholesale pork price adjusted for transportation costs.

Following the procedure used by the OECD(1987) an international price for pork can be calculated as follows. First, the U.S. wholesale (pork carcass) price is adjusted by a factor of 20% to reflect transportation and insurance costs. In addition, the c.i.f. pork price so obtained is adjusted for technical conversion rates which are not identical in Japan and the U.S. In particular the ratio of carcass weight to live weight is 62% in the U.S.; this ratio is assumed to be 65% in Japan. Hence the (estimated) c.i.f. price for pork is further adjusted by a factor of 95% ((0.62/0.65)=0.95) to reflect the difference in the weight conversion rates. In summary the international pork price h^*_{pk} is calculated by using the formula:

$$h^*_{pk} = \left(\frac{(1.20) \cdot h^{US}_{pk} \cdot (Y/\$)}{0.454} \right) \cdot (0.95) \tag{C.1}$$

where (Y/$) is the respective exchange rate and 1 lb=0.454 kgr.

The calculation of the pork tariff is carried out as follows: when the international pork price is above the domestic price, the tariff rate is calculated as 5% of the international price. For the periods where international pork price is below the domestic price the tariff rate equals the difference between the two prices, as long as this difference is higher than 5% of the international price.

In the case of poultry the international price is assumed to be the domestic wholesale price minus the tariff. Given that a tariff rate t=20% was imposed on poultry imports over the 1970-87 period, the respective tariff can be calculated as

$$\tau_{ch} \equiv h_{ch} - h_{ch}^{*} = h_{ch} - \left(\frac{h_{ch}}{1+t}\right) = h_{ch}\left(\frac{t}{1+t}\right) \qquad (C.2)$$

The international price of wheat is computed as the unit value of total wheat imports (i.e. ratio of total import value to total import quantity). The Japanese government administers two different resale prices for imported and domestically produced wheat. For the relevant TRI calculations, an average resale price is computed by weighing the two administrative resale prices by the volume of domestic production and imports respectively. Then the implicit consumer (user) subsidy is calculated as the difference between the average government resale price and the import unit value of wheat. Similarly, the implicit producer subsidy is calculated as the difference between the government purchase price and the import unit value.

Since no significant rice imports are recorded, the export price of a major rice exporting country is used as an indicator world price. In particular the international price of rice is calculated as the unit value (ratio of total export value to total export quantity) of Thailand's rice exports. The consumer (producer) subsidy is then computed as the difference between the government resale (purchase) price of rice and the international price.

Furthermore, the subsidy paid to rice growers for diversion of paddy fields to other crops is implicitly calculated as the ratio of the total government outlay on riceland diversion and the resulting actual riceland reduction (in thousands of hectares). In addition, Japan Statistical Yearbook reports annually estimates of the return-to-land along with other major production costs for the principal farm production processes. Thus the effect of riceland diversion on the balance of trade function is evaluated by considering the difference between the reported return-to-riceland and the respective diversion subsidy.

Turning to the imports of fresh oranges, the respective international price is again computed as the unit value of total orange imports. However, computation of the quota rent on fresh oranges requires some average wholesale price of imported oranges which was not available. In the absence of a better alternative, the quota rent of orange imports is computed as the difference between the landed price (import unit value + tariff) and the import unit value of total imports assuming a 40% tariff on orange imports. To the extent of course, that the wholesale price is higher than this estimated landed price, this implies an underestimation of the quota rent.

Table C.1 Japan: Beef - total beef imports, domestic, and international prices.

	Total imports		Import unit value	Domestic wholesale carcass price	Quota rent
	Quantity	Value			
Year	MT	million Y	Y/kgr	Y/kgr	Y/kgr
1969	18624	5678	304.89	813	508
1970	23227	8025	345.51	843	497
1971	41572	16183	389.27	880	491
1972	57609	24448	424.37	930	506
1973	127224	80103	629.63	1419	789
1974	53603	39349	734.07	1445	711
1975	44923	22371	497.98	1640	1142
1976	94234	50052	531.15	1986	1455
1977	84545	36854	435.92	2007	1571
1978	100863	46562	461.63	1938	1476
1979	131792	90139	683.95	1569	885
1980	123953	100488	810.69	1495	684
1981	123646	89021	719.97	1392	672
1982	122694	98064	799.25	1475	676
1983	137542	106198	772.11	1484	712
1984	145084	108109	745.15	1472	727
1985	150207	111042	739.26	1511	772
1986	177948	93470	525.26	1556	1031
1987	216671	115493	533.04	1546	1013

Sources: USDA (1983), OECD (1987), OECD (1990), LIPC North American Representative Office, Denver Co, (personal communication).

