AN ECONOMETRIC STUDY
ON COTTON AND TEXTILE INDUSTRIES AND TRADE

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ABSTRACT

A theoretical trade model for vertically integrated markets was developed, assuming near-homogeneity for each commodities, in a non-spatial partial equilibrium framework. Demand for cotton was defined as a derived demand for textile production. Product differentiation assumption allow us to observe multiple commodity prices by type of economic activities. This assumption was adopted to provide a basis for explaining demand, production, and trade activities of the industries. An econometric model was developed and applied to investigate the structural nature of the textile-cotton trade. Macro economic variables and foreign textile market prices were identified to be the major factors causing volatile US cotton market conditions. Effects of textile trade liberalization on the textile-cotton industry were measured. A negative welfare effect was estimated for the US cotton industry, while a positive total US welfare effect was estimated.

TABLE OF CONTENTS

LIST OF TABLES

Table

Table

LIST OF FIGURES

Figure

Chapter 1. Introduction

1. Background

The US cotton farmer has operated primarily under government programs. For analyzing the effects of farm programs, it is necessary to include these measures in farmer's supply response equations. As the farmer has the option of forfeiting the commodity loan which results in government stock accumulation, a level of carry over stocks is also associated with provisions of the cotton programs.

On the demand side, like other farm products, cotton is used as a raw material in industrial productions. A uniqueness of cotton is that it is used in only one industry -- textiles. Despite the tight linkage in the production process, little is known about the economic linkage between the cotton industry and the textile industry.

Mill demand and export demand have shown massive fluctuations over the past 20 years. These long and short term fluctuations in mill and export demands should be explored to find economically related structural characteristics. Because domestic demand for cotton is derived from domestic textile production, which is in turn affected by foreign textile imports to the US, domestic producers must compete with foreign cotton exports. An econometric investigation of these complex relationships is the focus of this dissertation.

Several characteristics of the world textile/clothing industries are cited in a report from the United Nations (1984). The report states, among others, that "a shift in production can be seen away from the developed countries towards the developing economies" in the textile and clothing industries for a period from 1970 to 1984. This shift is partly explained by foreign investment in developing countries reflecting the comparative advantage of lower wage rate. It is also partly explained by the increase in production from central planned economies.

However, this "shift in production" does not imply a shrinkage of production in developed economies. A change in production technologies can reduce the comparative advantage of developing countries, as it enables the cotton and textile producers to reduce labor costs with moderate levels of investment. Thus by shifting into production characterized by higher marginal value products of capital, firms in the developed countries can continue to remain in the industries. To address the shift in production and to find the derived input demand equations, the textile production functions in the developed and developing economies should be estimated.

In textile trade activity, there is another factor which also affects the shift in production. Against the global tide toward trade liberalization, the US textile industry is claiming exposure from keen competition, and a severe threat by foreign textile exports into the US market. The US government has been extending measures to correct "market disruptions" in the US textile market since 1955. Although the effect of this protection has not been measured in an agreeable manner, if the protection is effective, then there is an incentive for the textile producers to continue the production of protected textile items without production changes and shifts.

In addition, it is also observed that consumers' preferences are changing. Man-made fiber first appeared in the 1930's. Rapid production increase after the 1950's has resulted in equivalent market share with natural fibers by the middle of the 1970's (UN, 1987). Evaluation of the usage of man-made fibers therefore must be made in order to draw a forecast for future usage of cotton.

2. Objectives of the study.

This study develops a theoretical framework for an econometric model covering US cotton and textile, and world cotton and textile markets. It is surprising that many of the existing studies on the US textile industry rely on assumed price elasticities of US textile supply and demand. One reason might be that there are no consistent quantitative data describing the textile market. Therefore, a data set covering the textile industry must be constructed.

This study will develop a trade model in a partial equilibrium market model (PEM) framework. However, a necessary deviation from a standard PEM approach will be made. In the world cotton and textile trade market, few countries are suitably approximated by their net trade position. A textile trade model should have the capability of explaining cross hauling since a net trade position may not adequately reflect the magnitude of actual trade activities. An assumption that products are non-homogeneous and are differentiated by source is attractive to apply, however it is inadequate to adopt for this study because of its massive level of data requirement.

Non-homogeneity is taken as a starting assumption of the textile consumers preferences. The consumers view the imported and locally produced goods as different products. The logical extension is that textile producers provide two types of goods, one for the local market and the other for the export market. Clearly it is not logical to claim that these imported and exported goods are homogeneous. The assumption of homogeneous import and export goods contradicts the logic that supports cross hauling, under a competitive output market assumption.

This study takes a view that the imported, exported and locally supplied products are all differentiated, but that at an aggregated level these goods are approximated as near-homogeneous. This agrees with the treatment of goods used in reporting the textile trade data from the United Nations, and makes it possible to consider aggregated market behavior and market clearing conditions. The regional trade prices are linked to each other, reflecting the differences in quality of goods in addition to the transportation cost between the regions, import/export taxes, and the tax equivalents.

The suggested shift in the world textile production is explored by estimating the parameters of the structural equations. As indicated under trade restriction, the economic forces that drive trade flows are distorted. This distortion is expected to be measured in the price linkage relation. Estimated equations will provide a way to investigate the effect of textile trade liberalization.

Textile production consists of yarn and fiber production, fabric production, and textile/clothing production stages. Since all of the products are tradable between producing regions, the textile production decision involves production and marketing decisions of all these intermediate products. An investigation covering this type of production decision is given attention in this study. These decisions directly affect the use of raw cotton, thus the world cotton trade flow, implying the need for a global investigation of the cotton industry.

An investigation of the cotton farm's supply response to the government program is an important objective of the study. Recent studies suggest that without government programs, cotton farms, particularly in the Southern regions, will not earn enough revenue to cover variable cost of production. An increase in production costs is cited as an explanation for this situation. If the government program guarantees a minimum revenue to cover the increasing production costs for a certain class of cotton farmers, and if these farms continue to enroll in the program, then their decision to produce cotton is not adequately explained by a profit maximization hypothesis. It will be appropriate to hypothesize that these farmers decide to maximize their utility. Only the farms who can produce cotton at lower costs and can obtain a positive quasi profit, can respond to supply control programs. As an extension of the logic, it is assumed that, for these farms, the government program functions as a measure to provide minimum revenue. Furthermore, as it is difficult to believe that these farms are responding only to minimum revenue, it is assumed that they are responding to government programs to maximize expected utility.

This study will analyze the supply response by considering price and yield uncertainties. Specific attention will be given to the specification of the supply equation, considering a theoretical rationale for using expected quasi profit variables. The ending stock equation and the export equations will also be reviewed.

Throughout this study, the term "textile" refers industrial products which are classified as Standard International Trade Classification Code (Revision 2) (SITC) 841 to 847. The term "fabric" refers industrial products of SITC 652 to 659. The term "yarn" refers products of SITC 651.

3. Scope of the study

The first chapter discusses an overview of the textile and cotton industries. Then the objectives of the study are discussed with brief background explanations. The second chapter reviews the literature. A theoretical model is developed in the third and fourth chapters. The third chapter discusses theoretical textile and cotton market models as vertically integrated "multi-layer" market models with an attempt to explain the product differentiation problem. A trade model, which horizontally connects the regional textile-cotton models, is discussed in the fourth chapter. Explanations of variable definitions, sources of data, and parameter estimation procedures are presented in the fifth chapter. Explanations of the empirical model, discussion of results of empirical model validations and estimated results are presented in the sixth chapter. The effectiveness of US cotton farm program, the effects of textile trade liberalization, and an investigation of US cotton exports are discussed in the seventh chapter, followed by conclusions in the eighth chapter.

Appendix 1 will summarize the variable definitions and the estimated equations. Appendix 2 contains data used in parameter estimation and Appendix 3 reports regression equations used to estimate missing textile trade data. Appendix 4 contains PQ space diagrams of the empirical econometric model.

Chapter 2. Literature Review

The purpose of this chapter is to review previous modeling research relating to the US cotton and textile markets and the trade models which could be used for policy analysis and forecasting. First, background information about the US cotton-textile markets is surveyed. Next, previous econometric modeling research on US cotton and textile markets are reviewed. The effect of governmental income support program will be studied in order to build a basis for a theoretical model.

This review will not focus on empirical specification forms of government program variables, since there is a large number of studies in the field of supply response that are well documented (Chembezi, 1990).

It is seen that government programs are functioning as income redistribution systems (Gardner). The cotton farmers receive a certain level of income from the government program through deficiency payments or diversion payments for cotton production. When the cost of production is not compensated by the market price, and when this situation persistently prevails, what are the determinants of producers' decisions? This is a major question to keep in mind as the literature is reviewed.

The third part of the review focuses on the appropriate form of trade model specification. Unlike cotton export (import) from/by the US (Japan), there are non-negligible levels of cross hauling activities in the world textile market and cotton trade to/from the European Community (EC). The review is extended to cover inter-industry trade and the treatment of product differentiation, although the scope of this review is quite limited.

1. Cotton market

Cotton is an important farm product in the US. In 1988, for example, value of production at the farm level was $4.2 billion, American upland cotton production valued $4.0 billion, and extra-long staple (ELS) production valued $0.2 billion (USDA, Cotton and Wool Situation and Outlook, CWS-57 1990). According to the census of agriculture in 1987, which is reported by Meyer and Sanford, cotton is produced in 17 states spreading in the South, with an average farm size of 831 acres. In the 1988 crop year, about 97.8% of the US cotton production (15.4 million bales) was American upland cotton and about 2.2% (0.3 million bales) was the American-Pima or extra-long staple (ELS) cotton, mostly produced in Arizona, Texas and California. ELS is marketed for high value products such as sewing thread and expensive apparel items (ERS, 1989). About 7.72 million bales of upland cotton and 0.07 million bales of ELS were used in the

US cotton mill system in 1988. About 5.88 million bales of upland cotton and about 0.27 million bales of ELS cotton were exported in 1988, leaving about 7.03 million bales of upland cotton and 0.07 million bales of ELS cotton in the stocks (USDA, 1990). The crop year for cotton starts August 1st. The harvested seed cotton is first sent to a cotton gin and separated into lint and cottonseed. The lint is baled, following specifications set by the USDA, then put into the warehouse. The producer receives a warehouse receipt that enables the farmer to market the cotton (USDA, 1975: p.173).

The farmer markets the cottonseed at a fixed price set by the ginners. The ginners sell cottonseed to the cottonseed mills where further processing yields cottonseed oil, cottonseed meal, and a cottonseed cake. The cotton plants yield approximately 175 pounds of cottonseeds for each 100 pounds of cotton fiber (Hudson and Stewart, 1981).

According to a 1986/87 crop year survey, cotton market flow is summarized as follows. About 52% of the total shipment from cotton warehouses went to the Southeast mill area, including reshipment to the final destination. The Pacific coast is the leading cotton export area of the US (75% of total export was shipped from this area). The West Gulf ports area follows with about 21% of the total export. Inland transportation is conducted primarily by truck transportation.

Firch claimed that US government programs from the 1950s to the 1970s provided encouragement for foreign countries to expand cotton production, and for the synthetic fiber industries to develop, because support price had been set at higher than the free market price levels.

The relationships between synthetic fibers, natural fibers, and cotton fiber are apparently changing over time. In 1973, Firch observed that "by end of the 1960s, a complimentary relation between cotton and synthetic fibers was established". In 1990, ERS views the relation as, "decline in US cotton mill use was due to the loss of market share to manmade fibers, and the loss of market share to textile import".

The US cotton industry had been playing a role of "residual supplier" in the world cotton market, in a sense that world cotton price was directly related to the US support price during a period from the 1960s to the 1970s (Firch, 1973). However, that claim does not hold in the 1980s. The target price and deficiency payment program allows US cotton spot market price to reach a market equilibrium. Furthermore, a possible linkage between the US support price and the world price has been disconnected by an introduction of the marketing loan provision of the 1985 Food and Agricultural Security Act, although the program did provide an incentive for distorted market behavior, such as observed in the 1988 crop year. The marketing loan did not work as anticipated because "the program allowed owners of cotton to hold stocks for up to 18 months with little or no storage or other holding costs and no downside price risk" (USDA, 1990). The US is a "competitive exporter of raw cotton, but other countries, many of them also cotton producers, are more competitive as exporters of finished products" (ERS, 1987: p.9). The US exports 27% of world exported cotton, followed by USSR (14.4%), Pakistan (11.6%), and China (7.9%).

2. Cotton production

The profitability of cotton production does not seem attractive to farmers. Stults (1990), with data covering a period from 1975 to 1987, studied the production cost of cotton and found that "from 1980 through 1986, the farm value of cotton was insufficient to cover all production cost.... With government payments, cotton producers were able to earn a profit after paying all costs in every year since 1975 except 1980, when they took a small loss".

Another similar observation is mentioned in a study on cotton supply response to the 1985 Food and Agricultural Security Act provisions, by Mims, Duffy and Young using data from representative Alabama cotton farms. Their model showed that the cotton farmer may see a negative net return under the program. They claimed that the revised calculation formula to obtain the five-year average base acreage, and the limited cross compliance provisions are responsible for this result. The study used the actual 1986 crop year's farm price of cotton. This lower than average price reflected a record high level of carry over stock, although actual cotton yield was lower than average. However, they did not report any sensitivity analysis, so it is difficult to draw general policy implications from their study. But, Stults and Mims and other results indicate a possibility that the production decision may not be adequately explained by a profit maximization hypothesis on the cotton farm's production decision behavior. That is the farmers are rather responding to the government program provisions with the anticipation of securing an income to continue cotton production over their planning horizon. In other words, the government program is operated to provide minimum income insurance. This argument follows from Gardner, who studied the governmental price support programs as an income redistribution mechanism (1987). Brorsen, Chavas and Grant took the view that an economic evaluation of governmental income support programs should be made by incorporating risk factors, since income instability is the major reason for government intervention (1987, p.733). Turvey and Baker (1990) studied farmers' futures market usage under the government program, using aggregated US and Indiana corn-soybean data. They showed that government programs have acted as a substitute to the futures market by reducing the price variance or skewing the output price distribution function. They also concluded that the farms' liquidity position and capital structure significantly affect the farmers' decisions on their usage of the futures market. These findings confirm the above mentioned assumption on farmers' behavior in the government programs. They participate in the programs to reduce income risk over the planning horizon.

In empirical studies of farmers' supply response, two types of specification forms have been developed to quantify the provisions of government program. One approach is to incorporate farm program provisions into a single or multiple variables (Bailey and Womack: 1985, Bailey 1989), and the other approach is to disaggregate the program provisions (Lee and Helmberger, 1985). Bailey (1989) measured a planted acreage response of wheat using an expected per acre net return variable. This approach has a significant advantage in modelling farmers' response to the programs, since all the relevant provisions of government programs can be integrated into a single variable -- net return. Chavas and Holt rationalized their usage of the constant per acre quasi-net revenue specification by introducing a yield function which takes a Leontief type functional form (1990).

3. Cotton mill demand

The US domestic market demand for cotton was studied by Smith and Dardis (1972). They approached the problem by focusing on the market share of cotton and other fibers. (The "market share" in the study by Smith and Dardis refers to a market share of cotton in total fiber use, and is different from the study by Sirhan and Johnson, where the market share refers to US cotton share in total cotton exports). A basic assumption of Smith and Dardis' study is that the market share of fibers at each point in time are considered as a realized state of the first order Markov process. The transitional probabilities of the Markov process were estimated by minimizing absolute deviations using quadratic programming. Although the study lacks the ability to incorporate elements in production practices such as blending of fibers, its result shows that with the exception of a few lowest quality end uses, the cotton's market shares decrease in most end use categories.

The US mill demand for cotton was also studied by Lewis (1972). He approached the problem by noticing that the demand for cotton is a derived demand for textile production. However, because of data availability, he measured the demand in an ad-hoc specification. His model used an income variable as a proxy of textile product price, making it difficult to interpret his results. He used a nested hypothesis that textile producers adjust their input level following a stock-adjustment mechanism when they face changes in input prices.

A study by Jones-Russell and Sporleder (1988) selected a cotton fiber price, a polyester staple price, and variables representing the change in technology etc., for their demand for the cotton fiber equation.

4. Cotton export equations.

Some previous research treated US cotton exports as a residual demand from the world cotton market. That approach is inadequate under a situation where the US market price is no longer supporting the world cotton market price.

Ayuk and Ruppel argued that the cotton export activity should be measured by sales quantity but not by quantity shipped (1989). As a reasoning they argued that the forward sales contracts are extensively used in the cotton export market, and economic variables may change between the sale and actual shipment. However, when analyzing cotton trade with annual data (they used quarterly data), the suggested problem should not be serious.

5. Cotton trade model

There are two different views on world cotton trade. One treats all cotton, wherever produced, as a homogeneous good (FAPRI trade model). The other treats cotton from various regions as differentiated products.

In an article in 1979, Johnson, Grennes, and Thursby discussed the differentiated products. They argued that there are two possible reasons for the empirically observed price differentials. One is a spatial price differential which is caused by transfer costs and time aggregation. The other type of price differential is caused by product differentiation, information cost, and aggregation procedures of data. They took a view that even for a homogeneous good, like wheat, we observe price differentials. That is wheat traded is differentiated by country of origin because of the aggregation time. They further argued that the cross hauling activities can also be explained by the same elements used to explain price differentials.

A pioneering work in the study of cotton trade, treating cotton as non-homogeneous, was conducted by Sirhan and Johnson using information about market-share of fibers. They observed the world cotton market in a way in which:

(1) Government programs are important aspects of the market structure (for example, US programs to curtail production and export subsidies), and thus the market structure would be best approximated with a "dominant firms" model,

(2) Certain quality differences exist, since price differences exist (p.594).

Several assumptions were associated with their study.

First, cotton is differentiated by it's source of origin. Second, these imported products are close substitutes. Third, for a price change, consumers will react gradually. Their empirical equations were derived from a market-share model and a partial adjustment hypothesis.

In a comment to Sirhan and Johnson, Firch argued that an excess-demand or residual-supplier model serves more adequately than a market share model (p.375). As one reason, Firch mentioned that the nature of the world cotton market was best described where the US served as the almost absolute "price maker" (p.376). Firch also argued that the assumptions on the world cotton market structure were incorrect, and cotton is a homogeneous or near homogeneous product (p.376). A similar discussion was made on the adequateness of the Armington model for a study of cotton trade.

Several papers studied the elasticity of export demand for US cotton by applying the Armington model (Alston, Carter, Green and Pick (1990), Duffy, Wohlgenant and Richardson (1990), Babula(1987)). In order to apply the Armington trade model, the following assumptions are made on the cotton importers' utility or production function.

1) The importer's preferences are homogeneous and separable.

2) The importer's elasticity of substitution between any two products (cotton from different sources) are all

equal and constant.

There is no doubt that the adequateness of the market share approach depends on an assumption about the behavior of the fiber users. Specifying market share as a function of fiber prices, like Sirhan and Johnson adopted, requires an assumption that the production functions of the fiber users are separable, i.e., the fiber demands as a whole are separable from the rest of the inputs for fiber production. Moreover their adoption of a cotton-manmade fiber price ratio implies that the underlying production function is homothetic in terms of cotton and man-made fiber use.

It is difficult to find a convincing reason for Sirhan and Johnson's procedure, after observing consumer's taste changes for materials of textile products. From a practical point of view, the separability assumption is not likely to hold, thus results obtained the market share approach, based on a theory of Armington model approach, are most likely incorrect. Alston, Carter, Green, and Pick tested the Armington assumptions with wheat and cotton trade data. They found that the homotheticity assumptions on the importers' utility functions did not hold, and concluded that the Armington model generates specification biased results.

The questioned point that cotton traded is homogeneous or nonhomogeneous relates to studies on the mill demand for the cotton. However, the existing studies do not consider the point.

An example of a view that cotton is homogeneous is reflected in a partial equilibrium model. A partial equilibrium model (PEM) is used in the FAPRI trade model as a dynamic non-spatial partial equilibrium model. In this approach, in addition to the regional equilibrium level of supply, demand, and price, the net import and export from the regions and a world equilibrium price are found as a solution set of the model. However the origin and destination of the product flows are not obtainable.

The PEM is considered as an approximation of a general equilibrium model (GEM), and when the activity in the market of interest is small enough, compared to the rest of the activities, the PEM serves as "good enough" approach (Hertel, 1988). Therefore, under the assumption that the textile and cotton markets are small enough compared to the rest of the world economy, it is reasonable to treat the result of the PEM as an equivalent result from the GEM. This provides a rationale for extending a study to welfare analysis of the related market agents.

The PEM model consists of a system of equations explaining supply, ending stocks, use, and excess supply/demand for each region. Trade market equilibrium price is found by equating the sum of excess supply to the sum of excess demand. The equilibrium trade price is linked to the regional market price through price linkage equations so that each of the regional markets are also cleared at the same trade market equilibrium price level.

Monke, Cory and Heckerman studied an Egyptian cotton export equation for a study of the Egyptian Government's surplus disposal program (1987). They developed the Egyptian cotton export equation by applying an idea that a part of demand is explained by an inter-temporal storage model. As a dependent variable, consumption of ELS cotton by market economies is selected, and as explanatory variables, a cotton to polyester price ratio (one period lagged ratio, between CIF Liverpool price of the Egyptian cotton over FOB US mill price of polyester fiber), an income (real GDP for OECD countries), and a textile price (the Swiss textile price index) were selected. Their estimated own price elasticity was -0.38, the textile price elasticity was 1.45, and the income elasticity was 1.2.

Shui and Beghin studied textile cotton market linkage with a multimarket model, recognizing that the demand for cotton is a derived demand. Five markets were considered in their multimarket model: US textile, US apparel, foreign textile, foreign apparel, and US cotton markets. They took an assumption that the Multifibre Arrangement (MFA) was a binding constraint on foreign textile exports to the US textile market, therefore there exists price wedges between US and foreign market prices (p.5). The US demand for textile and apparel was specified as a function of income, price of the textile and apparel good, and price of the foreign substitute (p.5). Import demand for foreign produced textile and apparel was specified with the same arguments as domestic demand. The domestic supply of textile and apparel was specified as a function of input and output prices, including the US cotton price (p.5). Exports of US textiles, US apparel, and the whole foreign cotton market were excluded from their model. Foreign supply of textile and apparel depended on foreign output and input prices. They assumed that foreign cotton price is positively related to US cotton price (p.5). They used previously reported elasticity values for their model simulation, and concluded that an elimination of the MFA negatively affects US cotton farms.

There are a few questionable treatments in their study. First, it was assumed that the foreign cotton price is directly related to the US cotton market price. When the US cotton market plays a role as "residual supplier", this is a reasonable assumption. However, when considering the changes in US farm programs and noticing a change in the role of US market price, this assumption could not be considered adequate. Second, their simulation study started from an assumption that the Multifibre Arrangement (MFA) is a binding constraint, then computed an impact of an hypothesized elimination of MFA by equating the US price to the foreign apparel and textile prices. The whole portion of the price differentials should not be explained as an economic rent of quota, because some of the price differentials may have originated from transportation costs, difference in qualities, or costs of production, rather than economic rent of quota. Moreover, the specification of their textile demand equations implies that the domestic and foreign products are differentiated by sources, i.e., price differentials should not be totally eliminated when the MFA is eliminated.

6. Textile trade and effects of MFA

Under the Multifibre Arrangement (MFA), when market conditions of an importing country are distorted by inflows of imported textile products, governments of the importing and exporting countries negotiate bilateral trade agreements to determine the level of trade control. Currently, US textile producers can export their products to other industrial country markets without imposed quantity restrictions, while the developing countries have set quantity restrictions with most of the industrial countries' importers for their export. MFA was first signed in 1974, and has continuously been renewed with strengthening restrictions on textile trade. MFA IV was signed in 1986.

Dean (1990) studied the effects of the US MFA on eight small Asian textile exporting countries. He reported that the quota restriction by the US MFA has been a binding constraint on their exports for the studied period 1975-1984. However, his conclusion does not discuss the economic effects of the quota on total US import.

A study for the 1987 and 1988 textile import data, reported by Meyer (1989), gave more direct figures about the situation. Meyer reported the quota fill ratio by categories and by exporting countries. Several export quotas were binding in 1987 (i.e., quota was fully filled for several categories) and a few were binded in 1988 (p. 23-24).

Trela and Whalley (1990) conducted a general equilibrium analysis to measure welfare effects of the MFA. They take a view that there is no cross-hauling trade of regulated textile and apparel products, thus treating the goods as homogeneous without facing further theoretical problems. They split the textile market into 14 product categories. The constant elasticity of transformation (CET) textile production functions and the constant elasticity of substitution (CES) utility functions were used to explain the subgroups of textile supply and demand, applying the assumed value of -0.5 and 5.0, respectively. US total textile and apparel supply elasticity was assumed to be 1.0, following from previous studies. They also used an assumed total demand elasticity of -0.6 from Cline's study (1987).

They first computed the price differential caused by the MFA quota as export tax equivalents for the textile exporting countries, then converted them as the import tax equivalent in the textile importing countries. The welfare effects were then computed by eliminating the computed tax equivalents. They assumed the quota price on textile products to be half of the apparel products quota price, which was constructed based on the simple average of Hong Kong apparel quota price. They concluded that by an hypothesized elimination of MFA, the US could gain about $12.3 billion in welfare.

Chapter 3. Regional Market Model

1. Components of the model

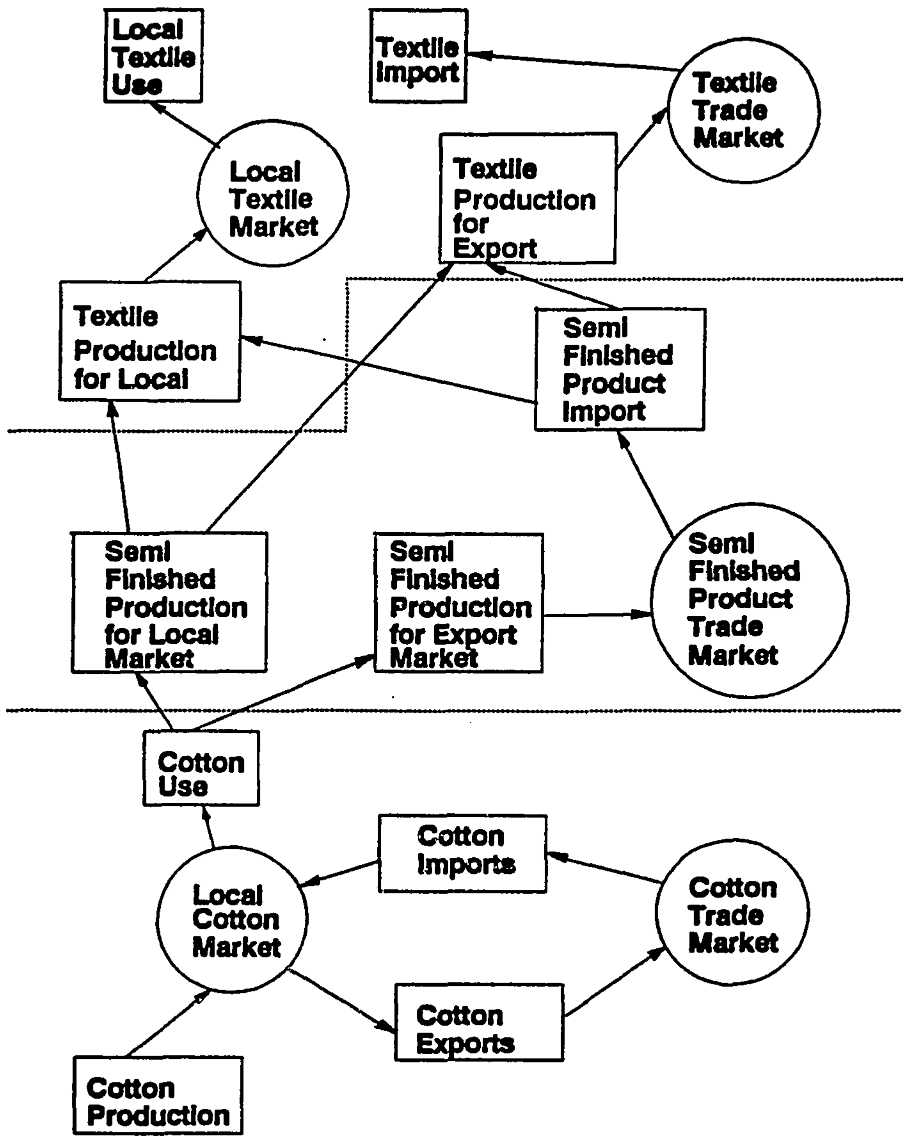
The trade model is composed of two submodels, covering textile and cotton sub-trade markets. Each of the submodels are further composed of regional market submodels and a trade market submodel.

Regional market submodels generate regional market clearing prices, and the trade market submodels provide textile and cotton trade market clearing prices with interactions between the market activities.

Each price is determined in a mutually dependent style. That is no single market price can be determined independently from others. Regional trade prices of textile and its intermediate products and of cotton are linked with their corresponding trade market clearing prices through trade price linkage equations, so that all trade submodels are cleared with a single price vector. That is, the model allows for a set of multi regional market clearing prices and a single trade market clearing price for both textile products and cotton.

This chapter discusses structures of the regional textile and cotton models.

Textile, Cotton Products Flow



An assumption on product flow within the textile production process is introduced here. It is assumed that there are three stages of production in the textile/clothing production process: a final textile/clothing production stage, a fabric production stage, and a yarn production stage. It is also assumed that all products are tradeable.

The industry produces two types of textile/clothing products, one for a domestic market and the other for an export market. These two products are assumed to be differentiated. In the fabrics production stage, the industry produces two types of fabrics, one for local markets and the other for export markets, using locally produced yarns and imported yarns. In the yarn production stage, the industry also produces two types of yarns, one for domestic markets and the other for export markets, using locally produced cotton and imported cotton. (In order to reduce the complexity of the model structure, it is assumed that imported and locally produced input factors are nearly homogeneous.)

Given a close linkage of production stages, it is assumed that the profit function of the industry is best approximated by a joint profit function. (This assumption is introduced to reduce the complexities of the model. With this assumption, regional intermediate good markets are eliminated. Yarn and fabric productions for use in the region are not considered as final products.)

Although wage rates are frequently cited as a source of comparative advantage in production, it is assumed that an aggregated labor supply is not fixed for the textile-cotton industry, therefore interaction between the labor market and the textile-cotton market is excluded. Similarly a capital market is not explicitly specified in the model. It is assumed that cotton-textile industries are price takers in labor and capital markets.

It is assumed that the demand for fabric (yarn) in a region is equal to the supply of fabric (yarn) to the region, i.e., demand includes consumption and stocks.

2. Textile production

The following few sections, will discuss conditions necessary to produce two types of products, where profits are obtained from vertically integrated production activities. Results of comparative static analyses of textile production will also be discussed.

2.1 Conditions to allow two types of production.

Suppose that the textile producer in region (A) has two outputs, one is for a domestic market (T^{A1}), and the other is for an export market (T^{A2}), with the following production functions.

$T^{A1} = T^{1}(F^{1di}, F^{Ii})$, and $T^{A2} = T^{2}(F^{1da}, F^{Ia})$,

where,

F^{1di} : Domestically supplied fabric used in textile productions for the local market.
F^{1da} : Domestically supplied fabric used in textile productions for the export market.
F^{Ii} : Imported fabric used in textile productions for the local market
F^{Ia} : Imported fabric used in textile productions for the export market

The profit function is shown in the following equation, assuming a competitive market structure in the output and the input markets:

$$\pi = P^{T1} * T^{A1}(F^{di}, F^{Ii}) + P^{T2} * T^{A2}(F^{1da}, F^{Ia}) - P^{F1d} * (F^{1di} + F^{1da}) - P^{FI} * (F^{Ii} + F^{Ia}),$$

where,

P^{T1} : Domestic textile market price
P^{T2} : Output price that the producer can charge in the trade market
P^{F1d} : Price of domestic fabric
P^{FI} : Price of imported fabric.

The producers select the level of inputs, so they can maximize their profit defined as above.

The first order condition on the usage of domestic fabric for the production of domestic textile is given in the following condition.

$$P^{T1}T^{A1}1(F^{di}, F^{Ii}) - P^{F1d} \leq 0,$$

where $T^{A1}1$ denotes the first derivative of function T^{A1} with respect to the first argument of the function.
Whenever its marginal value of product is equal to its price, domestic fabric is used for production of textiles to

be shipped to local markets. Similar first order conditions are obtained for the other types of input use.

The two hypothesized types of textile production activities are feasibly taking place under the conditions that (1) differences exist in marginal productivity of inputs between the two productions, and (2) output price differentiation exist.

The following results were obtained for this profit maximization problem. Results show that the production decisions for domestic and export textile are made independently under this assumed condition. Each of the input demand equations appear as follows:

$$F^{1di}=F^{1di}(P^{T1},\ P^{F1d},\ P^{FI}).$$
$$F^{Ii}=F^{Ii}(P^{T1},\ P^{F1d},\ P^{FI}).$$
$$F^{1da}=F^{1da}(P^{T2},\ P^{F1d},\ P^{FI}).$$
$$F^{Ia}=F^{Ia}(P^{T2},\ P^{F1d},\ P^{FI}).$$

Textile product supply functions are obtained by substituting the above derived demand equations into production functions.

$$T^{A1}=T^{A1}(F^{1di}(P^{T1},P^{F1d},P^{FI}),F^{Ii}(P^{T1},P^{F1d},P^{FI}))=T^{A1}(P^{T1},P^{F1d},P^{FI}).$$
$$T^{A2}=T^{A2}(F^{1da}(P^{T2},P^{F1d},P^{FI}),F^{Ia}(P^{T2},P^{F1d},P^{FI}))=T^{A2}(P^{T2},P^{F1d},P^{FI}).$$

Total demand for fabrics (F^{1d*}, F^{d*}) is given as the sum of corresponding input demands.

$$F^{1d*}=F^{1di}+F^{1da}\ =F^{1d*}(P^{T1},\ P^{T2},\ P^{F1d},\ P^{FI}).$$
$$F^{I*}=F^{Ia}+F^{Ii}\ =F^{I*}(P^{T1},\ P^{T2},\ P^{F1d},\ P^{FI}).$$

2.2 Introduction of "allocation" factor

When considering the problem at the industry level, however, it seems more adequate to add a constraint that there are allocations of input factors between the two alternative productions. The profit function is written as follows:

$$\pi = P^{T1}T^{1}(aF^{1d}, bF^{I}) + P^{T2}T^{2}((1-a)F^{1d}, (1-b)F^{I}) - P^{F1d}F^{1d} - P^{FI}F^{I}.$$

where, a and b are factors of allocation between the two types of production. The industry as a whole selects levels of F^{1d}, F^{I}, and factors of allocation (a, b) to maximize profit. Solutions obtained from this formulation differ from those obtained in the previous setting.

A uniqueness of this setting is the allowance for an undeterminable response in input decisions relative to changes in output prices.

The first order conditions for this profit maximization problem are,

$$aP^{T1}\ T^{1}1(aF^{1d}, bF^{I}) + (1-a)P^{T2}\ T^{2}1((1-a)F^{1d}, (1-b)F^{I})\ - P^{F1d} = 0.$$
$$bP^{T1}\ T^{1}2(aF^{1d}, bF^{I}) + (1-b)P^{T2}\ T^{2}2((1-a)F^{1d}, (1-b)F^{I})\ - P^{FI} = 0.$$
$$P^{T1}\ T^{1}1(aF^{1d}, bF^{I})\ -\ P^{T2}\ T^{2}1((1-a)F^{1d}, (1-b)F^{I}) = 0.$$
$$P^{T1}\ T^{1}2(aF^{1d}, bF^{I})\ -\ P^{T2}\ T^{2}2((1-a)F^{1d}, (1-b)F^{I}) = 0.$$

Production activities of final products are now clearly competing with each other, as shown in the third and fourth first order conditions.

