5-1989

Derived demand for tobacco by type and origin

Sean A. Coady

To the Graduate Council:

I am submitting herewith a thesis written by Sean A. Coady entitled "Derived demand for tobacco by type and origin." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

Gregory K. Pompelli, Major Professor

We have read this thesis and recommend its acceptance:

William Park, Darrell Mundy

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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S. Darrell Mundy

Accepted for the Council:

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Vice Provost
and Dean of The Graduate School

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Date 4-20-89

DERIVED DEMAND FOR TOBACCO
BY TYPE AND ORIGIN

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Sean A. Coady

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Dedicated to the memory of John Francis Coady,

my father, my friend

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ABSTRACT

The recent overhaul of the tobacco program was prompted in part by the increased use of imported tobacco in domestic cigarette manufacturing. A large portion of the blame for the loss in market share was placed on the high U.S. support prices for domestically produced tobacco. A more market oriented tobacco program was instituted to make U.S. tobacco more price competitive in both the domestic and export markets.

The purpose of this study was to examine the demand for tobacco and analyze the nature of the price linkages occurring within the domestic market. Price and expenditure linkages for the entire domestic market were examined, and these linkages were also studied for the components of tobacco imports. The Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980a, 1980b) was applied to model the domestic market and the import market from 1971-1986.

In the domestic market, prices are a significant determinant of budget shares. The demand for domestic flue-cured tobacco reacts strongly with changes in the price for imported flue-cured and burley tobacco. A price increases in one of these tobacco types will produce a significant increase in the other's market share. Domestic burley tobacco and oriental tobacco are relatively secure in the U.S. market with limited substitution available for these

tobaccos.

Prices are an important determinant of import market shares as well. Additionally, the decreasing average nicotine content of U.S. cigarettes has a significant role in the manner in which the U.S. imports tobacco. Brazil and Canada have benefitted in the import market, while Greece and Mexico are adversely affected by the lowering of the nicotine level.

Tobacco imports arrive in the U.S. from countries operating under democratic and centrally planned governments, and from countries in various stages of economic development. Tobacco imports can therefore be classified by the economic group of its source, i.e. imports originating from developed, less developed, or centrally planned economies. The import price of an economic group's tobacco was found to play a marginal role in how the U.S. imports tobacco. The wide variances of individual country prices within an economic group limits the inferences possible from this type of disaggregation. Developed countries were found to be, on average, a low price import, suggesting that factors such as government subsidies may play a part in determining market shares.

The findings of the study indicated generally inelastic demands for each type of tobacco. Elastic price responses were found for imported flue-cured and burley tobacco in the domestic market. In the import market, elastic price responses were found for Greece, Canada, and centrally planned countries. The elasticities are subject to skepticism however, since some own-price elasticities were positive.

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CHAPTER 1

INTRODUCTION

The Consolidated Omnibus Budget Reconciliation Act of 1985, along with legislative actions in the tobacco program, sought to make the U.S. tobacco program more market oriented and relieve U.S. taxpayers of the burden of financing the tobacco program. The desire to have the tobacco program become more responsive to market signals was due, in part, to U.S. tobacco's declining domestic market share.

At its inception, the tobacco program was successful in raising the income of tobacco producers, especially during the periods of strong demand for tobacco products. Flue-cured tobacco prices averaged 17 cents a pound from 1925 to 1929, but plummeted to 6 cents a pound in 1931 (Badger, 1980). Under production control, flue-cured prices rose from 15.3 cents a pound in 1933 to 22.2 cents in 1938 (Badger, 1980). However, the high U.S. support prices prompted many countries to expand production and search for methods of increasing the quality of their own tobacco.

The 1954 American Cancer Society's report on <u>Smoking and Health</u>, and the 1964 <u>Report of the Advisory Committee to the Surgeon General</u> which began linking smoking to various health disorders, initiated the current decline in the demand for tobacco products (Humberd and Mundy, 1979). Within the developed countries, the demand for tobacco products has become stagnant or declined. The report of the Surgeon General also prompted many consumers to seek cigarettes which have lower tar and nicotine levels. Cigarette manufacturers responded to the changing tastes of consumers by proliferating the market with brands of "light" cigarettes. Despite the declining demand for tobacco products, the high support prices for tobacco continued, and eventually the U.S. began to lose market share in both the world and domestic market. As the national quota for tobacco declined, many producers found themselves unable to produce tobacco economically.

The changing structure of the demand for tobacco products, along with the changes in the structure of tobacco production, has spawned renewed interest in the demand for tobacco. Producers and policymakers alike need to be aware of the potential consequences involved in alterations of the tobacco program. The demand for tobacco is determined by its usefulness as an input in the manufacture of tobacco products, and the question that arises is how will the recent changes in the tobacco program affect producers, given the nature of demand for tobacco products.

Statement of Problem to be Studied

The demand for domestic tobacco occurs within two markets, the export market and the domestic market. This study examines the demand for tobacco within the domestic market by focusing on U.S. imports of tobacco. The procedure involves estimating aggregate demand for tobacco within the U.S., and subsequently examining the structure of U.S. flue-cured and burley imports by disaggregating these imports according to the origin country. The question posed is what can U.S. producers stand to gain in the domestic market from price changes occuring due to the tobacco program? It may also be beneficial to determine how other countries have benefited, or stand to benefit, from the changes in the U.S. tobacco market.

Objectives

There were four objectives in the study. The first objective was to produce a model which can estimate the input demand of the U.S. cigarette industry for tobacco. This objective was accomplished by selecting the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980). This model was selected due to its intuitive appeal in regard to economic theory. The restrictions of economic theory are readily imposed and testable in the model, and the model itself has the capability of providing a first-order approximation to any demand system without imposing any a priori restrictions on the degree of substitution between the commodities in the system.

The second objective involved testing the nature of tobacco demand with respect to economic theory. Demand functions are required to possess the properties of homogeneity and symmetry, and these two properties are readily testable in the AIDS model.

The third objective in the study was to compute elasticities of the various tobacco types based on the estimation derived. Own-price and cross-price elasticities can be calculated from the parameters obtained in the estimation. Elasticities were estimated for aggregate tobacco types and for selected countries which export tobacco to the U.S.

The fourth objective of the study was to examine both the U.S. aggregate demand for tobacco, and the composition of U.S. imports for structural changes. This was accomplished through examination of the parameter estimates generated in the estimation.

Study Approach

The approach used in the study consisted of utilizing the demand systems approach to estimate U.S. input demand for tobacco. The Almost Ideal Demand System derives a series of budget share equations and estimates demand for each budget share simultaneously. The approach first estimated U.S. aggregate input demand given four types of tobacco. These tobacco types are: (1)oriental tobacco, (2) imported flue-cured and burley tobacco, (3) domestic flue-cured tobacco, and (4) domestic burley tobacco.

The AIDS formulation was then applied to oriental tobacco and imported flue-cured and burley tobacco so that each budget share was represented by an individual country or a rest of world equation. The individual countries selected were the most prominent and consistent exporters of tobacco to the U.S., and included: Canada, Greece, Mexico, Brazil, and South Korea. In addition to indivdual country estimates, the AIDS model was applied to imports based upon the economic group of the origin of the tobacco. Each exporting country was classified as having either a developed, less developed, or centrally planned economy.

Thus, there were three basic models that were estimated utilizing 1971-1986 data. Each model was examined in order to (1) estimate the nature of U.S. demand for tobacco according to the restrictions of economic theory, (2) derive own and cross-price elasticities, and (3) examine possible structural changes occuring during the study period.

CHAPTER 2

OVERVIEW OF THE TOBACCO INDUSTRY

In both international trade and domestic agriculture, tobacco has always been somewhat of an enigma. It has few, if any, substitutes; it enters world trade on a leaf basis; it is highly differentiated; its value makes it the largest nonfood crop in the world (Johnson, 1984); and its use is restricted and often banned while its production is subsidized.