Table C.2 Japan: pork - total imports, domestic and international prices.

	Total imports		U.S. whole sale price	Exchange rate	Estimated world price	Domestic wholesale price	Variable levy
	Quantity	Value					
Year	MT	million Y	cents/ lb	Y/$	Y/kgr	Y/kgr	Y/kgr
1968	10483.7	4132.5	55.30	360	499.9	438	24.99
1969	42651.1	18623.8	62.80	360	567.7	481	28.38
1970	17148.7	7533.5	63.40	360	573.1	397	28.66
1971	27203.9	11219.5	57.00	351	502.4	431	25.12
1972	67932.3	30506.0	71.30	303	542.5	456	27.12
1973	125739.3	63797.7	95.80	272	654.3	493	32.72
1974	41936.0	26837.9	85.50	292	626.9	559	31.34
1975	124512.7	91343.1	115.30	297	859.9	743	42.99
1976	148771.9	124213.9	105.20	297	784.6	747	39.23
1977	108110.0	89848.6	99.00	269	668.7	732	63.00
1978	103516.0	86282.0	107.70	210	567.9	691	123.00
1979	132161.2	111856.4	100.40	219	552.1	615	63.00
1980	108187.6	92168.5	98.00	227	558.6	627	68.00
1981	185747.1	158511.8	106.70	221	592.1	692	100.00
1982	141006.0	135457.7	121.80	249	761.5	656	38.08
1983	165450.8	153033.8	108.90	238	650.8	663	32.54
1984	194464.1	168380.4	110.10	238	658.0	648	32.90
1985	189121.3	165789.2	101.10	239	606.7	535	30.34
1986	206567.8	174826.2	110.90	169	470.6	509	38.00
1987	280003.3	204624.9	113.00	145	411.4	473	62.00

Sources: USDA(1983), OECD(1987), USDA(1990), LIPC North American Representative Office, Denver Co, (personal communication).

Table C.3 Japan: Poultry - total imports, domestic, and international prices.

	Total imports		Domestic wholesale carcass price	Estimated world price	Tariff
	Quantity	Value			
Year	MT	million Y	Y/kgr	Y/kgr	Y/kgr
1968	16204.4	3969.63	248	207	41
1969	20103.3	5390.03	234	195	39
1970	10686.2	2891.29	234	195	39
1971	27161.8	6549.14	261	218	44
1972	29278.2	6899.89	236	197	39
1973	25887.8	7357.64	268	223	45
1974	25349.7	9279.42	310	258	52
1975	21540.2	8026.69	341	284	57
1976	38274.2	14009.22	353	294	59
1977	47585.2	16979.43	349	291	58
1978	61588.7	18451.22	298	248	50
1979	72285.4	24692.92	277	231	46
1980	72172.3	25420.16	299	249	50
1981	101299.1	37371.18	324	270	54
1982	105532.1	40527.59	305	254	51
1983	104401.4	36470.25	295	246	49
1984	107412.4	41625.36	290	242	48
1985	105292.0	36713.59	264	220	44
1986	180110.3	48359.72	248	207	41
1987	203754.8	50934.32	207	173	35

Sources: USDA(1983), OECD(1987), USDA(1990), LIPC North American Representative Office, Denver Co, (personal communication).

Table C.4 Japan: wheat -total imports, domestic, and international prices.