At each production stage, the industry allocates inputs considering the relative size of marginal products of each input. Thus an increase in one of the output prices does not necessarily imply an increase in demand for a particular input. This is reflected in the following example.

(The following discussion is intended to merely illustrate the point "that response to price changes may not be unique". For this reason only a final solution is presented.)

Taking total differentials of the first order conditions and solving for dF^{1d} yields the following solution.

$$dF^{1d} = K1dP^{F1d} - K2dP^{FI} + ((K1+K4)T^{2}2 - (K2+K3)T^{2}1)dP^{T2} + (K3T^{1}1 - K4T^{1}2)dP^{T1}.$$

where,

$K1=a22(a33a44-a34a43)-a23(a32a44-a34a42)+a24(a32a43-a33a42).$
$K2=a12(a33a44-a34a43)-a13(a32a44-a34a42)+a14(a32a43-a33a42).$
$K3=a42(a13a24-a14a23)-a43(a12a24-a14a22)-a44(a12a23-a13a23).$
$K4=a32(a13a24-a14a23)-a33(a12a24-a14a22)-a34(a12a23-a13a23).$
$a12= -P^{T2}\ T^{2}11\ F^{1d}.$
$a13= P^{T2}\ T^{2}12\ (1-b).$
$a14= P^{T2}\ T^{2}12\ F^{I}.$
$a22= -P^{T2}\ T^{2}12\ F^{1d}.$
$a23= P^{T2}\ T^{2}22\ (1-b).$
$a24= -P^{T2}\ T^{2}22\ F^{I}.$
$a32= -(P^{T2}\ T^{2}11 + P^{T1}\ T^{1}11)\ F^{1d}.$
$a33= -(P^{T2}\ T^{2}12 + P^{T1}\ T^{1}12)\ F^{I}.$
$a34= P^{T2}\ T^{2}12(1-b) - P^{T1}\ T^{1}12\ b.$
$a42= -(P^{T2}\ T^{2}12 + P^{T1}\ T^{1}12)\ F^{1d}.$
$a43= -(P^{T2}\ T^{2}22 + P^{T1}\ T^{1}22)\ F^{I}.$
$a44= P^{T2}\ T^{2}22(1-b) - P^{T1}\ T^{1}22\ b.$

For changes in output or input prices, input requirement level changes, direction of change and magnitude of change is determined by the rate of changes of the marginal products.

2.3 Comparative static analysis with integrated production model

This section investigates the textile producers response to exogenously given price changes, where textile production is comprised of three levels of vertically integrated production stages, these are 2 final and 2 intermediate tradeable products, and total input levels and allocation ratios are choice variables.

Assuming that the three stages of productions are integrated, a profit function is specified as follows. (Subscripts are dropped to simplify the notation).

$$\pi = P^{T1}\, T^1(a\, F^{1d},\, b\, F^I) + P^{T2}\, T^2((1-a)F^{1d},\, (1-b)F^I)$$
$$-P^{F1d}\, F^{1d} - P^{FI}\, F^I + P^{F1s}\, F^{1s}(c\, Y^{1d},\, e\, Y^I)$$
$$+P^{F2}\, F^{2s}((1-c)\, Y^{1d},\, (1-e)\, Y^I) - P^{Y1d}\, Y^{1d} - P^{YId}\, Y^I$$
$$+P^{Y1s}\, Y^{1s}(fC^1) + P^{Y2}\, Y^2\, ((1-f)\, C^1) - P^{C1d}\, C^1\ ,$$

where,

T^1	: Production of textile/clothing for local market
T^2	: Production of textile/clothing for export market
F^{1d}	: Total demand for locally produced fabric
F^{1s}	: Production of fabric for the local market
F^I	: Total demand for imported fabric
F^2	: Production of fabric for the export market
Y^I	: Total demand for imported yarns
Y^{1d}	: Total demand for locally produced yarns
Y^{1s}	: Total supply of local yarn
Y^2	: Production of yarn for the export market
C^1	: Total demand for local cotton
P^{T1}	: Price of textiles produced for the local market
P^{T2}	: Price of textiles produced for the export market
P^{FI}	: User's price of imported fabric
P^{F1d}	: User's price of locally produced fabric
P^{F1s}	: Price of fabric for local market
P^{F2}	: Price of fabric for export market
P^{Y1d}	: User's price of locally produced yarns
P^{YId}	: User's price of imported yarns
P^{Y2}	: Price of yarn for export market

P^{Y1s} : Price of local yarn
P^{C1d} : Price of local cotton.
a : Proportion of local fabric used in production of textiles for the local market
b : Proportion of imported fabric used in production of textiles for the local market
c : Proportion of local yarn used in production of fabric for the local market
e : Proportion of imported yarn used in production of fabric for the local market
f : Proportion of cotton used in yarn production for the local market

For simplicity, suppose that supply and use level of yarn and fabric for a local market are equal, i.e., $F^{1d}= F^{1s}$, $Y^{1d}=Y^{1s}$. Also assume that the supplier's and the user's price for local fabric and yarn are equal, i.e., $P^{F1d}=P^{F1s}$ and $P^{Y1d}=P^{Y1s}$. Then the objective function takes the following form.

$$\pi=P^{T1}\ T^1(a\ F^1(c\ Y^1(f\ C^1),\ e\ Y^I),\ b\ F^I)$$
$$+P^{T2}\ T^2((1-a)\ F^1(c\ Y^1(f\ C^1),\ e\ Y^I),\ (1-b)\ F^I)$$
$$-P^{FI}\ F^I\ +P^{F2}\ F^2((1-c)\ Y^1(f\ C^1),\ (1-e)\ Y^I)$$
$$-P^{YI}d\ Y^I\ +P^{Y2}\ Y^2((1-f)\ C^1)\ -P^{C1}\ C^1.$$

The textile/clothing producer's choice variables are total demand for domestic cotton (C^1), total demand for imported yarn (Y^I), total demand for imported fabric (F^I), and allocating factors (a, b, c, e and f). Denoting a partial derivative of the production function (X) with respect to its first argument as X1, after some manipulations, the first order conditions are shown as follows.

$P^{Y2}\ Y^{2}1 - P^{C1d}=0.$

$P^{F2}\ F^{2}2 - P^{YId}=0.$

$P^{T2}\ T^{2}2 - P^{FI}=0.$

$P^{T1}\ T^{1}1 - P^{T2}\ T^{2}1=0.$

$P^{T1}\ T^{1}2 - P^{T2}\ T^{2}2=0.$

$P^{T2}\ T^{2}1\ F^{1}1 - P^{F2}\ F^{2}1=0.$

$P^{T2}\ T^{2}1\ F^{1}2 - P^{YId}=0.$

$P^{F2}\ F^{2}1\ Y^{1}1 - P^{C1d}=0.$

These are usual relations between value of marginal products and marginal costs. Allocation of input factors are summarized in the following way.

The marginal value product (MVP) of cotton for export yarn production and the MVP for export fabric production are equal to the cotton price. The MVP of imported yarns for export fabric production, and the MVP for exported textile production are equal to the import price of yarn. The MVP of imported fabric for export textile production is equal to the fabric import price. The MVP of local fabric for the two types of textile production are equal. Similarly, the MVP of imported fabric for the two types of textile productions are equal. The MVP of locally produced yarn for textile production for exports and for fabric production for exports are equal.

Since allocation ratios of input factors are involved, every choice variable is a function of all prices and marginal products, except the decision for yarn exports.

One of the possible problems of the framework developed here is the treatment of the marginal products. When production technologies are rapidly changing, these marginal products are not constant. The framework developed here focuses on the changes in line of products for given changes in prices by assuming constant production technologies over the sample period. Expansion of the model framework, however, greatly increases the complexity of model specification, thus greatly increasing the amount of data necessary for an empirical investigation.

2.4 Implied signs of parameters of structural equations

The system of equations derived from the first order conditions does not give a unique solution when insufficient information is available. This does not mean that the system of equations is under identified. It simply means that lacking information about input factor allocation ratios, it is not possible to estimate parameters consistently over the system, thus there is the possibility that the resulting parameters are biased. For example, when we observe an increase in demand for cotton, it is not necessarily explained by increases in both types of yarn production. It is safe to say only that demand for cotton has increased because production of at least one of the yarns has increased. To explain this point in a more formal way, the results of a comparative static analysis will be reported. (Again, the following discussion is presented only for illustration purposes. Initially, this comparative static study was conducted because it was expected that a solution set could be derived that adequately reflected the signs of the parameters of the structural equation in the estimation process. An alternative comparative static analysis, which is reported in the next section, was used to evaluate empirical econometric research.)

The following is the result of a comparative static study of mill demand. As can be seen, responses to any of the price changes depend on each stage's production technologies.

$$
\begin{aligned}
dC^1 = [& (K + a18\ (M_{11,17} + M_{11,67}))\ dP^{C1d} \\
& + a18(M_{11,57} - M_{11,17} - M_{11,67})\ dP^{Y1d} \quad - a18(M_{11,37} + M_{11,57})\ dP^{FI} \quad - Y^2 1\ K \\
& dP^{Y2} + a18(T^2 2\ M_{11,37} + T^2 1\ F^1 2\ M_{11,77} - T^2 1\ F^1 1\ Y^1 1\ M_{11,67})\ dP^{T2} \\
& + a18(\ F^2 2\ M_{11,17} - F^2 1\ Y^1 1\ M_{11,27})\ dP^{F2} \\
& + a18(\ T^1 2\ M_{11,57} - T^1 1\ F^1 2\ M_{11,47})\ dP^{T1}]/DET,
\end{aligned}
$$

where, DET is the determinant of the coefficient matrix. K is a common constant term and is defined as,

$$
\begin{aligned}
K = & a28M_{11,17} - a38M_{11,27} + a48M_{11,37} - a58M_{11,47} \\
& + a68M_{11,57} - a78M_{11,67} + a88M_{11,77}.
\end{aligned}
$$

$M_{ij,kl}$'s are minors, obtained by first striking out the ith row and jth column of the coefficient matrix, then by striking out the kth row and lth column of the resulted submatrix, the aij's are elements of the coefficient matrix and are defined as follows:

$a11= P^{Y2}\ Y^{2}11\ (1-f).$

$a18=-P^{Y2}\ Y^{2}11\ C^{1}\ .$

$a21= P^{F2}\ F^{2}12\ (1-c)\ Y^{1}1\ f.$

$a23= P^{F2}\ F^{2}22\ (1-e).$

$a26=-P^{F2}\ F^{2}12\ Y^{1}.$

$a27=-P^{F2}\ F^{2}22\ Y^{I}.$

$a28= P^{F2}\ F^{2}12\ (1-c)\ Y^{1}1\ C^{1}.$

$a31= P^{F2}\ (F^{2}1\ Y^{1}11\ +(Y^{1}1)^{2}\ F^{2}11\ (1-c))\ f.$

$a33= P^{F2}\ Y^{1}1\ F^{2}12\ (1-e).$

$a36=-P^{F2}\ Y^{1}1\ F^{2}11\ Y^{1}.$

$a37=-P^{F2}\ Y^{1}1\ F^{2}12\ Y^{I}.$

$a38= P^{F2}\ (F^{2}1\ Y^{1}11\ +(Y^{1}1)^{2}\ F^{2}11\ (1-c))\ C^{1}.$

$a41= P^{T2}\ T^{2}12\ (1-a)\ c\ f\ F^{1}1\ Y^{1}1.$

$a42= P^{T2}\ T^{2}22\ (1-b).$

$a43= P^{T2}\ T^{2}12\ (1-a)\ e\ F^{1}2.$

$a44=-P^{T2}\ T^{2}12\ F^{1}.$

$a45=-P^{T2}\ T^{2}22\ F^{I}.$

$a46= P^{T2}\ T^{2}12\ (1-a)\ F^{1}1\ Y^{1}.$

$a47= P^{T2}\ T^{2}12\ (1-a)\ F^{1}2\ Y^{I}.$

$a48= P^{T2}\ T^{2}12\ (1-a)\ c\ F^{1}1\ Y^{1}1\ C^{1}.$

$a51= P^{T1}\ (F^{1}1\ F^{1}2\ T^{1}11\ a\ +T^{1}1\ F^{1}12)\ c\ Y^{1}1\ f.$

$a52= P^{T1}\ F^{1}2\ Y^{2}12\ b.$

$a53= P^{T1}\ ((F^{1}2)^{2}\ T^{1}11\ a\ +\ T^{1}1\ F^{1}22)\ e.$

$a54= P^{T1}\ F^{1}2\ T^{1}11\ F^{1}.$

$a55= P^{T1}\ F^{1}2\ T^{1}12\ F^{I}.$

$a56= P^{T1}\ (F^{1}1\ F^{1}2\ T^{1}11\ a\ +T^{1}1\ F^{1}12)\ Y^{1}.$

$a57= P^{T1}\ Y^{I}\ ((F^{1}2)^{2}\ T^{1}11\ a\ +T^{1}1\ F^{1}22).$

$a58= P^{T1}\ c\ Y^{1}1\ C^{1}\ (F^{1}1\ F^{1}2\ T^{1}11\ a\ +T^{1}1\ F^{1}12).$

$a61= P^{T1}\ T^{1}12\ a\ c\ F^{1}1\ Y^{1}1\ f.$

$a62= P^{T1}\ T^{1}22\ b.$

$a63= P^{T1}\ T^{1}12\ a\ e\ F^{1}2.$

$a64= P^{T1}\ T^{1}12\ F^{1}.$

$a65= P^{T1}\ T^{1}22\ F^{I}.$

$a66= P^{T1}\ T^{1}12\ a\ F^{1}1\ Y^{1}.$

$a67= P^{T1}\ T^{1}12\ a\ F^{1}2\ Y^{I}.$

$a68= P^{T1}\ T^{1}12\ a\ F^{1}1\ Y^{1}1\ C^{1}\ c.$

$a71= P^{T2}((T^{2}1\ F^{1}11+F^{1}12\ T^{2}11\ (1-a))c(Y^{1}1)^{2}+T^{2}1F^{1}1Y^{1}11)\ f.$

$a72= P^{T2}\ F^{1}1\ Y^{1}1\ T^{2}12\ (1-b).$

$a73= P^{T2}\ (T^{2}1\ F^{1}12\ +F^{1}1\ F^{1}2\ T^{2}11\ (1-a))\ Y^{1}1\ e.$

$a74=-P^{T2}\ F^{1}1\ Y^{1}1\ T^{2}11\ F^{1}.$

$a75=-P^{T2}\ F^{1}1\ Y^{1}1\ T^{2}12\ F^{I}.$

$a76= P^{T2}\ (T^{2}1\ F^{1}11\ +(F^{1}1)^{2}\ T^{2}11\ (1-a))\ Y^{1}1\ Y^{1}.$

$a77= P^{T2}\ (T^{2}1\ F^{1}12\ +F^{1}1\ F^{1}2\ T^{2}11\ (1-a))\ Y^{1}1\ Y^{I}.$

$a78= P^{T2}\ ((T^{2}1F^{1}11+(F^{1}1)^{2}T^{2}11(1-a))c(Y^{1}1)^{2}+T^{2}1F^{1}1Y^{1}11)\ C^{1}.$

$a81= P^{T2}\ (T^{2}1\ F^{1}12\ +F^{1}1\ F^{1}2\ T^{2}11\ (1-a))\ c\ f\ Y^{1}1.$

$a82= P^{T2}\ F^{1}2\ T^{2}12\ (1-b).$

$a83= P^{T2}\ (T^{2}1\ F^{1}22\ +(F^{1}2)^{2}\ T^{2}11\ (1-a))\ q.$

$a84=-P^{T2}\ F^{1}2\ T^{2}11\ F^{1}.$

$a85=-P^{T2}\ F^{1}2\ T^{2}12\ F^{I}.$

$a86= P^{T2}\ (T^{2}1\ F^{1}12\ +F^{1}1\ F^{1}2\ T^{2}11\ (1-a))\ Y^{1}.$

$a87= P^{T2}\ (T^{2}1\ F^{1}22\ +(F^{1}2)^{2}\ T^{2}11\ (1-a))\ Y^{I}.$

$a88= P^{T2}\ (T^{2}1\ F^{1}12\ +F^{1}1\ F^{1}2\ T^{2}11\ (1-a))\ c\ C^{1}\ Y^{1}1.$

2.5 Signs of parameters (II).

In order to partly offset the difficulty of obtaining intuitive solutions, an alternative comparative static study was conducted assuming that producers decide aggregated input factor levels first, then make decisions on the allocation of each input factors.

The first order conditions are collapsed into the following three equations.

$$P^{T1}\ T^{2}1\ F^{1}1\ Y^{1}1 = P^{C1d}.$$
$$P^{T2}\ T^{2}1\ F^{1}2 = P^{YId}.$$
$$P^{T1}\ T^{1}2 = P^{FI}.$$

Totally differentiating and solving for dC^{1}, dY^{I}, and dF^{I}, yields the following relation:

$$dC^{1} = D[e\ P^{T1}\ P^{T2}\ [(F^{1}2)^{2}\ K1 - b\ T^{1}22\ T^{2}1\ F^{1}22]\ dP^{C1d}$$
$$-e\ P^{T1}\ P^{T2}\ T^{2}1\ F^{1}1\ Y^{1}1\ [(F^{1}2)^{2}\ K1 - b\ T^{1}22\ T^{2}1\ F^{1}22$$
$$+e(1-b)\ P^{T2}\ P^{T1}\ Y^{1}1\ (T^{2}1)^{2}\ T^{2}12\ K2\ T^{1}2]\ dP^{T1}$$
$$-(P^{T1})^{2}\ Y^{1}1\ e\ [F^{1}1\ F^{1}2\ K1 - b\ T^{1}22\ T^{2}1\ F^{1}12]\ dP^{YId}$$
$$+(P^{T1})^{2}\ Y^{1}1\ e\ T^{2}1\ F^{1}2\ [F^{1}1\ F^{1}2\ K1 - b\ T^{1}22\ T^{2}1\ F^{1}12]\ dP^{T2}$$
$$-e(1-b)\ P^{T2}\ P^{T1}\ Y^{1}1\ (T^{2}1)^{2}\ T^{2}12\ K2\ dP^{FI}].$$

where D is the inverse of the determinant, D>0, and K1-2 are defined as follows.

$$K1 = [(1-b)a\ T^{1}12\ T^{2}12 - (1-a)b\ T^{1}22\ T^{2}11].$$

$$K2 = [F^{1}12\ F^{1}2 - F^{1}22\ F^{1}1]$$

It is assumed that demand for cotton responds to its own price negatively. In order to have this negative relation, it is assumed that $K1 < 0$.

For changes in local and export textile output price, the directions of changes in demand for cotton are determined by textile, fabric and yarn production technologies. Cotton demand is not necessarily positively related to a change in textile prices, as seen in the above equation. For a change in yarn import price and a change in export textile price, cotton demand responds in the opposite direction, but a specific direction can not be given. For a positive change in fabric import price, cotton demand responds positively, when $K2 < 0$ and the two types of fabric inputs are complements.

Comparative static gives the following relation as a solution of the yarn import:

$$
\begin{aligned}
&dY^{I}=D(cfP^{T1}\ P^{T2}\ Y^{1}1[-F^{1}1F^{1}2K1+bT^{1}22\\
&T^{2}1F^{1}12][dP^{C1d}-T^{2}1F^{1}1Y^{1}1dP^{T1}]\\
&+f(P^{T1})^{2}[bT^{1}22T^{2}1[F^{1}1Y^{1}11+c(Y^{1}1)^{2}F^{1}11]-c(Y^{1}1)^{2}(F^{1}1)^{2}K1]\\
&[-dP^{YId}+T^{2}1F^{1}2dP^{T2}]\\
&+(1-b)fP^{T1}P^{T2}T^{2}1T^{2}12[c(Y^{1}1)^{2}(F^{1}1F^{1}12-F^{1}11F^{1}2)-F^{1}1F^{1}2Y^{1}11]\\
&[-dP^{FI}+T^{1}2dP^{T1}]).
\end{aligned}
$$

An increase in export textile price gives a positive change in yarn import, while an increase in own price (yarn import price) reduces yarn imports. Increased domestic textile price likely results as the level of yarn import increase. An increased fabric import price causes increased level of yarn imports. The directions of changes in yarn imports caused by an increased domestic textile price and an increased cotton price depend on the sign of following relation.

$$[-F^1 1F^1 2K1+bT^1 22T^2 1F^1 12]$$

When the above relation is negative, then the yarn import level increases with an increased domestic textile price without ambiguity, and cotton price gives a negative impact. But when the above relation has a positive value, an increase in cotton price results as an increased level of yarn imports, while the direction of change in yarn import caused by an increased local textile price is indeterminate.

The comparative static results in the following relation for the fabric import:

$$dF^I=D(acefP^{T1}P^{T2}T^1 12Y^1 1T^2 1K2[-dP^{C1d}+T^2 1F^1 1Y^1 1dP^{T1}]$$

$$+[aef(P^{T1})^2 T^1 12T^2 1(c(Y^1 1)^2(F^1 1F^1 12-F^1 2F^1 11)-F^1 2F^1 1Y^1 11)]$$

$$[-dP^{YId}+T^2 1F^1 2dP^{T2}]$$

$$+efP^{T1}P^{T2}T^2 1[F^1 1Y^1 11((1-a)T^2 11(F^1 2)^2+T^2 1F^1 22)$$

$$+(1-a)cT^2 11(Y^1 1)^2(F^1 22(F^1 1)^2+(F^1 2)^2 F^1 11-2F^1 2F^1 1F^1 12)$$

$$+cT^2 1(Y^1 1)^2(F^1 11F^1 22-(F^1 12)^2)][-dP^{FI}+T^1 2dP^{T1}]).$$

For an increased yarn import price, fabric imports most likely decreases and an increase in export textile price causes an increase in fabric imports, as long as the two types of fabric inputs are related as complements. An increased cotton price causes a positive change in the level of fabric import. The effect of an increase in domestic textile price is not clear. There are oppositely directed movements. One element is related to fabric production stage and causes a negative movement, and the other element is more related to textile production stage and causes a positive movement. The total effect depends on production technologies.

3. Textile demand under textile imports control

When an importing country controls textile import quantity, the users'/consumers' demand equation includes a variable that reflects the quantity permitted for import. This is represented in the following utility maximization problem. Consumption decisions are made to maximize sub-utility subject to two constraints: an income constraint and a quantity constraint. (An assumption that total utility is a function of the subutility function and that each of the subutility functions is separable from others is maintained).

$$L=U_{tex}(F, G)+\lambda_1(Y^A- P^{T1}F -P^{TI}G) +\lambda_2(\Sigma_j G_j -G).$$

The solutions of this utility maximization problem yields the following textile demand equations.

$$F=F(P^{T1}, P^{TI}, Y^A, \Sigma_j G_j),$$

and $G=G(P^{T1}, P^{T1}, Y^A, \Sigma_j G_j)$.

where,

$\Sigma_j G_j$: Sum of the import quotas which set for textile exporting country (j)

F	:	Quantity demanded for the locally produced textile
G	:	Quantity demanded for the imported textile
P^{Tl}	:	Price of locally produced textile product
P^{TI}	:	Price of imported textile products
Y^{A}	:	Income allocated to textile consumption.

When the second constraint is binding, consumers in the i-th region pay a higher price for the imported textile and the magnitude of this price difference is λ_2. Since the level of λ_2 is expressed with the same argument of textile demand, the price linkage equation which connects the trade market price and the import price may also include the same argument to explain systematic deviation of import price from trade market price.

Effects of import quotas on domestic product use level is indeterminate, as it depends on the shape of the utility function.

4. Cotton Market Model

4.1. US cotton planted acreage

Consider the objective function as:

$$L=\max_A \int U[\Sigma(p_i q_i A_i - c_i(q_i A_i))h_i(p_i, q_i | z)]\ dp\ dq,$$

where,

p_i	:	Uncertain output price
q_i	:	Uncertain yield
$h(p_i, q_i \| z)$	:	Probability distribution function of output price and yield with exogenously given z
z	:	Vector of exogenous variables (government policy variables are included in this vector)

A_i	:	Choice variable of this expected utility maximization problem and represents land area allocated to the i-th production activity
$c_i(q_iA_i)$	:	Variable cost of production
U	:	Twice differentiable utility function
i	:	Index assigned for each type of production activities.

With this specification, it is assumed that the cotton producer has an opportunity to engage in multiple production activities. In each of the activities he faces uncertain costs of production to achieve "q_iA_i" level of production since the cost depends on uncertain environmental conditions (this is different from Grandt where he considered cost of production with certainty). It is further assumed that the producer does not face constraints on total availability of land.

This expected utility maximization problem yields the following first order conditions:

$$E[(p_iq_i - c'_iq_i)U'] = 0, \ i=1...n.$$

In order to have an optimal solution, it is assumed that the utility function holds the properties that, $U'>0$, $U''< 0$, i.e., farm's attitude toward risk is assumed as risk averse, and $c_i''\geq 0$, i.e., the cost function exhibits a non-decreasing marginal cost, although this is not a necessary and sufficient condition to meet the second order condition. The Hessian matrix should be negative semi definite to obtain the solution, and this implies the following necessary conditions:

$E[(p_i\ q_i\ -q_i c'_i)^2 U''\ -q_i^2 c''_i U'] \leq 0,\ i=1...n.$

Using a relation that, $E[XY]=E[X]E[Y]+cov(X,Y)$, the above first order conditions are rewritten as,

$$E[p_i]E[q_i]\ -E[c'_i]E[q_i]\ +cov(p_i,q_i)\ -cov(c'_i,q_i)$$
$$=-cov(U',(p_i q_i - q_i c'_i))/E[U'],\ i=1...n.$$

From this condition, it is seen that, depending on the shape of the utility function, the level of input usage varies and the size of the deviations from the "certain case" is determined by unobservable covariance terms and by the shape of the utility function.

Stein's theorem provides the following relation for stochastic variables (X, Y), provided that X is normally distributed (see Grandt, or Marra and Carlson).

$$cov(f(X),Y)=E[f'(X)]cov(X,Y).$$

Assuming that the probability distribution of total profit, which is a random variable, is normal and applying Stein's theorem yields the following equation:

$$cov(U'(\pi),(p_i q_i - q_i c'_i))$$
$$=E[U''(\pi)]\ cov(\pi,(p_i q_i - q_i c'_i)).$$

This relation is further modified by plugging the following relation in place of the profit (π).

$$\pi=\Sigma[A_i p_i q_i - c_i(A_i q_i)].$$

Then, the covariance term in the first order conditions is further developed as:

$$\mathrm{cov}(U'(\pi),(p_iq_i-q_ic'_i)$$

$$=E[U''](\Sigma A_k(\mathrm{cov}(p_iq_i,p_kq_k)-\mathrm{cov}(q_ic'_i,p_kq_k))$$

$$+\Sigma\mathrm{cov}(c_k,q_ic'_i)-\Sigma\mathrm{cov}(c_k,p_iq_i)+A_i\mathrm{var}(p_iq_i)$$

$$-\mathrm{cov}(p_iq_i,c_i)-A_i\mathrm{cov}(p_iq_i,q_ic'_i)+\mathrm{cov}(c_i,q_ic'_i)),$$

$$k=1..n,\ k\neq i.$$

Therefore, the first order conditions are modified as follows.

$$E[p_i]E[q_i]\ -E[c'_i]E[q_i]\ +\mathrm{cov}(p_i,q_i)\ -\mathrm{cov}(c'_i,q_i)$$

$$=-[\Sigma A_k(\mathrm{cov}(p_iq_i,p_kq_k)-\mathrm{cov}(q_ic'_i,p_kq_k))$$

$$+\Sigma\mathrm{cov}(c_k,q_ic'_i)-\Sigma\mathrm{cov}(c_k,p_iq_i)+A_i\mathrm{var}(p_iq_i)$$

$$-\mathrm{cov}(p_iq_i,c_i)\ -A_i\mathrm{cov}(p_iq_i,q_ic'_i)$$

$$+\mathrm{cov}(c_i,q_ic'_i))](E[U'']/E[U']),$$

$$i=1...n,\ k=1..n,\ k\neq i.$$

In a special case, where the cost function is homogeneous in acreage, i.e., $c(q_iA_i)=A_ic(q_i)$, the following first order conditions are obtained after the same application of Stein's theorem:

$$E[p_i]E[q_i]\ -E[c_i]\ +\mathrm{cov}(p_i,q_i)$$

$$=-[\Sigma A_k(\mathrm{cov}(NR_i,NR_k)+A_i\mathrm{var}(NR_i)](E[U'']/E[U']),$$

$i=1...n$, $k=1..n$, $k\neq i$, where E is an expectation operator, and $NR_{i,k}=p_{i,k}q_{i,k}-c(q_{i,k})$.

When facing an increase in variable cost of production ($dEc_i>0$), it is assumed that $d(\mathrm{var}(NR_i))>0$, $d((Ep_iEq_i-Ec_i))\leq 0$, and $d(\mathrm{cov}(p_i,q_i))\leq 0$, the cotton farmer allocates land over the k-th production activity so that $d(\Sigma A_k(cov(NR_i,NR_k)))<0$, i.e., an increase in expected production cost causes diversification of production.

The observed cotton planted acreage (T) is composed of cotton program participant acreage (P) and non-participant acreage. In analyzing planting acreage responses to the cotton program, the participants' acreage is formulated as a product of farm program base acreage (BASE), set aside and diversion requirement ratio $(1-\alpha)$, and the participation rate in the program (β):

$$P=BASE(1-\alpha)\beta.$$

That is the participant's planted acreage is constrained by the size of $BASE(1-\alpha)$. By defining NR^*_i, such that

$$NR^*_i=E[p_i]E[q_i]-E[c_i],$$

and assuming cost functions are approximately homogeneous in acreage, the total planted acreage of cotton is estimated in the following fixed risk effects estimation form, i.e., $E[U'']/E[U']$ is assumed to be constant.

$$T=T(NR^*_i,B(1-\alpha),cov(p_i,q_i),cov(NR_i,NR_k),var(NR_i)),$$

where, i,k=cotton under program, cotton outside program, and other competing productions, $k\neq i$. The first moment of the truncated price and yield distribution under farm programs could be reflected in NR^*_i (see Chavas and Holt for this discussion). At the same time, this treatment allows us to incorporate all of the farm program variables in a single variable.

4.2 US cotton stock equation

The sources of stock are the current crop year's production and carry-over stock. With an assumption that farms or intermediate farm product agents make their decision whether to sell in the market or to store in order to maximize their expected profit, the current market price, an expected market price in next period, and the cost for carrying over to the next marketing year are the basic elements to explain stock activity.

However, there are a few elements to add complexity. In the case of US cotton, there are two types of stock activities, government stock and non-government stocks. US cotton farms can put their products into the government stock only when they participate in the cotton program. The farmers are allowed to repay the loan or forfeiting the commodity. In this sense, relevant determinants are associated with conditions for participation in programs and for repayment. If market price is rising, the chance to forfeit becomes smaller. If the interest rate is high, there will be a larger chance of eliminating profitability by repaying with cash, when they are required to pay storage costs for the government. When yield is high, farmers are more likely to put products in storage. Furthermore if an assumption that the US is a residual supplier of cotton to the world market, the level of exports is considered as exogenous to the US cotton market, which reduces the quantity marketed in the US cotton market. As for non-government stocks, it is assumed that there are few elements to connect stock activity of cotton mills, i.e., cotton mill operators do not carry the inventory to operate.

The following profit maximization problem is considered by assuming the existence of a regional market agent to identify explanatory variables:

$$\pi=\alpha E+pM+(f(p)-p(1+s+i))S-p_tF_t-p_{t-1}(1+s_{t-1}+i_{t-1}))S_{t-1}$$
$$-\chi I+\lambda(F+S_{t-1}+I-E-M-S).$$

where,

α	: Cotton export price
E	: Cotton exports
p	: Cotton market price in the region
M	: Cotton mill use
f(p)	: Expected market price in next crop year
s	: Storage cost
i	: Interest rate
S	: Ending stock
F	: Production of cotton
χ	: Import price of cotton
I	: Import of cotton.

In each crop year, the agent behaves to maximize his profit by selecting E,S,M.

It is assumed that the level of production of cotton (F) is predetermined because of a biological condition between production decision and harvest. The decision on the carried over stock (S_{t-1}) was made in the last crop year, and the import (I) decision is made by textile producers. It is also assumed that the cotton market is competitive.

Then the stock equation is explained by:

$(\alpha, p, p_{t-1}, \chi, s, i, s_{t-1}, i_{t-1})$ and (F, I, S_{t-1}).

Chapter 4. Theoretical Trade Model

1. Assumption and corresponding implication for trade price

The model developed in this paper attempts to explain trade market behaviors by using three types of prices within a non-spatial partial equilibrium model framework. An assumption is introduced for consumers tastes and preferences for textile product use to provide a basis for considering the three types of prices. For the consumers, it is assumed that imported and domestically produced textiles are different.

By introducing an assumption that traded products are differentiated from domestically produced and supplied products, we could consider three different price movements for any single product. That is, we could observe a price for the good which is locally produced and locally marketed, a price for the good which is imported, and a price for the good which is exported. For example, in the case of the US cotton market, there exists a US cotton import price, a US cotton export price, and a US cotton market price.

The prices of imported, exported, and locally marketed products could exhibit completely different movements. These price differentials may be explained by a time element in data aggregation, transportation costs, tastes and preferences, or market structures. It is also clear that where trade controls exist, import and export prices differ by tax equivalents in addition to the above mentioned elements.

2. A theoretical framework

First a general equation form is considered, then a theoretical specification is applied to explain the model in a two country case.

Define the following variables to describe the model.

Activity levels:

Textile supply for local market	: E
Textile demand, for local made	: F
Textile demand, for imports	: G
Textile supply for exports	: H
Semifinished good for exports	: J
Semifinished imported good demand	: K
Cotton production	: Q
Cotton demand, for imports	: R
Cotton exports	: S
Cotton ending stock	: T
Cotton supply, for imports	: V
Cotton demand mill use	: W

Prices:

Local textile price	: α
Exported textile price	: β
Semifinished good export price	: δ
Imported textile price	: ϵ
Semifinished good import price	: ϕ
Cotton price, for local cotton	: μ
Cotton price, for exports	: σ
Cotton price, for imports	: τ
Other input price vector	: ρ

Notation on the traded quantity:

G^A_B denotes imported textile by country A from country B, and similarly, H^A_B denotes exported textile from country A to country B.

This study proposes theoretical deliberations to analyze the trades of differentiated products in the non-spatial market equilibrium model framework.

There are at least two unique features to be enumerated in studying cotton trades. First, demand for imported cotton is explained as a derived demand for textile production. Second, the world cotton trade market consists of a large number of importers as well as exporters. This latter characteristic suggests that the cotton trade market operates under competitive market conditions.

This study proposes two types of approach to explain trades of differentiated products within the non-spatial trade model framework. The first type of approach proposed in this study is applied to explain cotton trade with assumptions: the cotton trade market is operated under competitive market conditions and, at the same time, the demand for imported cotton is explained as a differentiated demand. Sources of the differentiation are explained by production technologies of the textile industries. The analytical framework was constructed by first assuming demands that traded goods are distinguishable by country of origin, but are traded as near homogeneous products in a competitive trade market structure.

Previous studies which incorporated product differentiation constructed their analytical framework by focusing on the market shares in the importing countries, thus they failed to count the sources of differentiation.

An assumption that consumers put different tastes and preferences on domestically produced and marketed products and imported products provides a formal way to explain inter-industry trade and also provides an alternative reflection on the role of trade price. Although explanations are provided for the observed price differentials, few attempts were made to exploit these observed price differentials in empirical studies.

The second type of approach proposed in this paper stands on an assumption that traded goods are homogeneous, i.e., importers only concede differences between imported and locally produced goods. Similarly suppliers have a single channel to the trade market. This framework was presented as an explanation of textile products trade.