The economic influence of tobacco in the United States dates back to the English Jamestown colony. The struggling colony began exporting its leaf to England in 1612 and by 1630 tobacco exports totalled 1.5 million pounds (Mizelle and Givan, 1979). There have been a lot of changes in the tobacco industry since those early days of American history. This chapter provides an overview of the tobacco industry emphasizing the two major types of tobacco in the U.S., burley (type 31) and Flue-cured (types 11-14). This overview describes domestic tobacco supply and production, tobacco types, and government programs. Subsequent sections describe foreign tobacco supply, demand for tobacco products, international trade in tobacco, and the final section addresses government intervention in tobacco trade.

Domestic Tobacco Supply and Policy

Tobacco is the nation's sixth largest cash crop in sales with a 1985 farm value of $2.56 billion (Grise and Griffin, 1988). The primary use for tobacco is in cigarette manufacturing which utilizes 90 percent of total production (Grise and Griffin, 1988). Approximately 180,000 farms grow tobacco with about 60 percent of these farms located in Kentucky and North Carolina (Grise and Griffin, 1988). In terms of acreage, Tennessee is the nation's third largest tobacco producer behind North Carolina and Kentucky (Table 1).

Table 1. Leading Tobacco Producing States,1982.

STATE	FARMS (NUMBER)	TOBACCO ACREAGE	AVERAGE TOBACCO ACREAGE/FARM
North Carolina	29,489	337,696	11.4
Kentucky	74,166	256,619	3.5
Tennessee	36,515	82,390	2.3
Virginia	13,485	64,005	4.7
South Carolina	3,530	60,017	17.0
Georgia	3,005	44,749	14.9
Maryland	2,489	24,840	10.0
Ohio	4,846	14,023	2.9
Penn-sylvannia	1,939	11,793	6.1
Wisconsin	2,832	10,595	3.7

Source: Grise and Griffin,1988.

Cigarette production in the United States primarily uses flue-cured and burley tobacco, but also uses considerable amounts of Maryland and oriental tobacco. North Carolina, Virginia, South Carolina, and Georgia are the major flue-cured producing regions of the U.S. As can be seen in Table 1, and the average tobacco acreage is significantly greater than that of Kentucky and Tennessee, the major burley producing states (USDA, Tobacco: Background for 1985 Farm legislation, 1984). Flue-cured production has benefited from the introduction of technology, such as mechanical harvesting, which has lowered the number of producers and increased the average number of acres of production. Changes in burley production, however, have been much less dramatic because the air-cured properties of burley restrict the use of mechanical harvesting (Grise and Griffin, 1988).

Burley producers tend to be more reliant on off-farm income than flue-cured producers because the average burley farm has only 86 acres of total land and 40 acres of cropland (USDA, Tobacco Background for 1985 Farm Legislation,1984). However, both flue-cured and burley producers rely on off-farm income. In fact, 20 percent of both groups reported off-farm income of $10,000 or more and 68 percent reported at least some income being earned from non-farm sources (USDA, Tobacco: Background for 1985 Farm Legislation, 1984).

The production of tobacco in the U.S. is controlled by a price support/supply control program. The authority for a tobacco program stems from the Agricultural Adjustment Act of 1933. The act designated tobacco as a "basic" storable commodity, and the subsequent Agricultural Adjustment Act (AAA) of 1938 institutionalized the use of quotas to control production (Grise and Griffin, 1988). The 1938 act required growers to receive up to 75 percent of parity for their tobacco with the parity base period being August 1919 - July 1929 (Grise and Griffin, 1988). The objective of this legislation was to provide a "balanced flow" of tobacco (Grise and Griffin, 1988). A major consequence of the act was that tobacco production was bound within the counties it was then being produced, and also froze the location of the input suppliers and marketing channels (Carraro, 1988). Although there have been numerous changes in the tobacco program since 1938, the remainder of this section deals with the current tobacco program and the most recent series of legislative actions. Johnson (1984), and Grise and Griffin (1988) provide a complete historical picture of the transition in the tobacco program up to the 1970s.

In general, a tobacco program is initiated when the Secretary of Agriculture announces that a marketing quota is to be instituted for a particular kind of tobacco. For any type of tobacco to be eligible for price support, a referendum is held in which growers vote on the marketing quota. If the quota is approved, referendums are then held every three years to continue the program (USDA, Tobacco: Background for 1985 Farm Legislation, 1984). Growers are then assigned marketing quotas in exchange for price support. Currently, 96 percent of the tobacco production in the U.S. and Puerto Rico operates under price support programs (USDA, Tobacco: Background for 1985 Farm Legislation, 1984).

Under the current formula, price supports for burley and flue-cured tobacco are determined by weighting market prices and a cost of production index. A 5-year moving average of market prices with a two-thirds weight is multiplied by the cost of production index with a one-third weight (Grise and Griffin, 1988). Marketing quotas are determined by the Secretary of Agriculture and are based on the intended purchases of cigarette manufacturers, the average annual exports for the past three years, and the amount of tobacco needed to attain specified reserve stock levels (Grise and Griffin, 1988).

Price supports are differentiated by the class of tobacco, the type of tobacco, and the grade of tobacco (Johnson, 1984). There are six classes of tobacco: air-cured (burley being the major type), flue-cured, fire-cured, cigar filler, cigar wrapper, and cigar binder. Each class contains two or more types, and each type can then be differentiated into grades. Tobacco is graded based on stalk position, color, quality, and other characteristics. For example, there are 124 grades of flue-cured tobacco, each with its own support price (Johnson, 1984).

Price supports and marketing quotas are announced prior to the production season for each class of tobacco; however, the support prices by grade are not usually announced until the production season is underway (Marshall, 1979). Price support advances are available through financing made by the Commodity Credit Corporation (CCC). The CCC makes funds available to the producer owned stabilization cooperatives as loans. The cooperatives are required to provide loan proceeds to producers at the price support level (Marshall, 1979). Prior to 1982, losses on the loan program were borne by the CCC, and thus the taxpayer; however, the "No-Net-Cost Tobacco Program" of 1982 mandated that producers and buyers contribute to a fund to insure that the tobacco program operates at no-net-cost to the government, except for administrative expenses (Grise and Griffin, 1988).

Producers offer their lot of tobacco for sale at an auction warehouse where a government grader will tag the individual lots of tobacco as having a specific grade. Buyers are taken through the warehouse and an auctioneer solicits the highest bid. If no buyer offers a price at least one cent greater than the support price, the tobacco may be acquired by the stabilization cooperative (Marshall, 1979). The seller of a lot of tobacco has the right to refuse any bid and offer the lot for sale again (Marshall, 1979).

Tobacco transferred to the cooperative is offered for sale in either the domestic or export market. Sale proceeds are applied to the principal and interest on the loan and if any excess remains, it is retained by the cooperative. Losses are absorbed from the contributions provided by the producer and buyer assessments (Grise and Griffin, 1988).

Tobacco allotments/quotas are granted to qualified individual farmers based on the farm's production history. Qualified farms have either a production history traceable to the 1930s (the time of the AAA), or have subsequently been assigned a base by the Agricultural Conservation and Stabilization Service (Marshall, 1979). Flue-cured tobacco has both allotments (the maximum acreage which can be planted to tobacco) and quotas (the maximum poundage of tobacco which can be marketed), while burley tobacco is on a quota basis. For both flue-cured and burley tobacco it is the marketing quota which is the limiting factor.

Ownership of allotments and quotas has historically been an issue of major concern. Allotments and quotas represent the right to grow and market tobacco, and this right has substantial value. Allotments and quotas have generally been tied to the land. Over time, as farms with allotments and quotas were sold, and tobacco producers began to seek alternatives for their labor such as off-farm income, leasing or renting allotments and quotas gained significantly in popularity (GAO: Tobacco Program's Production Rights and Effects on Competition, 1982). The practice of leasing involves transferring part or all of a farm's allotment or quota to another farm within the same county (Marshall, 1979). A farmer could also rent his allotment or quota by allowing another farmer to produce the tobacco on the farm to which the allotment or quota is assigned (Grise and Griffin, 1988). Other factors which contributed to the rise in leasing and renting include: high support prices which raise the level of cash flow accruing from leasing or renting out quotas; the increased value of land which also arises from the high support prices and makes the purchase of land with allotments and quotas difficult; and the advent of mechanical harvesting (in flue-cured) and other optimal scale increasing technology (GAO: Tobacco Program's Production Rights and Effects on Competition, 1982). The result has been that most farmers wishing to produce tobacco must lease or rent for this right. Lease and rental rates vary significantly between counties depending on the cost of production. As expected, lease and rental rates are higher in low cost producing areas while the rates are lower in high cost producing areas (GAO: Tobacco Program's Production Rights and Effects on Competition, 1982). A 1981 survey by the Comptroller General of the United States found that nearly 53 percent of flue-cured allotment and quota owners and 44 percent of burley quota owners were nonfarmers. In fact, only 40 percent of the farms in the survey were owned by active full or part-time farmers. The benefits of the tobacco program have, over time, accrued to allotment and quota owners rather than the producers themselves. Active farmers found it necessary to either lease out their quotas or lease for additional quota for tobacco production to be economically viable (GAO: Tobacco Program's Production Rights and Effects on Competition, 1982).