	Total imports		Import unit value	Exchange rate	World price
	Quantity	Value			
Year	1000s MT	$10,000	$/MT	Y/$	Y/kgr
1970	4684.5	31839	68	360	24.468
1971	4871.9	34711	71	351	25.008
1972	5149.3	36151	70	303	21.272
1973	5386.0	65896	122	272	33.278
1974	5376.6	120692	224	292	65.547
1975	5654.2	111709	198	297	58.678
1976	5826.9	105392	181	297	53.719
1977	5675.7	74834	132	269	35.468
1978	5564.1	83743	151	210	31.606
1979	5925.8	109043	184	219	40.299
1980	5682.3	123614	218	227	49.382
1981	5632.6	126976	225	221	49.820
1982	5713.3	111698	196	249	48.681
1983	5816.3	112693	194	238	46.113
1984	5978.3	111402	186	238	44.350
1985	5509.6	99067	180	239	42.974
1986	5619.6	99036	176	169	29.783
1987	5476.2	79347	145	145	21.010

(continued)

Table C.4 - continued.

Year	Government resale price for imported wheat Y/kgr	Government resale price for domestic wheat Y/kgr	Domestic production 1000s MT	Average resale price Y/kgr
1970	34.460	32.330	474	34.264
1971	34.513	32.400	440	34.338
1972	33.900	31.580	284	33.779
1973	37.707	35.610	202	37.631
1974	45.420	43.150	232	45.326
1975	46.553	44.740	241	46.479
1976	58.800	53.630	222	58.610
1977	60.600	54.950	236	60.374
1978	60.600	54.550	367	60.226
1979	60.600	55.590	541	60.181
1980	69.145	60.780	583	68.367
1981	72.450	63.950	587	71.648
1982	73.100	64.400	742	72.100
1983	78.330	69.330	695	77.369
1984	78.217	68.917	741	77.191
1985	78.617	68.917	874	77.289
1986	79.117	68.917	876	77.741
1987	75.310	64.767	864	73.873

(continued)

Table C.4 - continued.

Year	Government purchase price for wheat Y/kgr	User subsidy Y/kgr	Producer subsidy Y/kgr
1970	57.180	10	33
1971	61.120	9	36
1972	63.500	13	42
1973	72.420	4	39
1974	92.730	-20	27
1975	102.150	-12	43
1976	109.600	5	56
1977	158.300	25	123
1978	161.500	29	130
1979	165.400	20	125
1980	178.400	19	129
1981	184.120	22	134
1982	184.120	23	135
1983	184.867	31	139
1984	184.867	33	141
1985	182.717	34	140
1986	173.750	48	144
1987	165.750	53	145

Sources: F.A.O. Trade Yearbook various issues, Japan Statistical Yearbook various issues, USDA (personal communication).

Table C.5 Japan: Rice - Domestic and international prices.

Year	World price (Thailand export unit value) Y/kgr	Government purchase price Y/kgr	Government resale price Y/kgr	Producer subsidy Y/kgr	User subsidy Y/kgr
1970	40.95	137.86	124.03	97	83
1971	30.86	142.03	122.95	111	92
1972	30.59	149.23	130.77	119	100
1973	56.49	171.68	130.10	115	74
1974	135.18	227.08	170.93	92	36
1975	91.92	259.50	203.42	168	112
1976	64.83	276.20	224.18	211	159
1977	60.39	287.20	246.18	227	186
1978	66.70	287.52	246.18	221	179
1979	59.79	287.98	256.52	228	197
1980	77.32	294.57	264.85	217	188
1981	85.22	295.93	273.18	211	188
1982	64.42	299.18	283.88	235	219
1983	60.00	304.43	283.88	244	224
1984	56.73	311.13	294.55	254	238
1985	48.82	311.13	305.45	262	257
1986	28.87	311.13	309.97	282	281
1987	28.79	292.61	309.97	264	281

Sources: F.A.O. Trade Yearbook various issues, Australian bureau of Agr. and Res. Econ. (1988).

Table C.6 Japan: rice - riceland rents and diversion subsidies.