Assumptions

A consumer in country A maximizes utility subject to a budget constraint, given in the following form:

$$U^A=U^A(u_1(F^A,G^A),u_2:z^A), \quad s.t. \quad F^A\alpha^A+G^A\epsilon^A < Y^A.$$

where,

U^A : Separable utility function
u_i : Sub-utility functions, i=1,2.
F^A : Use level of locally produced textile
G^A : Use level of imported textile
α^A : Price of local textile
ϵ^A : Price of imported textile
z^A : Vector of shift variables
Y^A : Budget allocated to total textile use.
superscript "A" denotes a country.

Utility maximization of these relationships yields the following demand equations for each type of textile.

$$F^A=F^A(\alpha^A,\ \epsilon^A,\ Y^A:\ z^A),\ \text{and}\ G^A=G^A(\alpha^A,\ \epsilon^A,\ Y^A:\ z^A).$$

These demand equations provide a basis for considering a differentiated product market as long as the product prices move differently.

(In the following discussions, superscripts which indicate the country will be dropped for simplification, since discussions focus on the activities within each of the countries.)

The textile producer behaves to maximize profit, which is defined as follows:

$$\pi=\alpha E(W_E,R_E,C_E)+\beta H(W_H,R_H,C_H)-\mu(W_E+W_H)-\tau(R_E+R_H)-\rho(C_E+C_H),$$

where,

E : Textile production for local market
H : Textile production for exports
α : Local textile price
β : Export textile price
τ : Imported cotton price
μ : local cotton price
ρ : Input price vector.
$R_{E,H}$: Imported cotton inputs in (E,H) production
$W_{E,H}$: Local cotton use in (E,H) production
$C_{E,H}$: Other inputs factors in (E,H) production

This profit maximization problem yields following output supply and input demand equations as a function of all output and input prices under certain conditions, for example, imposing a constraint on the total level of input use.

$X=X(\alpha,\beta,\mu,\tau:\rho)$, where $X=E$, H, W, R.

To model the behavior of the cotton trade market under product differentiation and competitive market structure conditions, assume that there exists an agent that handles cotton traded in the cotton trade market. That agent purchases cotton from exporting countries and sells that cotton to importing countries.

An empirical observation that countries are importing cotton from various sources of origin is interpreted as a reflection of the agent's production activities to provide services that meet the importers' tastes and preferences. That is the agent has a production function: his outputs are imported cotton, and his inputs are exported cotton. His profit function is given as:

$\pi=\tau V-\sigma S$, and $V=V(S)$,

where,

τ : Vector of cotton selling prices (import price)
V : Vector of production functions which explains cotton supplied to the importing country (that is cotton imported)
σ : Vector of cotton purchasing price (export price)
S : Vector of the inputs (cotton exported), and choice variables of this profit maximization problem.

First order conditions for this profit maximization problem are:

$\tau^j V^j_i = \sigma_i$,

where the superscripts denote destination (cotton importers), and the subscripts denote the sources of the traded good (cotton exporters). In order to maximize profit, the Hessian matrix is assumed negative semi-definite. From the first order conditions, traded quantities are explained by import and export prices of cotton.

The development of the discussion to explain the world cotton trade critically depends on a specification of the form of the production function of an hypothesized market agent. One could use the following logic: since inputs and outputs of the production function are measured in the same units, the proposed production function must take an additive functional form, thus the objective function is incorrectly specified. For example, if countries A and B export cars to country C, then total number of imported cars from A, B is given as a sum.

The proposed model is constructed by relying on the following logic. Country A exports steel sheets, and country B exports steel rods to country C. The hypothesized agent is assumed to provide assemble services with the sheets and rods before he delivers to country C. Total imported steel to country C is given as a sum of the weights of sheets and rods.

3. Models with two country setting

Cotton regional market

The cotton market of country A is in equilibrium when the following condition holds.

$$Q+R-W-S+(T_{t-1}-T)=0,$$

where,

Q	:	Production
R	:	Imports
W	:	Domestic mill use
S	:	Exports
T_{t-1}	:	Beginning stocks
T	:	Ending stock defined as $T=T(\mu:m)$, where m is a vector of shift variables.

It was assumed that cotton production decisions are made to maximize producer's expected utility, as there exist output price and yield uncertainties. Given this assumption, current year cotton price, μ, is replaced with an expected cotton price. Thus, cotton production is given as, $Q=Q(\mu^*: x)$,

where μ^* is an expected cotton market price and x is a vector of shift variables, including governmental farm program variables.

To simplify the overall model structure, replace regional imported cotton markets with reduced form cotton trade equations. From profit maximization of textile productions, demand for imported cotton of country A was specified as:

$$R^A=R^A(\tau^A:\ \alpha^A,\beta^A,\mu^A,:\ \rho^A),$$

and from profit maximization of the cotton trade agent, supply of imported cotton to country A is given as,

$$V_A=V_A(\tau^A:\ \sigma^A,\sigma^B,\tau^B)$$

An imported cotton market in country A is cleared with τ^A such that,

$$R^A(\tau^A:\ \alpha^A,\beta^A,\mu^A:\ \rho^A)=V_A(\tau^A:\ \sigma^A,\sigma^B,\tau^B).$$

As the similar relation is defined for τ^B, solving these imported cotton market equilibrium conditions for the imported cotton market clearing prices, $(\tau^{A*},\ \tau^{B*})$, yields:

$$\tau^{A*}=\tau^{A*}(\sigma^A,\sigma^B,\alpha^A,\beta^A,\mu^A,\rho^A,\alpha^B,\beta^B,\mu^B,\rho^B).$$

Evaluating the original cotton import equation at the equilibrium level of cotton import price yields the cotton import equation in reduced form:

$$R^A=R^A(\sigma^A,\sigma^B,\alpha^A,\beta^A,\mu^A,\rho^A,\alpha^B,\beta^B,\mu^B,\rho^B).$$

Similarly, the cotton export equation of country A is specified as:

$$S_A=S_A(\sigma^A,\sigma^B:\alpha^A,\beta^A,\mu^A,\rho^A,\alpha^B,\beta^B,\mu^B,\rho^B).$$

It is worth noting that an alternative reduced form cotton import equation is obtained by evaluating the original imported cotton supply equation, V_B, at $(\tau^{A*},\ \tau^{B*})$ yields:

$$V_B=V_B(\sigma^A,\sigma^B,\alpha^A,\beta^A,\mu^A,\rho^A,\alpha^B,\beta^B,\mu^B,\rho^B).$$

In this study, the cotton import equation is specified as a demand equation in order to emphasize the nature of cotton trades.

Thus to clear the cotton trade market requires the following condition:

$$(1) \quad S_A(\sigma^A,\sigma^B:\alpha^A,\beta^A,\mu^A,\rho^A,\alpha^B,\beta^B,\mu^B,\rho^B)$$
$$-R^B(\sigma^A,\sigma^B,\alpha^A,\beta^A,\mu^A,\rho^A,\alpha^B,\beta^B,\mu^B,\rho^B)$$
$$+S_B(\sigma^A,\sigma^B:\alpha^A,\beta^A,\mu^A,\rho^A,\alpha^B,\beta^B,\mu^B,\rho^B)$$
$$-R^A(\sigma^A,\sigma^B,\alpha^A,\beta^A,\mu^A,\rho^A,\alpha^B,\beta^B,\mu^B,\rho^B)=0.$$

Substituting elements yields the following regional market clearing conditions for country A:

$$(2) \quad Q^A(\mu^{*,A}:x^A)+R^A(\mu^A:\sigma^A,\sigma^B,\alpha^A,\beta^A,\rho^A,\alpha^B,\beta^B,\mu^B,\rho^B)$$
$$-W^A(\mu^A:\tau^A,\alpha^A,\beta^A,\rho^A) \qquad -S_A(\mu^A:\sigma^A,\sigma^B:\alpha^A,\beta^A,\rho^A,\alpha^B,\beta^B,\mu^B,\rho^B)$$
$$+(T^A{}_{t-1}(\mu^A{}_{t-1},m^A{}_{t-1})-T^A{}_t(\mu^A,m^A))=0,$$

Because of cotton trade activities, the cotton market equilibrium condition in country A involves variables of textile markets in countries A and B, as well as the cotton markets in countries A and B.

Regional textile market

The regional textile market handles only the locally made textile marketed in the local market. Thus, the following conditions are clear:

$$(3) \quad E^A(\alpha^A:\ \beta^A,\mu^A,\tau^A:\ \rho^A)=F^A(\alpha^A:\ \epsilon^A,\ Y^A:\ z^A),$$

$$(4) \quad E^B(\alpha^B:\ \beta^B,\mu^B,\tau^B:\ \rho^B)=F^B(\alpha^B:\ \epsilon^B,\ Y^B:\ z^B).$$

Textile Trade market

In the textile trade market, exports of textile from country B to country A is equated to a demand for imported textile of country A. Country B's textile export price does not necessarily move together with country A's textile import price. That is textile export decisions are made based on export prices received. Similarly demand for imported textile is considered as a function of imported textile price.

$$(5)\quad G^A_B(\epsilon^A:\ \alpha^A,\ Y^A:\ z^A)-H^B_A(\beta^B:\ \alpha^B,\mu^B,\tau^B:\ \rho^B)$$
$$+G^B_A(\epsilon^B:\ \alpha^B,\ Y^B:\ z^B)-H^A_B(\beta^A:\ \alpha^A,\mu^A,\tau^A:\ \rho^A)=0.$$

After introducing trade price linkage equations, a system of equations comprised of equations (1,2,3,4,5) can be solved for the regional textile market prices (α^A,α^B) the textile trade market prices ($\epsilon^A,\beta^A,\epsilon^B,\beta^B$), the regional cotton market prices (μ^A,μ^B) and a cotton trade price (σ^A,σ^B).

4. The bias in solution values

Because of the availability of trade data, the trade market equilibrium condition is specified as a single condition where the differentiated products are considered, i.e., the proposed trade model is designed in a non-spatial equilibrium model framework, while discussions indicate a spatial equilibrium setting. Because of this specification, obtained solutions are not freed from bias caused by market aggregation. This section discusses the aggregation bias associated with the specification. For simplicity, consider the problem with the following two goods linear market model.

$$Q^S_i=a_i+b_ip_i,\ Q^D_i=c_i+d_ip_i.\quad i=1,2.$$

An export volume of good i is specified as Q^S_i, and Q^D_i denotes an import volume of good i, where p_i is a trade price. The equilibrium level of price for each of the markets is given as:

$$p_i=(c_i-a_i)/(b_i-d_i),\ i=1,\ 2.$$

Alternatively, consider a case where the two markets are aggregated into one market and solve for one market clearing price. Suppose the market clearing prices are related as:

$$p_i=q\theta_i,$$

where,

q	: Market price of the aggregated market
θ_i	: Degree of product differentiations
p_i	: Market prices in each of the markets.

Then the market clearing condition and clearing price are given as follows:

$$Q^S_1+Q^S_2=Q^D_1+Q^D_2$$

$$\text{or}\quad a_1+b_1q\theta_1+a_2+b_2q\theta_2=c_1+d_1q\theta_1+c_2+d_2q\theta_2,$$

$$\text{and}\quad q=[(c_1-a_1)+(c_2-a_2)]/[(b_1-d_1)\theta_1+(b_2-d_2)\theta_2].$$

Therefore, a bias in market price of good 1 is found as follows:

$$\theta_1q-p_1=[(b_1-d_1)(c_2-a_2)\theta_1-(c_1-a_1)(b_2-d_2)\theta_2]$$
$$/[(b_1-d_1)\theta_1+(b_2-d_2)\theta_2].$$

Direction and size of the bias are determined by the given size of parameters of the structural equations and the θs. The equilibrium price level in market 1 is positively (not/negatively) biased, if a ratio of product differentiations, $[\theta_1/\theta_2]$, is greater (equal/lessor) than (to/than)

$$[(c_1-a_1)(b_2-d_2) / (b_1-d_1)(c_2-a_2)],$$

which is equal to a ratio of the market equilibrium prices, $[p_1/p_2]$. The size of the bias is large when larger product differentiation exists. The directions of the bias are indeterminate.

From above, we could conclude that without having information about specific trade flows, we are not able to determine or select the value of θs in a specific way. Thus the recovered vectors of separated market equilibrium prices, which are obtained from a vector of product differentiation and the market equilibrium prices for the aggregated market, are biased.

The proposed single market equilibrium condition associated with the market aggregation procedure can be supported as follows. Denote Y_{ij} as imports of the good from region j to region i, and Y_i as an total import by i, i.e., $Y_i=\Sigma_j Y_{ij}$. Suppose that the share of imports from j in a region i to it's total imports is proportionate to the exports market share of j to total world exports. (As will be seen below, this is an assumption which generates the equivalent market equilibrium condition of the single market framework under a disaggregated market framework.)

$$Y_{ij}/Y_i=(X_j/\Sigma_j X_j),$$

or $Y_{ij}=Y_i(X_j/\Sigma_j X_j)$.

The market equilibrium condition for the export good market from j is defined by equating the sum of the total imports from j to the exports from j.

$$X_j = \Sigma_i Y_{ij}.$$

Therefore, by replacing Y_{ij} with the above relation, the market equilibrium condition can be rewritten as:

$$X_j = \Sigma_i (Y_i (X_j / \Sigma_j X_j)).$$

This condition is equivalent to:

$$\Sigma_j X_j = \Sigma_i Y_i.$$

5. Discussions.

5.1 Price elasticities of trade with cross hauling

The following measure is presented to analyze the degree of cross hauling activity.

$$M = 1 - (H - G)/(H + G).$$

where,

H : Level of exports
G : Level of imports.

If a country is a pure importer, the measure is 2, and if a country is pure exporter the measure is 0. A country which exhibits a significant amount of cross hauling shows a number close to 1. In world textile and cotton trades, a few countries reflect a trade pattern that has received considerable attention. In 1986, levels of cross hauling trade activities for studied commodities were observed as follows.

Table 1. Cross hauling trades in 1986

	Cotton	Textile	Fabric	Yarn
Brazil	0.97	-	-	-
Hong Kong	1.60	-	-	-
Egypt	1.75	-	-	-
EC	1.79	1.25	0.97	1.03
US	0.02	1.83	1.36	0.98
Japan	2.00	1.76	0.43	1.04

The point of question with regard to the net trade position where cross hauling exists is seen with the following hypothesized model.

Let the demand for the imported good and supply of the exported good be denoted as follows:

Demand for import good $G(\epsilon, z1)$, $G'<0$,

Export $H(\beta, z2)$, $H'>0$,

where,

G : Imports to a region
H : Exports from the region
ϵ : Import price
β : Export price
z's : Shift variables.

Suppose further that trade prices are related to regional market price, α, as follows.

$\epsilon=\epsilon(\alpha,\ z3)$, $\beta=\beta(\alpha,\ z4)$,

where z3, and z4 are shift variables.

Net import (NI) is defined as G-H. The partial derivative of NI with respect to regional market price (α) is given as (G-H)', thus the price elasticity of net imports with respect to α is given as follows:

$$e=(G-H)'(\alpha/(G-H))=(G'\epsilon'-H'\beta')(\alpha/(G-H)).$$

On the other hand, when the two activities are separated, the equivalent price elasticity of net imports with respect to regional market price is defined as the difference of the import price elasticity and the export price elasticity:

$$e^*=G'\epsilon'(\alpha/G)-H'\beta'(\alpha/H).$$

Therefore, a possible difference between the two approaches is shown as follows:

$$e-e^*= (G'\epsilon'-H'\beta')(\alpha/(G-H)) - G'\epsilon'(\alpha/G) +H'\beta'(\alpha/H)$$
$$=[\alpha/GH(G-H)][(G'\epsilon'-H'\beta')(GH-G+H)],$$

i.e., the results from the two approaches most likely differ, although the results are identical when import (export) is large enough, relative to export (import).

5.2. Hypothesized conditions to explain the cross hauling.

The introduction of the import and export equations to the model causes a deviation from the general form of the PEM model. The PEM model, in general, treats goods as homogeneous. That provides a rationale for considering market equilibrium conditions with excess supply and demand equations.

The introduction of the cross hauling or inter-industry trade equation is rationalized by an assumption that consumers in a region assign different tastes and preferences to regionally produced and marketed products than to those on imported products.

This section discusses assumptions of cotton trade that are introduced to provide a basis for building a model to explain the cross hauling trade activity within a partial equilibrium model framework. Throughout the discussions in this section, the cotton trade market is assumed as a competitive market.

The textile producer considers tastes and preferences to be different for the foreign source cotton relative to the local source cotton, for this reason these two cottons are not considered as homogeneous. With the assumption that the cotton trade agent behaves to maximize his profit and the assumption that cotton is a homogeneous good, the market pricing mechanism drives regional cotton import and regional cotton market prices into a single market clearing price, since marginal revenue (regional cotton import price) is equated to the corresponding marginal cost (regional cotton market price). Resulting price differences are explained as differences in market costs, rather than as differences in users' tastes and preferences. Therefore, the homogeneity assumption must be dropped under the competitive trade market condition.

Because the cotton trade agent could consider aggregated revenues over his multiple output production and an aggregated costs over his multiple inputs, there exist an aggregated input or output price and an aggregated output level, such that aggregated marginal revenue is equal to his aggregated marginal cost. In this sense the trade market model has a single world trade market clearing price but also contains multiple regional trade market prices.

An intuitive explanation could be given as follows. Import demand is characterized as pooled demand, that is the imported cotton could originate from various countries. The trade market provides "processing" to fit importers tastes. (This is the primary reason to hypothesize that imported cotton and locally marketed cotton are non-homogeneous.) Then, cotton exports from each of regions are considered as demand for cotton for "processing". Because importers' preferences are involved, export prices may move differently among exporting countries.

5.3 Price linkage equations

The linkage equations function to generate a trade price vector so that regional textile markets, textile products trade markets, the cotton trade market, and regional cotton markets realize equilibriums simultaneously.

An introduction of the hypothesized cotton trading agent with a corresponding production function yields first order conditions for the profit maximization problem that are functions of import and export prices of cotton. These conditions constitute a basis for considering the price linkage equation without losing the assumption that the traded cotton is non-homogeneous and defines the cotton trade market equilibrium condition with single condition.

Where the homogeneity assumption is adequate to apply, a trade market equilibrium condition is defined by single condition. However, by construction, it was assumed that any trading country exports and imports the differentiated textile products, otherwise the model will not explain inter-industry trade activities. Because of this construction, the price linkage equations include ingredients explaining product differentiations.

The prices of imported textiles (ϵ^i) and exported textiles (β^i) are assumed to be related to trade market clearing price (β^*). These linkage equations, under the differentiated good assumption, are specified in the following forms.

$$\epsilon^a = e^a[\beta^*(1+v^{ai})(1+q^{ai})+t^{ai}]+u^{ai}.$$

$$\beta^* = (1/e^a)[\beta^a(1+v^{ae})(1+q^{ae})+u^{ae}]+t^{ae}.$$

where,

ϵ^a	: Imported textile price in region "a"
e^a	: Exchange rate (market currency unit per trade currency unit)
β^*	: Trade market clearing price
v^{ai}	: Ad-valorem import tax
t^{ai}	: Transportation cost of imported textile from trade market to market "a"
u^{ai}	: Specific textile import tax
β^a	: Textile export price from region "a"
v^{ae}	: Ad-valorem textile export tax
t^{ae}	: Textile transportation cost from region "a" to trade market
u^{ae}	: Specific textile export tax

$q^{ae,ai}$: Trade price differences due to differences in tastes and preferences on traded goods.

By substituting the trade market price, β^*, with the export price of country b, β^b, the following modified forms of import and export price linkage equations are obtained.

$$\beta^a=(e^a/e^b)(1+v^{be})(1+q^{be})/[(1+v^{ae})(1+q^{ae})]\beta^b$$
$$+(e^a/e^b)u^{be}/[(1+v^{ae})(1+q^{ae})] +[e^a(t^{be}-t^{ae})-u^{ae}]/[(1+v^{ae})(1+q^{ae})].$$

$$\epsilon^a=(e^a/e^b)[(1+v^{ai})(1+q^{ai})(1+v^{be})(1+q^{be})]\beta^b$$
$$+(e^a/e^b)u^{be}(1+v^{ai})(1+q^{ai}) +e^a[t^{be}(1+v^{ai})(1+q^{ai})+t^{ai}]+u^{ai}.$$

With this treatment, it is seen that changes in exchange rates may not necessarily have immediate effects on trades, as exporters or importers may bring compensating pricing elements through the variable "q", which accord with observations made by Stiglitz (p.201) and Knetter (p.201).

For an empirical investigation, these trade price linkage equations are estimated in a simple form, assuming conditions that $v^{ae}=v^{be}=0$, $u^{ae}=u^{be}=0$, and $t^{ae}=0$.

$$\beta^a=[(e^a/e^b)(1+q^{be})\beta^b+e^at^{be}]/(1+q^{ae}).$$
$$\epsilon^a=[(e^a/e^b)(1+q^{be})\beta^b(1+v^{ai})(1+q^{ai})+e^at^{ai}+u^{ai}.$$

Chapter 5. Data

1. Data on cotton market

World cotton supply and demand quantity data were developed from USDA data tapes by aggregating over countries. Regional cotton supply and demand data for US, EC(12), and Japan were also collected from the same USDA data tape. The data set was arranged and reported on a US cotton year base (September-August).

Per unit values of imported and exported cotton lint data were computed from cotton trade data collected from the FAO's Trade Yearbook.

US spot market price of cotton and US farm price of cotton were taken from various issue of USDA's Cotton and Wool Situation and Outlook. Variables which relate to US cotton farm programs were taken from Fact Sheet of ASCS, USDA.

2. Textile market data.

Throughout the textile production process, "mixing" of fibers take place. Because of this production practice, it is not feasible to track product flows by types of fiber. This study follows a textile products grouping rule which is used by the United Nations in reporting industrial productions statistics.

Textile industry production statistics are reported in Industrial Statistics Yearbook from the United Nations by 6 digit International Standard Industrial Classification of all Economic Activities (ISIC). The yearbook reports data in different units of measure. For example, fabric production is reported in squared meters, or in meters and textile products are reported in pair of socks. The Yearbook does not cover all types of fabric production, (the Yearbook covers -- cotton woven, silk fabric, linen woven, cellulosic fiber woven, non-cellulosic fiber woven, and knitted fabric). Because of the availability of data, this study takes the sum of reported yarn productions as total yarn production and expresses textile market activities in a yarn equivalent weight unit.

The Yearbook reports the following types of yarn production.

Cotton yarn, pure and mixed	(ISIC 321109)
Wool yarn, pure and mixed	(ISIC 321103)
Flax and hemp yarn	(ISIC 321116)
Yarn of other vegetable textile fibers	(ISIC 321125)
Cellulosic continuous filament	(ISIC 351340)
Noncellulosic staple yarn	(ISIC 351304)
Cellulosic staple yarn	(ISIC 351307)
Noncellulosic continuous yarn	(ISIC 351337)
Yarn of man-made staple	(ISIC 321119)

The textile market data measured in yarn equivalent units is constructed, by assuming that the textile industry uses the following production process.

The total quantity of yarn produced in a region was assumed to be allocated for exports and for domestic use. The quantity of fabric produced in a region was assumed to be a sum of an imported yarn and locally marketed yarn. The sum of the locally produced fabric and imported fabric minus exported fabric was assumed to be a quantity of total textile produced in the region. This quantity is "total textile produced", in a sense that it includes the production of textiles for exports and textiles for domestic use. Two types of textile products are supplied to the region, and the "total supply" of textile in the region is given as the sum of textile produced for the region and textile imported to the region.

Following an hypothesized production process as above, it was necessary to incorporate yarn production data with textile products trade data to develop textile market data.

Textile product trade data were collected from the International Trade Statistics Yearbook, UN. The Yearbook reports data based on the Standard International Trade Classification Revised (SITC). Supplemental trade data were also collected from the Commodity Trade Statistics of the United Nations.

The SITC codes were revised in 1976 (Revision 2) and a further revision was made in 1989 (Revision 3), reflecting changes in international trade. In this paper, SITC refers to Revision 2.

The Yearbook reports trade activities in trade values (export values are reported based on FOB values and import values are reported based on CIF values). These values are nominated in US dollars, applied by weighted average official exchange rates.

The source, however, does not provide traded quantity data in a consistent manner. Therefore, it was necessary to estimate missing traded quantity data.

In the estimation process, first, unit import and export values were calculated from non-missing observations. Next, missing unit values of imports and exports were estimated by applying the computed unit values of imports or exports of other countries, by commodity (SITC 3 digit code), by country, and by direction of trade (import or export). This procedure was selected to reduce estimation errors, as compared to a procedure which uses aggregated data. All estimations were made using OLS because of the limited sample size.

After the estimation, trade activity of SITC 651 was adopted as yarn trade, the sum of trade activities covering from SITC 652 to 659 was taken as trade activity of fabric, and finally the sum of activities covering from SITC 841 to 847 was used as textile products trade activity.

Variables used to describe textile production in the rest of the world (ROW) were constructed by using the following steps. The difference from world total yarn production and the sum of yarn produced by the US, EC(12) and Japan, (denote these as UEJ), was considered as yarn production of ROW. The sum of yarn exports from UEJ was treated as yarn imports by ROW, similarly the sum of yarn imports of UEJ was taken as yarn exports from ROW. Fabric production in ROW was given by the sum of yarn production of ROW and net yarn imports by ROW.

The same procedure was applied to obtain fabric imports, fabric exports, textile production, textile imports and textile exports data of ROW.

To compute the unit values of trades of yarn, fabric and textile traded by ROW, similar treatments were made on trade values, such that the sum of textile exports (imports) value of UEJ was considered as ROW's textile imports (exports) value.

This treatment ignores trade between EC, US and Japan. Therefore, ROW's trade activities were likely inflated above actual levels. This approximation method was taken because of data availability since trade data were not fully reported in the above mentioned source. Similarly, trade data for the EC includes trades between EC countries for the same reason.

This source excludes trade among the centrally planned economies, i.e., it covers trade which originates from or is shipped to the market economies.

3. Price data

It was necessary to find prices for locally made and locally marketed textile products. In the case of the US, a producer price index of textile/clothing (PPI) is reported in the Producer Price Index by the Department of Labor. Consumers price index of clothing (CPI) is reported in the Labor Statistics Yearbook by the UN, and a unit value of imported textile (UVI) is available from textile trade data as was described in the previous section. UVI is obtained as a nominal value that is expressed in $/weight. However PPI and CPI are indexes applied with different base prices. Therefore, a regression analysis was used to estimate base prices, and to convert indexed prices into nominal prices.

For estimation of base prices, it was assumed that nominal local aggregated textile price (CPIN) was defined as the weighted average of two prices, the nominal price for locally produced textile (PPIN) and the price for imported textile (UVI). Here, an additional assumption was made that the unit value of imported textiles was equivalent to the price of imported textiles in the region.

Then, aggregated textile price was given as

$$CPIN = \alpha PPIN + (1-\alpha) UVI,$$

where α is the ratio of locally made textiles to total textiles marketed in a region. By denoting CPIB and PPIB as the base prices to be estimated, above relation is rewritten as,

$$(CPI/CPIB)=\alpha(PPI/PPIB)+(1-\alpha)UVI \text{ or}$$

$$CPI=[\alpha(PPI/PPIB)+(1-\alpha)UVI)]\ CPIB.$$

As CPI, PPI, UVI and α are observable, PPIB and CPIB are estimable by treating them as constant parameters in an estimation equation. Then PPIN, which is a nominal price for locally produced and marketed textile products is computed using estimated PPIB and CPIB values.

$$PPIN=(1/\alpha)[CPI/CPIB-(1-\alpha)UVI].$$

Divisia price indices for the EC(12)'s regional aggregated and imported textile price variables were constructed using a formula from Griliche. Each member country's average value share in the total value was used as a weight in constructing the index.

4. Macro economy data

Macro economy variables, such as interest rates, exchange rates, populations, wage rates, national incomes (GDPs, GNPs), wholesale price index, and crude oil price were collected from the IMF's Financial Statistics Yearbook, supplemented by various monthly issues of the Financial Statistics of the IMF.

Because textile and macro data were reported on a calendar year basis, variables were transformed into a crop year base using a following formula.

$$X^*_t=(5/12)*X_t+(7/12)*X_{t+1}.$$

5. Estimation method

Parameters of model equations were mostly estimated by non linear seemingly unrelated regressions (SUR). However, where the applies SUR system of equations generate unfavorable results, the OLS estimator was selected.

By construction of the model, all the structural equations represent producers' simultaneous decisions. Similarly, all the trade price linkage equations are considered as policy tools which result from government decisions on textile and cotton trade, and which also are made simultaneously. Consequently, it is adequate to apply an estimation procedure which is capable of treating the behavioral equations and the trade price linkage equations as a system of equations. However, the data set used for parameter estimation is developed partly by applying regressions to fill in missing quantity data. This causes a measurement error or an aggregation error by constructing this data set. Unfortunately, when aggregation errors exists, it is ambiguous that whether the system of equations approach generates reliable results.

At the same time, the textile trade market data are only available from 1970 to 1987. Due to this small sample size, applicable estimation methods is limited to SUR. Other estimation method such as the two stages estimation method is not applicable with this sample size. Moreover, an application of systems of equations covering all equations does not produce manageable result where the number of equations are large and aggregation and a specification errors exist. Therefore, parameters were estimated by applying a system of equations approach by part, by market, and by region. Equations were dropped that indicated aggregation problems in data or specification problems. Basically, equations which exhibit an unstable estimator (shows signs opposite of those expected, shows a large size of sum square errors compared to other equations in a regional market equation set, or shows large deviations between OLS and SUR), are dropped from the SUR. The SUR estimator is estimated in two stages. First the OLS estimation is made for each of the systems of equations, then a covariance matrix is constructed from the error terms. The values of parameters are found by Gauss-Newton method, adding the covariance matrix obtained from the first stage estimation.

There are two sources of bias in estimating the parameter values, associating with the selected estimation method. First, the estimated parameter values are not reliable under a small sample size, since consistency depends on the asymptotic normality. Second, although the method does not rely on an assumption that regressors are linearly independent, it can not be freed from a multi-collinearity problem, because the resulting Jacobian matrix of partial derivatives of the residuals with respect to the parameters could approach a singular matrix. Therefore, in addition to the highly possible involvement of measurement errors which occurred in constructing the data set, the estimated parameters may also be biased and inefficient due to the possible multi-collinearities and the small sample size.

Chapter 6. Empirical Econometric Model.

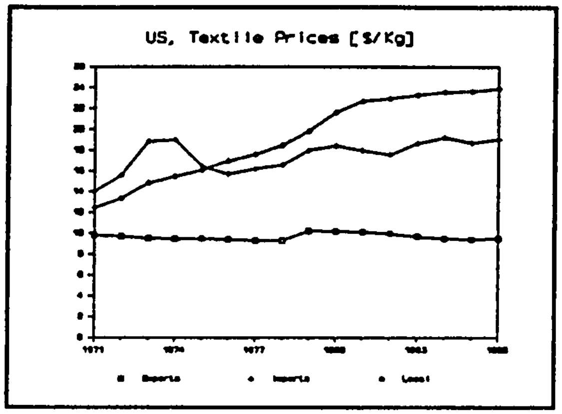
1. Price differentiation

It was assumed that textile products were differentiated because of the assumption of preferences on textile consumers. It was further assumed that differentiated preferences reflected as differentiated imported textile, locally made and locally marketed textile, and exported textile prices. This section investigates relative price movement among the US textile imports, exports, and local textile prices. Historical movements of the US textile prices are plotted in Figure 2. By observation, it was concluded that these three prices exhibited differentiated movements.

Application of the cointegration testing which applied in Baffes (1991) was also considered. However, as following two basic problems were acknowledged, testings were not made in a fully complied manner.

- Cointegration test is adequate to apply in long run perspectives, while the interested price differentials are also involve relatively short run phenomena. (The method uses a property of "stationarity". Where the available data for the investigation is limited to a small sample size, application of the procedure will not generate vigorous results.)

- Interested price differentials exist among endogenously related prices.



Baffes investigated the "Low of One Price" and discussed the cointegration testing procedures as summarized as below. The first test is made with a following regression: $x_{1,t}=\mu+\beta x_{2,t}+e_t$, where $x_{1,2}$ are interested prices, (μ,β) are parameters, and e is an error term. Test is conducted with hypothesis -- H_0: β is not unitary against H_1: β is one. When the test rejects H_0, concludes the existence of the Law of One Price. Where the two prices being tested are weakly stationary of order "d" (which are denoted as I(d), d>0), the cointegration test is transformed into a stationarity test of the differences between the prices. Therefore, an alternative test is made on a regression:

$$(z_t-z_{t-1})=\mu+\beta z_{t-1}+e_t, \text{ where } z_t=x_{1,t}-x_{2,t}.$$

The hypothesis tested is-- H_0:z_t is not I(0) against H_1:z_t is I(0). H_0 is rejected if the estimate of β is negative and significantly different from zero (p. 1266-1267). The first referred regression is adequate to apply where x_2 is exogenously determined with respect to pricing of x_1. Where $x_{1,2}$ are endogenously determined, it is necessary to specify unique value for β. Thus, the testing procedure necessarily involves specification errors in the analysis where the value of β is unknown. Because of the above stated difficulties and for a simplicity purpose, assume the US textile imports and local market prices are both stationary of order 0, and error terms of the regression are white noise. Then, the hypothesis testing between the US textile import and the local prices resulted as a rejection of H_0 at 25% significance level. That is the two prices are most likely different to each other.

2. The model

An empirical econometric model was constructed to represent eight regional submodels covering cotton and textile markets of the US, EC, Japan and the rest of the world (RW), and four trade market submodels for textile, fabric, yarn and cotton. Estimated equations are reported in the Appendix. Market clearing conditions were defined as a combination of prices and quantities that simultaneously clear all 12 cotton-textile sub markets.

For each of the regional textile market submodels, 8 structural equations were specified: local textile demand, textile production for exports, imported textile demand, fabric production for exports, imported fabric demand, yarn production for exports, imported yarn demand, and yarn (or textile) production for it's own regional market (there were 32 structural equations in textile market model).

Similarly, for each of the 4 regional cotton market submodels, the following structural equations were specified. There were 17 structural equations for the total cotton market model: area planted or harvested (except Japan), imported cotton demand (except US), cotton export demand (except Japan), mill use demand, and ending stocks. In total, 27 textile market prices (3 regional textile market prices and 24 textile trade prices), and 7 cotton market prices (US market price, US farm price, and 5 cotton trade prices) were endogenized in the model to explain textile-cotton trade markets. For RW textile and cotton markets, trade prices were used as proxies of regional prices. For cotton markets of EC (Japan), cotton export (import) price was used as a proxy of regional cotton market price.

In order to reduce difficulties in updating model equations, the number of exogenous variables was suppressed to 43: 11 variables related to the US cotton program, 8 variables related to US cotton, soybean and sorghum productions, and 24 macro economy variables. All data were collected from readily available sources.

A simulation model was developed on the LOTUS spread sheet.

3. Imposed restrictions

The developed theoretical models were modified in the following ways.

3.1 Non zero constraint

All activity levels were assumed as non-negative. This constraint was not binding in model simulation. However, the constraint was imposed to prevent negative values in the iteration process.

3.2 Identities

The regional textile market activity levels are constrained by the following identity:

(Textile for local)+(Textile for export)+(Fabric for export)
=(Yarn for local)+(Yarn import)+(Fabric import).

The textile production level for the EC, Japan, and RW were determined through the above identities, using values obtained from structural equations of yarn production, yarn imports, fabric imports, fabric exports and textile exports. In the US textile market, local textile production was specified as a single structural equation. In the EC, Japan, and RW textile markets, yarn production level was specified by a structural equation.

Demand for locally made textiles, and for imported textile were specified by structural equations in all four regions. Regional textile market prices were determined by equating the demand for the locally marketed textiles to supply. Textile trade market clearing prices were found by equating the sum of exports from the four regions to the sum of imports by the four regions. EC textile export price was selected as an instrument price to represent the textile market clearing price. Fabric trade market and yarn trade market clearing prices were obtained in the same manner. EC's fabric and yarn export prices were used as instrument price variables to find market clearing prices. US cotton spot market price is selected as an instrument to find the US cotton market clearing condition.