At the time of the inception of the tobacco program, the U.S. was the world's leader in tobacco production and quality. In addition, with few substitutes and rising, inelastic demand, the tobacco program was considerably successful in increasing farm income (Carraro, 1988). Foreign producers of tobacco began to expand output and search for methods of increasing the quality of their tobacco. As foreign tobacco production increased and the quality improved, demand for U.S. tobacco began to decline. The U.S. share of the world and domestic market continually decreased as the demand for U.S. tobacco became more price responsive (Carraro, 1988). The national marketing quota had to be continually reduced, and with scale increasing technology, individual allotment and quota owners found it uneconomical to produce tobacco without leasing for additional quota (GAO: Tobacco Program's Production Rights and Effects on Competition, 1982). This also prompted many producers to lease out their quota and not produce at all (GAO: Tobaccco Program's Production Rights and Effects on Competition, 1982).

The falling national quotas and the increased price sensitivity by potential buyers of U.S. tobacco together to create falling revenues for both the producers and quota owners (Carraro, 1988). These results have prompted legislative changes to make tobacco more market oriented (Carraro, 1988). The first of these changes involve the "No-Net-Cost Tobacco Program." In addition to the assessment on producers and buyers, the law allowed the sale of flue-cured allotments and quotas to be conducted separately from the land to which it is attached (Grise and Griffin, 1988). The law requires the sale of these rights to be made to active producers or to those planning to become active producers within the same county (Grise and Griffin, 1988). The 1982 law also gave the Secretary of Agriculture the authority to reduce support rates for tobacco considered to be in excess supply (Grise and Griffin, 1988).

Potential liability for stored tobacco loomed as a major problem in 1985. Assessments to flue-cured producers and buyers since the 1982 law took effect include: 3 cents/pound in 1982, 7 cents/pound in 1983 and 1984, 25 cents/pound in 1985, and the estimated assessment in 1986 was 30 cents/pound (Grise and Griffin, 1988). To alleviate some of the burden on producers, legislation enacted in 1985 allowed the CCC to take title on most of the surplus flue-cured and burley tobacco and offer it for sale at discounts of up to 90 percent, thus reducing the 1986 assessment on flue-cured tobacco to 2 1/2 cents/pound (Carraro, 1988).

Other recent legislative action included requiring the sale of flue-cured tobacco quotas by nonfarm institutions by December 1, 1984. The sales had to be to active producers or to those intending to become active producers within the same county. Additional legislation included the following provisions:

- Lease and transfer of flue-cured tobacco quotas was abolished in 1987.
- No more than 15,000 pounds of burley quota could be transferred to a single farm in 1984 (down from the previously allowed 30,000 pounds).
- Price supports in 1983, 1984, and 1985 were frozen at the 1982 level, and in 1986 the Secretary of Agriculture retained the authority to approve as little as 65 percent of the increase in the support price called for by the legislative formula.

The objective of the legislative changes was to make U.S. tobacco more market oriented. As a result, the changes in the tobacco program led to significantly lower prices. Average grower prices fell from $1.80/pound in 1985 to $1.46/pound in 1986 (Carraro, 1988). In 1987, exports began to rise and imports fell, while marketing quotas were indeed on the rise (Carraro, 1988).

Foreign Tobacco Supply and Policy

U.S. tobacco production has increased about 23 percent since the inception of the tobacco program in the 1930s while world production has nearly doubled (Grise and Griffin, 1988). However, since the late 1940s, U.S. production has actually declined and world production has increased by 85 percent (Grise and Griffin, 1988). Currently the U.S. is the world's second largest tobacco producer representing more than 8 percent of production. China, the world's leading tobacco producer, has roughly 30 percent of world production (Grise and Griffin, 1988). Other major producing nations include Brazil, The Soviet Union, Turkey, and India. The major types of tobacco produced are the cigarette tobaccos: flue-cured, burley, and oriental. In the late 1950s, the U.S. produced approximately 41 percent of the world's flue-cured tobacco, currently the U.S. produces around 15 percent (Grise and Griffin, 1988; Johnson, 1984). Meanwhile, flue-cured production in China, Brazil, and South Korea have dramatically increased (Grise and Griffin, 1988).

A somewhat similiar situation exists for burley tobacco. The U.S. produced around 80 percent of the world's burley in the 1950s, it now produces around 45 percent (Grise and Griffin, 1988; Johnson, 1984). While burley production in the U.S. has declined, production in Italy, the world's second largest burley producer, increased 263 percent from the mid 1960s to the mid 1980s (Grise and Griffin, 1988). Other major burley producers include Brazil, Mexico, Spain and South Korea. Tables 2,3 and 4 summarize tobacco production in the 1980s in the major producing countries.

The growth in tobacco production is due to numerous factors. The report of the Surgeon General linking smoking to various health disorders has caused a shift in the demand for tobacco. Within developed countries actions such as advertising bans, health warnings, and restrictions on its use have begun to negatively impact demand; however, the reduction in demand is a relatively recent event, and in the growing developing countries, cigarette demand is rapidly increasing (Pompelli and Haden, 1988). Worldwide, strong demand for tobacco provided many producers with the opportunity to enhance farm income. Developing countries in particular benefitted from tobacco's foreign exchange earning potential and the employment generated from tobacco's substantial labor requirements. This environment produced a strong growth in production and, within individual countries, the perceived need to foster and protect domestic production.

The remainder of this section focuses on tobacco production policies in the countries which have been

Table 2. Major Burley Producing Countries, 1980-1986.

YEAR	UNITED STATES	ITALY	BRAZIL	MEXICO	MALAWI	SOUTH KOREA
	PRODUCTION (1000 METRIC TONS)					
1980	254.4	53.0	23	28.9	17.5	27.3
1981	331.0	49.5	20	23.5	19.3	22.6
1982	330.7	53.0	31	25.8	27.3	27.5
1983	218.4	60.4	38	27.1	41.5	35.9
1984	323.1	59.4	44	23.5	27.0	31.0
1985	260.0	50.8	42	24.8	33.6	26.3
1986	185.0	41.5	41	34.3	30.5	26.0

Source: FAS, Foreign Agricultural Circular-Tobacco.

Table 3. Major Flue-cured Producing Countries, 1980-1986.

YEAR	UNITED STATES	CHINA	BRAZIL	CANADA	ZIMBABWE	SOUTH KOREA
	PRODUCTION (1000 METRIC TONS)					
1980	492.6	748	228	105.9	122.6	64.9
1981	530.2	1,150	205	110.2	67.4	64.1
1982	448.6	1,150	218	117.2	89.5	63.3
1983	372.5	1,151	234	109.5	94.3	64.7
1984	392.2	1,400	265	88.6	119.6	63.1
1985	363.0	2,075	257	86.6	105.6	49.3
1986	292.4	1,382	263	69.0	114.3	57.0

Source: FAS, Foreign Agricultural Circular-Tobacco.

Table 4. Major Oriental Producing Countries, 1980-1986.

YEAR	TURKEY	BULGARIA	GREECE	ITALY	SOVIET UNION
	PRODUCTION (1000 METRIC TONS)				
1980	227.8	102.0	98.9	25.1	284
1981	179.5	102.6	99.1	24.3	290
1982	209.5	115.0	93.0	24.0	300
1983	232.7	107.4	85.2	27.0	379
1984	189.8	123.2	110.2	25.9	365
1985	170.5	102.9	117.8	28.0	372
1986	161.5	110.0	129.6	27.5	377

Source: FAS, Foreign Agricultural Circular Tobacco.

consistent exporters to the U.S. and for which information is available. The information is derived from a congressional request for tobacco information in 1986, and was compiled by the Foreign Agricultural Service.