Year	Government outlay on riceland diversion billion Y	Actual land reduction 1000s ha	Average diversion subsidy Y/ha
1970	81.8	351	233048
1971	184.0	541	340111
1972	202.9	566	358481
1973	202.7	562	360676
1974	127.9	313	408626
1975	106.1	264	401894
1976	78.7	194	405670
1977	95.6	212	450943
1978	304.5	438	695205
1979	228.1	472	483263
1980	303.4	585	518632
1981	362.2	668	542216
1982	365.2	672	543452
1983	344.7	639	539437
1984	268.3	620	432742
1985	239.1	594	402525
1986	250.1	616	406006
1987	182.6[a]	600[a]	304333

(continued)

Table C.6 - continued.

Year	Unit: kgr	Paddy fields land rent	Paddy field land rent	Planted area	Rice production	Paddy field land rent
		Y	Y/MT	1000s ha	1000s MT	Y/ha
1970	150	2349	15660	2923	12689	67981
1971	150	2683	17887	2695	10887	72257
1972	150	2867	19113	2640	11889	86075
1973	150	3241	21607	2620	12144	100149
1974	60	1824	30400	2724	12292	137179
1975	60	2280	38000	2764	13165	180995
1976	60	2664	44400	2779	11772	188081
1977	60	2616	43600	2757	13095	207088
1978	60	2931	48850	2548	12589	241355
1979	60	3100	51667	2497	11958	247429
1980	60	3373	56217	2377	9751	230614
1981	60	3540	59000	2278	10259	265707
1982	60	3750	62500	2257	10270	284393
1983	60	3905	65083	2273	10366	296812
1984	60	3430	57167	2315	11878	293316
1985	60	3584	59733	2342	11662	297442
1986	60	3528	58800	2303	11647	297370
1987	60	3626	60433	2146	10627	299266

[a] Estimate.

Sources: Japan Statistical Yearbook various issues, Australian Bureau of Agr. and Res. Econ. (1988).

Table C.7 Japan: fresh oranges, total imports.

Year	Total imports MT	Total imports 1000s $	Import unit value $/kgr	Exchange rate (Y/$)	Import unit value Y/kgr	Estimated quota rent Y/kgr
1970	4313	1422	0.329701	360	119	47.48
1971	6896	2515	0.364704	351	128	51.20
1972	13479	4577	0.339565	303	103	41.16
1973	16418	6792	0.413692	272	113	45.01
1974	20437	8479	0.414885	292	121	48.46
1975	22116	11008	0.497739	297	148	59.13
1976	24401	11839	0.485185	297	144	57.64
1977	22676	11728	0.517199	269	139	55.65
1978	51493	36028	0.699668	210	147	58.77
1979	54350	44330	0.815639	219	179	71.45
1980	71814	43184	0.601331	227	137	54.60
1981	75684	64674	0.854527	221	189	75.54
1982	82658	75621	0.914866	249	228	91.12
1983	89489	63159	0.705774	238	168	67.19
1984	89231	82705	0.926864	238	221	88.24
1985	111971	92487	0.825991	239	197	78.96
1986	117661	99283	0.843806	169	143	57.04
1987	123545	121809	0.985948	145	143	57.19

Sources: F.A.O. Trade Yearbook, various issues.

Table C.8 Japanese meat imports: beef, pork, and poultry.

Quantity: 1000s MT, Value: $ 1000s.

Year	Australian beef		New Zealand beef		U.S. beef	
	Quantity	Value	Quantity	Value	Quantity	Value
1962	2.796	1455	1.746	833	-[a]	-
1963	3.390	1635	1.130	549	-	-
1964	5.245	3082	0.803	434	-	-
1965	7.774	4750	2.569	1608	-	-
1966	9.345	7107	3.293	2208	-	-
1967	9.938	8797	2.393	2100	-	-
1968	10.031	9092	2.298	1884	-	-
1969	15.062	12249	3.081	2592	0.097	380
1970	20.123	18070	2.511	2521	0.362	1363
1971	36.959	40625	4.004	4111	0.507	1284
1972	52.712	71785	3.870	4880	0.597	2100
1973	107.271	240421	9.464	19470	9.527	33150
1974	42.356	101025	2.929	7157	7.712	25827
1975	37.109	51881	3.512	6221	3.545	15824
1976	76.138	116188	4.465	8568	11.267	37793
1977	71.738	102696	3.858	8671	7.264	21328
1978	77.541	152100	7.751	16084	12.745	47209
1979	100.430	289700	3.432	11816	23.534	96514
1980	92.935	306106	3.924	16730	22.437	104877
1981	86.952	258093	6.143	22610	26.464	109833
1982	85.998	237467	3.641	12852	31.57	133990
1983	90.952	272288	7.724	25686	37.714	144471
1984	91.842	268345	7.576	23252	42.238	153035
1985	92.935	248313	6.955	22415	46.514	180111
1986	105.166	281541	6.038	18716	63.389	238930
1987	121.127	364243	7.862	27525	85.292	380939
1988	136.321	471762	10.422	43315	109.845	637146