In order to have unique solution set and to obtain dynamic stability of the model, some regional cotton trade prices were obtained from price linkage equations. EC's cotton import price and RW's cotton export price were linked to US cotton market price and textile trade prices, respectively. RW's cotton export level was obtained from the cotton trade market clearing condition with a market clearing price which was provided to the market through a trade price linkage equation. By imposing this condition, the cotton trade market is cleared for the level of cotton exports from RW, which is also the level of cotton exports to clear RW's regional cotton markets. Thus, RW cotton market served as trade and regional markets simultaneously.

4. Model validation (I)

A dynamic model simulation was conducted over the period 1982 to 1987 to evaluate model performance and also to evaluate forecasting performance. (The six years time period was selected because of a restriction on computer memory.) Percent root mean square errors (% rms) were computed for endogenously determined production and trade activities to evaluate resulting market prices. Values of percentage rms for the textile market variables ranged from 32.9% (US fabric import price) to 1.4% (EC's local textile price).

Simulated results yielded the following percentage rms for US cotton market variables: cotton market price 2.6%, production 2.0%, exports 1.3%, mill use 1.3%, and ending stocks 6.5%. Percentage rms measures for EC cotton market variables were, 16.6% for cotton export price, 16.7% for cotton import price, 1.2% for mill use, 5.7% for cotton exports, 5.8% for ending stocks, 1.3% for cotton imports, and 1.0% for cotton production. For the cotton market of Japan, percentage rms error were 1.2% for cotton imports, 0.7% for cotton mill use, 12.9% for ending stocks, and 18.1% for cotton import price, which was used as the proxy for Japanese cotton market price. Visual model evaluation was also conducted by counting turning points errors. Percentage rms levels were considered as acceptable, and no serious turning point error was detected.

5. Model validation (II)

5.1 Effects of US GNP increase.

Second step validation was conducted by shocking the model for specific exogenous variables. This section reports results when US national income was increased over the simulation period.

Expected movements are as follows.

When the US income level is increased, it causes excess demand for textile products in the US. The size of this excess demand is associated with the demand elasticities for income. The resulting excess demand is necessarily cleared through the local as well as the textile trade market, as imports and exports decisions are involved.

Increase in the textile trade market price and the regional textile market prices cause second round movements. Increase in US textile import results in a upward shift of total textile import demand in the textile trade market. US textile exports increase with the increase in the textile trade price. Since textile production for exports and for local markets are competitive in the US textile market, local textile production reduces to a point where the marginal value of products for the locally marketed and for the exported textile are equalized. Therefore, market equilibrium levels of textile market prices and quantities are critically dependent on the change in textile trade market prices. This is so because the two types of textile demand are function of local and imported textile prices. As the output prices are changed, the adjustment process continues for fabric, yarn and cotton inputs. Thus given a positive shock in US national income, all market prices are expected to change.

Results from comparative static analysis suggests that demand for cotton does not necessarily increase if final textile prices increase, as the change in cotton demand is determined by all stages of textile production technologies and input use decisions.

Simulated results.

The simulated results were reported as Table 2. Model simulation results suggest an increase in the textile trade market price over an evaluation period, 1985-1987. At the same time, the following changes were observed: increased US local textile market price, increased quantity marketed in the US local textile market, and increased textile imports and exports. The increment in US textile imports were compensated by increased exports from RW and reduced textile imports in EC and RW. The US textile import price decreased because supply of the textile in the textile trade market increased reflecting the increased textile export prices. Cotton mill use increased, cotton exports decreased, and cotton ending stock increased. Cotton market price increased. Simulated results also suggest increased fabric and yarn trade prices. Yarn production levels increased in all regions because of the resulting textile price increase.

These measured consequences agree with suggested results from comparative static analysis. The simulated results presented a "shift in production" of yarn, fabric, and textile production between regions. Theoretical evaluation of this particular result for intermediate textile products was not conducted, since there are no previous empirical reports that discuss "shift in intermediate textile production".

Based on these findings, it was concluded that the developed model behaves adequately, at least for measured impacts associated with exogenous changes in US national income.

Table 2. Effects of increase in US GDP by 5 %

	unit	USA simu.	USA change	EC simu.	EC change	Japan simu.	Japan change	RW simu.	RW change	World total	World change
Textile production	1000 Mt	6810.5	371.4	4993.4	21.3	2695.3	10.4	17013.6	-1.7	31512.8	401.4
Textile import	1000 Mt	1000.9	57.9	1199.0	-5.5	185.2	0.2	822.5	-5.8	3207.6	46.7
Textile export	1000 Mt	92.8	1.1	681.9	-0.4	34.9	-1.9	2397.9	47.9	3207.6	46.7
Fabric import	1000 Mt	197.2	-11.4	797.5	9.7	65.8	1.0	1150.3	1.5	2210.8	0.7
Fabric export	1000 Mt	97.1	0.0	767.8	-2.1	221.4	-2.8	1124.5	5.7	2210.8	0.7
Yarn production	1000 Mt	6628.7	388.5	3646.4	25.6	2609.8	1.6	17027.4	55.7	29912.3	471.4
Yarn import	1000 Mt	174.5	-4.6	1999.3	-16.4	276.0	3.1	2358.2	-5.3	4808.1	-23.2
Yarn export	1000 Mt	165.0	-6.7	1848.1	-28.1	255.0	0.2	2540.0	11.3	4808.1	-23.2
Cotton area, pl'd hav'd	1000 Ha	4218.8	0.0	290	0.0			26126.2	-0.0	30634.6	-0.0
Cotton production	1000 Mt	2098.1	0.0	301	0.0			13058.0	-0.0	15457.3	-0.0
Cotton mill use	1000 Mt	1907.6	239.3	1393	16.4	768.6	8.8	14269.6	33.4	18338.9	298.0
Cotton export	1000 Mt	1261.1	-229.4	133	-0.0	0.0	0.0	4254.8	237.8	5648.7	8.3
Cotton import	1000 Mt	0.7	0.0	1245	-44.1	807.6	-1.2	3595.0	53.6	5648.7	8.3
Cottn ending stock	1000 Mt	987.4	-9.9	372	-60.5	169.8	-10.0	5977.4	-217.6	7507.0	-298.0
Textile, local price		25.47	0.46	205.15	0.40	129.35	1.05				
Textile, import price	$/kg	20.74	-0.54	23.12	0.67	19.69	0.48	28.51	0.79		
Textile, export price	$/kg	9.25	0.16	31.44	0.95	25.70	0.30	21.70	0.43		
Fabric, import price	$/kg	10.25	1.09	11.93	0.45	12.70	0.44	10.32	0.32		
Fabric, export price	$/kg	7.72	0.37	12.83	0.47	14.57	0.39	11.96	0.40		
Yarn, import price	$/kg	4.55	0.20	5.01	0.15	3.42	0.06	6.78	0.23		
Yarn, export price	$/kg	3.87	0.12	5.65	0.19	5.96	0.17	5.92	0.21		
Cotton, market price	c/lb	55.14	1.18								
Cotton, farm price	c/lb	52.28	1.01								
Cotton import price	c/lb			36.34	0.76	35.35	0.82	29.13	0.72		
Cotton export price	c/lb			34.77	1.14			32.44	0.99		

5.2. Further exogenous shocks to the model

The model was simulated to examine its response to other exogenous shocks. Observed responses are summarized in the following sections.

It was seen that changes in textile production levels were almost identically associated with changes in yarn production levels. It was also observed that the model generated reasonable estimated responses for intermediate traded products for given exogenous shocks, thus the developed trade model generated information about "shifts in input usage" which is also associated with "shift in textile production".

US producer price index.

When the US producer price index was raised, quantity marketed in the US local textile market increased because of a decline in real local textile price (Table 3). Textile imports declined, as the textile trade market price increased. By the same reasoning, US production of textile for export increased. US yarn production increased and mill use of cotton increased. The export of cotton declined as foreign textile market prices were virtually unchanged while US cotton price rose. Cotton import prices in EC and Japan decreased, as the cotton importers reduced cotton import from US and increased imports from non US sources.

Table 3. Effects of increase in US producer price index by 5%

	unit	USA		EC		Japan		RW		World	
		simu.	change	simu.	change	simu.	change	simu.	change	total	change
Textile production	1000 Mt	6826.9	387.8	4987.5	15.4	2698.8	13.9	17015.2	-0.1	31528.4	417.1
Textile import	1000 Mt	925.0	-18.0	1202.9	-1.6	185.1	-0.0	828.1	-0.2	3141.0	-19.8
Textile export	1000 Mt	91.0	-0.7	682.9	0.6	40.4	3.6	2326.7	-23.4	3141.0	-19.8
Fabric import	1000 Mt	186.7	-21.9	791.5	3.7	66.2	1.3	1154.1	5.3	2198.5	-11.5
Fabric export	1000 Mt	97.8	0.7	767.9	-2.0	223.5	-0.7	1109.3	-9.5	2198.5	-11.5
Yarn production	1000 Mt	6656.1	415.9	3575.2	-45.6	2626.9	18.7	16932.2	-39.5	29790.4	349.5
Yarn import	1000 Mt	172.9	-6.2	2071.7	55.9	269.6	-3.3	2364.9	1.3	4879.1	47.8
Yarn export	1000 Mt	188.4	16.8	1925.1	49.0	256.6	1.8	2508.9	-19.7	4879.1	47.8
Cotton area, pl'd hav'd	1000 Ha	4202.9	-15.8	290	0.0			26126.2	-0.0	30618.8	-15.8
Cotton production	1000 Mt	2083.1	-15.0	301	0.0			13058.0	-0.0	15442.4	-15.0
Cotton mill use	1000 Mt	2023.0	354.7	1355	-21.5	753.2	-6.6	14201.0	-35.2	18332.3	291.4
Cotton export	1000 Mt	679.2	-811.3	139	6.7	0.0	0.0	4778.2	761.2	5596.9	-43.4
Cotton import	1000 Mt	0.7	0.0	1250	-39.9	799.0	-9.8	3547.7	6.3	5596.9	-43.4
Cottn ending stock	1000 Mt	1438.9	441.6	408	-25.1	176.6	-3.2	5475.3	-719.7	7498.6	-306.4
Textile, local price		25.01	0.00	204.50	-0.25	127.87	-0.43				
Textile, import price	$/kg	22.01	0.72	22.47	0.03	19.23	0.02	27.76	0.03		
Textile, export price	$/kg	8.92	-0.17	30.53	0.04	25.41	0.01	21.28	0.02		
Fabric, import price	$/kg	6.79	-2.37	10.86	-0.62	11.64	-0.62	9.55	-0.45		
Fabric, export price	$/kg	6.83	-0.52	11.71	-0.65	13.63	-0.55	11.01	-0.56		
Yarn, import price	$/kg	4.13	-0.22	4.69	-0.17	3.28	-0.07	6.29	-0.26		
Yarn, export price	$/kg	3.62	-0.13	5.25	-0.21	5.60	-0.20	5.47	-0.24		
Cotton, market price	c/lb	57.26	3.30								
Cotton, farm price	c/lb	53.17	2.84								
Cotton import price	c/lb			35.13	-0.45	34.24	-0.30	28.46	0.05		
Cotton export price	c/lb			33.32	-0.31			31.52	0.07		

Table 4. Effects of US wage rates increase by 5%

	unit	USA		EC		Japan		RW		World	
		simu.	change	simu.	change	simu.	change	simu.	change	total	change
Textile production	1000 Mt	6229.4	-209.7	4962.3	-9.8	2683.2	-1.7	17014.6	-0.7	30889.4	-221.9
Textile import	1000 Mt	959.8	16.9	1204.0	-0.5	185.1	0.1	826.0	-2.3	3174.9	14.1
Textile export	1000 Mt	91.8	0.1	681.8	-0.5	34.7	-2.1	2366.7	16.6	3174.9	14.1
Fabric import	1000 Mt	224.9	16.4	790.7	2.9	64.8	-0.1	1147.4	-1.4	2227.8	17.8
Fabric export	1000 Mt	115.6	18.5	766.0	-3.9	223.3	-0.9	1122.9	4.1	2227.8	17.8
Yarn production	1000 Mt	6010.1	-230.1	3644.7	24.0	2601.8	-6.3	17009.7	38.0	29266.4	-174.5
Yarn import	1000 Mt	201.7	22.6	1974.7	-41.0	274.6	1.7	2347.0	-16.5	4798.0	-33.3
Yarn export	1000 Mt	138.5	-33.2	1857.1	-19.1	256.6	1.8	2545.8	17.1	4798.0	-33.3
Cotton area, pl'd hav'd	1000 Ha	4218.8	0.0	290	0.0			26126.2	-0.0	30634.6	-0.0
Cotton production	1000 Mt	2098.1	0.0	301	0.0			13058.0	-0.0	15457.3	-0.0
Cotton mill use	1000 Mt	1304.5	-363.8	1398	21.3	767.2	7.4	14263.3	27.1	17732.9	-308.0
Cotton export	1000 Mt	1780.4	289.9	130	-2.5	0.0	0.0	3758.8	-258.3	5669.4	29.1
Cotton import	1000 Mt	0.7	0.0	1295	5.3	812.9	4.0	3561.1	19.7	5669.4	29.1
Cottn ending stock	1000 Mt	1071.2	73.9	420	-13.4	176.4	-3.4	6445.9	250.9	8113.0	308.0
Textile, local price		25.71	0.70	205.24	0.49	128.93	0.63				
Textile, import price	$/kg	21.07	-0.22	22.72	0.27	19.41	0.19	28.04	0.32		
Textile, export price	$/kg	9.16	0.06	30.87	0.38	25.52	0.12	21.44	0.17		
Fabric, import price	$/kg	10.19	1.03	11.90	0.42	12.67	0.41	10.30	0.30		
Fabric, export price	$/kg	7.70	0.35	12.80	0.44	14.55	0.37	11.94	0.37		
Yarn, import price	$/kg	4.58	0.22	5.03	0.17	3.43	0.07	6.81	0.26		
Yarn, export price	$/kg	3.89	0.13	5.67	0.21	5.99	0.20	5.95	0.24		
Cotton, market price	c/lb	52.99	-0.98								
Cotton, farm price	c/lb	50.43	-0.84								
Cotton import price	c/lb			36.11	0.52	35.01	0.48	28.69	0.28		
Cotton export price	c/lb			34.24	0.62			31.84	0.38		

Table 5. Effects of increase in crude oil price by 5%

	unit	USA simu.	USA change	EC simu.	EC change	Japan simu.	Japan change	RW simu.	RW change	World total	World change
Textile production	1000 Mt	6372.1	-67.0	4969.1	-3.0	2699.6	14.7	17014.8	-0.4	31055.6	-55.7
Textile import	1000 Mt	949.9	7.0	1203.9	-0.6	185.1	0.0	825.3	-3.0	3164.2	3.3
Textile export	1000 Mt	90.6	-1.1	682.0	-0.3	36.6	-0.2	2355.1	5.0	3164.2	3.3
Fabric import	1000 Mt	206.7	-1.9	790.7	2.9	65.2	0.4	1147.7	-1.1	2210.3	0.2
Fabric export	1000 Mt	94.1	-3.0	768.8	-1.1	222.9	-1.4	1124.5	5.7	2210.3	0.2
Yarn production	1000 Mt	6171.8	-68.4	3605.2	-15.6	2620.2	12.1	16982.9	11.2	29380.1	-60.8
Yarn import	1000 Mt	178.2	-0.9	2024.0	8.2	273.6	0.7	2363.8	0.3	4839.6	8.3
Yarn export	1000 Mt	168.4	-3.3	1869.0	-7.1	251.1	-3.6	2551.0	22.4	4839.6	8.3
Cotton area, pl'd hav'd	1000 Ha	4218.8	0.0	286	-3.8			26291.9	165.7	30796.4	161.8
Cotton production	1000 Mt	2098.1	0.0	297	-4.0			13140.8	82.8	15536.2	78.8
Cotton mill use	1000 Mt	1647.5	-20.8	1378	1.6	770.5	10.7	14236.7	0.5	18032.9	-8.0
Cotton export	1000 Mt	1544.2	53.7	133	-0.1	0.0	0.0	3954.3	-62.8	5631.2	-9.2
Cotton import	1000 Mt	0.7	0.0	1277	-12.8	813.3	4.5	3540.6	-0.8	5631.2	-9.2
Cottn ending stock	1000 Mt	964.3	-33.0	415	-18.3	173.6	-6.2	6339.2	144.3	7891.9	86.8
Textile, local price		25.01	0.00	205.01	0.26	128.55	0.25				
Textile, import price	$/kg	21.14	-0.14	22.62	0.17	19.34	0.12	27.93	0.20		
Textile, export price	$/kg	9.13	0.04	30.73	0.25	25.48	0.08	21.38	0.11		
Fabric, import price	$/kg	9.32	0.16	11.55	0.07	12.32	0.07	10.05	0.05		
Fabric, export price	$/kg	7.41	0.05	12.43	0.07	14.24	0.06	11.62	0.06		
Yarn, import price	$/kg	4.37	0.02	4.87	0.02	3.36	0.01	6.57	0.02		
Yarn, export price	$/kg	3.77	0.01	5.48	0.02	5.81	0.02	5.73	0.02		
Cotton, market price	c/lb	54.03	0.06								
Cotton, farm price	c/lb	51.32	0.05								
Cotton import price	c/lb			35.98	0.39	34.96	0.42	28.86	0.45		
Cotton export price	c/lb			33.98	0.36			31.68	0.23		

US wage rate

Increased US wage rates resulted in reduced US textile productions (Table 4). Both types of yarn production declined, and US cotton mill use level and US cotton market price also declined. US local textile price and textile trade market prices were slightly strengthened due to a decrease in US productions of textiles. While US lowered cotton export price, other regions increased US cotton imports by reducing the non-US cotton import, resulting in increased regional cotton trade prices.

Crude oil price

Increasing oil price by 5% resulted in decreased US yarn production and US textile production for local market, but had little effect on US textile market prices (Table 5). Textile market trade prices increased but not large enough to induce a "shift in production". However, the model estimated a decrease in the US mill use level and a slight increase in RW's mill use of cotton.

The model estimated a positive changes in the US textile market prices. Assuming that the change in oil price reflects a change in input price, these results are acceptable. A decrease in US textile import price is considered as a reflection of a shift in quality of imported products. The oil price also represents the man-made fiber price. An increase in man-made fiber price provides a condition where natural fiber usage is more favorable.

Comparing a decrease in US yarn production by 1.08%, US cotton mill use declined by 1.24%. Thus at the US yarn production stage the man-made fiber to cotton fiber relationship is considered as complementary.

6. Model calibration

Because the model adopted dynamic structural equations, the simulation analyses were made after providing model calibration, in order to yields plausible levels of simulation results.

The system of structural equations of the model is written as:

$$AY+BY_{-1}+CX=0,$$

where A, B and C are coefficient matrices and Y and Y_{-1} are vectors of current and lagged endogenous variables and X is a vector of exogenous variables.

The deviation in levels of simulated endogenous variables between the calibrated and uncalibrated cases are given as follows, where Y^* is a vector of observed values, Y^H is a vector of simulated levels with calibration, $Y^{H'}$ is a vector of levels without the calibration, and E is a vector of simulation errors. For each cases, simulated levels are related to the observed levels as follows:

$$Y^*-Y^H=0,\ Y^*-Y^{H'}=E.$$

In the second period, without calibration, the model yields:

$$Y^{H'}_{+1}=-A^{-1}CX_{+1}-A^{-1}BY^{H'}=-A^{-1}CX_{+1}-A^{-1}B(Y^*-E).$$

Similarly, in the second period, with calibration, the model yields: $Y^{H}_{+1} = -A^{-1}CX_{+1} - A^{-1}BY^{H} = -A^{-1}CX_{+1} - A^{-1}BY^{*}$.

Therefore, levels of the simulated endogenous variables differ between the calibrated or non-calibrated cases by $-A^{-1}BE$.

7. Estimated partial elasticities

The following partial elasticities were obtained from the model equations. (The equation numbers in the parenthesis reference estimated structural equations reported in the Appendix.)

US textile production

<u>US textile production for US local market:</u> (Equation 1)

US textile production for the US market (measured in yarn equivalent weight) ranged between 5.3 million to 6.2 million tons from 1981 to 1986. Own price elasticity of supply ranged between 3.869 to 5.371, with an average value of 4.389 for this same time period. (For simplification purposes, only average elasticity values will be stated for the simulated results.)

Compared to its own high price elasticity, US local textile production exhibited fairly strong cross price elasticities. For the same time period, a cross price elasticity of -1.387 was estimated for the US export textile price, and -3.182 was measured for the US wage rate. Labor demand in textile production for the local market was found to be very elastic, i.e., when facing a change in wage rates, significant levels of production adjustments were made. Crude oil price was used in two different variable forms -- in an attempt to measure its effect as an energy input cost and as a proxy of man-made fiber price. It should be noted that oil prices were declining over the simulated period (1982-1987). The oil price cross elasticity was measured at -0.320.

US textile demand for locally made textile: (Equation 2)

For locally produced textiles, own price elasticity of demand was estimated at -1.216, with a cross price elasticity of 0.174 (elasticity of demand with respect to textile import price), and income elasticity of 1.707.

US textile production for export: (Equation 3)

Textile production for exports was elastic, showing an average value for the own price elasticity of 1.615. Local textile price, real interest rate, and oil price showed -1.216, -0.139 and 0.106, respectively.

US textile demand for imported textile: (Equation 4)

Own price elasticity of demand for imported textiles was estimated at -0.428 (price elasticity for textile import price), and 0.897 for income (measured in per capita GNP). Local textile price elasticity was estimated at 0.555.

The above findings were compared to those estimated in previous literature. Trela and Whalley quoted and used US textile demand and supply elasticities from Cline (1987).

The US total demand elasticity for textile and apparel products was assumed at -0.60 and total textile and apparel product supply elasticity was assumed at 1.0. Trela and Whalley also quoted the estimated US elasticity of demand for imported textile and apparel of -1.8 from Hufbauer et al. (1986) and mentioned their estimated import elasticity of demand of -6.4. (These are estimated by researchers best judgement, not through numerical analysis.)

US fabric production for export: (Equation 5)

Fabric production for exports was negatively related to the US yarn export price as its cross price elasticity was -0.363. Own price elasticity was estimated at 0.219. Most of the fluctuations in fabric production for exports were explained by a change in US wage rate, showing a price elasticity of 4.459.

Changes in oil prices negatively affected fabric production for exports, as higher oil prices increased the cost of production. By the mid 1980's declining oil prices however provided a more favorable condition for fabric production. The Elasticity was estimated at -0.108.

US demand for imported fabric: (Equation 6)

US fabric imports and US wage rates were positively related (2.633 as the cross price elasticity), while own price elasticity was -1.223 and oil price elasticity was -0.034. US local textile price elasticity was estimated at 0.002.

US demand for imported yarn: (Equation 7)

During the simulation period, US yarn imports increased from 0.060 to about 0.180 million metric tons. The US wage rate has not kept pace with price levels in the textile market. Therefore, resulting cross price elasticities have dropped from 9.873 in 1981 to 3.006 in 1986, with an average level of 5.594, i.e., suggesting that US textile production has been shifting toward production technologies which are characterized by reduced labor intensity over the period. Import demand for yarn was elastic, showing an own import price effect of -2.278. The level of yarn imports increased as US local textile price, US cotton market price and real interest rate increased. Relevant cross price elasticities were estimated to be 2.690, 0.384 and 0.246 respectively.

US yarn production for export: (Equation 8)

Own price elasticity of US yarn exports was estimated at 0.747. An increase in US local textile price is negatively related to the US yarn export level. The local textile price elasticity was estimated to be -1.876. Changes in oil prices showed a negative effect on yarn exports, with a price elasticity of -0.475.

US cotton market

US cotton export: (Equation 46)

Own price elasticity showed a sharp decline to -8.50 in 1985 when US cotton export dropped to 1.960 million bales. For the rest of the period, the own price elasticity ranged from -0.19 to -1.78, with an average value of -2.052.

Babula reported a price elasticity of demand for weighted average cotton import price in the world of -1.028, using the Armington trade model. Duffy, Wohlgenant and Richardson reported -1.50 as the total export demand elasticity, using an extended Armington framework. The Armington framework relies on assumptions that demand for the traded good is separable from any other goods, and further that demand is approximated as constant elasticity of substitution between the goods imported from various sources. Alston, Carter, Green and Pick tested and rejected assumptions used in the Armington trade model analysis (1990). Ayuk and Ruppels selected an export sales volume as the dependent variable and took a CIF Liverpool US cotton price as a proxy for the export price, and reported -4.99 as the own price elasticity of export demand for US cotton (1988).

US cotton demand for mill use: (Equation 47)

Mill use was positively related to the local textile price, textile price for exports, and level of US yarn production for the US local market, with measured cross price elasticities of 3.508, 0.520, and 1.405, respectively. Own price elasticity was estimated to be -0.004. Changes in interest rates and US wage rates showed negative effects on mill use, with cross price elasticity of -0.231 and -5.397, respectively.

US cotton ending stock: (Equation 48)

Own price elasticity for ending stock demand was estimated at -0.069. US textile export price showed -8.577 as it's cross price elasticity on stock demand. US fabric export price was estimated to be 3.727. US interest rate showed it's price elasticity as -13.467, and cotton program's loan rate was estimated at 1.397.

US cotton, planted acreage: (Equation 49)

Cotton planted acreage was explained by the mean and variances of expected per acre quasi net profit. Program participants (non-participant's) quasi net profit elasticities was estimated at 0.028 (0.143). Quasi net profit elasticities for sorghum was estimated at -0.215. A covariance between soybean's yield and farm price was estimated at -0.119.

Program variables were also used as separate explanatory variables. A change in farm program base caused a positive effect in planted acreage, and an elasticity value of 0.610 was obtained. Set aside land requirement rate was estimated at -0.119.

EC's Textile production

EC textile production for export: (Equation 13)

Own price elasticity of EC's textile production for exports was estimated at 0.074. Average cross price elasticity for cotton import price showed a value of -0.114.

EC fabric production for export: (Equation 14)

Own price elasticity for EC's fabric export was estimated at 0.126. EC's local textile price, and FRG's interest rate showed negative cross price elasticities of -4.189 and -0.063. FRG's wage rates had a negative effect with an elasticity of -0.007.

EC demand for imported fabric: (Equation 15)

EC's fabric import showed a positive relation to textile production for the local and export markets, yielding price elasticities of 0.181 and 0.548, respectively. For FRG's wage rates an elasticity of -1.062 was estimated, while FRG's interest rate showed 0.04 as an estimated elasticity.

EC yarn production for EC market: (Equation 16)

Spanish wage rates has a negative effect on EC's yarn production with an elasticity of -0.51. Cross price elasticity of EC's cotton import price was inelastic, with an average value of -0.108.

EC Cotton market

EC cotton demand for mill use: (Equation 52)

Own and cross price elasticities computed for mill use, yielded -0.071 for EC's cotton export price, 0.395 for EC's local textile price, 0.516 for EC's yarn import price.

EC cotton import demand: (Equation 53)

EC's cotton imports increased during the period. For cotton price, price elasticities were -0.365 for RW's cotton export price. FRG's wage rate was elastic at -3.093. EC's textile export price was inelastic at 0.319, and EC's local textile price elasticity was at 0.087.

Japan's textile market

Japan textile demand for locally made textile: (Equation 22)

Own price elasticity of demand for locally produced textiles was elastic, -1.333, income elasticity was 0.743, and cross price elasticity of imported textile was 0.557.

Japan textile demand for imported textile: (Equation 23)

Demand for the imported textiles indicated an own price elasticity of -0.037, and a cross price (local textile price) elasticity of 0.061. Income elasticity was 8.245.

Japan textile production for export: (Equation 24)

Own price elasticity of textile export was estimated at 2.254. Relatively elastic cross price effects were estimated: local textile price of -2.901, and fabric export price of -2.004.

Japan fabric production for export: (Equation 25)

Fabric production for exports was stable in the simulated period. Own price elasticity was 0.007. Cross price elasticities were -0.071 for local textile price and -1.504 for wage rates.

Japan yarn production for export: (Equation 26)

In yarn exports, own price elasticity was 0.783. Cross price elasticities were -0.956 for fabric export price, -0.305 for wage rates, and -0.381 for oil prices.

Japan demand for imported yarn: (Equation 27)

Yarn imports indicates an own price elasticity of -1.983 and cross price elasticities of 0.953 for the textile export price, 1.155 for the fabric import price, and 5.373 for the wage rates.

Japan cotton market

Japan cotton demand for mill use: (Equation 58)

Mill demand for cotton indicates an own price elasticity of -0.135. Cross price elasticities of 1.214 was estimated for local textile price, and 0.201 for yarn export price.

Japan cotton import demand: (Equation 59)

Cross price elasticities of cotton import were estimated as follows. For US cotton market price at -0.287, for local textile price at 0.019, for Japan's yarn export price at 0.037, and for Japan's wage rates at -1.083.

Chapter 7. Studied results on textile and cotton industries.

1. Textile import control and the US cotton industry.

This section examines the impacts of removing textile trade restrictions. In the US, the textile industry is protected by tariffs and restrictive quotas. The US imposes tariffs of 26.6% on imported cotton based textile products, 17.5% on fabric products and 13.1% on yarn products. These tariff rates are higher than EC and Japan in each of the product levels -- corresponding tariff rates were, (18.5%, 15%, and 10%) for EC, and (21%, 10.5%, and 5.6%) for Japan (United Nations, 1974).

Textile exporters in developing countries (and also Japan) are exporting their textile products to the U.S. under a bilateral textile trade agreement under the Multiple Fibre Arrangement (MFA).

These trade restrictions are expected to be reduced in the near future, for example through trade agreements with Mexico or progresses made in GATT's Uruguay Round. An analysis that investigates the effect of textile trade liberalization is of great importance for cotton program planners.

The first step of this investigation is to briefly review the US MFA's effect to determine the appropriate model specification for this simulation analysis.

Under MFA, import quotas can grow at 6% per year (Dean, p.63), thus it is reasonable to evaluate the effects of the MFA by examining the growth rate of imported textile quantities. If the growth rate exceeded 6%, then the MFA was considered as a non binding constraint.

Growth rates of US textile imports were estimated at 1.101 (increasing by about 10% per year) during the estimation period (1970-1987), strongly indicating that MFA was not a binding constraint in US textile import. A similar result was found for the EC's textile import.

Estimated results were consistent with Deans' study. In his study, Dean concluded that for the US MFA "it is a binding constraint on exporters". An imposition of export quantity restriction on large textile exporters results in "diversifying import demand to smaller exporters".

Dean's argument, however, suggests a possible import price decline if the MFA is eliminated. Removal of the US MFA will increase imports from larger exporting countries, especially for those that have a comparative advantage over smaller exporting countries. Under this situation, effects of removal of MFA can be measured by adopting quota removed textile import prices. In order to decide the magnitude of this decline in importing price, exporter's supply price for textiles must be known. Trela and Whalley estimated Hong Kong quota prices of apparels to the US market. They estimated average quota prices were 10% and 42% of export prices for 1982 and 1984. One-half of these prices were estimated as quota prices for textile products (p.1195). Following their strategy, this study took 20% of the import price as the approximated tariff-equivalent quota price to analyze the effects of US MFA, i.e., it was assumed that because of US MFA, although import quantities of textile were not constrained, US textile import prices were distorted at about 1.2 times higher than the expected free market price level.

Procedures

First, the above mentioned tariff rates were removed from the US, EC, and Japan's textile fabric and yarn import prices by discounting import prices by the sum of tariff and tariff equivalents. For example, US textile import price was discounted by a factor of (1+0.2+0.266), where, 0.2 was a tariff equivalent caused by MFA, 0.266 was a tariff.

Following a previously discussed specification form, the import price linkage equations were specified in a following form:

$$p=\alpha q+\beta+\delta,$$

where p is the regional trade price, q is the trade market clearing price, β is a price difference associated with a term -- product of an exchange rate ratio, importers' ad-valorem tax and importers' tastes and preferences, α is an approximated constant term associated with the product of the exchange rates ratio, importers' and exporters' ad-valorem taxes and tastes and preferences, δ is a term corresponding to the sum of transportation costs and specific tax. Price linkage equations that remove tariffs were modified as follows:

$$p^{*}=(\alpha q+\beta+\delta)/(1+\tau),$$

where p^{*} is the tariff removed regional trade price after trade liberalization, τ is the tariff and tariff equivalent.

Trade price differences between regions that remain are considered to be associated with any other factors than those identified in the trade control program.

RW's textile products import prices were also discounted by applying approximated tariff rates. The lowest tariff rate among the EC, US and Japan were applied as the RW's tariff rates: (18.5%, 10.5%, and 5.6%) for textile, fabric and yarn products.

The starting values of the model were calibrated to the 1985 historical levels, to provide base values for policy simulation. Values of lagged dependent variables were fixed at their historical levels for the first simulation period, also levels of cotton productions and carryover stocks were fixed at historical activity levels. Then, the model was simulated to find market equilibrium prices and quantities for given levels of exogenous variables for the 1986-1987 period. The responses are summarized and reported in Table 6.

Table 6. Effects of Textile Trade Liberalization

	unit	USA		EC		Japan		RW		World	
		simu.	change	simu.	change	simu.	change	simu.	change	total	change
Textile production	1000 Mt	6022.0	-417.0	5066.6	94.5	2755.2	70.3	17005.3	-9.9	30849.2	-262.1
Textile import	1000 Mt	1083.8	140.8	1213.1	8.6	184.7	-0.4	866.6	38.3	3348.1	187.3
Textile export	1000 Mt	100.3	8.6	678.8	-3.5	41.8	5.0	2527.2	177.1	3348.1	187.3
Fabric import	1000 Mt	195.5	-13.0	854.5	66.7	73.3	8.4	1180.9	32.1	2304.3	94.3
Fabric export	1000 Mt	96.1	-1.0	872.9	103.0	207.6	-16.6	1127.7	8.9	2304.3	94.3
Yarn production	1000 Mt	5852.3	-387.9	3629.8	9.0	2654.0	45.8	17211.9	240.2	29348.1	-92.8
Yarn import	1000 Mt	170.5	-8.5	2134.0	118.3	277.3	4.4	2267.3	-96.2	4849.3	18.0
Yarn export	1000 Mt	180.4	8.8	1840.7	-35.5	264.9	10.1	2563.2	34.6	4849.3	18.0
Cotton area, pl'd hav'd	1000 Ha	4218.8	0.0	290	0.0			26126.2	-0.0	30634.6	-0.0
Cotton production	1000 Mt	2098.1	0.0	301	0.0			13058.0	-0.0	15457.3	-0.0
Cotton mill use	1000 Mt	1629.3	-39.0	1345	-31.5	710.6	-49.2	14358.2	122.0	18043.3	2.4
Cotton export	1000 Mt	1864.5	374.0	145	12.0	0.0	0.0	3636.5	-380.5	5645.8	5.4
Cotton import	1000 Mt	0.7	0.0	981	-308.5	817.7	8.9	3846.4	305.0	5645.8	5.4
Cottn ending stock	1000 Mt	662.3	-335.0	144	-289.0	237.9	58.1	6758.5	563.5	7802.6	-2.4
Textile, local price		25.12	0.11	199.13	-5.62	122.92	-5.39				
Textile, import price	$/kg	12.32	-8.96	19.09	-3.36	18.23	-0.98	27.36	-0.36		
Textile, export price	$/kg	10.04	0.95	36.15	5.66	27.21	1.81	23.84	2.58		
Fabric, import price	$/kg	10.37	1.21	11.61	1.13	12.21	-0.05	9.86	-0.14		
Fabric, export price	$/kg	8.38	1.03	13.66	1.30	15.28	1.10	12.67	1.11		
Yarn, import price	$/kg	4.54	0.18	4.95	0.09	3.41	0.06	7.07	0.52		
Yarn, export price	$/kg	4.21	0.46	6.20	0.74	6.47	0.68	6.55	0.84		
Cotton, market price	c/lb	49.89	-4.08								
Cotton, farm price	c/lb	49.82	0.00								
Cotton import price	c/lb			41.73	6.15	40.54	6.00	32.63	4.22		
Cotton export price	c/lb			41.62	7.99			37.24	5.79		

Results

Trade liberalization is estimated to have negative effects on the US cotton and textile industries. Total US textile use (the sum of local supply and imports) was estimated to decrease by 0.26 million metric tons (MMT), from 7.38 to 7.11 MMT, and US total textile production (the sum of local supply and exports) was estimated to lower from 6.53 to 6.12 MMT because of a decreased textile import price (from 21.28 to 12.32 [$/MT]), an increased local textile market price (from 25.06 to 25.12 [$/MT]), and an increased textile export price (from 9.09 to 10.04 [$/MT]). Quantity of imported textiles increased by about 0.14 MMT, from 0.94 to 1.08 MMT. US cotton mill demand decreased by 0.04 MMT, while cotton export increased by 0.37 MMT. Cotton market price decreased from 54.12 to 49.89 cents/pound.