Brazil

Production of flue-cured and burley tobacco is concentrated in southern Brazil. The government subsidizes production through the rural credit system and energy rebates which are available to all farmers. Farmers can obtain loans for operating expenses at interest rates below market rates. Interest rates for producers for the 1985/86 crops were 3 percent plus monetary correction for cruzeiro devaluations, while market interest rates were around 25 percent plus correction during the same period. The 1986/87 crops had interest rates fixed at 10 percent. Farmers are also entilted to rebates of 60 percent on power obtained from state owned public utilities. The government also subsidizes production by exempting the profits earned on the exports of tobacco (along with many other agricultural commodities) from Brazilian income tax.

The actual production of tobacco occurs under a contract system between tobacco companies and farmers. The producer contracts to sell his tobacco, at the industry agreed price, to a specific tobacco company prior to the production season. The tobacco company provides technical advice, provides the seeds, supplies the fertilizer and chemicals (at cost and the producer reimburses the company at harvest), pays the freight for bringing the tobacco to market, pays the interest on financing and the building of curing barns, and purchases the producer's entire lot of tobacco. Tobacco companies provide considerable support to Brazilian producers and have considerable input in the production process.

Canada

Ninety percent of tobacco production in Canada occurs in Ontario, and nearly all production is in flue-cured tobacco. There is no separate tobacco policy in Canada, rather tobacco producers receive benefits directed to farmers in general. In addition to these benefits, tobacco producers receive assistance from the Canadian Tobacco Manufacturers Council (CTMC).

Farmers in Ontario are entitled to a provincial fuel tax rebate for unlicensed farm vehicles. The rebates in 1986 were 8.3 Canadian (CDN) cents per liter for gasoline and 9.9 CDN cents per liter for diesel (6 and 7.2 U.S. cents per liter respectively). Farmers in Ontario are also eligible for a 60 percent rebate of farmland taxes, excluding the residence and one acre, provided production value exceeds 8,000 CDN dollars (5,800 U.S. dollars). Financial assistance and crop insurance is also available to qualified farmers.

The Canadian Tobacco Manufacturers Council (CTMC) seeks to maintain a viable tobacco production industry by establishing guaranteed minimum prices for flue-cured tobacco. The guaranteed price in 1986 was 4.06 CDN dollars per kilogram (1.34 U.S. dollars per pound) with a minimum grade price of 2.64 CDN dollars per kilogram (.87 U.S. dollars per pound). The CTMC guarantees this price for Canadian flue-cured tobacco sold for use in domestic manufacturing; export prices are not guaranteed. To bolster the returns of flue-cured producers, the CTMC provides an adjustment fund to the Ontario Flue-cured Tobacco Grower's Marketing Board which partially offsets the difference between returns on the domestic market and the returns on the export market. Annually, about 30 percent of flue-cured production is exported.

Greece (Policies of the EEC)

Greece and Italy are the two most prominent producers of tobacco in the European community. Greece produces flue-cured, burley, and oriental tobacco with oriental being produced in far greater amounts. Price support for tobacco production falls mainly within the policy framework of the EEC's Common Agricultural Policy (CAP).

The production of tobacco in the European Community is based on a "norm" price and an intervention price system covering 26 varieties of tobacco. For each variety, the norm price is fixed at levels guaranteeing producers a fair income taking production requirements and the economic viability of firms into account (FAS, 1986; National Policies for Agricultural Trade, 1987). The intervention price is the lowest price growers can receive and is set at 85 percent of the norm price (90 percent prior to 1983). Intervention agencies will buy at the intervention price all tobacco offered to them. A derived intervention price is set for baled tobacco which is calculated based on the intervention price plus processing costs. Premiums are paid to buyers who purchase leaf tobacco from growers and process the tobacco into bales (National Policies for Agricultural Trade, 1987). The objective of the premium price is to provide an incentive for buyers to purchase EC tobacco so that growers are able to reach the norm price. Within the individual countries producers can be organized into cooperatives and may receive certain other subsidies based on the individual country's objectives. Greece for example, also provides a rebate to all exporters of Greek products. The rebate is 5 percent the Drachma equivalent of the foreign exchange generated by the export. The Greek government also provides cooperatives with subsidies for pesticides and farm machinery. The Greek tobacco sector received 26.4 percent of the total EEC inflow to Greece from intervention buying and export subsidies.

Turkey

Turkey primarily produces oriental tobacco. Flue-cured and burley production does take place; however, production of these types represents less than 1 percent of total production. Tobacco farming in Turkey is considered a family operation with minimal hired workers. Small farmers with an annual income below 3,300 dollars are exempt from income taxes; however, commercial sales are subject to a 7 percent tax and exports as well are taxed. Production of tobacco is controlled by TEKEL, a state monopoly administration. TEKEL is the sole cigarette manufacturer and controls the production and marketing of tobacco and their products. Recently, the Turkish government has allowed foreign cigarette manufacturers to operate within Turkey. However, TEKEL is to be a partner in any of these operations and will be the sole authority on the importation, pricing, and the distribution of any cigarettes within Turkey. Importing any leaf tobacco requres the permission of the Ministry of Finance and Customs. Cigarettes containing imported tobacco are subject to a surcharge determined by the Ministry of Finance and Customs.

Despite the strict control of TEKEL over the Turkish tobacco industry, producers do not receive the benefits of this monopoly power. The monopoly's selling support price for the best quality leaf is $1.70 per pound, yet producers are not expected to receive more than 90 cents per pound.

With the possible exception of countries such as Turkey which tax commercial sales and exports, tobacco production throughout the world is domestically supported to some degree, a condition comparable to most other agricultural commodities. Domestic subsidies and border measures (to be discussed later in this chapter) have maintained conditions that support rising production. World production has increased from 6.6 billion pounds in the late 1930s to 13.5 billion pounds in the early 1980s. The degree to which the U.S. tobacco program influenced world production is not known, however, high U.S. support prices certainly created some impetus to the increase in world production. The possibility exists for world stockpiles of tobacco to become a serious problem in the future. The agricultural crisis of the 1980s is due in large part to the domestic programs of individual countries. Tobacco is by no means insulated from this type of situation. Demand in the developed countries is stagnant or declining, and as manufacturers aggressively pursue new markets, primarily in the developing countries, more barriers to the free flow of tobacco are a distinct possibility.

Tobacco Demand

The predominant use of tobacco is in cigarette manufacturing; however, other tobacco products include: cigars, chewing tobacco, snuff, and various types of smoking tobacco such as pipe and roll-your-own cigarettes. In the U.S., 103 companies manufactured tobacco products in 1982, fourteen of which were highly mechanized cigarette plants (Grise and Griffin, 1988). The tobacco industry generated gross receipts in the U.S. of $10.6 billion in 1982, excluding excise taxes, with cigarette manufacturing accounting for $9.6 billion (Grise and Griffin, 1988). These firms employed 50,000 people paying them over $1.2 billion in wages and benefits (Grise and Griffin, 1988). While tobacco manufacturing is a sizable economic entity, the remainder of this section concentrates on cigarette demand and the manufacturing firms.

In the United States, consumption of cigarettes peaked in 1981 at a level of 640 billion cigarettes (Grise and Griffin, 1988). Per capita consumption reached its peak in 1963 with 4,345 cigarettes per year (Grise and Griffin, 1988). Table 5 summarizes cigarette output and consumption in the U.S. from 1967 to 1986.

The most predominant factor in the declining demand for cigarettes has been the report of the Surgeon General linking cigarettes to various health disorders. Warning labels, anti-smoking campaigns, and bans on advertising have significantly reduced per capita cigarette consumption in the United States. Similiar health warnings and advertising bans are in effect for most developed countries of the world, historically the major buyers of U.S. tobacco and

Table 5. U.S. Cigarette Output and consumption, 1967-1986.