(continued)

Table C.8 - continued.

Year	Pork		Poultry	
	Quantity	Value	Quantity	Value
1962	-	-	0.284	246
1963	6.500	5486	3.471	2550
1964	4.000	3130	5.900	4099
1965	0.070	59	6.135	4602
1966	-	-	7.935	6044
1967	-	-	8.400	5912
1968	10.484	11480	16.205	11028
1969	42.651	51737	20.103	14973
1970	17.149	20928	10.687	8035
1971	27.204	32458	27.162	18947
1972	67.815	98954	29.278	22425
1973	125.795	234275	25.888	27003
1974	42.020	92267	25.350	31827
1975	124.549	307920	21.539	27048
1976	148.905	406794	37.613	46470
1977	109.967	332022	47.585	63505
1978	103.327	410085	61.589	88570
1979	131.652	509802	72.285	113118
1980	108.158	407667	72.172	112560
1981	183.629	711445	101.298	169852
1982	141.086	540932	105.532	163246
1983	166.253	644551	104.401	153613
1984	195.611	709971	107.413	175451
1985	190.221	700422	105.292	155078
1986	207.776	1044147	180.110	288756
1987	280.565	1418692	203.754	353179
1988	322.900	1655832	270.600	476522

[a] None or negligible.
Sources: U.N. Data Summary, F.A.O. Trade Yearbook various issues.

Table C.9 Japan: consumption levels of beef, pork, poultry, wheat, and rice.

	(Gross) food: 1000s MT				
Year	Beef	Pork	Poultry	Wheat	Rice
1965	220	407	211	3700	12037
1966	163	565	269	4025	11512
1967	168	603	311	4106	11412
1968	185	600	354	4119	11188
1969	246	631	443	4168	10972
1970	292	751	515	4092	10894
1971	332	870	597	4169	10812
1972	371	953	672	4250	10877
1973	371	1099	731	4316	10941
1974	369	1140	782	4409	10950
1975	394	1165	787	4522	10878
1976	387	1205	870	4602	10761
1977	442	1279	824	4655	10487
1978	501	1387	922	4681	10367
1979	576	1604	1169	4749	10227
1980	602	1639	1194	4839	10198
1981	630	1642	1238	4808	10320
1982	679	1647	1302	4845	10837
1983	722	1678	1359	4865	10494
1984	750	1697	1425	4900	9989
1985	772	1804	1466	4920	9962
1986	815	1890	1574	4922	9859
1987	891	1994	1641	4938	9709

Sources: OECD (1981) Food Consumption Statistics 1964-1978, and OECD (1991) Food Consumption Statistics 1979-1988.

REFERENCES

Anderson J.E. (1991). 'The Coefficient of Trade Utilization: The Cheese Case.' in R.E. Baldwin (ed) *Empirical Studies of Commercial Policy* NBER, Chicago: University of Chicago Press.

Anderson J.E. (1992). 'Tariff Index Theory.' mimeo, Boston College.

Anderson J.E. and G. Bannister (1991). 'The Trade Restrictiveness Index: An Application to Mexican Agriculture.' mimeo, World Bank.

Anderson J.E. and J.P. Neary (1991a). 'A New Approach to Evaluating Trade Policy.' mimeo, Boston College.

Anderson J.E. and J.P. Neary (1991b). 'The Coefficient of Trade Utilization: Back to the Baldwin theorem.' in Jones R.W. and A.O. Krueger (eds) *The Political Economy of International Trade: Essays in Honor of Robert E. Baldwin*, New York: Basil Blackwell.