The simulated results depicted a possible "shift in production". Total textile production in the world (the sum of textile production for local and for export) decreased by 0.075 MMT. The US reduced it's total production level while the EC, Japan and RW regions increased their total textile productions by 0.10 MMT, 0.07 MMT, and 0.03 MMT, respectively. Most of those changes were connected to changes in yarn production stages: the US lost it's relative competitiveness in world yarn production. The portion that the US lost was picked up by RW. The increased yarn production in RW was then finalized as an increase in textile exports, which is directed to the US market. In the US cotton market, reduced yarn production softened the cotton market price because demand for cotton declined. That made the US cotton export price favorable in the cotton trade market, and US cotton captured the export market by displacing RW cotton.

Based on the simulated changes, an approximated US welfare gain was computed. US cotton production value at market level dropped by $0.11 billion. US textile consumers' expenditure was reduced by $16.5 billion, US textile producers lost $9.51 billion (computed by summing changes in revenue from local textile production, yarn, fabric and textile exports, and yarn, and fabric imports). Net US gain was about $6.9 billion. Trela and Whalley quoted Cline's estimated gain of $8 billion using 1986 data, and they reported their own estimate of $11.3 billion (p.1200), which is almost twice the size of the figure estimated in this study. (A large part of this difference is explained by an assumption placed on traded goods, as their study adopted the assumptopn of homogenous goods. The difference was much sharper when compared to the simulated result where only US MFA was removed. Estimated approximate net welfare gain was $4.1 billion: textile producers lost $3.2, textile users gained by $7.2, and cotton value decreased by $0.11 billion, respectively.)

Discussions

Contrary to anticipated favorable effects of trade liberalization, the simulation results suggest consequences that were not beneficial to the US textile- cotton industry, while showing a smaller net US welfare gain.

Since estimated results were derived contingent to the estimated model structure, a restatement of the basic context of the model should be reexamined. The model was constructed under the assumption that demand for textile products was split into two types of textile demand, one for imported textiles and the other for locally made textiles. Production of textiles were also comprised of two types of textile products, one for the local market and the other for the export market.

This model structure allows for the consideration of local textile prices, imported textile prices, and exported textile prices to explain market activities. When two types of production are competing with each other and products are substitutes, then the direction of price movement for these three prices are determined by the relative sizes of own and cross price elasticities of supply and demand activities.

There are two interesting points to note. First, because the textile imported and the textile locally produced are differentiated products, a change in use level of locally produced textile will not necessarily substituted for imported textiles. Second, a change in US local textile price was explained by shifts in the local textile supply and demand schedules. A decrease in imported textile price caused a downward shift in demand for locally produced textile. At the same time, as the textile trade market price increased, US textile supply for the local market is reduced. Thus, the new equilibrium level for the US local textile market quantity decreased, as the estimated structure of the market revealed a higher US local textile market equilibrium price.

When the export market of the textile was not highly protected (e.g., US exports to developed countries), a smaller shift in local textile supply was expected, as price wedges in the textile export price resulted from US textile importers' import controls were small. On the other hand, exporters to the US market noticed larger changes in their export prices, and US users saw a larger price change in import price, while RW and Japanese consumers observed a smaller change in import price, i.e., it was expected that large changes in quantity would results as import control were increased.

More formal explanations for these results are developed as follows. Suppose that demand for locally made textile (f) and imported (g) are shown as:

$f=f(p,q)$, $f1<0$, $f2>0$, and $g=g(p,q)$, $g1>0$, $g2<0$.

where p is a local textile market price, and q is an imported textile price. Suppose further that production of textiles for local (l) and export markets (e) are:

$l=l(p,r)$, $l1>0$, $l2<0$, and $e=e(p,r)$, $e1<0$, $e2>0$,

where r is a price for exported textiles.

Assume that trade prices (q, r) are related to a trade market price (w) as follows:

$q=w+t$, $r=w+s$,

where t and s explain price differentials from the trade market price.

For simplicity, consider a "small country open economy case" such that, in the rest of the world, there will be no changes in the levels of textile consumptions and trades. Then, market equilibrium conditions are approximated as:

$f=l$, and $g=e$.

Because a change in textile import price is represented by a change in the level of "t", solving for changes in local textile price and trade market price with respect to the change in "t" yields the following result (by assumption dw=0, therefore dq=dt):

$dp=(1/D)(e2f2-g2l2)dt$, $ds=(1/D)(f2(g1-e1)-g2(f1-l1))dt$.

Thus,

$dr=(1/D)(f2(g1-e1)-g2(f1-l1))dt$,

where D is the determinant of the coefficient matrix, which is specified as: $D=l2(g1-e1)-e2(f1-l1)$.

From this analysis, the following conclusions are obtained: for a decrease in the import tariff, responses in trade price (r), local market price (p), and marketed quantity (f, l, g, and e) are wholly dependent on the relative size of price elasticities of the demand and supply equations. Even when the local textile price (p) declines, levels of demand for imported and locally produced textiles are indeterminate. The results significantly differ from outcomes obtained under an assumption that locally produced and imported goods are homogeneous, where a reduction of import control results in decreased domestic production and increased imports.

Implications in cotton market

An interesting point was found in input factor usage responses. As parts of the liberalization of textile product trades, the trade market price of fabric was reduced. However, this decline may not induce increased levels of textile production. Similarly, for a change in the total level of US textile production, the level of US cotton mill demand changed asymmetrically. For example, in the estimated simulation, cotton mill demand decreased by 0.03 MMT (5.3%), whereas the US total yarn production decreased by 0.38 MMT (3.2%). This measured consequence is associated with the structure of demand for cotton that is determined as part of a simultaneous decision which covers yarn production-import-export, fabric import-export, and textile production-export decisions.

Conclusion

From these findings, it was concluded that trade liberalization could be harmful to the US cotton industry.

A possible decline in demands were particularly important findings for cotton program planning. Serious attention should be given to the finding that trade liberalization will trigger "a shift in production", which involves "a shift in inputs flow" in its process, thus the trade flow of cotton could be changed. Because of this concern, US cotton exports will be studied in the next section.

Adequateness of this analysis depends on assumptions used in model development. To rationalize the assumption, textile user's preferences are necessarily diversified relative to imported and locally made products. Clearly, where demand for goods is dominated by a type of demand that is characterized as "subsistence", the framework applied in this study may not be adequate. In this sense, the treatment of the RW textile market is questionable. Although statistical results obtained from estimated structural equations support the demand assumption, disaggregation of the RW market may be beneficial.

2. US cotton export.

US cotton exports reflected rather large fluctuations in the middle of the 1980s. The level of exports was 6.215

million bales in the 1984 crop year and dropped to 1.96 million bales in 1985, then bounced to 6.684 million bales in 1986.

This section evaluate historical data and simulated results in an attempt to provide some explanation for these fluctuations.

First, an examination was made to determine if "US cotton was priced at an un-competitively high level". The investigation was limited to the historical data. Unit export values of cotton were computed from FAO's Trade Yearbook for three exporting regions: the US, the market economy countries (excluding the US), and the centrally planned economies. Then, export values were obtained by indexing using 1987 as the base year, so that relative movements of export values could be identified.

If the above mentioned claims are correct, then the unit value of US cotton export must exhibits deviations for the period, particularly from the 1984 to the 1986 crop year. Obtained results showed identical price movements for the period. As far as the unit export values are concerned, there was no evidence of uncompetitive pricing.

In the econometric study in this paper, the structural equation for US cotton exports was specified as a derived demand equation for US cotton from the rest of the countries. Consequently, foreign textile market prices were used as explanatory variables. This approach allowed us to extract particular relationships between the US cotton exports and textile production activities in the rest of the world.

Suppose that the industry shifts its production into higher marginal valued products with respect to some constrained input factors, such as capital or labor, when forced to reduce total output. That change in production should appear as a change in input factor use. Increased cotton use with declining final output could result from this type of production decision. Because each region operates under different production endowments, response in fiber usage patterns most likely reflects regional variations. This leads to the question "what changes were prevailed in the world textile industry which could cause the massive swing in US cotton export demand? ".

In the following sections, historical data are studied in an attempt to find an answer to this question.

First, historical changes in world textile market conditions were tabulated in a matrix form. The matrix was constructed showing percent changes in textile market activity levels and their prices for 1985 and 1986 (Table 7). The first number of each matrix element is percent change in the activity levels, and the second number is percent change in the corresponding prices. (For example, it was observed that in 1985, US yarn import increased, with reduced import price.)

Table 7. Changes in textile production activity levels

Changes in activity levels in 1985

	Yarn					Fabric				Textile				
	Production	Import		Export		Import		Export		Production	Import		Export	
	Volume	Volume	Price	Volume	Price	Volume	Price	Volume	Price	Volume	Volume	Price	Volume	Price
US	2%	20%	-3%	-2%	2%	-1%	10%	6%	-2%	2%	19%	-3%	10%	-1%
EC	4%	3%	12%	-0%	14%	6%	20%	1%	22%	4%	14%	12%	10%	17%
Japan	-5%	-6%	-3%	3%	-1%	4%	12%	-6%	11%	-4%	24%	3%	-10%	8%
Others(RW)	7%	0%	11%	3%	10%	-0%	17%	5%	18%	5%	9%	16%	17%	5%

Changes in activity levels in 1986

	Yarn					Fabric				Textile				
	Production	Import		Export		Import		Export		Production	Import		Export	
	Volume	Volume	Price	Volume	Price	Volume	Price	Volume	Price	Volume	Volume	Price	Volume	Price
US	6%	12%	3%	-6%	13%	3%	3%	16%	-3%	6%	14%	2%	26%	1%
EC	-5%	9%	13%	12%	9%	5%	20%	5%	14%	-2%	19%	17%	9%	19%
Japan	-3%	9%	15%	-5%	9%	13%	11%	-9%	12%	-1%	40%	10%	-17%	12%
Others(RW)	5%	8%	10%	9%	13%	3%	12%	5%	16%	2%	10%	17%	18%	10%

From the matrix, in 1985 the following combination of conditions was observed.

(1) Increased yarn production activities in the EC and RW.

(2) Relatively stagnant textile production in US. The EC and RW expanded textile production activities, while US showed little increase and Japan had reduceions in their total textile production activities.

(3) Small increase in US fabric export, while demand for fabric had strengthened in EC.

By comparing elements of the matrix constructed for the 1985 and 1986 periods, it is also noticed that the shift in world textile production appears as quite dynamic. As the US expanded textile production in 1986, the matrix reflects market responses as shown in the bottom part of Table 7.

Based on the above findings, 1985's decline in US cotton exports can be explained in the following manner.

A drop in US cotton export was estimated to be inversely related to the expansion of world economies which stimulated the textile industry's activities in the EC and RW, but shrank production activities in Japan and the US. A combination of these responses provided the necessary conditions for a reduction in demand for US cotton.

A simulation was made to attest this claim by raising the national income by 2% for foreign regions while maintaining the US national income and lowering crude oil price by 5%. The results are reported in table 8. In the

US cotton market, the major change observed was a decline in cotton exports, with almost the same level of market price. It was also observed that RW's cotton export displaced US cotton in the cotton trade market. These movements were consistent with the historical observations.

Conclusion

A major point of this discussion is that the determinants affecting the level of US cotton exports is not the export prices of cotton from other regions. In addition to the dynamic nature of the textile industry's decision making, levels of the world textile production activities, the textile products trade market prices, and macro economic variables should receive most of the attention when examining trade policy and farm programs for cotton planning.

Changes in US cotton export can be forecasted if we can forecast changes in some particular market as a result of a "shift in world wide textile production". This further implies that effective cotton export promotion will require market identification based on corresponding textile production technology. Production levels of textiles do not necessarily serve as reliable indicators, because patterns of input requirements are not uniform. It is necessary to identify countries whose textile production exhibits intensive use of cotton when they are faced with a reduction in total textile production.

Table 8. Decreased crude oil price by 5%, and increase national incomes of EC, Japan and Spain by 2%

	unit	USA		EC		Japan		RW		World	
		simu.	change	simu.	change	simu.	change	simu.	change	total	change
Textile production	1000 Mt	6470.0	31.1	5045.4	73.1	2678.9	-6.3	17110.3	95.1	31304.6	192.9
Textile import	1000 Mt	953.0	10.0	1205.9	1.4	185.4	0.3	846.9	18.6	3191.3	30.4
Textile export	1000 Mt	98.3	6.6	681.4	-0.8	31.7	-5.1	2379.9	29.8	3191.3	30.5
Fabric import	1000 Mt	178.4	-30.3	808.0	20.2	66.6	1.7	1155.1	6.2	2208.1	-2.1
Fabric export	1000 Mt	104.1	7.0	761.3	-8.7	219.4	-4.8	1123.2	4.4	2208.1	-2.1
Yarn production	1000 Mt	6336.0	96.4	3724.8	104.2	2582.8	-25.6	17105.0	133.2	29748.6	308.2
Yarn import	1000 Mt	157.9	-21.5	1955.3	-60.8	280.6	7.7	2353.4	-10.2	4747.3	-84.8
Yarn export	1000 Mt	172.1	0.4	1805.8	-71.6	261.6	6.8	2507.8	-20.4	4747.3	-84.8
Cotton area, pl'd hav'd	1000 Ha	4243.1	0.0	297	7.7			25686.4	-354.6	30226.7	-347.0
Cotton production	1000 Mt	2113.1	0.0	309	8.0			12838.1	-177.2	15260.4	-169.3
Cotton mill use	1000 Mt	1755.1	87.1	1419	42.3	762.1	2.2	14330.1	94.2	18265.9	225.8
Cotton export	1000 Mt	1304.1	-168.1	132	-0.8	0.0	0.0	4250.3	217.3	5686.2	48.3
Cotton import	1000 Mt	0.7	0.0	1201	-87.7	801.2	-6.4	3683.0	142.4	5686.2	48.3
Cottn ending stock	1000 Mt	1075.0	80.9	311	-121.1	163.6	-8.6	5671.7	-346.2	7221.4	-395.1
Textile, local price		25.15	0.13	205.65	0.91	130.70	2.39				
Textile, import price	$/kg	20.10	-1.18	23.91	1.46	20.26	1.05	29.45	1.73		
Textile, export price	$/kg	9.44	0.35	32.57	2.08	26.07	0.67	22.21	0.95		
Fabric, import price	$/kg	11.98	2.82	12.63	1.15	13.39	1.14	10.82	0.82		
Fabric, export price	$/kg	8.30	0.95	13.56	1.20	15.19	1.01	12.59	1.02		
Yarn, import price	$/kg	4.85	0.50	5.23	0.38	3.51	0.16	7.13	0.58		
Yarn, export price	$/kg	4.05	0.29	5.93	0.47	6.22	0.43	6.25	0.53		
Cotton, market price	c/lb	54.97	0.84								
Cotton, farm price	c/lb	49.82	0.00								
Cotton import price	c/lb			37.15	1.59	36.12	1.60	29.44	1.03		
Cotton export price	c/lb			36.22	2.61			33.66	2.20		

3. US loan rate program.

When expected market price of cotton is higher than the loan rate, it is expected that the level of the US loan rate will not affects world cotton prices while providing income supports to US cotton farms. The simulated results depicted the expected figures. Lowering the loan rate by 5 cents per pound did not change market prices in the US, or in foreign regions. Reflecting the estimated elastic own price elasticity of US cotton export demand, US cotton exports increased as the level of ending stock reduced, but these changes remained in quite marginal ranges. Foreign cotton and textile market prices were unaffected by change in the US loan rate.

The lowered loan rate could have a negative effect on US cotton production when the expected market price is lower than the loan rate level. However with the estimated low elasticities in US cotton production and ending stocks, little effect was estimated in the US cotton market.

Table 9. Effects of decrease in US loan rate by 5 cents/bu

	unit	USA simu.	USA change	EC simu.	EC change	Japan simu.	Japan change	RW simu.	RW change	World total	World change
Textile production	1000 Mt	6439.0	-0.0	4971.6	-0.6	2684.7	-0.2	17015.2	-0.0	31110.6	-0.7
Textile import	1000 Mt	943.0	0.0	1204.5	0.1	185.1	0.0	828.3	-0.0	3160.9	0.1
Textile export	1000 Mt	91.7	0.0	682.2	-0.1	36.8	-0.0	2350.2	0.2	3160.9	0.1
Fabric import	1000 Mt	208.5	-0.1	787.8	0.0	64.9	-0.0	1148.8	-0.0	2209.9	-0.1
Fabric export	1000 Mt	97.1	0.0	769.8	-0.1	224.2	0.0	1118.8	0.0	2209.9	-0.1
Yarn production	1000 Mt	6240.5	0.2	3620.1	-0.7	2608.0	-0.2	16971.9	0.2	29440.4	-0.5
Yarn import	1000 Mt	178.9	-0.2	2015.7	-0.1	272.9	0.0	2363.6	0.1	4831.1	-0.2
Yarn export	1000 Mt	171.7	-0.0	1875.9	-0.3	254.8	-0.0	2528.8	0.1	4831.1	-0.2
Cotton area, pl'd hav'd	1000 Ha	4218.8	0.0	290	0.0			26126.2	-0.0	30634.6	-0.0
Cotton production	1000 Mt	2098.1	0.0	301	0.0			13058.0	-0.0	15457.3	-0.0
Cotton mill use	1000 Mt	1668.9	0.6	1377	-0.1	759.7	-0.1	14236.4	0.2	18041.5	0.6
Cotton export	1000 Mt	1624.7	134.2	133	-0.1	0.0	0.0	3884.8	-132.3	5642.2	1.9
Cotton import	1000 Mt	0.7	0.0	1291	1.1	810.3	1.4	3540.7	-0.7	5642.2	1.9
Cottn ending stock	1000 Mt	862.4	-134.9	434	1.3	181.4	1.6	6326.3	131.3	7804.4	-0.6
Textile, local price		25.01	0.00	204.76	0.01	128.31	0.01				
Textile, import price	$/kg	21.28	-0.00	22.45	0.00	19.22	0.00	27.72	0.00		
Textile, export price	$/kg	9.09	0.00	30.49	0.00	25.40	0.00	21.26	0.00		
Fabric, import price	$/kg	9.17	0.01	11.48	0.00	12.26	0.00	10.00	0.00		
Fabric, export price	$/kg	7.36	0.00	12.37	0.00	14.18	0.00	11.57	0.00		
Yarn, import price	$/kg	4.35	0.00	4.86	0.00	3.35	0.00	6.55	0.00		
Yarn, export price	$/kg	3.75	0.00	5.46	0.00	5.79	0.00	5.71	0.00		
Cotton, market price	c/lb	53.41	-0.56								
Cotton, farm price	c/lb	50.79	-0.48								
Cotton import price	c/lb			35.67	0.08	34.59	0.06	28.41	-0.00		
Cotton export price	c/lb			33.69	0.06			31.45	-0.00		

Chapter 8. Summary and Conclusion

This study first developed a theoretical framework for building an econometric model to investigate an economic relationship between textile and cotton industries. Theoretical models covering textile and cotton trades were also developed by introducing an assumption of preferences on textile users. The model was constructed by considering utility maximization of textile users, an integrated profit maximization problem of textile producers, an expected utility maximization of cotton producers, and a profit maximization of cotton traders.

It was assumed that textile products were differentiated, i.e., imported and exported textile products are differentiated from the consumers' point of view. This assumption allowed us to consider differentiated trade price movements of textile and cotton products.

The above argument, then extended to a discussion about the necessary characteristic of traded textile and cotton products to explain observed cross hauling under a limited trade model framework. That consideration is associated with the assumption that traded goods are non homogeneous, but are near-homogeneous. The trade model was developed in a non-spatial equilibrium model framework, while considering the product differentiation. This approach necessarily brings an aggregation error or bias in solving for the market clearing conditions. The size of bias depends on relative sizes of estimated parameters of structural equations and the degree of product differentiations. Where the larger the products differentiation exists, the larger the bias is expected.

Given the assumption that the textile sector produces goods for the local market and for the export market by using locally made and imported materials, trade activities of textile products were considered as a part of the textile production activities. In other words, decisions on imports of cotton, imports and exports of intermediate products, and exports of final products were treated as part of a simultaneous decisions made by textile producers. Therefore, a primarily linkages between the textile and cotton markets were made through mill demands and trade activities of cotton in the cotton markets. Linkages were also established in the textile markets by including cotton prices in the textile production equations. Mill demand for cotton, and cotton imports and exports equations were specified as derived input demands for textile productions.

A theoretical model of cotton planted acreage was developed by considering price and yield uncertainties. The model was constructed on the assumption that cotton producer maximizes expected utility. It was shown that under certain assumptions, the means and covariances of per acre quasi net profits were adequate to use in explaining cotton farmers behavioral decisions on planted acreage.

Textile and cotton trade market data sets were developed from published production and trade data sources to complement the empirical development of the theoretical model. Further assumptions were introduced on the textile production process so that vertically integrated textile production activities were captured in a common unit of measurement. A yarn equivalent weight was selected as the measuring unit.

Structural specifications were followed from the derived theoretical specification for each component of the textile-cotton trade econometric model. The model is comprised of structural, product identity, and price linkage equations covering the US, EC, Japan and the rest of the world (RW) regions for the textile-cotton industries and textile, fabric, yarn and cotton trades. Equilibrium levels of prices and quantities were obtained as a solution vector that simultaneously clears regional textile and cotton markets, and trade markets for textile, fabric, yarn and cotton. There were 12 sub-markets in the model. Most of the market clearing conditions were solved for prices, but because of observed dynamic instability, some market clearing conditions were solved for quantities so that the model yielded an unique solution set in a stable manner.

Percent root mean square errors were calculated and turning points errors were counted on simulated results. Model validation was also made by adding shocks through exogenous variables and then by comparing observed results to theoretically implied movements. It was concluded that the model behaves adequately in the sense that resulted directions of endogenous variable move consistently with theoretically implied directions and should be appropriate to use for economic analysis. Changes in regional input usage pattern were estimated through the yarn and fabric trade markets and provided insights to understand the trade flow of cotton.

The model indicates overreaction for some price variables when solving the whole market equilibrium conditions for prices. Part of reasons is associated with the underlying economic structures of the textile-cotton industry. Because the relative size of price elasticities do affect model response, and inelastic own price and elastic cross price elasticities of demands for cotton were measured, market clearing prices in the cotton market tended to inflate over the simulation period.

For an improvement of model performance, disaggregation of RW market models was suggested. Nevertheless, the developed model performed in a reasonably acceptable manner for short term policy analysis.

Historically observed fluctuations in cotton market activities were well explained by movements of textile markets prices, as expected.

Several key price elasticities were estimated by simulating the model. Comparing to frequently cited assumed elasticity of -0.6, US demand for local textiles was estimated to be relatively elastic (-1.216). Similarly own price elasticity of local textile supply was estimated to be more elastic (4.38) than the literature estimated value of 1. An average value of own partial price elasticity of US cotton exports was estimated at -2.05.

Fluctuations in US cotton exports, particularly a large shrinkage of exports in 1985 was explained by changes in textile, fabric, and yarn trade market prices, not by US cotton trade pricing relative to foreign cotton exported.

A change in man-made fiber usage apparently affects the cotton market. This economical relationship varied according to the level of production, in the yarn and fabric stages for example a complementary relationship was detected. Considering the existence of regional differences in input endowments, relationships must be evaluated by region and by stage of production. A further investigation to find an economical linkage between cotton-manmade fiber markets is a subject to be conducted in the future. Results obtained from the study would have significant importance in identifying markets for US cotton exports, thus to increase or to support the US cotton farms' income.

A model simulation to investigate the effect of a hypothesized US and other countries' textile trade liberalization was conducted. A decrease in the textile import control triggered a complicated set of effects in the textile trade market. Since exact movements were critically dependant on world textile production technologies, and estimated own price elasticities of cotton demands were relatively inelastic compare to responses to the textile market prices, care must be exercised in evaluating the simulated results.

With model equations and model structures which is reported in the Appendix, and evaluating as short run effects, estimated consequences suggest that the US cotton market will very likely suffer negative effects from textile trade liberalization.

An approximated net US welfare gain was estimated at $6.9 billion: US textile consumer gains by $16.5 billion, however, US cotton production value at market level is reduced by $0.11 billion, and US textile producers' gain was reduced by $9.51 billion. Contrary to a case where imported and locally produced goods can be suitably assumed as homogeneous, smaller effects in the textile industry was estimated.

Cotton acreage equation which was specified with mean and covariance terms of expected quasi net profits reasonably explained the historical movement of planted acreage. Elasticities of expected quasi-profit of cotton production under the program was estimated at 0.028, and cotton production outside the program was estimated at 0.143. It was also found that changes in cotton program provisions could provide incentives to produce cotton under the program. Aggregated cotton planted acreage was negatively related to profitabilities of competitive crop productions- sorghum's per acre net return, and a covariance between yield and market price of soybean.

An another important finding from the study for policy analysis is that effectiveness of the US cotton policy variables are crucially dependant on world textile-cotton trade market conditions. And utmost attention should be given to the highly dynamic market behavior of the US and foreign textile industries as detected by the impact study of textile trade liberalization. This has particular importance for cotton program planners, with given findings that cotton market activity levels showed much higher response to changes in textile market variables than to cotton policy variables.

Given the estimated inelastic nature of cotton supply and the very elastic cotton demands with respect to the textile market prices, particularly to the foreign textile market prices, results in extremely volatile US cotton use levels, and US cotton market and farm prices.

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Appendix 1.

Estimated Structural Equations

This appendix lists variable definitions and model equations. Numbers in the parenthesis shows t-values.

1. Variable definitions.

Endogenous variables

USTEXDU	:USA, locally made textile use, [1000 MT].
USTEXIQ	:USA, imported textile use, [1000 MT].
USTEXSQ	:USA, textile production for US market, [1000 MT].
USTEXEQ	:USA, textile production for export, [1000 MT].
USFABSQ	:USA, fabric production for US market, [1000 MT].
USFABIQ	:USA, fabric import, [1000 MT].
USFABEQ	:USA, fabric production for export, [1000 MT].
USYRNSQ	:USA, yarn production for US market, [1000 MT].
USYRNIQ	:USA, yarn import, [1000 MT].
USYRNEQ	:USA, yarn production for export, [1000 MT].
USCTAP	:USA, cotton area planted, [Million Acres].
USCTEX	:USA, cotton export, [1000 Bales].
USCTSP	:USA, cotton production, [1000 Bales].
USCTMD	:USA, mill demand for cotton, [1000 Bales].
USCTES	:USA, cotton ending stock, [1000 Bales].
USELSMD	:USA, ELS cotton mill demand, [1000 Bales].
ECTEXDU	:EC(12), locally made textile use, [1000 MT].
ECTEXIQ	:EC(12), imported textile use, [1000 MT].
ECTEXSQ	:EC(12), textile production for EC, [1000 MT].
ECTEXEQ	:EC(12), textile production for export, [1000 MT].
ECFABSQ	:EC(12), fabric production for EC, [1000 MT].
ECFABIQ	:EC(12), fabric import, [1000 MT].
ECFABEQ	:EC(12), fabric production for export, [1000 MT].
ECYRNSQ	:EC(12), yarn production for EC market, [1000 MT].
ECYRNIQ	:EC(12), yarn import, [1000 MT].
ECYRNEQ	:EC(12), yarn production export, [1000 MT].
ECCTAH	:EC(12), cotton harvested acreage, [1000 Ha].
ECCTSQ	:EC(12), cotton production, [1000 Bales].
ECCTMD	:EC(12), mill demand for cotton, [1000 Bales].
ECCTEX	:EC(12), cotton export, [1000 Bales].
ECCTES	:EC(12), cotton ending stock, [1000 Bales].
ECCTIM	:EC(12), cotton import, [1000 Bales].
JATEXDU	:Japan, locally made textile use, [1000 MT].
JATEXIQ	:Japan, imported textile use, [1000 MT].
JATEXSQ	:Japan, textile production for local, [1000 MT].
JATEXEQ	:Japan, textile production for export, [1000 MT].
JAFABSQ	:Japan, fabric production for local, [1000 MT].
JAFABIQ	:Japan, fabric import, [1000 MT].
JAFABEQ	:Japan, fabric production for export, [1000 MT].
JAYRNSQ	:Japan, yarn production for local, [1000 MT].
JAYRNIQ	:Japan, yarn import, [1000 MT].
JAYRNEQ	:Japan, yarn production for export, [1000 MT].
JACTMD	:Japan, mill demand for cotton, [1000 Bales].
JACTIM	:Japan, cotton import, [1000 Bales].
JACTES	:Japan, cotton ending stock, [1000 Bales]
RWTEXSQ	:ROW, textile production for locaL, [1000 MT].
RWTEXEQ	:ROW, textile production for export, [1000 MT].

RWTEXIQ	:ROW, textile import, [1000 MT].
RWTEXDU	:ROW, locally made textile use, [1000 mt]
RWFABSQ	:ROW, fabric production for local, [1000 MT].
RWFABIQ	:ROW, fabric import, [1000 MT].
RWFABEQ	:ROW, fabric export, [1000 MT].
RWYRNSQ	:ROW, yarn production for local, [1000 MT].
RWYRNIQ	;ROW, yarn import, [1000 MT].
RWYRNEQ	:ROW, yarn export, [1000 MT].
RWCTAH	:ROW, cotton area harvested, [1000 Ha].
RWCTSP	:ROW, cotton production, [1000 Bales].
RWCTEX	:ROW, cotton export, [1000 Bales].
RWCTIM	:ROW, cotton import, [1000 Bales].
RWCTES	:ROW, cotton ending stock, [1000 Bales].
RWCTMD	:ROW, cotton mill demand, [1000 Bales]
USTEXPRC	:USA, locally made textile price, [$/Kg].
USTEXEXP	:USA, textile unit export value, [$/Kg].
USTEXIMP	:USA, textile unit import value, [$/Kg].
USFABEXP	:USA, fabric, unit export value, [$/Kg].
USFABIMP	:USA, fabric, unit import value, [$/Kg].
USYRNEXP	:USA, yarn, unit export value, [$/Kg].
USYRNIMP	:USA, yarn, unit import value, [$/Kg].
USCOTPF	:USA, upland cotton farm price, [c/lb].
USCOTPM	:USA, upland cotton market (spot) price, [c/lb].
USELSPF	:USA, ELS cotton farm price, [c/lb].
ECTEXPRC	:EC(12), locally made textile price, [$/Kg].
ECTEXEXP	:EC(12), textile unit export value, [$/Kg].
ECTEXIMP	:EC(12), textile unit import value, [$/Kg].
ECFABEXP	:EC(12), fabric, unit export value, [$/Kg].
ECFABIMP	:EC(12), fabric, unit import value, [$/Kg].
ECYRNEXP	:EC(12), yarn, unit export value, [$/Kg].
ECYRNIMP	:EC(12), yarn, unit import value, [$/Kg].
ECCTIMP	:EC(12), cotton, unit import value, [$/Kg].
ECCTEXP	:EC(12), cotton, unit export value, [$/Kg].
JATEXPRC	:Japan, locally made textile price, [$/Kg].
JATEXEXP	:Japan, textile unit export value, [$/Kg].
JATEXIMP	:Japan, textile unit import value, [$/Kg].
JAFABEXP	:Japan, fabric, unit export value, [$/Kg].
JAFABIMP	:Japan, fabric, unit import value, [$/Kg].
JAYRNEXP	:Japan, yarn, unit export value, [$/Kg].
JAYRNIMP	:Japan, yarn, unit import value, [$/Kg].
JACTIMP	:Japan, cotton, unit import value, [$/Kg].
RWTEXEXP	:ROW, textile export unit value, [$/Kg].
RWTEXIMP	:ROW, textile import unit value, [$/Kg].
RWFABIMP	:ROW, fabric import unit value, [$/Kg].
RWFABEXP	:ROW fabric export unit value, [$/Kg].
RWYRNIMP	:ROW, yarn import unit value, [$/Kg].
RWYRNEXP	:ROW, yarn export unit value, [$/Kg].
RWCTEXP	:ROW, cotton export unit value, [$/Kg].
RWCTIMP	:ROW, cotton import unit value, [$/Kg].
WDYRNSQ	:World, total yarn production, [1000 MT].

Exogenous variables.

USWAGE	:USA, manufactures wage rates index.
USEXC	:USA, exchange rate, [$/SDR]
USPPI	:USA, PPI index.
USPOP	:USA, population, [million].
USGNP	:USA, GNP, [Billion $].
USITB	:USA, 3 month T-bill interest rate.
USCTYLD	:USA, cotton yield, [lb/acre].
GYWAGE	:Germany, manufactures wage rates index.
GYEXC	:Germany, exchange rate, [DM/SDR].
GYCPI	:Germany, CPI index.
GYINT	:Germany, interest rate.
ECPOP	:EC(12), population, [million].
ECGDP	:EC(12), sum of national income [billion SDR].
ECCTYLD	:EC(12), cotton yield, [Kg/Ha]
ECCTLS	:EC(12), cotton loss, [1000 Bales]
OIL	:Crude oil export price, [$/barrel].
var(OIL)	:Variance of crude oil export price.
JAWAGE	:Japan, manufactures wage rates index.
JAEXC	:Japan, exchange rate, [Yen/SDR].
JACPI	:Japan, CPI index.
JAPOP	:Japan, population, [million].
JAGDP	:Japan, GDP, [billion Yen].
JAINT	:Japan, money market interest rate.
JACTLS	:Japan, cotton loss, [1000 Bales].
JACTEX	:Japan, cotton exports, [1000 Bales].
SNWAGE	:Spain, wage rates index.
SNCPI	:Spain, CPI.
SNPOP	:Spain, population, [million]
SNGDP	:Spain, GDP, [billion pesetas]
SNINT	:Spain, interest rate
SNEXC	:Spain, exchange rate, [peseta/SDR]
COTLR	:USA, cotton loan rate, [c/lb].
COTTP	:USA, cotton target price, [c/lb].
SPRTP	:USA, cotton support price, [c/lb].
ACR	:USA, cotton conservation acreage requirement.
ARP	:USA, cotton acreage reduction requirement, [%].
AWP	:USA, adjusted US cotton world price, [c/lb].
USCOTVC	:USA, cotton variable cost of production [$/acre].
USCTIM	:USA, cotton import, [1000 Bales].
USCTLS	:USA, cotton loss [1000 Bales].
SA_COST	:USA, cotton cost for set aside
SA_RATE	:USA, cotton set aside requirement, [%].
SETASIDE	:USA, cotton set aside land area, [million acres].
BASE	:USA, cotton farm base acreage [million acre].
VDR	:USA, voluntary diversion rate, [%]
DR	:USA, land diversion requirement, [%].
DP	:USA, land diversion payment, [c/lb].
DR1	:USA, land diversion requirement.
SOYPF	:USA, soybean farm price.
SOYYD	:USA, soybean yield.