YEAR	CIGARETTE OUTPUT	U.S. CONSUMPTION	CIGARETTE EXPORTS	PER CAPITA CONSUMPTION	POUNDS (PER CAPITA)
	------- (BILLION PIECES)		------:	------- (NUMBER)	-------
1967	576.2	549.2	23.7	4,280	8.86
1968	579.5	545.7	26.5	4,186	8.69
1969	557.6	528.9	25.0	3,993	8.11
1970	583.2	536.4	29.2	3,985	7.77
1971	576.4	555.1	31.8	4,037	7.75
1972	599.1	566.8	34.6	4,043	7.95
1973	644.2	589.7	41.5	4,148	7.92
1974	635.0	599.0	46.9	4,141	7.90
1975	651.2	607.2	50.2	4,123	7.73
1976	693.4	613.5	61.4	4,092	7.35
1977	665.9	617.0	66.8	4,051	7.21
1978	695.9	616.0	74.4	3,967	6.89
1979	704.4	621.5	79.7	3,861	7.00
1980	714.1	631.5	82.0	3,849	6.78
1981	736.5	640.0	82.6	3,836	6.52
1982	694.2	634.0	73.6	3,739	6.45
1983	667.0	600.0	60.7	3,488	6.19
1984	668.8	600.4	56.5	3,446	5.89
1985	665.3	594.0	58.9	3,370	5.91
1986	658.0	583.8	64.3	3,274	5.88

Source: Tobacco Outlook and Situation, Various issues.

cigarettes (FAS, Tariff and Nontariff Measures on Tobacco, 1984).

The response on the part of consumers and manufacturers has been to switch to filter cigarettes and the promotion of low tar/nicotine cigarettes. In 1985, 95 percent of cigarettes were filter tipped compared to just 1 percent in 1950 (Grise and Griffin, 1988). The introduction of the filter-tipped cigarette has been to reduce the amount of tobacco used per cigarette (Grise and Griffin, 1988; Sumner and Alston, 1987). The low tar/nicotine cigarettes have been heavily promoted by manufacturers (Grise and Griffin, 1988). This type of cigarette has prompted some substitution of imported tobacco for U.S. tobacco, since U.S. leaf tends to have much higher tar and nicotine contents than imported leaf (Chang, Beghin, and Sumner, 1988).

The shrinking market for tobacco products in the U.S. and the other developed nations has prompted three of the "Big Six" U.S. manufacturing firms to seek additional markets. The "Big Six" manufacturers are: R.J. Reynolds, Philip Morris, Ligget and Myers, American Tobacco, Brown and Williamson, and Lorillard. On the international scene Philip Morris, R.J. Reynolds, and American Tobacco are investing heavily to acquire foreign markets (Overton, 1981). The top cigarette manufacturer in the world is British American Tobacco Industries, with Philip Morris and R.J. Reynolds aggressively pursuing (Overton, 1981). The difficulty in acquiring foreign markets lies in the many state owned monopolies. Many nations utilize tobacco monopolies (Turkey for example) as the sole manufacturer of cigarettes in the country. This protects the domestic tobacco market both in the production and manufacturing stages. The large tobacco manufacturers have pursued cooperative agreements with state owned monopolies to acquire a foothold in foreign markets and promote their blended cigarettes, while allowing the monopolies to retain its manufacturing and distribution control (Overton, 1981).

The current direction in the search for new markets occurs in the developing countries with growing economies and incomes (Huebner, 1981). East Asia, the Middle East, and North Africa offer market potential for U.S. leaf tobacco and U.S. manufacturing firms (Huebner, 1981). The export market and foreign tobacco product markets contain the principal method for expanding the demand for U.S. tobacco.

International Trade in Tobacco

The world leaf tobacco market has grown considerably over the past few decades. World exports of flue-cured tobacco have grown from almost 800 million pounds in 1970 to over 1.5 billion pounds by 1982 (Johnson, 1984). In the same time period, the U.S. share of the flue-cured market declined from 46 percent to 26 percent. The burley export market has grown from 125 million pounds in 1970 to almost

350 million pounds in 1982, meanwhile the share of the burley export market controlled by the U.S. declined from 33 percent to 20 percent (Johnson, 1984).

Despite the loss in market share of the world market, the U.S. has retained its position as the world leader in tobacco exports. However, U.S. exports have declined from 615 million pounds in the late 1970s to just under 550 million pounds in 1985. Exports from Brazil, Malawi, and Zimbabwe were all increasing during the same time period. Other major exporters of tobacco include Greece, India, and Turkey. Many developing nations, while offering the potential for expanded markets for U.S. tobacco, have also found that tobacco offers significant foreign exchange earning potential (Kinney, 1981). Tables 6 and 7 summarize flue-cured and burley exports from 1977-1986.

The historical prominence of the U.S. in the world market stems from the perceived quality difference between U.S. and other tobaccos (Carraro, 1988). U.S. tobacco is consistently viewed as having the highest quality, yet high U.S. support prices, increased production, and improved quality of foreign tobacco, have led to a decline in the U.S. share of the world market in percentage and absolute terms.

Half of U.S. exports are accounted for by five countries: Japan, West Germany, Egypt, Netherlands, and Italy (Pompelli and Haden, 1988). Exports to the major

Table 6. Flue-cured Exports, World and Selected Countries, 1977-1986.

YEAR	WORLD	UNITED STATES	INDIA	BRAZIL	ZIMBABWE	CANADA
			(1000 METRIC TONS)			
1977	561.8	186.8	67.9	65.0	64.4	18.7
1978	619.7	206.3	66.0	70.0	74.4	25.7
1979	560.5	168.1	60.0	83.1	58.6	31.3
1980	601.5	177.4	64.5	90.0	105.3	18.6
1981	684.8	175.2	90.0	110.0	114.7	32.1
1982	694.3	158.0	84.6	126.0	79.5	28.1
1983	641.2	140.9	66.3	130.0	87.9	22.5
1984	673.2	158.7	62.0	145.0	84.9	24.8
1985	697.3	151.0	58.0	152.0	93.3	23.5
1986	678.9	150.0	60.0	132.0	97.2	25.0

Source: FAS, Foreign Agricultural Circular-Tobacco.

Table 7. Burley Exports, World and Selected Countries, 1977-1986.

YEAR	WORLD	UNITED STATES	ITALY	MEXICO	BRAZIL	SOUTH KOREA
			(1000 METRIC TONS)			
1977	132.1	35.9	19.8	15.1	10.0	17.0
1978	144.6	41.3	22.2	21.2	8.0	17.1
1979	142.2	37.2	27.8	17.7	8.0	15.4
1980	152.3	41.2	21.7	12.2	9.0	12.2
1981	155.6	33.6	27.8	6.6	16.0	6.6
1982	159.5	47.0	35.8	6.0	8.0	6.0
1983	189.3	41.2	24.0	10.0	16.0	15.3
1984	186.2	33.4	29.3	11.4	18.0	9.6
1985	179.0	46.4	22.5	8.7	18.0	10.2
1986	195.9	47.0	26.0	15.0	15.0	10.0

Source: FAS, Foreign Agricultural Circular-Tobacco.

developed nations declined in the 1980s in response to many factors, high U.S. support prices and improved foreign tobacco quality being the main reasons. Other factors contributing to the decline include the dollar's high value during this period, and government intervention in tobacco trade (Pompelli and Haden, 1988).

Whatever the reason, it is the export market which holds the potential for increasing the demand for U.S. tobacco and tobacco products. Even while U.S. exports have been decreasing, the role of exports in the tobacco industry remains quite prominent.

In 1970, burley exports accounted for approximately 10 percent of U.S. burley disappearance. By 1986, burley exports were 26 percent of U.S. burley disappearance (Grise and Griffin, 1988). Burley exports have continually risen throughout the 1970s and 1980s with only drought and an unusually poor quality crop lowering exports (Snell and Reed, 1987). Despite the gain in burley exports, total U.S. exports have been on the decline. Flue-cured exports have fallen from a 1978 high of 599 million pounds to 417 million pounds in 1986, yet flue-cured exports have consistently represented approximately 45 percent of U.S. flue-cured disappearance (Grise and Griffin, 1988).