Anderson J.E. and J.P. Neary (1992a). 'Trade Reform with Quotas, Partial Rent Retention, and Tariffs' *Econometrica, 60(1) pp. 57-76.*

Anderson J.E. and J.P. Neary (1992b). 'Domestic Distortions and International Trade.' mimeo, Boston College.

Armington P.S. (1969). 'A Theory of Demand for Products Distinguished By Place of Origin.' *IMF Staff Papers*, 21, pp. 159-77.

Australian Bureau of Agricultural and Resource Economics (1988). *Japanese Agricultural Policies: A Time for Change*, Canberra: Australian Government Publishing Service.

Balassa Bela (1965). 'Tariff Protection In Industrial Countries: An Evaluation.' *Journal of Political Economy*, 73(6), pp. 573-94.

Barber C.L. (1955). 'Canadian Tariff Policy.' *Canadian Journal of Economics and Political Science,* 21, pp. 81-7.

Barten A.P. (1964). 'Consumer Demand Functions Under Conditions Of Almost Additive Preferences.' *Econometrica*, 32, pp. 1-38.

Basevi G. (1966). 'The United States Tariff Structure: Estimates of Effective Rates of Protection of United States Industries and Industrial labor.' *Review of Economics and Statistics*, 48, pp. 147-60.

Bieda K. (1963). 'Trade Restrictions in the Western Community.' *American Economic Review*, 53(1), pp. 130-32.

Bowden R.J. and D.A. Turkington (1984). *Instrumental variables*, New York: Cambridge University Press.

Bruno M. (1972). 'Domestic Resource Cost and Effective Protection: Clarification and Synthesis.' *Journal of Political Economy*, 80, pp. 16-23.

Chambers R.G. (1988). *Applied Production Analysis: A Dual Approach*, Cambridge University Press.

Corden W.M. (1963). 'The Tariff' in A. Hunter (ed.) *The Economics of Australian Industry*. Melbourne: Melbourne University Press, pp. 174-214.

Corden W.M. (1966). 'The Effective Protective Rate, the Uniform Tariff Equivalent and the Average Tariff' *Economic Record*, 42 pp.200-16.

Corden W.M. (1971). *The Theory of Protection*, Oxford: Clarendon Press.

Corden W.M. (1985). *Protection, Growth and Trade: Essays in International Economics*, Oxford, England: Basil Blackwell.

Crawford G.J. (1934). 'Tariff Level Indices' *Economic Record*, 10, pp. 213-21.

Deaton A.S. (1979). The Distance Function in Consumer Behavior with Applications to Index Numbers and Optimal Taxation, *Review of Economic Studies*, 46, pp. 391-405.

Debreu G. (1951). The Coefficient of Resource Utilization, *Econometrica*, 19, pp. 273-292.

Diewert W.E. (1980). 'Aggregation Problems in the Measurement of Capital' in D. Usher (ed) *The Measurement of Capital*, Chicago: University of Chicago Press.

Dixit A. K. and V. Norman (1980). *Theory of International Trade: A Dual, General Equilibrium Approach*. London: Cambridge University Press.

Feenstra R.C. (1988). *Empirical Methods for International Trade*, London: MIT Press.

Feenstra R.C. (1990). 'New goods and Index Numbers: U.S. Import prices.' mimeo, University of California, Davis.

Feenstra R.C. and J.R. Markusen (1991). 'Accounting for Growth with New Inputs.' Working Paper #380, Dept. of Economics, University of California, Davis.

Fitchett D.A. (1988). 'Agricultural Trade Protectionism in Japan: A Survey.' *World Bank Discussion Papers*, #28.

Food and Agriculture Organization-(FAO) (1973). *Agricultural Protection: Domestic Policy and International Trade*, FAO Conf. Doc. C73/LIM/9, Rome.

Food and Agriculture Organization-(FAO) (1975). *Agricultural Protection and Stabilization Policies: A Framework of Measurement in the Context of Agricultural Adjustment*, FAO Conf. Doc. C75/LIM/2, Rome.