SBVARC	:USA, soybean variable costs, [$/acre].
SOYNR	:USA, non program soy bean net profit, [$/acre].
SGMNR	:USA, non program sorghum net profit, [$/acre].
SGVARC	:USA, sorghum variable costs, [$/acre].
SGSYLD	:USA, sorghum yield.
SGPFRRM	:USA, sorghum farm price.
PIK	:USA, payment in kind program requirement.
RWCTLS	:ROW, cotton loss, [1000 Bales].
NPARNR	:USA, cotton expected profit outside program
PARNR	:USA, cotton expected profit in the program
YLDP	:USA, cotton program yield
COTPFE	:USA, cotton expected farm price
dif	:difference operator.
lag	:lag operator.

US, Textile Market

1. US, textile production for domestic market.

```
     USTEXSQ=10568.47 +24209.52*USTEXPRC/lag(USTEXPRC)
             (0.45)     (1.22)
     -54590.87*USTEXEXP/USPPI
     (-1.95)
     -17086.07*USWAGE/lag(USWAGE)  -7655.6*OIL/USPPI
     (-1.06)                       (-2.74)
 -4.69544*var(OIL)  +0.24044*lag(USTEXSQ)-401.59*(YEAR-1969)
(-0.39)             (0.67)                (-1.60)
```

SSE=214339, df=6, R^2=0.8300.

2. US, demand for domestic textile

```
      USTEXDU=( 44.17854 -116.53*USTEXPRC/USPPI
                (1.44)    (-1.50)
   +17.46365*USTEXIMP/USPPI +1205.94*dif(USPOP)/lag(USPOP)
   (1.13)                    (1.85)
        -0.21426*(USITB-dif(USPPI)/lag(USPPI))
        (-0.97)
   +0.39385*(dif(USGNP)/dif(USPOP))/(lag(USGNP)/lag(USPOP))
    (3.01)
  -32.19537*OIL/USPPI+0.11225*lag(USTEXDU)/lag(USPOP))*USPOP
  (-2.14)              (0.71)
     -39.23343*(YEAR-1969).
     (-0.43)
```

SSE=84354.27, df=5, R^2=0.9331.

3. US, textile production for export

```
     USTEXEQ=-38.39916 -71.10502*USTEXPRC/USPPI
             (-0.41)   (-0.36)
       +85.87825*USTEXEXP/lag(USTEXEXP)
       (1.33)
          -0.98629*(USITB-dif(USPPI)/lag(USPPI))
          (-0.88)
          +0.57158*var(OIL)  +0.6412*lag(USTEXEQ)
          (3.25)             (2.45)
```

SSE=343.75, df=8, R^2=0.9264.

4. US, demand for imported textile

```
USTEXIQ=(1-0.07301 +2.37677*USTEXPRC/USPPI
           (-0.23)    (1.34)
 -1.9013*USTEXIMP/USPPI -0.0022415*var(OIL)
  (-1.83)                (-1.65)
+0.00920276*(dif(USGNP)/dif(USPOP))/(lag(USGNP/USPOP)))
 (0.82)
            *lag(USTEXIQ)
```

SSE=5011.09, df=9, R^2=0.9946.

5. US, fabric production for export

```
USFABEQ=-296.29 +246.36*USFABEXP/USPPI
         (-2.53) (0.46)
     -777.00*USYRNEXP/USPPI -76.06736*OIL/USPPI
     (-0.83)                (-1.09)
   +0.949*var(OIL) +366.01*USWAGE/lag(USWAGE)
     (4.84)          (2.58)
   +2.62814*(USITB-dif(USPPI)/lag(USPPI))
   (1.58)
```

SSE=477.61, df=7, R^2=0.8880.

6. US, demand for imported fabric

```
USFABIQ=-78.55952 +295.6*USWAGE/USPPI
         (-0.87)   (2.71)
     -1071.53*USFABIMP/USPPI -2.87072*OIL/lag(OIL)
     (-6.61)                 (-0.49)
     +.00027352*USTEXPRC/(dif(USPPI)/lag(USPPI))
      (0.21)
     +0.33978*lag(USFABIQ)
     (2.61)
```

SSE=820.67, df=8, R^2=0.9813.

7. US, demand for imported yarn

```
USYRNIQ=-528.05 +220.46*USTEXPRC/lag(USTEXPRC)
         (-2.85)  (1.49)
 -4545.94*USYRNIMP/USPPI +512.38*USWAGE/USPPI
 (-9.24)                 (8.11)
   +3.97835*(USITB-dif(USPPI)/lag(USPPI))
   (4.33)
+25.10867*USCOTPM/USPPI +0.47709*lag(USYRNIQ)
(4.48)                  (5.49)
```

SSE=248.69, df=7, R^2=0.9878.

8. US, yarn production for export

```
USYRNEQ=633.48 -1030.01*USTEXPRC/USPPI
         (2.36)  (-1.70)
   +113.92*USYRNEXP/USYRNIMP -351.31*USWAGE/lag(USWAGE)
   (1.09)                     (-1.02)
-388.83*OIL/USPPI +20.42259*(USITB-dif(USPPI)/lag(USPPI))
     (-1.79)            (3.20)
```

SSE=3334.88, df=8, R^2=0.8259.

9. US, demand for ELS cotton

```
USELSMD  =12.05722 +59.0366*USTEXEXP/lag(USTEXEXP)
         (0.30)    (1.46)
   +79.72546*USCOTPM/USPPI -1796.78*USELSPF/USPPI
   (3.93)                  (-2.15)
   -2.71291*(USITB-dif(USPPI)/lag(USPPI))
   (-4.12)
```

SSE=264.56, df=9, R^2=0.8667.

10. US, textile market clearing condition

USTEXSQ-USTEXDU =0.

11. US, yarn production

USYRNSQ=USFABSQ+USYRNIQ-USFABEQ.

EC, Textile Market

12. EC, textile production for EC market.

ECTEXSQ=ECYRNSQ+ECYRNIQ+ECFABIQ-ECFABEQ-ECTEXEQ.

13. EC, textile production for export

```
ECTEXEQ=345.69 +135.56*ECTEXEXP/ECTEXPRC
        (3.36)  (0.96)
-411.84*SNWAGE/SNCPI -2.10478*GYINT
(-3.24)               (-0.61)
+0.67187*OIL/lag(OIL)
 (0.07)
-45.54433*ECCTIMP/lag(ECCTIMP))+0.5125*lag(ECTEXEQ)
 (-2.74)                         (1.90)
+27.16871* (YEAR-1969).
 (2.64)
```

SSE=897.6, df=7, R^2=0.9947.

14. EC, fabric production for export

```
     ECFABEQ=(1+4.16687 -3.90520*ECTEXPRC/lag(ECTEXPRC)
               (4.33)   (-4.30)
   +1.21150*ECFABEXP/GYCPI +0.07980*OIL/lag(OIL)
    (1.84)                  (2.94)
   -0.0082766*GYWAGE/GYCPI -0.01372*GYINT )*lag(ECFABEQ).
    (-0.05)                 (-2.44)
```

SSE=2603.42, df=9, R^2=0.9604.

15. EC, demand for imported fabric

```
     ECFABIQ=624.24 +87.58472*ECTEXPRC/GYCPI
             (1.37)   (2.53)
+318.25*ECTEXEXP/lag(ECTEXEXP)-52.097*ECFABIMP/lag(ECFABIMP)
 (2.69)                         (-0.41)
-619.1*GYWAGE/lag(GYWAGE)+5.18673*GYINT+0.395*lag(ECFABIQ).
 (-1.44)                   (1.49)         (3.62)
```

SSE=2024.25, df=8, R^2=0.9702.

16. EC, yarn production for EC market

```
     ECYRNSQ=1501.81 -397.92*ECCTIMP/lag(ECCTIMP)
             (1.45)   (-2.59)
     +0.04988*ECTEXPRC/(dif(SNCPI)/lag(SNCPI))
     (0.30)
     +1089.83*ECFABEXP/lag(ECFABEXP)
      (2.43)
     -0.01662*OIL/(dif(GYCPI)/lag(GYCPI))
      (-1.08)
      -196.62*SNINT/lag(SNINT)
      (-0.96)
     -6871.14*ECYRNEXP/SNCPI-67.09971*(YEAR-1969)
     (-1.25)                 (-1.25)
     +0.79376*lag(ECYRNSQ).
      (2.32)
```

SSE=52517.69, df=6, R^2=0.8332.

17. EC, yarn production for export

```
     ECYRNEQ=(2.27179 +34.45136*ECYRNEXP*(USEXC/GYEXC)/GYCPI
              (4.22)   (2.05)
       -14.25768*ECFABEXP/GYCPI -0.61607*SNWAGE/SNCPI
       (-2.01)                   (-1.70)
  +0.01344*(YEAR-1969) -0.03356*OIL/lag(OIL) )*lag(ECYRNEQ).
   (1.17)               (-0.89)
```

SSE=47247.91, df=9, R^2=0.9124.

18. EC, demand for EC made textile

```
    ECTEXDU =12009.06 -10097.31*ECTEXPRC/lag(ECTEXPRC)
               (3.76)    (-2.94)
 +1240.13*ECTEXIMP/lag(ECTEXIMP) -40.52337*(YEAR-1969)
  (2.42)                          (-1.83)
 -646.45*SNINT/lag(SNINT) +14448.35*(ECGDP/ECPOP)/GYCPI
 (-3.28)                    (2.50)
 +0.55528*lag(ECTEXDU).
  (1.97)
```

SSE=96897.29, df=8, R^2=0.8633.

19. EC, demand for imported textile

```
    ECTEXIQ=-47449.64    -1126.59*ECTEXIMP/GYCPI
               (-2.54)     (-0.67)
 +950.37*ECTEXPRC/lag(ECTEXPRC) +46451.56*ECPOP/lag(ECPOP)
  (1.53)                         (2.50)
    -28.25342*GYINT+16.28811*(YEAR-1969)
    (-2.30)          (0.64)
 +6503.68*(ECGDP/ECPOP)/GYCPI)+0.38688*lag(ECTEXIQ).
 (1.36)                        (1.09)
```

SSE=4429.24, df=7, R^2=0.9911.

20. EC, demand for imported yarn

```
    ECYRNIQ=-307.31+684.08*ECTEXPRC/GYCPI
             (-0.46) (4.10)
    +3240.07*ECTEXEXP/GYCPI -31152.15*ECYRNIMP/GYCPI
     (1.86)                  (-1.91)
 +94.51393*OIL/lag(OIL)-0.66651*GYINT +1226.90*GYWAGE/GYCPI.
  (1.25)                (-0.06)        (1.25)
```

SSE=18845.45, df=8, R^2=0.9876.

21. EC, textile market clearing condition

ECTEXSQ-ECTEXDU=0.

Japan textile Market

22. Japan, demand for locally made textiles

```
JATEXDU=-3138.39 -2849.15*JATEXPRC/JACPI
         (-3.12)  (-4.61)
+1394.26*JATEXIMP/lag(JATEXIMP) +39.26734*JAPOP
 (3.26)                           (2.80)
+1930.56*((JAGDP/JAPOP)/JACPI)/lag((JAGDP/JAPOP)/JACPI)
 (1.19)
-4.31583*var(OIL) +0.43467*lag(JATEXDU)
 (-3.29)            (3.46)
```

SSE=21878.86, df=7, R^2=0.9417.

23. Japan, demand for imported textile

```
JATEXIQ= -246.54 -1.20923*JATEXIMP*dif(JAEXC)/JACPI
         (-2.27)  (-1.50)
+3.41995*JATEXPRC/lag(JATEXPRC) +195.0*JAGDP/JACPI
 (0.03)                           (6.47)
-1.47151*JAINT -2.47135*JACPI
 (-0.65)        (-3.13)
```

SSE=858.73, df=8, R^2=0.9442.

24. Japan, textile production for export

```
JATEXEQ= 174.65 -74.05563*JATEXPRC/JACPI
         (6.28)  (-4.77)
-546.77*JAFABEXP/JACPI +353.22*JATEXEXP/JACPI
 (-6.50)                (4.53)
-82.67194*JAWAGE/JACPI +0.29189*lag(JATEXEQ)
 (-3.58)                (4.26)
```

SSE=11.91873, df=8, R^2=0.9493.

25. Japan, fabric production for export

```
JAFABEQ= 895.26 +0.0036688*JAFABEXP/(dif(JACPI)/lag(JACPI))
         (3.93)  (1.41)
     -17.44866*JATEXPRC/lag(JATEXPRC)
      (-0.27)
     -229.54*JATEXEXP/lag(JATEXEXP) -14.36249*OIL/lag(OIL)
      (-3.89)                         (-2.00)
-431.08*JAWAGE/JACPI -1.42294*JAINT +0.24691*lag(JAFABEQ)
 (-4.10)              (-0.47)         (0.92)
```

SSE=631.58, df=6, R^2=0.8739.

26. Japan, yarn production for export

```
JAYRNEQ=1112.15    -439.33*OIL/JACPI
        (7.03)     (-4.60)
-2000.58*JAFABEXP/JACPI +3837.9*JAYRNEXP/JACPI
 (-6.86)                 (3.89)
+6.01489*JACPI+2.51385*JAINT
 (3.64)        (1.35)
-1499.07*JAWAGE/JACPI +7.79856*(YEAR-1969)
 (-8.82)               (1.92)
+0.29038*lag(JAYRNEQ)
 (1.89)
```

SSE=151.1, df=5, R^2=0.9478.

27. Japan, demand for imported yarn

```
JAYRNIQ= -507.09 +93.86266*JATEXEXP/lag(JATEXEXP)
         (-3.14) (1.28)
+121.78*JAFABIMP/lag(JAFABIMP) -4540.36*JAYRNIMP/JACPI
(3.95)                          (-6.66)
+671.46*JAWAGE/JACPI
(6.29)
```

SSE=2464.45, df=9, R^2=0.9636.

28. Japan, textile production for local market.

JATEXSQ=JAYRNSQ+JAYRNIQ+JAFABIQ-JAFABEQ-JATEXEQ.

29. Japan, demand for imported fabrics

```
JAFABIQ=-19.83917 +36.25895*JATEXPRC/lag(JATEXPRC)
         (-0.85)   (1.28)
+121.03*JATEXEXP/lag(JATEXEXP) -0.129*JAINT
 (8.47)                         (-0.22)
-227.06*JAFABIMP/JACPI -73.92823*JAWAGE/lag(JAWAGE)
 (-6.49)                (-1.99)
+0.20028*lag(JAFABIQ)
 (1.53)
```

SSE=35.3023, df=7, R^2=0.9507.

30. Japan, yarn production for local market

```
JAYRNSQ= (2.51064

+(1.22E-06)*JATEXPRC/(dif(JACPI)/lag(JACPI))
    (3.80)      (0.86)
-0.0015492*var(OIL) -1.33809*JAWAGE/lag(JAWAGE)
 (-1.63)              (-4.17)
+1.96305*JATEXEXP/JACPI -.0072607*JAINT
 (1.27)                     (-0.83)
-.0347*JACTIMP/lag(JACTIMP)-.027*(YEAR-1969))*lag(JAYRNSQ)
  (-1.39)                          (-3.43)
```

SSE=28243.88, df=5, R^2=0.8429.

31. Japan, textile market clearing condition

JATEXSQ-JATEXDU=0

Rest of the world, Textile Market

32. RW, textile production for RW local market

RWTEXSQ=RWYRNSQ-RWYRNEQ+RWYRNIQ+RWFABIQ-RWFABEQ-RWTEXEQ.

33. RW, textile production for export

```
RWTEXEQ=-264.19 +1289.44*RWTEXEXP/lag(RWTEXEXP)
        (-0.69)  (4.10)
     -311.16*RWCTEXP/lag(RWCTEXP) -23.60066*(YEAR-1969)
     (-3.58)                        (-0.92)
     +6.10357*(YEAR-1969)^2.
     (5.15)
```

SSE=38339.37, DF=9, R^2=0.9866.

34. RW, fabric production for export

```
RWFABEQ=(1.79125 -2.79846*RWYRNEXP/SNCPI
         (2.63)  (-1.82)
+0.27735*RWFABEXP/lag(RWFABEXP) -0.87404*SNWAGE/SNCPI
(1.88)                            (-1.40)
     -0.0015657*var(OIL) )*lag(RWFABEQ).
     (-1.28)
```

SSE=10356.41, DF=9, R^2=0.9446.

35. RW, yarn production for RW market

```
     RWYRNSQ=(0.89454 +0.07439*RWTEXEXP/lag(RWTEXEXP)
              (13.75)   (0.85)
+0.0486*RWFABEXP/lag(RWFABEXP)-0.001377*SNINT)*lag(RWYRNSQ)
 (0.73)                         (-1.60)
          +50.02371*(YEAR-1969).
           (2.26)
```

SSE=290427, DF=9, R^2=0.9963.

36. RW, yarn production for export market

```
RWYRNEQ=(1.01908-0.26036*RWTEXEXP/SNCPI
          (3.63)  (-0.66)
     +0.00177391*RWYRNEXP/(dif(SNCPI)/lag(SNCPI))
         (0.89)
     -0.00127*lag(RWYRNEXP)  -0.13205*RWCTIMP/lag(RWCTIMP)
      (-0.04)                 (-1.26)
    -0.0022651*var(OIL))*lag(RWYRNEQ)  +0.19302*YEAR
      (-1.14)                            (0.73)
```

SSE=38178.94, DF=7, R^2=0.9828.

37. RW, demand for local made textile

```
     RWTEXDU=(-3.18597 +4.13191*SNPOP/lag(SNPOP)
              (-1.44)    (1.88)
          -(1.58E-05)*RWTEXEXP/(dif(SNCPI)/lag(SNCPI))
           (-0.13)
     +0.00169658*RWTEXIMP/lag(RWTEXIMP)
      (0.03)
   +0.27*(SNGDP/lag(SNGDP)-SNCPI/lag(SNCPI)))*lag(RWTEXDU)
     (0.89)
     +73.30*(YEAR-1969)
     (1.22)
```

SSE=417977, DF=8, R^2=0.9932.

38. RW, demand for imported textile

```
     RWTEXIQ=(-13.16945 +0.32578*RWTEXEXP/lag(RWTEXEXP)
               (-2.37)     (1.03)
     -0.45515*RWTEXIMP/lag(RWTEXIMP)+14.102*SNPOP/lag(SNPOP)
      (-1.88)
          +1.65472*(SNGDP/lag(SNGDP)-SNCPI/lag(SNCPI))
           (2.62)
          -0.05003*OIL/lag(OIL))*lag(RWTEXIQ)
           (-1.83)
          +9.15895*(YEAR-1969).
          (2.22)
```

SSE=2277.63, DF=7, R^2=0.9869.

39. RW, demand for imported fabric

```
RWFABIQ= 647.75 +227.07*RWTEXEXP/lag(RWTEXEXP)
          (2.00)   (2.05)
     -0.756276*RWFABIMP/(dif(SNCPI)/lag(SNCPI))
      (-1.91)
     -168.36*SNWAGE/lag(SNWAGE) +0.73089*var(OIL)
      (-0.78)                     (1.30)
     +0.28734*lag(RWFABIQ)
      (1.19)
     -1.70709*SNINT +12.79855*(YEAR-1969).
      (-0.92)          (2.19)
```

SSE=4089.21, DF=6, R^2=0.9088.

40. RW, demand for imported yarn

```
RWYRNIQ=(1.16496 +0.08405*RWTEXEXP/lag(RWTEXEXP)
          (6.69)    (0.46)
   +0.50065*RWFABIMP/lag(RWFABIMP)
    (4.69)
   -0.54739*RWYRNIMP/lag(RWYRNIMP)
    (-6.12)
   -0.0173*OIL/lag(OIL) -0.0037864*SNINT
    (-1.29)               (-2.23)
   -0.09429*SNWAGE/lag(SNWAGE) )*lag(RWYRNIQ).
    (-0.95)
```

SSE=17652.43, DF=7, R^2=0.9717.

41. RW, Textile market clearing condition

RWTEXSQ-RWTEXDU=0.

42. Textile Trade Market Equilibrium Condition.

USTEXEQ+ECTEXEQ+JATEXEQ+RWTEXEQ=
USTEXIQ+ECTEXIQ+JATEXIQ+RWTEXIQ.

43. Fabric Trade Market Equilibrium Condition.

USFABEQ+ECFABEQ+JAFABEQ+RWFABEQ=
USFABIQ+ECFABIQ+JAFABIQ+RWFABIQ.

44. Yarn Trade Market Equilibrium Condition.

USYRNEQ+ECYRNEQ+JAYRNEQ+RWYRNEQ=
USYRNIQ+ECYRNIQ+JAYRNIQ+RWYRNIQ.

45. **World Total Yarn Production.**

```
WDYRNSQ=USYRNSQ+USYRNEQ+ECYRNSQ+ECYRNEQ+JAYRNSQ+JAYRNEQ
            +RWYRNSQ+RWYRNEQ.
```

Cotton Market Equations

US, Cotton Market

46. **US cotton export**

```
USCTEX=146106 -3.31405*USCOTPM/(dif(JACPI)/lag(JACPI))
        (3.73)   (-7.51)
-233904*GYWAGE/lag(GYWAGE)+5043.70*OIL/lag(OIL)
(-5.83)                    (7.99)
+1.11375*ECTEXEXP/(dif(GYCPI)/lag(GYCPI))
(7.95)
+0.96506*RWTEXEXP/(dif(OIL)/lag(OIL))
(2.14)
+92804.09*ECTEXPRC/lag(ECTEXPRC)
(3.40)
+545.31*(YEAR-1969)-0.36312*lag(USCTEX).
(2.25)                (-1.87)
```

SSE=1636031, df=5, R^2=0.9590.

47. **US cotton mill demand**

```
USCTMD= 2490.37 +86422.78*USTEXPRC/USPPI
        (0.16)     (2.05)
      +3354.28*USTEXEXP/lag(USTEXEXP)
      (0.67)
      -0.01068*USCOTPM/(dif(USPPI)/lag(USPPI))
      (-0.34)
      -36611.89*USWAGE/USPPI -192.54*USITB
      (-1.73)                (-0.75)
      +1.62063*USYRNSQ +729.02*(YEAR-1969)
      (2.22)            (2.03)
      -0.40995*lag(USCTMD).
      (-1.18)
```

SSE=977509, df=4, R^2=0.8113.

48. US cotton ending stock

```
USCTES=20811.13 -0.10794*USCOTPM/(dif(USPPI)/lag(USPPI))
       (2.84)    (-2.20)
     -34939.51*USTEXEXP/lag(USTEXEXP)
     (-4.33)
     +14511.49*USFABEXP/lag(USFABEXP)
     (2.73)
+0.556*USCTSP*1000 +140.83*COTLR -7212.60*USITB/lag(USITB)
(2.22)                (2.21)         (-4.63)
     -12987.14*OIL/USPPI +0.25726*lag(USCTES).
     (-2.88)              (0.83)
```

SSE=3187961, df=4, R^2=0.9397.

49. US, cotton planted acreage

```
USCTAP=6.79893 +2.57497*NPARNR -3.50175*SGMNR
        (6.79)     (7.84)          (-8.86)
     +0.64381*BASE*(1-SA_RATE)
     (12.74)
     +2.1929*var(PARNR) -10.25714*var(NPARNR)
     (3.71)                (-4.89)
     +0.0000143*cov(CTYLDP,REVE)
     (3.45)
     +3.45739*cov(SOYYDE,SOYPFE)
     (12.80)
     +0.51007*cov(PARNR,SGMNR)
     (1.16)
     +0.03597*lag(USCTAP).
     (0.70)
```

SSE=0.73488, df=8, R^2=0.9861.

50. US cotton production

```
USCTSP=(-0.37785
        (-0.20)
     +0.98608*USCTAP-0.004148*USPPI)*(USCTYD/480).
       (9.47)         (-0.34)
```

SSE=2.31147, df=5, R^2=0.9667.

51. US, cotton market equilibrium condition

lag(USCTES)+USCTSP+USCTIM-USCTMD-USCTEX-USCTES-USCTLS=0.

EC, Cotton Market

52. EC cotton mill demand

```
ECCTMD=8692.86
         (4.22)
+1565.58*ECTEXPRC/GYCPI-351.5*ECCTEXP/lag(ECCTEXP)
    (4.01)                (-1.29)
-8241.64*GYWAGE/GYCPI+2549.25*ECYRNIMP/lag(ECYRNIMP)
(-3.06)                  (3.53)
```

SSE=441612, df=8, R^2=0.7525.

53. EC, cotton import

```
ECCTIM=16799.58-14.82567*RWCTEXP/(dif(GYCPI)/lag(GYCPI))
          (2.77)   (-1.19)
+0.51703*ECTEXEXP/(dif(GYCPI)/lag(GYCPI))
 (1.28)
-15338.66*GYWAGE/GYCPI-360.12*OIL/lag(OIL)
 (-1.96)                 (-1.43)
+3162.67*ECYRNEXP/lag(ECYRNEXP)
(2.10)
+0.44372*ECTEXPRC/(dif(SNCPI)/lag(SNCPI))
(0.59)
-0.34318*lag(ECCTIM)+114.41*(YEAR-1969)
(1.07)                  (0.67)
```

SSE=358693, df=6, R^2=0.9059.

54. EC, cotton ending stock

```
ECCTES= -5138.13+1441.98*ECTEXEXP/lag(ECTEXEXP)
          (-2.27)   (0.91)
+12644.28*GYWAGE/GYCPI-61809.42*ECCTEXP/GYCPI
 (3.19)                  (-1.90)
+7137.28*OIL/GYCPI-8314.04*SNWAGE/SNCPI
 (1.90)              (-4.35)
+0.66094*ECCTSP-156.47*GYINT.
 (1.81)          (-2.35)
```

SSE=57632.81, df=5, R^2=0.8802.

55. EC, cotton export

```
     ECCTEX=987.46+1167.83*RWTEXEXP/lag(RWTEXEXP)
            (1.09)  (0.85)
-523.61*RWFABEXP/lag(RWFABEXP)-478.77*SNWAGE/lag(SNWAGE)
 (-0.43)                          (-0.90)
     -58.76344*OIL/lag(OIL)-201.82*ECCTEXP/lag(ECCTEXP)
      (-0.22)               (-0.62)
     -12.71546*SNINT-0.9430*lag(ECCTEX)
      (-1.16)        (-1.98)
```

SSE=65942.66, df=5, R^2=0.5642.

56. EC cotton area harvested

```
     ECCTAH= 287.00+863.64*lag(ECCTEXP)/lag(OIL)
             (4.12)   (1.86)
     -46.2878*OIL/lag(OIL)+0.17424*lag(var(OIL))
      (-1.41)              (0.36)
     -4.6250*(SNINT-dif(SNCPI)/lag(SNCPI))
      (-2.18)
     -2330.96*(SNWAGE/SNCPI-lag(SNWAGE)/lag(SNCPI))
      (-3.52)
     +0.25761*lag(ECCTAH)
      (1.06)
```

SSE=5181.24, df=9.5, R^2=0.6150.

57. EC, cotton market equilibrium condition

```
   lag(ECCTES)+ECCTSP+ECCTIM-ECCTMD-ECCTEX-ECCTES-ECCTLS=0.
```

Japan Cotton Market

58. Japan, cotton mill demand

```
     JACTMD=1029.22+3248.59*JATEXPRC/JACPI
            (1.28)   (5.09)
+627.2*JAYRNEXP/lag(JAYRNEXP)+804042*OIL*(USEXC/JAEXC)/JACPI
 (3.01)                        (7.65)
     -2049.87*JAWAGE/JACPI-73.15715*JAINT
      (-3.02)              (-4.05)
-5727363*JACTIMP*(USEXC/JAEXC)/JACPI-0.11238*lag(JACTMD)
 (-4.14)                              (-0.90)
```

SSE=20696.95, df=6 R^2=0.9527.

59. Japan, cotton import

```
JACTIM=8742.371 -1163.22*USCOTPM/USPPI
         (2.91)   (-1.92)
+0.01268*JATEXPRC/(dif(JACPI)/lag(JACPI))
(1.88)
-769.36*lag(USCOTPM)/lag(USPPI)
(-1.84)
+117.88*JAYRNEXP/lag(JAYRNEXP)
(0.15)
+483.10*OIL/lag(OIL) -0.30993*lag(JACTIM)
 (1.69)                (-0.75)
-3947.35*JAWAGE/JACPI.
(-2.79)
```

SSE=216503, df=7 R^2=0.7688.

60. Japan, cotton ending stock

```
JACTES= 2553.95 +1442.60*JATEXPRC/JACPI
         (1.79)    (1.67)
+19516.48*JAYRNEXP/JACPI +1115.94*JAFABIMP/lag(JAFABIMP)
 (1.60)                    (2.87)
 -1602.65*JATEXEXP/lag(JATEXEXP)
  (-1.24)
 +0.81123*var(OIL) -3655.24*JAWAGE/JACPI -65.30444*JAINT
  (0.31)            (-3.00)                (-1.56)
```

SSE=40920.68, df=6 R^2=0.9115.

61. Japan, cotton market equilibrium condition

lag(JACTES)+JACTIM-JACTMD-JACTEX-JACTES-JACTLS=0.

Rest of the World Cotton Market

62. RW, cotton export.

RWCTEX=(USCTIM+ECCTIM+JACTIM+RWCTIM)-(USCTEX+ECCTEX).

```
(RWCTEX=3133.84-584307*RWCTEXP/USPPI
         (0.33)   (-2.40)
        +10096.33*ECFABEXP/lag(ECFABEXP)
        (2.33)
        +11587.54*JATEXPRC/JACPI
        (1.24)
        +22.1468*var(OIL)*OIL/lag(OIL)
        (1.00)
        -168.75*(YEAR-1969)-0.12397*lag(RWCTEX)
        (-0.76)             (-0.41)
```

SSE=9666347, df=7, R^2=0.8010.)

63. RW, cotton import

```
     RWCTIM=959.25-1763.31*ECCTEXP/lag(ECCTEXP)
           (0.17)  (-1.43)
+59.88*var(OIL)*OIL/lag(OIL)-0.5248*lag(RWCTIM)+126.5*SNINT
 (2.88)                        (-1.84)              (1.97)
     +13429.09*RWTEXEXP/lag(RWTEXEXP)+320.73*(YEAR-1969).
      (3.09)                          (3.67)
```

SSE=3549480, df=7, R^2=0.9098.

64. RW, cotton area harvested

```
     RWCTAH=36354.1 +95117.39*lag(RWCTEXP)/SNCPI
            (31.13)  (11.44)
     +2115.74*OIL/lag(OIL)
      (22.03)
     -30.25682*var(OIL)   -0.49303*lag(RWCTEX)-110.38*SNINT
      (-12.04)             (-35.43)             (-12.67)
     -0.43982*lag(RWCTAH)+607.51*(YEAR-1969).
      (-14.95)             (21.31)
```

SSE=210847, df=10, R^2=0.9795.

65. RW, cotton mill demand

```
 RWCTMD=-16890.3-2795.69*RWCTIMP/lag(RWCTIMP)+3.9120*RWYRNSP
       (-1.60)  (-1.47)                       (3.68)
     -1655.07*(YEAR-1969) +0.5866*lag(RWCTMD).
      (-2.98)               (2.17)
```

SSE=9,304,017, df=9, R^2=0.9816.

66. RW, cotton ending stock

```
RWCTES=-36099.57-0.5353*RWYRNSQ+0.91408*(lag(RWCTES)+RWCTSP)
       (-2.03)    (-1.35)
     +11659.33*SNWAGE/lag(SNWAGE)   -446.56*SNINT
      (1.06)                        (-3.36)
-0.5394*lag(RWCTES)-17.96582*RWCTIMP/(dif(SNCPI)/lag(SNCPI))
 (-6.87)             (-0.06)
```

SSE=6,908,098, df=7, R^2=0.9900.

67. RW, cotton market equilibrium condition

lag(RWCTES)+RWCTSP+RWCTIM-RWCTMD-RWCTEX-RWCTES-RWCTLS=0.

68. Cotton trade market equilibrium condition

USCTEX+ECCTEX+JACTEX+RWCTEX=USCTIM+ECCTIM+JACTIM+RWCTIM.

Price linkage equations

69. US, cotton farm price

USCOTPF=2.4337 +0.86155*max(USCOTPM, USCOTLR)
(0.41) (8.68)

SSE=381.1556, df=14, R^2=0.8434.

70. US, textile import price

USTEXIMP=-16.812-1.0278*ECTEXEXP
(-1.64) (-3.11)
+0.151*USPPI+1.0063*RWTEXEXP+24.784*USEXC.
(2.05) (1.57) (2.55)

SSE=10.5018, df=11, R^2=0.7034.

US, textile import price (2)

USTEXIMP=-1063.666 -1.199628*ECTEXEXP +0.5364*YEAR
(-1.11) (-3.30) (1.09)
-0.081921*USPPI+2.2480*RWTEXEXP+12.8543*USEXC.
(-0.36) (1.72) (0.88)

SSE=9.3845, df=10, R^2=0.7350.

71. US, fabric import price

USFABIMP=24.302+2.3129*ECFABEXP-20.423*USEXC
(1.90) (2.03) (-1.53)
-0.1702*USPPI+0.0806*USYRNIMP.
(-1.92) (0.09)

SSE=9.8823, df=11, R^2=0.4947.

72. US, yarn import price

USYRNIMP=3.4328 +1.0475*ECYRNEXP-3.5886*USEXC
(4.63) (13.10) (-5.36)

SSE=0.6853, df=13, R^2=0.9298.

73. US, textile export price

USTEXEXP=16.05534+0.16745*ECTEXEXP
(5.63) (2.22)
-0.036138*USPPI -6.3621*USEXC.
(-2.04) (-2.33)

SSE=0.9232, df=12, R^2=0.3450.

74. US, fabric export price

USFABEXP=9.1221 +0.79226*ECFABEXP-8.6476*USEXC
(6.51) (12.49) (-6.60)

SSE=2.4309, df=13, R^2=0.9238.

75. US, yarn export price

USYRNEXP=1.8478 +0.61511*ECYRNEXP-1.0862*USEXC
(5.88) (18.16) (-3.84)

SSE=0.1229, df=13, R^2=0.9629.

76. Japan, textile import price

JATEXIMP=5.15547 +0.5029*ECTEXEXP -0.00694*JAEXC.
(0.89) (4.47) (-0.57)

SSE=29.5620, df=13, R^2=0.8458.

77. Japan, fabric import price

JAFABIMP=-2.06267 +0.946*ECFABEXP +0.01432*JAEXC.
(-0.58) (4.76) (2.01)

SSE=10.3498, df=13, R^2=0.7123.

78. Japan, yarn import price

JAYRNIMP=-5.8385 +0.3363*ECYRNEXP
(-2.91) (1.20)
+0.0465*JACPI +0.01457*JAEXC.
(3.07) (3.48)

SSE=1.9202, df=13, R^2=0.7475.

79. Japan, textile export price

JATEXEXP=28.7398+0.3202*ECTEXEXP-0.07148*JAEXC
(4.12) (2.35) (-4.83)

SSE=43.3189, df=13, R^2=0.9139.

80. Japan, fabric export price

JAFABEXP=7.4728 +0.8440*ECFABEXP -0.02034*JAEXC.
(2.04) (4.11) (-2.76)

SSE=11.0179, df=13, R^2=0.9036.

81. Japan, yarn export price

$$JAYRNEXP=1.70369 +0.91293*ECYRNEXP -0.00489*JAEXC.$$
$$(1.16) \quad (4.62) \quad (-1.70)$$

SSE=1.9208, df=13, R^2=0.8743.

82. EC, textile import price

$$ECTEXIMP=-0.9558 +0.70495*ECTEXEXP+0.8310*GYEXC.$$
$$(-0.21) \quad (10.43) \quad (0.74)$$

SSE=6.0780, df=13, R^2=0.9741.

83. EC, fabric import price

$$ECFABIMP=-2.4734 +0.9608*ECFABEXP +0.4863*GYEXC.$$
$$(-2.38) \quad (21.49) \quad (1.99)$$

SSE=0.2779, df=13, R^2=0.9938.