As U.S. exports slid, imports began to rise. The many types and grades of tobacco reflect the heterogeneity of the product. This heterogenous nature which also leads countries to both export and import tobacco. The nature of its production leads countries to produce tobacco with certain distinct characteristics. This creates a myriad of different tobaccos among countries even when all are producing the same tobacco type. In manufacturing, tobacco is blended in cigarettes to derive a distinct flavor. In the short run this precise blend limits the degree to which tobacco of the same type, but produced in different countries, are substitutable for one another. Over time, as preferences and technology change and quality improves, substitution becomes easier between tobaccos.

This substitution effect has become somewhat of a focal point in regard to U.S. imports of foreign produced tobacco. The share of imported flue-cured and burley tobacco in domestic manufacturing has increased from 1.6 percent for flue-cured and .6 percent for burley in 1970, to 24.1 and 24.5 percent for imported flue-cured and burley in 1985 (Grise and Griffin, 1988). The U.S. has consistently been the world leader in importing tobacco; however, the increasing use of imported tobacco has become an issue of major concern. The data in Table 8 show U.S. tobacco imports from 1971 to 1986.

Table 8. U.S. Flue-cured and Burley Imports, 1971-1986.

YEAR	FLUE-CURED	BURLEY
	(FARM SALES WEIGHT, MILLION POUNDS)	
1971	11.2	4.6
1972	12.7	8.9
1973	20.4	30.7
1974	23.1	47.7
1975	24.4	46.7
1976	30.8	37.9
1977	55.0	85.4
1978	60.1	89.1
1979	84.8	113.4
1980	72.7	136.9
1981	63.3	109.7
1982	103.1	141.3
1983	94.4	135.0
1984	120.1	163.8
1985	151.0	137.8
1986	176.6	120.4

Source: Tobacco Outlook and Situation, April, 1988.

Another issue of major concern is the use of trade barriers in international trade. The developed countries of the world import most of the tobacco, however, these countries are experiencing stagnant or declining demand for cigarettes (Grise and Griffin, 1988). The more "developed" developing countries such as Pakistan, India, Venezuela, Malaysia, and Brazil are experiencing rapid growth in cigarette demand (Pompelli and Haden, 1988). The international trade arena is now focused on these countries and the various trade barriers erected to protect domestic industries.

Government Intervention

Protection for the domestic tobacco industry occurs at two levels, domestic policies designed to subsidize producers and maintain viable domestic production, and border measures designed to restrict the imports of foreign tobacco and/or tobacco products. Examples of domestic tobacco production policies have already been presented, therefore, this section emphasizes the use of border restrictions.

Nations attempt to restrict the inflow of commodities for one or all of three reasons: protect the domestic industry from foreign competition, control the balance of payments, or generate revenue (Howland, 1983). To accomplish this task, countries utilize tariffs or nontariff barriers or a combination of both.

Tariffs on tobacco, whether expressed as ad valorem or as specific per import unit, are in place for most nations with the exception of countries such as Finland, Norway, and Sweden which do not have domestic tobacco production and import tobacco essentially duty free. Egypt does not have a tobacco production industry, but maintains a relatively high tariff rate in order to generate revenue. Likewise, Hong Kong uses its tariff to generate tax revenue (Howland, 1983). Net exporting countries typically have high tariff rates, while importing countries have low to moderate tariff rates (Howland, 1983).

The purpose of the tariff for most countries is to protect the domestic industry by impeding imports. With the exception of the EEC's preferential tariff rates for former colonies and less developed countries, tariffs are not regarded as the most important determinant of imports (Howland, 1983). Non-tariff barriers have become much more formidable for countries attempting to expand exports. Many countries utilize state monopolies which retain sole authority over the domestic industry and the level of imports. Thailand and Korea are major exporters with high tariff rates and state monopolies which have effectively restricted imports (Howland, 1983).

Australia and New Zealand utilize mixing regulations as a form of import control. Mixing regulations specify the maximum amount of foreign tobacco which can be used in domestic products (Howland, 1983). Some countries utilize import licenses which requires an exporter to obtain permission before exporting to that country. Import licenses can be restrictive depending on the degree of difficulty in obtaining them. Argentina, Brazil, Mexico, and Turkey have historically used this type of barrier, and as a general rule, import licenses for tobacco are just not granted in these countries (Howland, 1983); however, Turkey has begun to open its market somewhat, albeit on a very small scale.

Sanitation requirements for all agricultural products can become a significant barrier. Countries have a legitimate right to protect their population from the overuse of pesticides and chemicals, or to enforce a pesticide ban by not allowing imports of a product from countries which use the banned pesticide. This concern, however can be turned into a restrictive barrier when the requirement is perceived as being unreasonable.

Among the developing countries, foreign exchange requirements and the sophistication of the market can limit imports. Countries such as Sudan use import licenses to control the outflow of hard currency (FAS, Tariff and Nontariff Measures on Tobacco, 1984). Zimbabwe, Malawi, and India require further market development through positive trade balances and higher incomes before their markets can advance (Howland, 1983). Zimbabwe, for example, had to suspend the importation of packaging materials due to a lack of foreign exchange (FAS, Tariff and Nontariff Measures on Tobacco, 1984).

Government involvement in the tobacco industry occurs at nearly all levels in international markets, and the potential for market distortion is undoubtedly already in existence. The overhaul of the U.S. tobacco program beginning in 1982 arose not only from falling market shares, but also from the accumulation of tobacco stocks and the expenses associated with the storage and disposal incentives of these stocks (Pompelli and Haden, 1988). The income problem of small farmers continues to exist, while the supply and demand market signals become increasingly distorted in a haze of government intervention.

CHAPTER 3

LITERATURE REVIEW

Research dealing with demand estimation is extensive in economics. The literature relevant to this study is reviewed in three sections. The first segment deals with literature in the analysis of tobacco demand. The second segment considers empirical models as applied to demand estimation and import demand. The final section then reviews the literature on the Almost Ideal Demand System model.

Tobacco Demand

The literature on the demand for tobacco extends to both the export and domestic market. Demand for tobacco is derived from the demand for tobacco products, and the nature of tobacco products is such that consumers develop habits with respect to its consumption (Zanias, 1987). Manufacturers will attempt to maintain fairly constant blends of the tobacco types used in the manufacturing process, thereby limiting the substitution effects in the short-run (Zanias, 1987).Over time, tastes and technology change and substitution then becomes easier.

This hypothesis was examined by Zanias (1987) with respect to the Greek export market. Zanias used a dynamic model to incorporate adjustment costs in the export demand for Greek oriental tobacco. A major finding of the study was that buyers of Greek tobacco react slowly to price signals (Zanias, 1987). His research showed that while static models captured the short-run effects, the long-term effects were often incomplete or ignored. This finding illustrates how changes in the U.S. tobacco program accrue over time as manufacturers and consumers react to the price changes. Zanias also found that elasticity estimates differ significantly between the short-run and the long-run. The elasticity for Greek tobacco increased from -.736 in the short-run to -4.59 in the long-run.

Reed and Schnepf used a three-equation recursive model to estimate the demand for U.S. burley tobacco in the European community. Their model assumed separability between burley tobacco and other tobaccos in addition to the assumption of perfect substitutability between burley tobacco originating from countries other than the U.S. Their results produced a European elasticity of demand for U.S. burley tobacco of -.78. However, Sumner and Alston (1987) noted that research into tobacco exports has been empirically difficult due to the numerous trade barriers and government subsidies existing in tobacco.

Research into U.S. input demand for tobacco and the substitution effects in the manufacturing process was first examined by Sumner and Alston (1987). The model used a system of translog functions in which demand for U.S. tobacco, imported tobacco, and other inputs were estimated in reference to input demand in cigarette manufacturing. The procedure used by Sumner and Alston was to first derive output constant elasticities, and then estimate demand for U.S. cigarettes to capture output effects on the demand for tobacco. They derived a total elasticity of demand for U.S. tobacco of -2.5, but scaled this estimate down to -1.5 due to its perceived unreasonable magnitude. This approach was revised by Chang, Beghin, and Sumner (1988). In the original estimation, domestic flue-cured and burley tobacco were aggregated together, and the various tobacco imports were also aggregated together. The second estimation decomposed domestic tobacco into flue-cured and burley, and decomposed imports into oriental tobacco and imported flue-cured and burley tobacco. They again applied a system of translog equations to estimate demand and also utilized a nicotine content indicator (average nicotine level per cigarette) as a trend variable in the estimation. They also imposed the theoretical constraints of concavity and negativity on the function through a Bayesian estimation technique. Their results produced generally inelastic demands for all tobacco types with only domestic flue-cured tobacco exceeding unity. They also found that the expansion of the low tar/nicotine cigarettes have negatively affected the demand for U.S. tobacco.