Griliches Z. (1961).'Hedonic Price Indexes for Automobiles: An Econometric Analysis of Quality Change' in, *The Price Statistics of the Federal Government*, New York: National Bureau of Economic Research.

Haberler G. (1936). *The Theory of International Trade With its Applications to Commercial Policy*, London: William Hodge.

Hansen L.P. (1982). 'Large Sample Properties of Generalized Method of Moments Estimators', *Econometrica,* 50(4), pp.1029-54.

Hausman J.A. (1978). 'Specification Tests in Econometrics', *Econometrica,* 46, pp.1251-72.

Humphrey D.D. (1962). *The United States and the Common Market*, New York: Praeger.

Josling T.E. (1980). *Developed Country Agricultural Policies and Developing Country Supplies: The Case of Wheat,* Report No. 14, International Food Policy Research Institute: Washington DC.

Johnson H.G. (1960). 'The Cost of Protection and the Scientific Tariff.' *Journal of Political Economy*, 58, pp. 327-45.

Krueger O. A. (1972). 'Evaluating Restrictionist Trade Regimes: Theory and Measurement.' *Journal of Political Economy*, 80, pp.48-62.

League of Nations (1927). *Report on Tariff Indices 1927*, (Doc. C.E.I. 37) Geneva: League of Nations.

Lerdau E. (1957). 'On the Measurement of Tariffs: The U.S. Over Forty Years.' *Economia Internazionale*, 10, pp. 232-47.

Lloyd P. J. and Schweinberger A. G. (1988). Trade Expenditure Functions and the Gains from Trade, *Journal of International Economics*, 25, pp. 275-98.

Lloyd P. J. and Schweinberger A. G. (1990). Distortions, True Trade Price and Quantity Indices and Welfare, *Scandinavian Journal of Economics*, 92(4), pp. 541-57.

Longworth J. W. (1983). *Beef in Japan*, St. Lucia: University of Queenland Press, Australia.

Loveday A. (1929). 'The Measurement of Tariff Levels.' *Journal of the Royal Statistical Society*, 92, pp. 487-516.

Loveday A. (1930). 'The Australian Tariff: A Criticism' *Economic Record*, 6, pp. 272-8.

Mori Hiroshi and W.D. Gorman (1985). 'Issues, Facts, and Opportunities for Exports of U.S. Beef to Japan', *Agribusiness, 1(2) pp.211-18.*

Mori Hiroshi and W.D. Gorman (1986). 'U.S. Grain-fed Beef in the Japanese Market', in W.D. Gorman, G.A. Welsh and J.S. Hillman (ed) *Research Opportunities in Beef Export Markets: United States and Pacific Rim countries*, Tucson, Arizona: University of Arizona.

Neary J.P. (1988). Tariffs, Quotas, and Voluntary Export Restraints with and without Internationally Mobile Capital' *Canadian Journal of Economics*, 21, pp. 714-735.

Neary J.P. (1989). 'Trade Liberalization and Shadow Prices in the Presence of Tariffs and Quotas.' Working Paper # 89/4, Centre for Economic Research, University College Dublin.

Neary J.P. and K.W.S. Roberts (1980). 'The Theory of Household Behavior Under Rationing' *European Economic Review*, 21, pp. 25-42.

Organization for Economic Cooperation and Development (OECD) (1981). *Food Consumption Statistics 1964-1978*, Paris: OECD.

Organization for Economic Cooperation and Development (OECD) (1987). *National Policies and Agricultural Trade. Country Study: Japan.* Paris: OECD.

Organization for Economic Cooperation and Development (OECD) (1991). *Food Consumption Statistics 1979-1988*, Paris: OECD.

Roningen V.O. and P. M. Dixit (1991). 'A Simple Measure for Agricultural Trade Distortion.' Working Paper #91-10, *International Agricultural Trade Research Consortium (I.A.T.R.C.)*.

Research and Policy Committee of the Committee for Economic Development (1964). 'The Height of United States and EEC Tariffs' in *Trade Negotiations for Better Free World Economy: A Statement on National Policy*, New York: The Committee foe Economic Development.