84. EC, yarn import price

$$ECYRNIMP=0.9549 +0.7923*ECYRNEXP -0.1845*GYEXC.$$
$$(4.03) \quad (32.12) \quad (-3.73)$$

SSE=0.0180, df=13, R^2=0.9975.

85. EC, textile export price

This price is found as a trade market clearing price.

86. EC, fabric export price

This price is found as a trade market clearing price.

87. EC, yarn export price

This price is found as a trade market clearing price.

88. RW, textile import price

$$RWTEXIMP=0.4877 +0.8303*ECTEXEXP +0.0122*SNEXC.$$
$$(1.48) \quad (47.99) \quad (4.71)$$

SSE=1.2943, df=13, R^2=0.9968.

89. RW, fabric import price

RWFABIMP=-0.4575 +0.6855*ECFABEXP +0.0126*SNEXC.
(-1.43) (14.80) (5.50)

SSE=0.9759, df=13, R^2=0.9779.

90. RW, yarn import price

RWYRNIMP=0.0959 +1.2272*ECYRNEXP-0.0016*SNEXC.
(0.65) (24.80) (-1.58)

SSE=0.1806, df=13, R^2=0.9864.

91. RW, textile export price

RWTEXEXP=5.1940 +0.4554*ECTEXEXP +0.0139*SNEXC.
(7.82) (13.02) (2.65

SSE=5.2859, df=13, R^2=0.9636.

92. RW, fabric export price

RWFABEXP=-0.3938 +0.8520*ECFABEXP +0.0090*SNEXC.
(-0.58) (8.62) (1.85)

SSE=4.4495, df=13, R^2=0.9248.

93. RW, yarn export price

RWYRNEXP=1.4803 +1.1271*ECYRNEXP -0.0122*SNEXC.
(4.69) (10.65) (-5.76)

SSE=0.8259, df=13, R^2=0.8984.

94. EC, cotton import price

ECCTIMP=0.9669-0.007167*USCOTPM+0.9978*RWCTEXP+0.01119*OIL
(0.84) (-2.37) (4.31) (1.56)
-0.002183*ECTEXEXP-0.2146*GYEXC.
(-0.14) (-0.87)

SSE=0.1038, df=10, R^2=0.9487.

95. EC, cotton export price

This price is found as a regional cotton market clearing price.

```
(ECCTEXP=0.00987-0.005462*USCOTPM+1.1968*RWCTEXP+0.0040*OIL
         (0.06)  (-2.40)           (8.00)           (0.82)
   +0.004634*ECTEXEXP-0.0006328*SNEXC.
   (0.92)             (-0.75),
```

SSE=0.0623, df=10, R^2=0.9646.)

96. Japan, cotton import price

This price is found as a regional cotton market clearing price.

```
(JACTIMP=1.7704-0.005127*USCOTPM+1.2463*RWCTEXP+0.01302*OIL
         (2.42)  (-1.57)          (6.12)          (1.93)
         -0.04174*JATEXEXP-0.004599*JAEXC.
         (-2.10)           (-2.62)
```

SSE=0.1270, df=10, R^2=0.9517.)

97. RW, cotton export price

```
RWCTEXP=-2.89135+0.28311*RWTEXEXP-0.05351*ECTEXEXP
         (-5.01)  (5.75)           (-2.05)
     +0.04149*GYCPI-0.17147*JATEXEXP.
     (2.93)         (-3.86)
```

SSE=0.09868, df=11, R^2=0.9215.

98. RW, cotton import price

This price is found as a regional cotton market clearing price.

```
(RWCTIMP=-3.60593+0.20826*RWTEXEXP-0.00728*ECTEXEXP
          (-5.46)  (3.67)           (-0.24)
     +0.06663*GYCPI-0.23744*JATEXEXP.
     (4.10)         (-4.66)
```

SSE=0.1295, df=11, R^2=0.9101.)

Computed variables

99. Variance of variable (ex. OIL)

$var(OIL)=(OIL^2_{t-2}+OIL^2_{t-1}+OIL^2)/3-(OIL_{t-2}+OIL_{t-1}+OIL)/3)^2.$

100. Expected US cotton farm price

COTPFE=2.59501+0.924407*lag(COTPF).

101. US cost for set aside land

SA_COST=0.1*COTVC.

102. US cotton trend yield

TRDYLD=281.825+0.44291*lag(COTYD).

103. US cotton program yield

YLDP=(sum(YLDS)-max(YLDS)-min(YLDS)/3.
YLDS={lag5(COTYD),lag4(COTYD),lag3(COTYD),
lag2(COTYD),lag(COTYD)}.

104. US soybean expected profit (per acre).

SOYPFE=0.123884+0.948541*lag(SOYPF).
SOYYDE=12.5086+0.541319*lag(SOYYD).
SOYNR=(SOYPFE*SOYYDE)-SBVARC)/USPPI.

105. US, sum of set aside requirements

SA_RATE=ARP+DR+VDR+PIK+DR1.

106. US, cotton expected market revenue

REV1=(TRDYLD*COTPFE).

107. US, cotton expected deficiency payment

REV2=(max(0,YLDP*(max(SPRTP,COTTP)-max(COTPFE,COTLR)))).

108. US, cotton expected revenue from CCC non recourse loan

REV3=TRDYLD*max(0,COTLR-COTPFE).

109. US, expected diversion and set aside payment revenue

REV4=YLDP*((1-DR1)*DP1+DP*DR+PIK*0.85*COTPFE).

110. US, cotton expected total revenue under program

```
REVE=REV1+REV2+REV3+REV4.
```

111. US, cotton covariance
(between program yield and total revenue.)

```
cov(CTYLDP,REVE)
     =(lag2(YLDP)*lag2(REVE)+lag(YLDP)*lag(REVE)
    +YLDP*REVE)/3 -(lag2(YLDP)+lag(YLDP)+YLDP)
 *(lag2(REVE)+lag(REVE)+REVE)/9.
```

112. US, cotton expected profit under program.

```
PARNR=( ((REV1+REV2+REV3)/100-USCOTVC)*(1-SA_RATE)
        +REV4/100-SA_RATE*SA_COST )/USPPI.
```

113. US, cotton expected profit outside programs

```
NPARNR=(REV1/100-COTVC)/USPPI.
```

114. US, sorghum expected farm price.

```
SGPFRMH=(0.1504+1.1063*lag(SGPFRM)-0.224*lag2(SGPFRM)).
```

115. US, sorghum expected yield

```
SGSYLDH=(18.2435+0.617059*lag(SGSYLD)).
```

116. US, sorghum expected profit

```
SGMNR=(SGPFRMH*SGSYLDH-SGVARC)/USPPI.
```

Appendix 2.

Textile and Cotton Trade Data

Data 1. World Yarn Market

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Production for local market [unit:1000 metric ton]																
USA	4447	4737	5532	5788	5726	6008	6283	6545	6293	5944	5390	5534	5774	5577	5680	6016
EC	4099	4177	4094	3727	3863	3917	3826	4011	4010	3888	3747	3687	3684	3839	3977	3762
Japan	2879	3026	2875	2508	2582	2671	2717	2883	2910	2779	2729	2724	2762	2801	2672	2602
Others	10011	9977	10174	10867	11172	11736	12326	12596	13282	13992	14225	14343	14604	15331	16306	17063
s-total (1)	21436	21918	22674	22890	23343	24332	25152	26035	26495	26603	26091	26287	26823	27548	28634	29443
Production for export market																
USA	68	107	152	136	133	148	140	172	208	254	247	187	169	200	196	184
EC	1172	1328	1371	1264	1331	1405	1462	1524	1518	1551	1532	1564	1697	1770	1769	1976
Japan	259	237	243	244	226	246	243	204	212	244	236	237	251	250	257	245
Others	1104	1255	1275	1176	1321	1440	1536	1722	1768	1731	1762	1868	2088	2253	2329	2546
s-total (2)	2603	2928	3041	2820	3012	3238	3381	3622	3705	3781	3778	3856	4204	4473	4552	4952
Total (1)+(2)	24040	24846	25716	25710	26355	27570	28532	29657	30200	30384	29869	30143	31028	32021	33186	34395
Yarn import																
USA	153	135	98	70	76	93	92	64	46	54	60	76	110	133	159	178
EC	903	1043	1095	1048	1178	1276	1328	1486	1563	1536	1531	1612	1760	1860	1924	2101
Japan	49	77	82	58	68	71	115	172	159	141	171	181	218	260	245	267
Others	1499	1672	1766	1644	1691	1798	1845	1900	1937	2050	2016	1988	2116	2220	2223	2406
s-total (3)	2603	2928	3041	2820	3012	3238	3381	3622	3705	3781	3778	3856	4204	4473	4552	4952

Data 2. World Yarn Market Prices

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Yarn import prices			[unit:$/kg]													
USA	2.13	2.08	2.26	2.21	2.21	2.33	2.72	3.35	3.98	3.98	4.01	3.94	3.86	3.74	3.62	3.72
EC	2.05	2.32	2.81	2.99	2.91	3.09	3.42	3.86	4.30	4.14	3.81	3.62	3.51	3.52	3.94	4.46
Japan	1.31	1.99	2.28	3.38	4.02	3.72	3.42	3.44	3.61	3.66	3.46	3.24	3.33	3.26	3.16	3.62
Others	2.71	3.00	3.46	3.97	3.97	4.02	4.55	4.06	4.65	4.49	4.16	4.04	3.94	3.88	4.31	4.73
Yarn export prices																
USA	2.03	2.05	2.30	2.54	2.59	2.70	2.77	2.99	3.39	3.35	3.22	3.27	3.24	3.03	3.09	3.49
EC	2.18	2.49	3.06	3.25	3.17	3.31	3.66	4.22	4.81	4.59	4.22	4.04	3.90	3.91	4.45	4.84
Japan	2.02	2.34	2.92	2.77	2.72	3.01	3.25	3.82	4.68	5.02	4.78	4.63	4.67	4.37	4.31	4.72
Others	2.91	3.23	3.90	4.57	4.25	4.21	4.62	3.80	4.23	4.10	3.78	3.60	3.51	3.50	3.83	4.32

Data 3. World Fabric Trade Market

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Production for local market [unit:1000 metric ton]																
USA	4548	4805	5536	5770	5716	6012	6286	6500	6212	5861	5340	5532	5805	5628	5751	6092
EC	4443	4608	4555	4170	4431	4563	4487	4780	4861	4724	4594	4604	4708	4920	5116	5036
Japan	2661	2858	2710	2289	2361	2443	2552	2812	2827	2652	2636	2638	2709	2795	2667	2641
Others	10076	10186	10502	11139	11307	12066	12754	13040	13853	14428	14480	14564	14797	15627	16678	17361
s-total (4)	21728	22457	23303	23368	23815	25084	26079	27132	27753	27664	27050	27338	28019	28970	30212	31130
Production for export market [unit:1000 metric ton]																
USA	52	68	94	89	85	88	88	109	127	138	110	78	78	83	88	102
EC	559	613	633	605	610	630	667	717	712	700	684	694	735	778	785	827
Japan	267	245	248	277	289	299	281	243	243	268	264	266	271	266	250	228
Others	568	683	747	682	662	701	763	834	840	816	798	819	914	963	1007	1057
s-total (5)	1446	1608	1722	1652	1646	1719	1800	1903	1922	1921	1857	1858	1999	2090	2130	2213
Total (4)+(5)	23174	24065	25024	25020	25461	26803	27878	29035	29675	29586	28907	29196	30019	31060	32342	33343
Fabric import [unit:1000 metric ton]																
USA	84	109	110	71	56	70	88	89	94	118	130	148	203	211	210	217
EC	467	530	577	567	570	592	627	689	692	646	618	622	657	699	742	778
Japan	17	43	60	43	35	39	48	56	53	52	51	50	54	53	55	62
Others	878	926	975	971	984	1017	1036	1069	1082	1105	1058	1038	1085	1127	1123	1157
s-total (6)	1446	1608	1722	1652	1646	1719	1800	1903	1922	1921	1857	1858	1999	2090	2130	2213

Data 4. World Fabric Trade Market Prices

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Fabric import prices			[unit:$/kg]													
USA	7.39	5.76	5.14	7.40	8.78	8.19	8.30	9.20	8.99	8.33	7.73	6.99	6.25	6.81	7.47	7.71
EC	4.03	4.72	5.27	5.75	5.85	6.17	7.15	8.12	8.92	8.65	8.10	7.70	7.16	7.28	8.75	10.46
Japan	8.61	7.41	7.16	9.48	10.76	10.38	10.92	12.22	12.31	11.43	10.60	9.77	8.90	9.46	10.58	11.73
Others	4.63	5.42	6.26	6.74	6.83	7.10	8.11	9.43	10.40	10.20	9.78	9.44	9.01	8.99	10.52	11.79
Fabric export prices																
USA	3.15	3.50	3.86	4.64	4.87	4.73	5.19	5.93	7.01	7.08	7.19	7.64	7.13	6.75	6.62	6.42
EC	4.91	5.65	6.59	7.28	7.29	7.64	8.69	9.88	10.81	10.23	9.47	9.01	8.57	8.74	10.62	12.12
Japan	4.33	5.35	6.32	6.23	6.45	6.65	7.66	9.65	10.97	11.72	11.66	11.10	10.76	10.44	11.55	12.96
Others	4.41	4.70	5.54	6.10	6.62	7.25	7.51	8.51	9.14	8.78	8.20	7.70	7.06	7.29	8.58	9.97

Data 5. World Textile Trade Market

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Production for local market				[unit:1000 metric ton]												
USA	4610	4888	5611	5799	5725	6023	6314	6517	6219	5879	5381	5608	5941	5773	5889	6218
EC	4616	4812	4781	4373	4606	4755	4720	5042	5103	4909	4736	4694	4803	5038	5221	5119
Japan	2609	2849	2733	2301	2365	2450	2568	2845	2858	2679	2662	2660	2731	2815	2693	2678
Others	10444	10497	10799	11385	11424	12121	12785	12969	13740	14314	14264	14251	14371	15063	15829	16188
s-total (7)	22279	23045	23923	23858	24120	25350	26387	27373	27920	27781	27044	27213	27846	28689	29632	30204
Production for export market				[unit:1000 metric ton]												
USA	23	27	36	42	48	59	61	73	87	100	89	72	67	66	72	91
EC	294	326	351	364	395	400	394	426	450	461	475	532	563	581	637	694
Japan	68	52	37	31	31	33	31	23	22	25	25	28	32	32	29	24
Others	510	615	678	724	867	962	1005	1140	1196	1218	1274	1352	1511	1692	1972	2330
s-total (8)	895	1020	1102	1161	1341	1453	1491	1662	1755	1805	1863	1983	2173	2371	2710	3139
Total (7)+(8)	23174	24065	25024	25020	25461	26803	27879	29035	29675	29586	28907	29196	30019	31060	32342	33343
Textile import				[unit:1000 metric ton]												
USA	122	130	120	130	194	246	293	323	326	370	425	497	609	720	854	977
EC	369	443	493	541	624	660	648	737	792	774	770	780	817	868	989	1173
Japan	18	42	65	53	50	56	65	80	78	75	79	75	85	103	128	180
Others	385	404	424	437	474	491	487	522	559	587	589	631	662	679	739	810
s-total (9)	895	1020	1102	1161	1341	1453	1491	1662	1755	1805	1863	1983	2173	2371	2710	3139

Data 6. World Textile Trade Market Prices

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Textile import prices			[unit:$/kg]													
USA	14.09	15.64	18.88	19.02	16.49	15.75	16.22	16.59	18.00	18.43	17.96	17.58	18.63	19.24	18.69	19.07
EC	10.25	11.45	12.99	14.14	14.34	15.48	17.98	19.49	21.75	21.94	20.41	19.29	18.44	18.06	20.27	23.62
Japan	7.65	8.79	10.74	11.87	12.34	13.19	14.19	16.29	17.93	18.70	18.71	17.78	16.78	15.97	16.43	18.14
Others	11.57	13.38	14.94	16.40	16.87	18.19	21.27	24.24	26.57	25.19	23.59	21.64	21.23	22.34	25.99	30.30
Textile export prices			[unit:$/kg]													
USA	9.83	9.71	9.55	9.47	9.51	9.44	9.31	9.31	10.24	10.16	10.10	9.98	9.68	9.48	9.40	9.49
EC	12.84	14.56	16.05	17.70	18.22	19.96	23.75	27.25	30.15	28.83	26.32	23.45	22.65	23.85	27.87	33.11
Japan	6.53	7.78	9.60	10.51	11.44	12.23	13.51	15.69	17.62	19.15	19.88	20.14	20.74	21.07	22.84	25.69
Others	11.11	12.22	13.81	14.83	14.65	15.41	17.23	18.48	20.46	20.67	19.48	18.57	18.46	18.42	19.41	21.37
Textile local prices																
USA,nominal,$/kg	12.50	13.40	14.87	15.51	16.12	16.98	17.63	18.49	19.87	21.62	22.70	22.96	23.30	23.56	23.63	23.92
USA, index	54.50	58.43	64.87	67.64	70.34	74.09	76.92	80.64	86.67	94.31	99.00	100.14	101.64	102.75	103.06	104.32
EC, index	48.14	52.34	58.79	66.45	72.88	79.90	87.20	95.96	107.10	118.24	129.69	141.54	153.83	167.08	182.63	200.81
Japan, index	48.49	59.34	73.65	78.09	83.78	88.98	92.42	97.11	102.23	106.48	109.74	112.08	115.29	119.77	123.57	126.83

Date 7. US Cotton Market

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Supply			[unit: 1000 bales]			[unit: 1000ha]										
Begi'g stock	4203	3258	4221	3808	5708	3681	2928	5347	3958	3000	2668	6632	7937	2775	4102	9348
Ac'g planted	5000	5666	5051	5536	3830	4541	5536	5644	5324	5902	5826	4207	3394	4858	4256	3489
Ac'g harvested	4643	5255	4844	5086	3560	4417	5372	5018	5193	5348	5601	3939	2973	4200	4140	3427
Yield	438	507	520	441	453	465	520	420	547	404	542	590	508	600	630	552
Production	10477	13704	12974	11540	8302	10581	14389	10856	14629	11122	15646	11963	7771	12982	13432	9731
Demand			[unit: 1000 bales]													
Mill use	8259	7769	7472	5860	7250	6674	6483	6352	6506	5891	5264	5513	5928	5540	6399	7452
Export	3385	5311	6123	3926	3311	4784	5484	6180	9229	5926	6567	5207	6786	6215	1960	6684
End'g stock	3258	4221	3808	5708	3681	2928	5347	3958	3000	2668	6632	7937	2775	4102	9348	5026
Loss	-150	-307	-160	-111	-141	-86	8	-283	-142	-333	-123	-42	185	-74	-140	-25
Cotton Prices			[unit: cents/lb]													
Spot market	33.0	35.6	67.1	41.7	58.0	70.9	52.7	61.6	71.5	83.0	60.5	63.1	73.1	60.5	60.0	53.2
farm price	28.2	27.3	44.6	42.9	51.3	64.1	52.3	58.4	62.5	74.7	54.3	59.4	66.4	58.7	56.8	51.5

Data 8. EC Cotton Market

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Supply			[unit: 1000 bales]			[unit: 1000ha]										
Begi'g stock	1497	1544	2185	1853	1953	2106	1729	2003	1856	1787	1625	1761	1685	1578	1521	1663
Ac'g harvested	213	293	243	260	203	208	265	214	195	207	201	189	211	255	270	285
Yield	3.46	3.10	2.91	3.27	3.92	3.47	3.48	3.98	3.50	3.88	4.37	3.66	3.67	3.61	4.04	4.72
Production	736	907	706	852	795	722	922	852	683	803	878	691	774	920	1090	1345
Import	5241	5763	4818	4550	4971	4460	4513	3924	4744	3924	4283	4643	4678	4775	4816	5933
Demand			[unit: 1000 bales]													
Mill use	5539	5551	5499	4992	5146	5236	4744	4964	5202	4687	4676	5093	5177	5405	5452	6125
Export	379	418	345	271	388	275	345	296	293	200	347	247	377	347	312	665
End'g stock	1544	2185	1853	1953	2106	1729	2003	1856	1787	1625	1761	1685	1578	1521	1663	2151
Loss	12	60	12	39	79	48	72	7	1	2	2	70	5	-0	0	0
Cotton Prices			[unit: $/kg]													
Import price	0.69	0.80	0.92	1.50	1.17	1.34	1.72	1.50	1.72	1.86	1.88	1.57	1.62	1.80	1.62	1.22
Export price	0.69	0.80	1.10	1.58	1.10	1.28	1.65	1.47	1.67	1.79	1.79	1.46	1.62	1.76	1.44	1.17

Data 9. Japan Cotton Market

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Supply			[unit: 1000 bales]			[unit: 1000ha]										
Begi'g stock	1055	1014	1190	1111	1194	974	818	836	861	794	706	784	631	669	607	515
Import	3555	3883	3728	3228	3220	3037	3150	3382	3336	3207	3504	3137	3338	3125	3054	3688
Demand			[unit: 1000 bales]													
Mill use	3573	3683	3615	2875	3166	3110	3063	3288	3355	3295	3426	3290	3300	3187	3146	3445
Export	0	0	165	243	250	52	32	32	32	0	0	0	0	0	0	0
End'g stock	1014	1190	1111	1194	974	818	836	861	794	706	784	631	669	607	515	758
Loss	23	24	27	27	24	31	37	37	16	0	0	-0	0	-0	0	0
Cotton Prices			[unit: $/kg]													
Import price	0.68	0.76	0.81	1.35	0.93	1.36	1.77	1.49	1.67	1.87	1.96	1.57	1.68	1.84	1.54	1.17

Data 10. The rest of the World Cotton Market

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Supply			[unit: 1000 bales]			[unit: 1000ha]										
Begi'g stock	15619	17035	17316	20943	24580	19254	16478	17061	15044	15552	15456	16108	14946	18928	36204	35646
Ac'g harvested	28360	28003	27758	28234	27213	25962	27522	27716	26825	26542	27145	27393	27774	29529	27396	26185
Yield	1.70	1.69	1.78	1.84	1.66	1.75	1.77	1.74	1.88	2.00	2.01	2.02	2.05	2.52	2.37	2.27
Production	48153	47411	49488	51829	45097	45325	48811	48180	50410	53052	54672	55470	57010	74310	65038	59363
Import	9818	11517	10988	9684	10809	10036	11480	12135	15147	12540	12425	11648	11137	12273	12356	16327
Demand			[unit: 1000 bales]													
Mill use	41253	42794	44295	44177	46365	45881	46963	48947	51118	52254	52770	54371	53900	55737	60811	65426
Export	14922	15468	12949	13056	15143	12460	13287	13281	13678	13572	13324	13994	12002	13635	17987	18602
End'g stock	17035	17316	20943	24580	19254	16478	17061	15044	15552	15456	16108	14946	18928	36204	35646	26566
Loss	381	385	-394	644	-276	-203	-542	105	253	-137	352	-84	-1737	-65	-846	743
Cotton Prices			[unit: $/kg]													
Import price	0.77	0.82	0.90	1.35	1.34	1.32	1.58	1.42	1.56	1.67	1.83	1.49	1.53	1.66	1.46	1.17
Export price	0.71	0.78	1.27	1.33	1.12	1.28	1.54	1.39	1.58	1.65	1.68	1.46	1.50	1.64	1.39	1.12

Data 11. Macro Economic Variables

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
EC																
Nat'l income	3196.5	3257.7	3247.8	3271.4	3210.0	3190.4	3320.7	3466.6	3432.8	3175.3	2873.4	2592.8	2458.4	2621.6	2864.1	3016.1
Population	306.5	308.4	310.0	311.4	312.6	313.7	314.6	315.7	317.1	318.5	319.6	320.3	320.9	321.6	322.4	323.4
Germany																
CPI	54.25	57.63	61.61	65.58	69.05	71.88	74.19	76.59	80.19	84.87	89.86	93.85	96.56	98.78	99.96	99.98
exc'g rate	3.52	3.39	3.55	3.45	2.67	2.48	2.34	2.37	2.55	2.62	2.72	2.95	2.93	2.57	2.32	2.31
int. rate	4.21	5.54	6.58	4.96	3.50	3.29	3.00	4.25	6.63	7.50	6.46	4.58	4.21	4.29	3.79	3.08
wage rate	44.8	49.2	54.3	59.1	63.2	67.5	71.6	75.4	80.2	85.1	89.4	92.8	95.4	98.5	102.0	105.9
Japan																
Nat'l income	181.7	196.5	201.0	202.9	210.9	221.6	233.3	245.5	257.0	267.1	276.0	284.7	296.9	311.3	322.2	334.6
Population	106.6	108.1	109.6	111.0	112.3	113.4	114.5	115.5	116.4	117.3	118.1	118.9	119.7	120.4	121.2	121.8
CPI	40.4	44.0	52.2	60.6	66.7	72.5	76.7	79.8	84.6	89.7	93.0	95.1	97.1	99.2	100.4	100.7
exc'g rate	333.7	333.7	355.7	361.9	347.3	311.8	269.4	289.8	282.6	257.2	257.9	249.8	244.9	231.0	205.3	183.3
int. rate	5.42	6.14	10.30	11.45	8.52	6.22	4.91	5.24	8.82	8.89	7.14	6.62	6.22	6.31	5.49	4.04
wage rate	27.7	32.4	39.1	47.4	55.4	62.1	67.6	72.3	76.7	80.9	85.1	89.2	93.0	96.8	100.3	103.1
Spain																
Nat'l income	19673	21240	22635	23306	23823	24581	25173	25387	25636	25847	26034	26512	27057	27626	28422	29735
Population	34.3	34.7	35.1	35.4	35.8	36.2	36.5	36.9	37.3	37.7	37.9	38.1	38.2	38.4	38.6	38.8
CPI	15.8	17.4	19.8	23.0	26.7	32.2	39.1	45.9	53.0	60.9	69.7	78.9	88.0	96.6	105.1	112.1
exc'g rate	70.1	68.8	68.7	69.4	75.4	90.4	94.2	88.9	95.3	108.3	128.1	153.4	167.5	169.6	165.0	157.7
int. rate	5.00	5.58	6.58	7.00	7.00	7.47	12.88	13.18	15.35	18.66	19.63	19.78	15.43	12.02	11.54	14.17
wage rate	7.8	9.3	11.5	14.7	19.1	24.8	31.7	39.4	47.4	56.6	66.2	76.1	86.4	96.1	105.9	115.7
USA																
Nat'l income	21.92	23.04	23.45	23.22	23.76	24.89	26.14	27.09	27.34	27.63	27.43	27.70	29.16	30.39	31.37	32.37
Population	209.0	211.1	213.0	215.1	217.2	219.3	221.6	224.1	226.6	228.9	231.3	233.6	235.8	237.9	240.0	242.1
PPI	39.1	42.8	50.0	56.4	60.0	63.3	67.8	75.1	85.2	94.6	99.2	100.7	102.7	103.4	101.4	101.7
exc'g rate	0.95	0.87	0.83	0.83	0.85	0.86	0.82	0.78	0.77	0.81	0.88	0.92	0.96	0.98	0.91	0.81
int. rate	4.18	5.80	7.52	6.67	5.34	5.15	6.41	8.87	10.96	13.06	12.12	9.50	9.17	8.36	6.60	5.89
wage rate	39.0	41.8	44.9	48.8	53.0	57.5	62.6	68.0	73.8	80.7	86.9	91.2	94.8	98.5	101.2	103.2
Oil	2.30	3.06	7.46	10.62	11.12	11.95	12.42	17.96	23.09	30.18	32.03	29.71	27.46	26.69	17.78	14.55

Data 12. US cotton market variables

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Base ac'g	11.73	11.47	10.14	11.15	11.16	11.16	10.86	10.07	13.40	11.91	12.92	15.31	15.18	15.63	15.89	15.73
Set asided area	2.10	2.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	1.60	6.80	2.50	3.60	4.20
expected net returns		[unit: $/acre]														
non program	0.61	1.01	0.78	1.66	0.81	1.35	1.87	1.21	0.96	0.82	0.69	0.55	0.55	0.55	0.35	0.35
program	1.90	2.17	2.88	3.18	1.30	1.45	3.11	2.59	2.26	1.69	1.55	0.80	1.47	1.40	1.27	1.88
sorghum	0.78	0.58	0.96	1.38	1.25	0.90	0.57	0.49	0.43	0.60	0.47	0.27	0.46	0.45	0.31	0.33
soybean	1.26	1.25	1.72	1.99	1.93	1.43	1.82	1.54	1.37	1.14	1.15	1.12	1.07	1.22	0.97	0.89
set aside cost	8.93	9.29	10.22	13.09	15.31	15.57	17.47	17.95	21.64	23.12	25.00	26.71	25.01	26.55	27.07	22.86
set aside req't	0.20	0.20	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.15	0.55	0.25	0.30	0.25
soil cons.req't	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AWP	19.50	19.50	19.50	27.06	36.12	39.92	44.63	48.00	50.23	48.00	52.46	57.08	55.00	55.00	57.30	48.96
Acr'g red. pay't	0.20	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.20	0.25	0.20	0.25
Loan rate	19.50	19.50	19.50	27.06	36.12	39.92	44.63	48.00	50.23	48.00	52.46	57.08	55.00	55.00	57.30	55.00
Target prc.	0.00	0.00	0.00	38.00	38.00	43.20	47.80	52.00	57.70	58.40	70.90	71.00	76.00	81.00	81.00	81.00
Var. cost (cotton)	89.3	92.9	102.2	130.9	153.1	155.7	174.7	179.5	216.4	231.2	250.0	267.1	250.1	265.5	270.7	228.6
Div. pay't (I)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00	30.00	0.00
Div. req't (I)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.10	0.00
Div. pay't (II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Div. req't (II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PIK req't	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00
Support prc.	35.00	35.85	41.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Volut.div.pay't	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix 3.

In compiling the textile trade data set, missing quantity data were estimated by regressions. This appendix reports the regression model specifications.

Estimation of missing textile products traded quantities

Variable definition.

The first two digit represents country.

- US: USA
- GY: Germany (west)
- NH: Netherlands
- IT: Italy
- FR: France
- BL: Belgium, Luxembourg
- GR: Greece
- IR: Ireland
- PG: Portugal
- DK: Denmark
- UK: United Kingdom
- SN: Spain
- JA: Japan

The next 3 digit code shows SITC codes (Revision 2).

- SITC 651: Textile yarn
- SITC 652: Cotton fabrics, woven
- SITC 653: Fabrics, woven, of man-made fibres
- SITC 654: Textile fabrics, woven, other than cotton or man-made fibres
- SITC 655: Knitted or crocheted fabrics
- SITC 656: Tille, lace, embroidery, ribbons, trimmings and other small wares
- SITC 657: Special textile fabrics and related products
- SITC 658: Madeup articles, wholly or chiefly of textile products
- SITC 659: Floor coverings
- SITC 841: Apparel and clothing (SITC revised)
- SITC 842: Outer garments, men's and boy's
- SITC 843: Outer garments, women's girl's and infant's
- SITC 844: Under garments of textile fabrics
- SITC 845: Outer garments and other articles, knitted or crocheted, not elastic nor rubberized
- SITC 846: Under garments, knitted or crocheted
- SITC 847: Clothing accessories, of textile fabrics

The last 3 digit shows type of trade by which unit value of trades were computed.

- IUV: unit import value (value of import/qty of import)
- EUV: unit export value (value of export/qty of export).

2. Yarn trade

[651]
US yarn unit import value under category SITC 651
US651IUV=f(c,GY651IUV,PG651IUV,NH651IUV). R-sq=.8820.
Belgium yarn unit import value under category SITC 651
BL651IUV=f(c,GY651IUV,PG651IUV,NH651IUV). R-sq=.9874.
Denmark yarn unit import value under category SITC 651
DK651IUV=f(GY651IUV,PG651IUV,NH651IUV). R-sq=.9999.
UK yarn unit import value under category SITC 651
UK651IUV=f(c,GY651IUV,PG651IUV,NH651IUV). R-sq=.9710.
US yarn unit export value under category SITC 651
US651EUV=f(c,GY651EUV,IT651EUV,UK651EUV,JA651EUV).
R-sq=.9408.
France yarn unit export value under category SITC 651
FR651EUV=f(c,GY651EUV,IT651EUV,UK651EUV,JA651EUV).
R-sq=.9884.
Denmark yarn unit export value under category SITC 651
DK651EUV=f(c,GY651EUV,IT651EUV,UK651EUV,JA651EUV).
R-sq=.9532.

3. Fabric Trade

[652]
US fabric unit import value under category SITC 652
US652IUV=f(c,GY652IUV,PG652IUV,NH652IUV). R-sq=.9821.
Belgium fabric unit import value under category SITC 652
BL652IUV=f(c,GY652IUV,IT652IUV,NH652IUV). R-sq=.9864.
France fabric unit import value under category SITC 652
FR652IUV=f(IT652IUV,NH652IUV). R-sq=.9997.
UK fabric unit import value under category SITC 652
UK652IUV=f(c,GY652IUV,IT652IUV,NH652IUV). R-sq=.9603.
Portugal fabric unit import value under category SITC 652
PG652IUV=f(c,GR652IUV,DK652IUV,NH652IUV). R-sq=.9063.
Spain fabric unit import value under category SITC 652
SN652IUV=f(c,GR652IUV,DK652IUV,NH652IUV). R-sq=.9403.
Ireland fabric unit import value under category SITC 652
IR652IUV=f(c,GR652IUV,PG652IUV,NH652IUV). R-sq=.8756.
US fabric unit export value under category SITC 652
US652EUV=f(c,GY652EUV,IT652IUV). R-sq=.3582.
Italy fabric unit export value under category SITC 652
IT652EUV=f(c,NH652Euv,BL652EUV,GR652IUV). R-sq=.9291.
France fabric unit export value under category SITC 652
FR652EUV=f(c,Bl652EUV). R-sq=.2321.
UK fabric unit export value under category SITC 652
UK652EUV=f(c,GY652EUV,BL652EUV). R-sq=.9402.
Denmark fabric unit export value under category SITC 652
DK652EUV=f(c,GY652EUV,BL652EUV,NH652EUV). R-sq=.9235.
Spain fabric unit export value under category SITC 652
SN652EUV=f(c,GY652EUV,BL652EUV,NH652EUV). R-sq=.9543.
Ireland fabric unit export value under category SITC 652
IR652EUV=f(c,GY652EUV,BL652EUV,NH652EUV). R-sq=.8429.

[653]
France fabric unit import value under category SITC 653
FR653IUV=f(c,GY653IUV,IT653IUV,NH653IUV). R-sq=.9653.
Belgium fabric unit import value under category SITC 653
BL653IUV=f(c,GY653IUV,IT653IUV,NH653IUV). R-sq=.9605.
US fabric unit export value under category SITC 653
US653EUV=f(c,GY653EUV,DK653EUV,BL653EUV). R-sq=.9208.
Italy fabric unit export value under category SITC 653
IT653EUV=f(c,GY653EUV,DK653EUV,JA653EUV). R-sq=.9881.
France fabric unit export value under category SITC 653
FR653EUV=f(c,GY653EUV,NH653EUV,JA653EUV). R-sq=.9726.
Denmark fabric unit export value under category SITC 653
DK653EUV=f(c,GY653EUV,NH653EUV,JA653EUV). R-sq=.7477.
Greece fabric unit export value under category SITC 653
GR653EUV=f(c,IR653EUV,JA653EUV). R-sq=.7510.

[654]
US fabric unit import value under category SITC 654
US654IUV=f(c,GY654IUV,JA654IUV). R-sq=0.999.
UK fabric unit import value under category SITC 654
UK654IUV=f(c,NH654IUV,JA654IUV). R-sq=0.7457.
Belgium fabric unit import value under category SITC 654
BL654IUV=f(c,GR654IUV,JA654IUV). R-sq=0.6660.
Spain fabric unit import value under category SITC 654
SN654IUV=f(c,GR654IUV,PG654IUV). R-sq=0.7704.
Italy fabric unit import value under category SITC 654
IT654IUV=f(c,GR654IUV,JA654IUV). R-sq=0.7909.
Ireland fabric unit import value under category SITC 654
IR654IUV=f(c,GR654IUV,PG654IUV,JA654IUV). R-sq=0.7772.
Denmark fabric unit import value under category SITC 654
DK654IUV=f(c,GR654IUV,JA654IUV). R-sq=0.7478.
US fabric unit export value under category SITC 654
US654EUV=f(c,GY654EUV,IT654EUV,UK654EUV). R-sq=0.9328.
Denmark fabric unit export value under category SITC 654
DK654EUV=f(c,IR654EUV,JA654EUV). R-sq=0.6626.