Anti-smoking campaigns, advertising bans, and the federal excise tax all have had negative effects on the demand for tobacco (Snell and Reed, 1984). Public policy decisions, whether made for the benefit of public health or raising revenue, affect the demand for tobacco by shifting the demand for tobacco products (Sumner and Wohlgenant, 1985). The effects of a change in the excise tax on the demand for tobacco was examined by Sumner and Wohlgenant (1985). Their results concluded that an active export market in cigarettes and raw tobacco offsets price increases in cigarettes. The demand for tobacco declines in the domestic market but increases in the export market, and the overall effect on tobacco is relatively small, even with a large (100%) change in the excise tax rate (Sumner and Wohlgenant, 1985).

Trade flows in the international trade of tobacco were analyzed by Johnson (1984). Johnson's approach was to utilize a series of import demand, supply and price equations for each trading nation. The model used in the estimation was an Armington type model which can differentiate similiar goods according to the origin of the good (see Armington, 1969). The model's appeal rests in its ability to incorporate price and demand shifter variables as well as policy variables (Johnson, Grennes, Thursby, 1979). The Armington model is, however, highly restrictive. The model assumes that "the elasticity of substitution between any two kinds of a good is constant and equals the elasticity of substitution between any other kinds of goods in the same market," (Johnson, Grennes, and Thursby, 1979). Therefore, cross-price elasticities are invariant with respect to the product demanded. The Armington model is also criticized on the basis of its homothecity restriction in which an importer's market share is independent of group expenditures (Winters, 1984).

Empirical Models in Demand Estimation

The choice of which particular model to use in estimating a function is becoming increasingly difficult due to the already large number of models existing. The true functional form a given relationship exhibits is impossible to specify, and the researcher must therefore select the most appropriate model based upon the objectives in the research (Grffin, Montgomery, and Rister, 1984).

Sarris (1981) identified many of the empirical models used to estimate trade flows. Sarris considers primarily spatial models and market share models used in identifing microeconomic relationships in international trade. Griffin, Montgomery, and Rister (1984) presented a criterion for selecting a functional form in production analysis, and also identified the properties of eighteen different functions used in both production and consumption analysis. Johnson, Hassan, and Green (1984) applied many of the demand systems models to Canadian consumption data.

The systems approach to demand estimation has also been explored by Theil (1975,1980,1981) and Deaton and Muellbauer (1980a,1980b). Most of the literature on demand analysis has been devoted to consumer demand; however, Theil (1980) expanded the analysis from consumer demand to input demand by extending the theory of consumer preferences to production theory. Theil found that in traditional input-output production analysis, which utilizes the CES function, little or no attention is paid to price substitution. Output is described in terms of final demand for the product, rather than relative prices. Theil then extended the flexible functional form to production analysis.

Chang, Beghin, and Sumner (1988) utilizied a system of translog functions in their estimation of input demand for tobacco. The properties of the translog function can be found in Griffin, Montgomery and Rister (1984) and Johnson, Hassan, and Green (1984). The approach by Chang, Beghin and Sumner was to make the model more consistent with economic theory by imposing concavity and negativity constraints in the estimation. They found that both concavity and negativity were to be rejected a majority of the time. This possibly suggests that an alternative functional form may be more appropriate for demand estimation with respect to tobacco.

Deaton and Muellbauer's Almost Ideal Demand System (AIDS) is a possible alternative to the translog function. The model begins with a specification of a cost function rather than a utility or production function (Deaton and Muellbauer, 1980b). The functional form of the model is consistent with economic theory and has been applied to a variety of demand estimation applications.

Studies Using the AIDS Specification

The Almost Ideal Demand System (AIDS) was developed by Deaton and Muellbauer in 1980 and was applied to British postwar data. In the results the properties of demand theory (homogeneity, symmetry, and concavity of the function) were to be rejected in most cases. This result, however, is not new within the literature (Barten, 1969; Laitinen, 1978; Bera, Byron, and Jarque, 1981), since factors such as price expectations and time trend variables were omitted in the estimation (Deaton and Muellbauer, 1980a). The model has since been used in other studies and a few of these studies are described below.

Blanciforti and Green (1983) estimated the AIDS model for U.S. postwar consumption data and incorporated a lagged dependent variable in the estimation. They found homogeneity to be rejected in half of the equations, but concluded that the addition of a dynamic element into the estimation added significantly to the overall results.

Winters (1984) used the AIDS model to estimate the import allocation of consumer goods in the United Kingdom. Winters compared the AIDS model to the Armington model and found that the assumptions of homotheticity and mutual separability of demands for different imports to be overly restrictive in the Armington model. Winters observes that the generality and tractability of the AIDS model offer promising results in its use in analysis and hypothesis testing.

In the context of consumer demand, Eales and Unnevhr (1988) used a first-difference form of the AIDS model to estimate the demand for beef and chicken. Their procedure was to first estimate demand with aggregate chicken, beef, and pork and then estimate a second demand system using disaggregated chicken (whole birds, processed parts) and disaggregated beef (hamburger, and table cuts). Their analysis included a test for structural change in demand. The test for structural change involves allowing an intercept term in the first difference model, and this intercept then represents the exogenous change in demand. Their findings indicate that through the intercept term, evidence exists that exogenous changes in the demand for chicken were due to strong growth in the demand for processed chicken parts. Another interesting finding was that for aggregate commodities the AIDS model derives elasticities which become less price elastic as expenditures grow, and that for disaggregated commodities, the sign of the elasticities cannot be specified a priori.

Application to input demand for the U.S. manufacturing industry was conducted by Segerson and Mount (1985). Their procedure was to estimate input demand for energy given the energy types of: coal, oil, natural gas, and electricity. Input demand for these equations was then estimated with the constraints of homogeneity and symmetry imposed. Elasticity estimates based on this procedure produced negative own-price elasticities for each equation with the exception of coal. They also found that structural change in the composition of energy inputs was reflected in the own-price and expenditure coefficients for coal.

CHAPTER 4

THEORY AND METHODOLOGY

Empirical models of internationally traded commodities are widely utilized in forecasting and policy analysis (Sarris, 1981). The purpose of these models depend upon the objectives of the researcher. Analysis of trade flows, general equilibrium, and exchange rate and trade balance impacts are examples of the macroeconomic character of trade research objectives. These models tend to aggregate across commodities and this level of aggregation distorts the pricing mechanisms and trade policies which influence the trade pattern of individual commodities (Sarris, 1981). Thus, models which utilize frameworks such as national excess supply and demand in determining gross import or export demand functions have little use when the purpose is to focus in on individual commodities or a single country.

When the researcher is concerned with a single commodity or a group of related commodities in relation to a single country or a group of trading partners, a more microeconomic framework is desired to capture the market and pricing mechanisms. Many such models have been developed and the choice of the functional form is dependent on the goals of the researcher. Sarris (1981) provides a summary of the basic models utilized in the trade of agricultural commodities, concentrating on the analysis of trade flows.

Import demand models for disaggregated commodities can be regarded as a method for estimating a microeconomic relationship in international trade. These models are often viewed as extensions in consumer demand, and utilize such accepted models as the translog and Rotterdam models to analyze the economic relationships involved in import demand.

Another method available for estimating import demand is through the Almost Ideal Demand System. The AIDS model is similiar to the translog and Rotterdam models, and can be used to differentiate between the different sources of imports similiar to the Armington model. The AIDS model derives a system of equations in which the expenditures on a nonseparable group of goods, such as tobacco, can be broken down into its budget shares. The remainder of this chapter includes a review of the basic properties of demand functions, derivation of the AIDS demand function, and a presentation of the methodology used in the estimation of U.S. demand for cigarette leaf tobacco.