Schwartz N.E. and S.Parker (1988). 'Measuring Government Intervention in Agriculture for the GATT Negotiations' *American Journal of Agricultural Economics*, 70(5) pp. 1137-45.

Tangermann S., T.E. Josling and S.Pearson (1987). 'Multinational Negotiations on Farm-support Levels' *World Economy*, 10, pp. 265-81.

Theil H. (1967). *Economics and Information Theory*, Amsterdam: North-Holland Publishing Company.

Theil H. (1980). *The System-Wise Approach to Microeconomics*, Chicago: The University of Chicago Press.

Towle L.W. (1956). *International Trade and Commercial Policy*, New York: Harper and Brothers.

U.S. Department of Agriculture (USDA) (1983). *'Japan's Feed-Livestock Economy: Prospects for the 1980s'* Econ. Res. Serv. FAER no. 177, Washington DC.

U.S. Department of Agriculture (USDA) (1984). *The 1984 U.S. - Japan Beef and Citrus Understanding: An Evaluation*, Econ. Res. Serv. FAER no. 222, Washington DC.

U.S. Department of Agriculture (USDA) (1987). *Government Intervention in Agriculture: Measurement, Evaluation, and Implications for Trade Negotiations*, Econ. Res. Serv. FAER No. 229, Washington DC.

U.S. Department of Agriculture (USDA) (1988). *Estimates of Producer and Consumer Subsidy Equivalents: Government Intervention in Agriculture 1982-86*, Econ Res. Serv. Staff Report AGES880127, Washington DC.

U.S. Department of Agriculture (USDA) (1989a). *Agriculture in the Uruguay Round: Analysis of Government Support*, Econ. Res. Serv. Staff Report AGES880802, Washington DC.

U.S. Department of Agriculture (USDA) (1989b). *'Elasticities in the Trade Liberalization Database'* Econ. Res, Serv. AGES 89-20, Washington DC.

U.S. Department of Agriculture (USDA) (1990). *Estimates of Producer and Consumer Subsidy Equivalents: Government Intervention in Agriculture 1982-87,* Econ Res. Serv. Statistical Bulletin No 803, Washington DC.

Weatherspoon D.D. and Seale J.L.Jr. (1992). 'Do the Japanese Discriminate Against Australian Beef Imports? Evidence from the Differential Approach' Paper presented at the American Agricultural Economics Association Annual meeting, Baltimore, Maryland August 9-12, 1992.

White H. (1982). 'Instrumental Variables Regression With Independent Observations', *Econometrica*, 50(2), pp.483-500.

White H. and I. Domowitz (1984). 'Nonlinear Regression With Dependent Observations',*Econometrica,* 52(1), pp.143-61.

BIOGRAPHICAL SKETCH

Christos Pantzios was born on October 22, 1963, in Almiros - Volou, Greece. After graduating from high school, he enrolled at the Economics Department of The Graduate Industrial School of Thessaloniki, Greece, and graduated with a bachelor's degree in economics in April, 1986.

In August 1987, he started postgraduate studies in agricultural economics, at the Mediterranean Agronomic Institute of Hania, Greece. He received the Postgraduate Diploma of I.C.A.M.A.S. (International Center for Advanced Mediterranean Agronomic Studies) in August 1988, and the Master of Science (M.S.) degree of I.C.A.M.A.S. in March, 1990.

While finishing his M.S. program, Mr Pantzios was accepted in the doctoral program of the Food and Resource Economics (F.R.E.) Department, at the University of Florida. He begun his Ph.D. studies at the F.R.E. in August 1989, with primary field of specialization the area of agricultural production economics and productivity and secondary field the area of agricultural trade. His doctorate was awarded in December 1993.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Timothy G. Taylor, Chair
Professor of Food and Resource Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

William G. Boggess
Professor of Food and Resource Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Gary F. Fairchild
Professor of Food and Resource Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

James L. Seale, Jr.
Associate Professor of Food and Resource Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Elias Dinopoulos
Professor of Economics

This dissertation was submitted to the Graduate Faculty of the College of Agriculture and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

December 1993

Jack L. Fry
Dean, College of Agriculture

Dean, Graduate School