[655]
US fabric unit import value under category SITC 655
US655IUV=f(c,GY655IUV,FR655IUV,UK655IUV,JA655IUV).
R-sq=0.8003.
Spain fabric unit import value under category SITC 655
SN655IUV=f(c,GR655IUV,FR655IUV,GY655IUV). R-sq=0.9593.
Portugal fabric unit import value under category SITC 655
PG655IUV=f(c,GR655IUV,FR655IUV,GY655IUV). R-sq=0.5582.
Ireland fabric unit import value under category SITC 655
IR655IUV=f(c,GR655IUV,FR655IUV,GY655IUV). R-sq=0.9814.
Denmark fabric unit import value under category SITC 655
DK655IUV=f(c,GR655IUV,JA655IUV). R-sq=0.8155.
US fabric unit export value under category SITC 655
US655EUV=f(c,GY655EUV,IT655EUV,NH655EUV). R-sq=0.7987.

Portugal fabric unit export value under category SITC 655
PG655EUV=f(c,US655EUV,DK655EUV,UK655EUV). R-sq=0.7874.
Greece fabric unit export value under category SITC 655
GR655EUV=f(c,US655EUV,DK655EUV,UK655EUV). R-sq=0.9166.
Ireland fabric unit export value under category SITC 655
IR655EUV=f(c,US655EUV,DK655EUV,UK655EUV). R-sq=0.7270.

[656]
US fabric unit import value under category SITC 656
US656IUV=f(c,GY656IUV,NH656IUV). R-sq=.9869.
France fabric unit import value under category SITC 656
FR656IUV=f(c,GY656IUV,NH656IUV,JA656IUV). R-sq=.8924.
Belgium fabric unit import value under category SITC 656
BL656IUV=f(c,GY656IUV,NH656IUV,JA656IUV). R-sq=.6646.
Denmark fabric unit import value under category SITC 656
DK656IUV=f(c,GY656IUV,NH656IUV,JA656IUV). R-sq=.9097.
Spain fabric unit import value under category SITC 656
SN656IUV=f(c,GY656IUV,NH656IUV,year). R-sq=.5872.
Greece fabric unit import value under category SITC 656
GR656IUV=f(c,GY656IUV,NH656IUV,JA656IUV). R-sq=.5440.
Ireland fabric unit import value under category SITC 656
IR656IUV=f(c,GY656IUV,NH656IUV,JA656IUV). R-sq=.8335.
Portugal fabric unit import value under category SITC 656
PG656IUV=f(c,GY656IUV,year). R-sq=.0953.
UK fabric unit import value under category SITC 656
UK656IUV=f(c,GY656IUV,NH656IUV). R-sq=.5476.
Italy fabric unit import value under category SITC 656
IT656IUV=f(c,GY656IUV,NH656IUV). R-sq=.7959.
US fabric unit export value under category SITC 656
US656EUV=f(c,GY656EUV,BL656EUV,NH656EUV). R-sq=.2207.
Italy fabric unit export value under category SITC 656
IT656EUV=f(c,GY656EUV,BL656EUV,NH656EUV,GR656EUV,JA656EUV).
R-sq=.5687.
France fabric unit export value under category SITC 656
FR656EUV=f(GY656IUV,NH656EUV). R-sq=.9893.
UK fabric unit export value under category SITC 656
UK656EUV=f(c,GY656IUV,NH656IUV,JA656IUV,NH656EUV).
R-sq=.8359.
Denmark fabric unit export value under category SITC 656
DK656EUV=f(c,GY656IUV,NH656IUV,JA656IUV,NH656EUV).
R-sq=.8062.
Portugal fabric unit export value under category SITC 656
PG656EUV=f(c,GY656EUV,BL656EUV,GR656EUV,NH656EUV).
R-sq=.7259.
Spain fabric unit export value under category SITC 656
SN656EUV=f(c,GY656EUV,BL656EUV,GR656EUV,NH656EUV,D79).
R-sq=.8983.
Ireland fabric unit export value under category SITC 656
IR656EUV=f(c,GY656EUV,BL656EUV,GR656EUV,NH656EUV).
R-sq=.7499.

[657]
US fabric unit import value under category SITC 657
US657IUV=f(c,GY657IUV,IT657IUV). R-sq=.9994.
Belgium fabric unit import value under category SITC 657
BL657IUV=f(c,GY657IUV,IT657IUV,FR657IUV,NH657IUV,DK657IUV).
R-sq=.9290.

UK fabric unit import value under category SITC 657
UK657IUV=f(c,GY657IUV,IT657IUV,FR657IUV,NH657IUV).
R-sq=.9155.
Spain fabric unit import value under category SITC 657
SN657IUV=f(c,GY657IUV,IT657IUV,FR657IUV,NH657IUV).
R-sq=.7653.
Ireland fabric unit import value under category SITC 657
IR657IUV=f(c,GY657IUV,IT657IUV,FR657IUV,NH657IUV).
R-sq=.8806.
US fabric unit export value under category SITC 657
US657EUV=f(IT657EUV,GY657EUV). R-sq=.9956.
France fabric unit export value under category SITC 657
FR657EUV=f(c,GY657EUV,IT657EUV,NH657EUV). R-sq=.9504.
Belgium fabric unit export value under category SITC 657
BL657EUV=f(IT657EUV,GY657EUV). R-sq=.9948.
UK fabric unit export value under category SITC 657
UK657EUV=f(IT657EUV,GY657EUV). R-sq=.9980.
Denmark fabric unit export value under category SITC 657
DK657EUV=f(c,GY657EUV,IT657EUV,NH657EUV). R-sq=.9175.
Spain fabric unit export value under category SITC 657
SN657EUV=f(c,GY657EUV,IT657EUV,NH657EUV). R-sq=.7751.
Greece fabric unit export value under category SITC 657
GR657EUV=f(GR657IUV,IT657EUV,PG657EUV). R-sq=.9014.
Ireland fabric unit export value under category SITC 657
IR657EUV=f(IT657EUV,GR657IUV). R-sq=.9348.
Japan fabric unit export value under category SITC 657
JA657EUV=f(c,GY657IUV,IT657EUV,GR657IUV). R-sq=.9360.

[658]
US fabric unit import value under category SITC 658
US658IUV=f(c,GY658EUV,UK658IUV). R-sq=.3225.
France fabric unit import value under category SITC 658
FR658IUV=f(c,GY658IUV,NH658IUV,GY658EUV,UK658EUV).
R-sq=.8961.
Italy fabric unit import value under category SITC 658
IT658IUV=f(c,GY658IUV,UK658EUV,NH658EUV). R-sq=.7184.
Belgium fabric unit import value under category SITC 658
BL658IUV=f(c,GY658IUV,UK658EUV,NH658EUV). R-sq=.7237.
Denmark fabric unit import value under category SITC 658
DK658IUV=f(c,GY658IUV,UK658EUV,NH658IUV). R-sq=.9261.
Portugal fabric import value under category SITC 658
PG658IV=f(c,SN658EV,GR658EV,IR658EV,GY658EV,SN658IV).
R-sq=.7844.
Portugal fabric unit import value under category SITC 658
PG658IUV=f(c,GY658EUV,UK658EUV,PG658EUV). R-sq=.7407.

Spain fabric unit import value under category SITC 658
SN658IUV=f(BL658IUV,SN658EUV). R-sq=.9651.
Greece fabric unit import value under category SITC 658
GR658IUV=f(c,GY658IUV,UK658EUV,GR658EUV). R-sq=.6063.
Ireland fabric unit import value under category SITC 658
IR658IUV=f(c,GY658IUV,UK658EUV). R-sq=.9383.
US fabric unit export value under category SITC 658
US658EUV=f(c,GY658EUV,UK658EUV,NH658EUV,GY658IUV).
R-sq=.7184.
Italy fabric unit export value under category SITC 658
IT658EUV=f(c,GY658EUV,UK658EUV,NH658EUV,GY658IUV).
R-sq=.9686.
France fabric unit export value under category SITC 658
FR658EUV=f(c,GY658EUV,DK658EUV). R-sq=.6197.
Belgium fabric unit export value under category SITC 658
BL658EUV=f(c,GY658EUV,UK658EUV,NH658EUV,DK658EUV,SN658EUV).
R-sq=.9030.
Ireland fabric unit export value under category SITC 658
IR658EUV=f(c,UK658EUV,NH658EUV,DK658EUV). R-sq=.8298.
Japan fabric unit export value under category SITC 658
JA658EUV=f(c,GY658EUV,UK658EUV,NH658EUV,DK658EUV,Sn658EUV).
R-sq=.9246.

[659]
US fabric unit export value under category SITC 659
US659EUV=f(c,DK659EUV). R-sq=.0069.
US fabric unit import value under category SITC 659
US659IUV=f(c,GY659IUV,DK659EUV). R-sq=.9913.
France fabric unit import value under category SITC 659
FR659IUV=f(c,GY659IUV,BL659IUV,NH659IUV,DK659IUV,JA659IUV,
GY659EUV,BL659EUV,NH659EUV,DK659EUV,PG659EUV,GR659EUV).
R-sq=.9899.
Italy fabric unit import value under category SITC 659
IT659IUV=f(c,GY659IUV,BL659IUV,NH659IUV,DK659IUV,JA659IUV,
GY659EUV,BL659EUV,NH659EUV,DK659EUV,PG659EUV,GR659EUV).
R-sq=.9981.
UK fabric unit import value under category SITC 659
UK659IUV=f(c,GY659IUV,BL659IUV,NH659IUV,DK659IUV,JA659IUV,
GY659EUV,BL659EUV,NH659EUV,DK659EUV,PG659EUV,GR659EUV).
R-sq=.9860.
Portugal fabric unit import value under category SITC 659
PG659IUV=f(c,GY659IUV,DK659IUV,JA659IUV,GY659EUV,BL659EUV,
NH659EUV,DK659EUV). R-sq=.9670.
Spain fabric unit import value under category SITC 659
SN659IUV=f(c,GY659IUV,DK659IUV,GY659EUV,BL659EUV,NH659EUV,
DK659EUV). R-sq=.9744.
Greece fabric unit import value under category SITC 659
GR659IUV=f(c,GY659IUV,DK659IUV,GY659EUV,BL659EUV,
NH659EUV,DK659EUV). R-sq=.9805.
Ireland fabric unit import value under category SITC 659
IR659IUV=f(c,GY659IUV,DK659IUV,GY659EUV,BL659EUV,
NH659EUV,DK659EUV). R-sq=.9717.

US fabric unit export value under category SITC 659
US659EUV=f(c,GY659EUV,NH659EUV,PG659EUV). R-sq=.8704.
Italy fabric unit export value under category SITC 659
IT659EUV=f(c,GY659EUV,NH659EUV,FR659EUV). R-sq=.9070.
France fabric unit export value under category SITC 659
FR659EUV=f(c,GY659EUV,NH659EUV,DK659EUV). R-sq=.9356.
UK fabric unit export value under category SITC 659
UK659EUV=f(c,GY659EUV,NH659EUV,GY659IUV). R-sq=.8464.
Spain fabric unit export value under category SITC 659
SN659EUV=f(c,GY659EUV,NH659EUV). R-q=.8618.

Ireland fabric unit export value under category SITC 659
IR659EUV=f(GY659EUV,NH659EUV,BL659EUV). R-sq=.9947.

[651, 1st revised]
US fabric unit import value under category SITC 651-R1
US65IUV=f(GY65IUV,JA65IUV). R-sq=.9995.
France fabric unit import value under category SITC 651-R1
1st Revised
FR65IUV=f(IT65IUV,GY65IUV,SN65EUV). R-sq=.9992.
UK fabric unit import value under category SITC 651-R1
UK65IUV=f(GY65IUV,IT65IUV). R-sq=.9890.
Denmark fabric unit import value under category SITC 651-R1.
DK65IUV=f(GY65IUV,IT65IUV). R-sq=.9982.
Italy fabric unit import value under category SITC 651-R1.
IT65IUV=f(GY65IUV,JA65IUV). R-sq=.9910.
Belgium fabric unit import value under category SITC 651-R1
BL65IUV=f(GY65IUV,JA65IUV). R-sq=.9953.
Spain fabric unit import value under category SITC 651-R1.
SN65IUV=f(GY65IUV,IT65IUV). R-sq=.9853.
Portugal fabric unit import value under category SITC 651-R1
PG65IUV=f(GY65IUV,IT65IUV). R-sq=.9928.
Ireland fabric unit import value under category SITC 651-R1
IR65IUV=f(GY65IUV,IT65IUV). R-sq=.9934.
US fabric unit export value under category SITC 651-R1
US65EUV=f(GY65EUV,JA65IUV). R-sq=.9845.
France fabric unit export value under category SITC 651-R1
FR65EUV=f(GY65EUV,JA65IUV). R-sq=.9996.
UK fabric unit export value under category SITC 651-R1
UK65EUV=f(GY65EUV,JA65EUV). R-sq=.9938.
Denmark fabric unit export value under category SITC 651-R1
DK65EUV=f(GY65EUV,JA65EUV). R-sq=.9961.
Italy fabric unit export value under category SITC 651-R1
IT65EUV=f(GY65EUV,JA65IUV). R-sq=.9932.
Belgium fabric unit export value under category SITC 651-R1
BL65EUV=f(GY65EUV,JA65EUV). R-sq=.9961.
Portugal fabric unit export value under category SITC 651-R1
PG65EUV=f(GY65EUV,JA65EUV). R-sq=.9893.
Greece fabric unit export value under category SITC 651-R1
GR65EUV=f(GY65EUV,SN65IUV). R-sq=.9775.
Ireland fabric unit export value under category SITC 651-R1
IR65EUV=f(GY65EUV,JA65EUV). R-sq=.9977.

US yarn unit import value under category SITC 651-R1
US650IUV=f(c,GY650IUV,IT650IUV,NH650IUV,GR650IUV).
R-sq=0.6965.
France yarn unit import value under category SITC 651-R1
FR650IUV=f(c,GY650IUV,IT650IUV,NH650IUV,GR650IUV).
R-sq=0.9962.
Belgium yarn unit import value under category SITC 651-R1
BL650IUV=f(c,GY650IUV,IT650IUV,NH650IUV,GR650IUV).
R-sq=0.9867.
UK yarn unit import value under category SITC 651-R1
UK650IUV=f(c,GY650IUV,IT650IUV,NH650IUV). R-sq=0.8715.
Denmark yarn unit import value under category SITC 651-R1
DK650IUV=f(c,GY650IUV,IT650IUV,NH650IUV). R-sq=0.9840.
Ireland yarn unit import value under category SITC 651-R1
IR650IUV=f(c,GY650IUV,IT650IUV,NH650IUV,GR650IUV).
R-sq=0.8586.
US fabric unit export value under category SITC 651-R1
US650EUV=f(c,GY650EUV,IT650EUV,JA650EUV,SN650EUV).
R-sq=0.7346.
France fabric unit export value under category SITC 651-R1
FR650EUV=f(c,GY650EUV,IT650EUV,JA650EUV,SN650EUV).
R-sq=0.9905.
Belgium fabric unit export value under category SITC651-R1
BL650EUV=f(c,GY650EUV,IT650IUV,JA650IUV,SN650IUV).
R-sq=0.9698.
UK fabric unit export value under category SITC651-R1
UK650EUV=f(c,GY650EUV,IT650IUV,JA650IUV,SN650IUV).
R-sq=0.9214.
Denmark fabric unit export value under category SITC 651-R1
DK650EUV=f(c,GY650EUV,IT650IUV,JA650IUV,SN650IUV).
R-sq=0.9584.
Ireland fabric unit export value under category SITC 651-R1
IR650EUV=f(c,GY650EUV,IT650EUV,JA650EUV,SN650EUV).
R-sq=0.7912.

4. Textile trade

[841]
US textile unit import value under category SITC 841
US841IUV=f(c, GY841EUV, GY841IUV).
France textile unit import value under category SITC 841
FR841IUV=f(c, NH841IUV). R-sq=0.7536.
Belgium-Lux. textile unit import value under category SITC 841
BL841IUV=f(c, GY841EUV, GY841IUV). R-sq=0.9807.
UK textile unit import value under category SITC 841
UK841IUV=f(IT841IUV, GY841EUV, GY841IUV). R-sq=0.9977.
Ireland textile unit import value under category SITC 841
IR841IUV=f(IT841IUV, GY841EUV, GY841IUV). R-sq=0.9970.

US textile unit export value under category SITC 841
US841EUV=f(c, GY841EUV, GY841IUV). R-sq=0.0953.
France textile unit export value under category SITC 841
FR841EUV=f(c, GY841EUV, GY841IUV). R-sq=0.9645.
Belgium-Lux. textile unit export value under category SITC 841
BL841EUV=f(c, GY841EUV, GY841IUV). R-sq=0.8698.
UK textile unit export value under category SITC 841
UK841EUV=f(NH841EUV, JA841IUV, GY841EUV, GY841IUV). R-sq=.8698.
Denmark textile unit export value under category SITC 841
DK841EUV=f(NH841EUV, JA841IUV, GY841EUV, GY841IUV). R-sq=.9981.
Ireland textile unit export value under category SITC 841
IR841EUV=f(GY841EUV, GY841IUV). R-sq=.9967.

[842]
US textile unit import value under category SITC 842
IR842IUV=f(c, GY842IUV). R-sq=.0789.
Italy textile unit import value under category SITC 842
IT842IUV=f(c, IT842EUV, GR842EUV). R-sq=.8695.
Denmark textile unit import value under category SITC 842
DK842IUV=f(c, DK842EUV,IR842EUV, GR842EUV). R-sq=.9325.
Portugal textile import value under category SITC 842
PG842IV=f(SN842IV,FR842IV, GY842IV). R-sq=.9761.
Portugal textile unit import value under category SITC 842
PG842IUV=f(UK842IUV,FR842EUV, JA842EUV). R-sq=.9932.
Spain textile unit import value under category SITC 842
SN842IUV=f(c, GY842IUV, UK842IUV). R-sq=.8995.
Greece textile unit import value under category SITC 842
GR842IUV=f(FR842EUV, BL842EUV, GY842IUV). R-sq=.9874.
US textile unit export value under category SITC 842
US842EUV=f(c,BL842EUV,JA842EUV,FR842EUV,UK842IUV). R-sq=.9996.
Denmark textile unit export value under category SITC 842
DK842EUV=f(c,BL842EUV,JA842EUV,FR842EUV). R-sq=.9462.
Spain textile unit export value under category SITC 842
SN842EUV=f(c,IT842EUV,FR842EUV,IR842EUV). R-sq=.6758.

[843]
US textile unit import value under category SITC 843
US843IUV=f(c,GY843IUV). R-sq=.0815.
Italy textile unit import value under category SITC 843
IT843IUV=f(c,IT843EUV,DK843IUV,IR843IUV,JA843IUV). R-sq=.8856.
Portugal textile unit import value under category SITC 843
PG843IUV=f(c,GY843EUV,DK843IUV). R-sq=.9614.
Spain textile unit import value under category SITC 843
SN843IUV=f(c,GY843IUV,DK843IUV,IR843IUV). R-sq=.9649.
Greece textile unit import value under category SITC 843
GR843IUV=f(c,GY843IUV,FR843EUV). R-sq=.8213.

Japan textile unit import value under category SITC 843
JA843IUV=f(UK843EUV,BL843EUV,FR843IUV). R-sq=.9985.
US textile unit export value under category SITC 843
US843EUV=f(c,GY843EUV,IT843EUV,UK843IUV,DK843IUV).
R-sq=.8668.
Spain textile unit export value under category SITC 843
SN843EUV=f(c,GY843EUV,IT843EUV,UK843IUV). R-sq=.9817.

[844]
Italy textile unit import value under category SITC 844
IT844IUV=f(DK844IUV,IR844IUV,JA844IUV). R-sq=.9998.
France textile unit import value under category SITC 844
FR844IUV=f(GY844IUV,BL844IUV,UK844IUV). R-sq=.9999.
Portugal textile import value under category SITC 844
PG844IV=f(PG844EV,SN844IV,FR844IV). R-sq=.9941.
Portugal textile unit import value under category SITC 844
PG844IUV=f(GY844IUV,BL844IUV,FR844EUV). R-sq=.9997.
Spain textile unit import value under category SITC 844
SN844IUV=f(GY844IUV,BL844IUV,DK844EUV). R-sq=.9992.
Greece textile unit import value under category SITC 844
GR844IUV=f(c, US844IUV). R-sq=.6526.
Ireland textile unit import value under category SITC 844
IR844IUV=f(FR844IUV,UK844EUV,GY844IUV). R-sq=.9997.
US textile unit export value under category SITC 844
US844EUV=f(JA844IUV,GY844IUV). R-sq=.9742.
Italy textile unit export value under category SITC 844
IT844EUV=f(DK844EUV,GR844EUV,JA844IUV). R-sq=.9931.
Belgium textile unit export value under category SITC 844
BL844EUV=f(c,GY844EUV,FR844IUV,US844IUV). R-sq=.9881.
Denmark textile unit export value under category SITC 844
DK844EUV=f(US844IUV,GY844IUV,UK844IUV). R-sq=.9913.
Spain textile unit export value under category SITC 844
SN844EUV=f(FR844EUV,IT844EUV,US844IUV,JA844IUV,GY844IUV).
R-sq=.9979.
Greece textile unit export value under category SITC 844
GR844EUV=f(c,IT844EUV,PG844EUV). R-sq=.9027.
Ireland textile unit export value under category SITC 844
IR844EUV=f(c,FR844EUV,PG844EUV). R-sq=.5235.
Japan textile unit export value under category SITC 844
JA844EUV=f(US844IUV,GY844EUV,UK844EUV). R-sq=.9954.

[845]
US textile unit import value under category SITC 845
US845IUV=f(c,GY845EUV). R-sq=.2276.
Italy textile unit import value under category SITC 845
IT845IUV=f(DK845IUV,GR845EUV). R-sq=.9761.
Portugal textile unit import value under category SITC 845
PG845IUV=f(c,US845EUV,GY845IUV). R-sq=.9991.
Spain textile unit import value under category SITC 845
SN845IUV=f(PG845EUV,IR845IUV,GY845IUV). R-sq=.9995.

Greece textile unit import value under category SITC 845
GR845IUV=f(FR845EUV,UK845IUV). R-sq=.9485.
Japan textile unit import value under category SITC 845
JA845IUV=f(FR845EUV,UK845EUV,US845IUV). R-sq=.9952.
US textile unit export value under category SITC 845
US845EUV=f(GY845EUV,IT845EUV,GR845EUV). R-sq=.9928.
Japan textile unit export value under category SITC 845
JA845EUV=f(c,GY845EUV,IT845EUV,GR845EUV). R-sq=.9775.

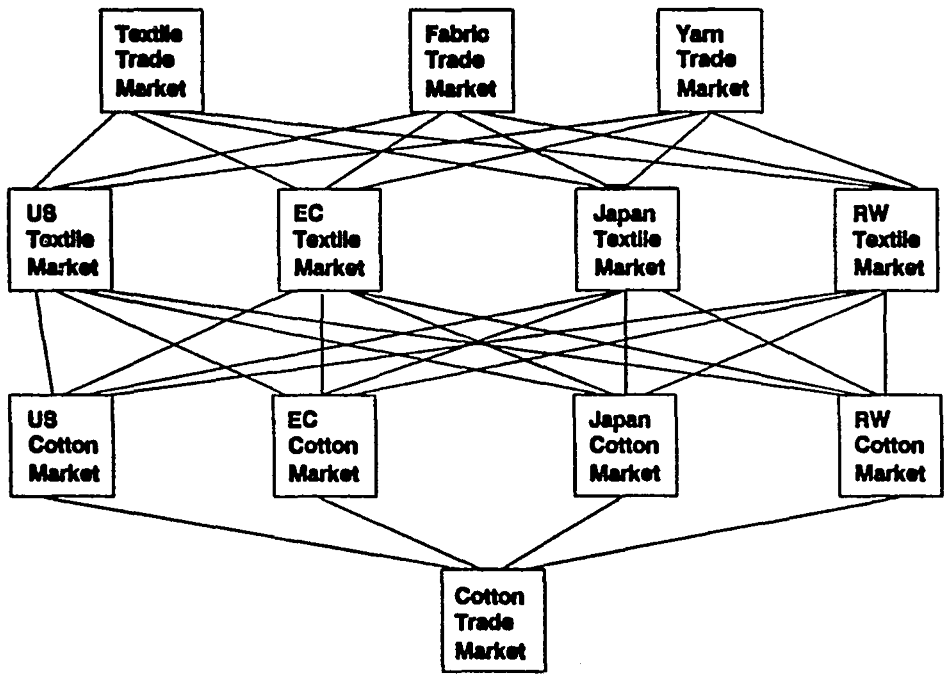
[846]
Portugal textile unit import value under category SITC 846
PG846IUV=f(c,UK846IUV,IR846IUV,DK846IUV). R-sq=.9284.
Spain textile unit import value under category SITC 846
SN846IUV=f(c,US846IUV,DK846IUV,IR846IUV). R-sq=.9856.
Greece textile unit import value under category SITC 846
GR846IUV=f(c,DK846IUV,IR846IUV). R-sq=.7927.
US textile unit export value under category SITC 846
US846EUV=f(c,GY846IUV,IR846EUV,UK846EUV). R-sq=.7385.
Belgium textile unit export value under category SITC 846
BL846EUV=f(c,GY846IUV,FR846EUV,UK846EUV). R-sq=.8981.
Spain textile unit export value under category SITC 846
SN846EUV=f(IR846EUV,GR846EUV). R-sq=.9845.
Japan textile unit export value under category SITC 846
JA846EUV=f(IR846EUV,DK846IUV). R-sq=.9802.

[847]
US textile unit import value under category SITC 847
US847IUV=f(c,BL847IUV). R-sq=.9958.
Portugal textile unit import value under category SITC 847
PG847IUV=f(GY847IUV,FR847EUV). R-sq=.9865.
Spain textile unit import value under category SITC 847
SN847IUV=f(GY847IUV,FR847EUV). R-sq=.9937.
Greece textile unit import value under category SITC 847
GR847IUV=f(IT847IUV,FR847EUV). R-sq=.9825.
Ireland textile unit import value under category SITC 847
IR847IUV=f(IT847IUV,FR847EUV). R-sq=.9922.
US textile unit export value under category SITC 847
US847EUV=f(UK847EUV,GY847EUV,GY847IUV). R-sq=.9949.
Denmark textile unit export value under category SITC 847
DK847EUV=f(IT847EUV,GY847EUV,GY847IUV). R-sq=.9951.
Greece textile unit export value under category SITC 847
GR847EUV=f(GY847EUV,GY847IUV). R-sq=.9973.
Ireland textile unit export value under category SITC 847
IR847EUV=f(UK847EUV,FR847EUV,GY847EUV). R-sq=.9981.

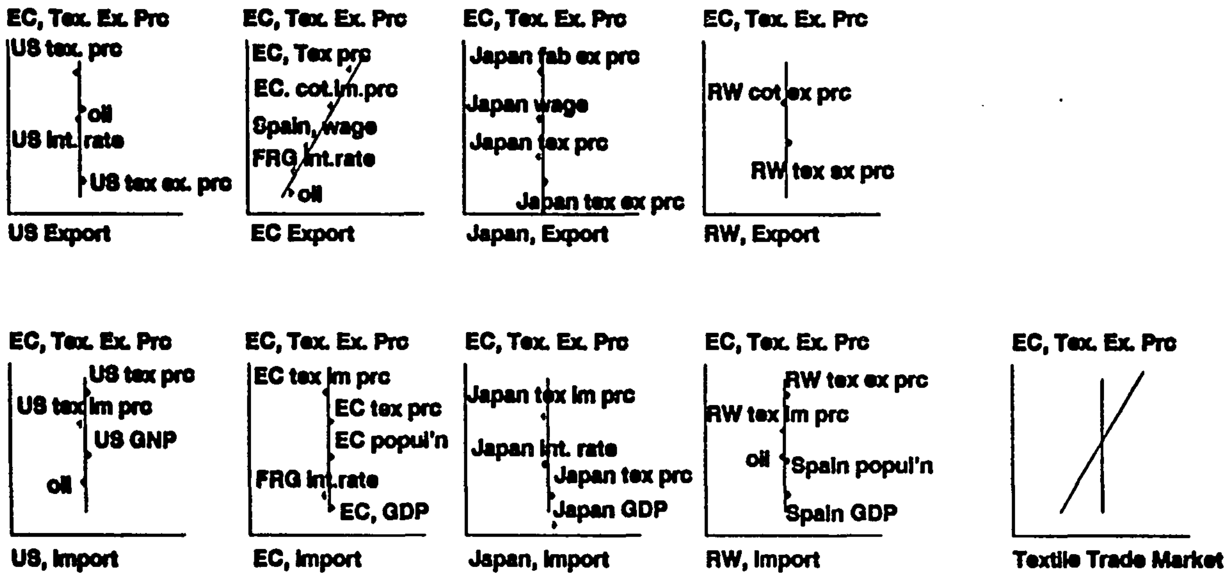
Appendix 4.

PQ Space Diagrams and Flow Charts

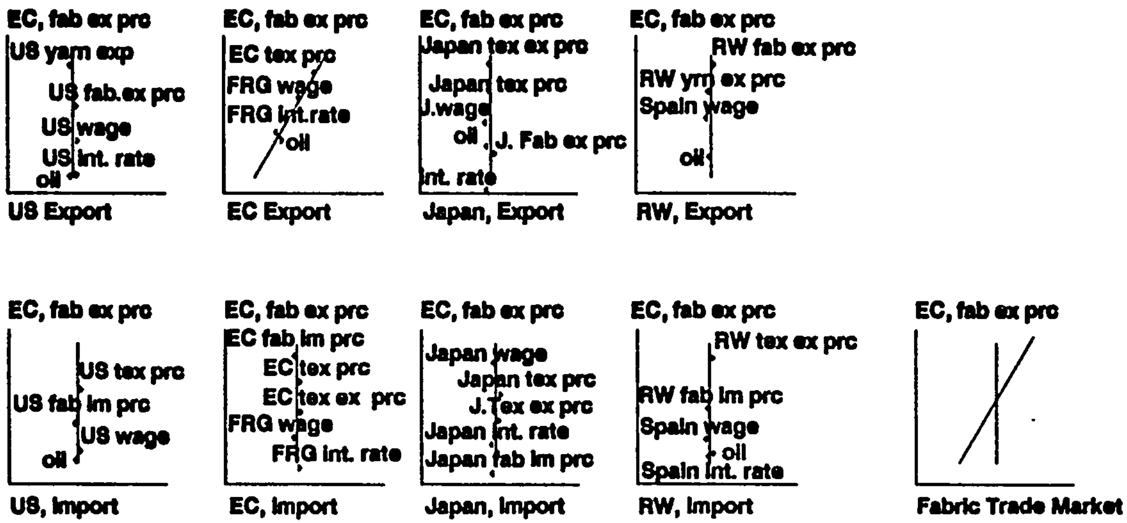
Cotton-Textile Trade Model



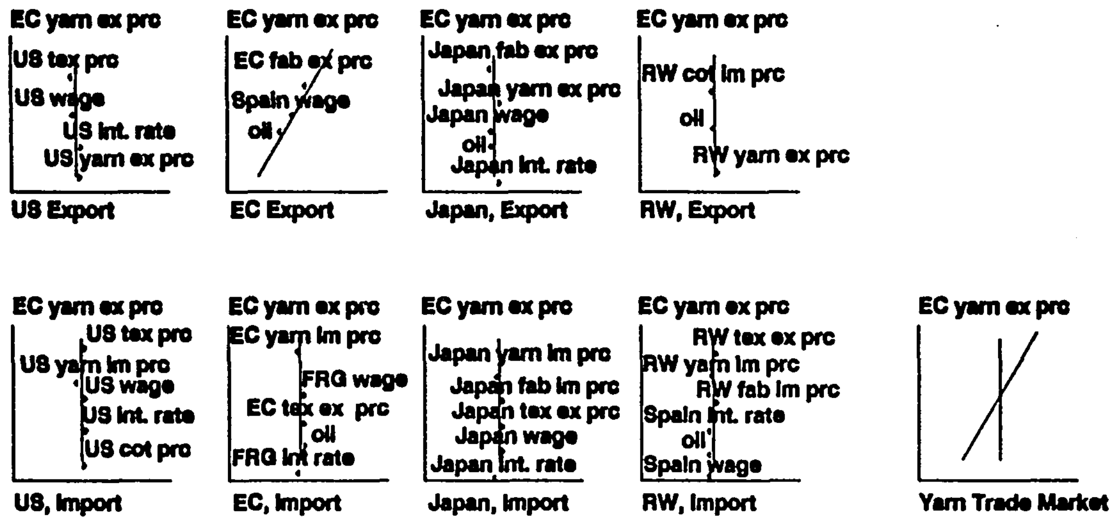
Textile Trade Market



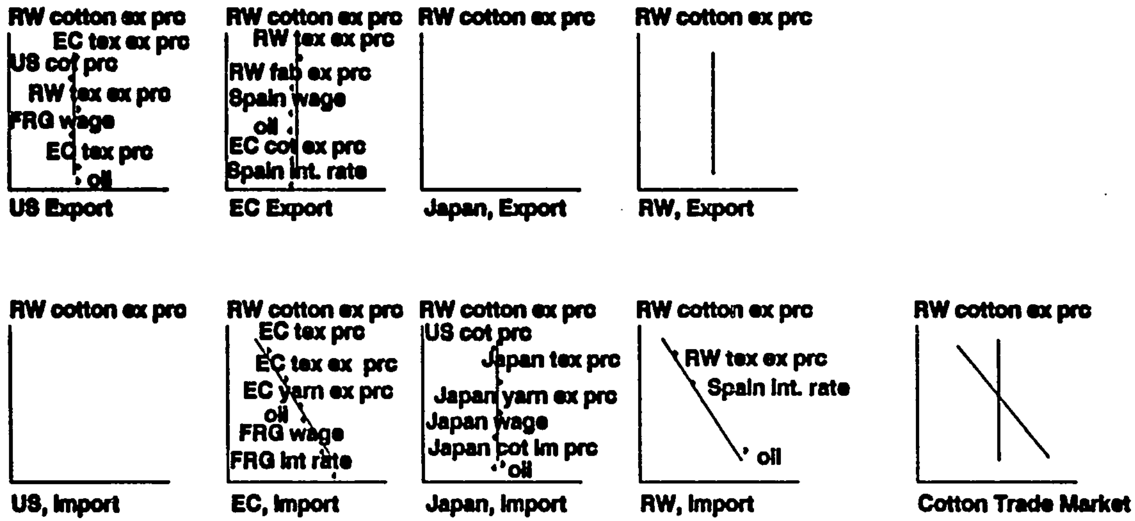
Fabric Trade Market



Yarn Trade Market



Cotton Trade Market



Vita

Koji Yanagishima was born October 12, 1947, in Hokkaido, Japan. He received the following degrees: Bachelor of Engineering from Hokkaido University (1970); M.A. in Agricultural Economics from North Dakota State University (1986); M.A. in Economics from Iowa State University (1988); Ph.D. in Agricultural Economics from the University of Missouri at Columbia (1991). He worked for Kawasaki Heavy Industries as a R&D engineer from 1970 to 1985. While pursuing a Ph.D. degree at the University of Missouri, he worked as a Research Assistant in the Food and Agricultural Research Institute (FAPRI) of the Department of Agricultural Economics.