Properties of Demand Functions

The broad notion of demand theory can be broken down into its various subdisciplines. Consumer demand is based on utility maximization, while input demand is derived from profit maximization. These subdisciplines can then be applied to market demand in either the product or factor markets. The objective of the individual consumer or firm is to maximize the desired objective, and this is normally accomplished through the first and second-order conditions for maximization. The precise nature of utility and profit maximization cannot be addressed within this paper, but rather the purpose of this section is to present a review of the common element existing in both consumer and input demand, the demand function.

There are two basic types of demand functions: Marshallian demand functions and Hicksian demand functions. The Marshallian demand function can be denoted as:

$$q_i = g_i(x,p)$$

where the quantity demanded of good i (q_i) is a function of income (x) and (p) a vector of prices.

In the context of input demand where profit maximization is the original objective, this problem can be restated as a dual problem in which the objective is to minimize cost for a given level of output. In either case the optimal choice of q_i is the problem at hand. In terms of consumer choice, the original objective is to maximize utility, but this problem can also be reformulated in terms of a dual problem in which the objective is to minimize the cost of obtaining a given utility level. The new dual problem then has output or utility fixed and can thus describe how the quantity demanded changes in response to changes in prices only. This type of demand function is known as a Hicksian or compensated demand function and is denoted by:

$$q_i = h_i(u, p)$$

where the quantity demanded of good i (q_i) is a function of a given utility level (u) and a price vector (p).

The Hicksian demand function is a restatement of the Marshallian demand function, and both functions have four general properties.

Property (D1): Homogeneity. The Hicksian demand function is homogeneous of degree zero in prices, and the Marshallian demand function is homogeneous of degree zero in prices and expenditures. The homogeneity property states that a proportional change in both prices and expenditures does not affect quantity demanded.

Property (D2): Adding-up. The adding-up property of demand functions states that the total value of demand be equal to total expenditure.

Property (D3): Symmetry. The cross price derivatives of the Hicksian demand functions are symmetric, i.e.,

$$\frac{\partial h_i(u,p)}{\partial p_j} = \frac{\partial h_j(u,p)}{\partial p_i}$$

Property (D4): Negativity. Negativity states that an increase in the price of a good, with utility or output constant, must cause the demand for that good to fall or remain unchanged.

The symmetry property asserts that the effect of a price change in good j on the demand for good i is identical to the effect of a price change in good i on the demand for good j. In the context of input demand, symmetry is a test of the consistency of input choice. For example, the change in the demand for imported flue-cured tobacco arising from a compensated one dollar change in the price of domestic burley tobacco, is equal to the change in demand for domestic burley tobacco as a result from a compensated one dollar change in the price of imported flue-cured tobacco.

The negativity property places a series of restrictions on the matrix of the compensated price responses. In the Hicksian demand function the cross price effect (s_{ij}) can be denoted by:

$$\partial h_i/\partial p_j = s_{ij}$$

With respect to the Marshallian demand function the compensated price effect is denoted as:

$$s_{ij} = \partial q_i/\partial x \; q_j + \partial g_i/\partial p_j$$

(the slutsky equation)

The compensated cross price effects form a matrix which is denoted by S. The negativity property requires the elements s_{ii} to be negative, which is the "law of demand," in that compensated demand functions can never slope upwards.

The S matrix also serves to define goods as economic complements or substitutes. Goods are complements if the s_{ij} element is negative, and substitutes if the s_{ij} element is positive.

Transforming the Hicksian demand function into a Marshallian demand function allows symmetry and negativity to become testable, since the elements of the S matrix are unaffected by the transformation. Empirically, models such as the Rotterdam or AIDS are designed to test or impose all four properties of demand theory, and these models have been used extensively in both consumer demand and input demand (Theil, 1980;Theil, 1981; Deaton and Muellbauer, 1980b).

The solution of the demand function requires substitution into a cost function. In terms of the Hicksian demand function, the cost function is defined as:

$$x = \Sigma p_k h_k(u,p) = c(u,p)$$

The solution of the cost function yields the minimum cost of obtaining u, at prices p, in terms of the outlay, x, and this is the starting point for the AIDS demand function. The AIDS model begins through a specification of a cost function because the cost function describes the minimum cost of producing a given output, at the specified prices. Therefore, given input prices, output must be produced in the cheapest way possible. The functional form for the cost function is derived by formulating a function which satisfies five properties (Deaton and Muellbauer, 1980b).

Property (C1): The cost function is homogeneous of degree one in prices.

Property (C2): The cost function is increasing in output, nondecreasing in prices, and increasing in at least one price.

Property (C3): The cost function is concave in prices.

Property (C4): The cost function is continuous in prices.

Property (C5): The partial derivatives (where they exist) of the cost function with respect to prices are the Hicksian demand functions. i.e.,

$$\partial c(u,p)/\partial p_i = h_i(u,p) = q_i \quad \text{(Shephard's lemma)}$$

Deaton and Muellbauer then construct a cost function which satisfies these five properties and establish the basis for the AIDS model. In this light, application of the AIDS model to input demand for an industry is made through a cost function for the industry as a whole.

For most industries, the input decision can be restated as an input allocation decision and a total input decision. The total input decision involves the change in output rather than input prices, whereas the input allocation decision is dependent upon input prices, and aggregate inputs (Theil, 1980). Reformulating the decision process in this manner makes desirable the use of a system of equations in which the demand for input i is stated in terms of its budget share. The input decision can thus be regarded as a two stage process.

The AIDS model represents the second stage of a two-stage decision model. The first stage determines the broad input allocation and can be denoted as:

$$X_g = f_g(X,P^*)$$

where X_g is expenditure on group g(tobacco), X is total expenditures on all goods, and P* a vector of price indices of the various groups (Winters, 1984). Given the allocation from the first stage, the second stage determines the within group allocation, i.e. the suppliers from which the U.S. obtains cigarette leaf tobacco.

The implication of the first stage is that an industry determines its expenditures on each input group based upon its total expenditures and on aggregate price indexes (Segerson and Mount, 1985). Weak separability between inputs is a necessary condition for this specification of the first stage. The weak separability assumption imposes three restrictions on behavior. First, the marginal rate of substitution between two goods from the same group is invariant with respect to the consumption of goods in other groups. That is, the marginal rate of substitution between burley and flue-cured tobacco is independent of the consumption of, for example, coffee. Second, the substitution effect between goods in different groups is limited to a group expenditure effect. The price change of a commodity in one group affects demand for a commodity in another group only through the group expenditure effect. Third, price and income effects between commodities are equal. No matter what factor causes changes in the expenditures for a group, the effect on quantity demanded is the same, i.e. $\partial p_i/\partial p_j = \partial p_i/\partial x$, with utility constant

(Winters, 1984; Segerson and Mount, 1985).

The issue of separability revolves around how the groups are defined, if the groups are unrelated then weak separability does not seem unreasonable (Winters, 1984). For our purpose, the assumption of weak separability between tobacco and other goods does not seem unreasonable. Weak separability simplifies the estimation and makes the model more tractable in the second stage (Segerson and Mount, 1985).

The broad allocation problem is further complicated by when the within group prices must be aggregated into a broad group price index (Segerson and Mount, 1985). The existence of a single group price index requires that the utility function (production function) be additive in groups or the subaggregate functions be homothetic (Segerson and Mount, 1985). Generally, homotheticity is applied, yet this restricts the within group shares to be independent of the total group expenditure (Segerson and Mount, 1985; Winters, 1984). The AIDS model formulation permits tractable estimation of the second stage process without imposing restrictions on expenditure effects or on the marginal rate of substitution on the within group allocation (Segerson and Mount, 1985).

Derivation of the AIDS Demand Function

The AIDS model is derived from the generalized Gorman

Polar Cost (expenditure) function

$$\ln m(U,p) = \ln a(p) + U\ln b(p) \quad (1)$$

The generalized Gorman Polar form allows for nonlinear Engel curves without imposing the restriction of homothecity on the results (Deaton and Muellbauer, 1980). The AIDS model therefore does not impose linear preferences, but it is linear in its variables thereby avoiding the need for nonlinear estimation (Blundell and Ray, 1984).

The functional forms for ln a(p) and ln b(p) define the AIDS cost function in a flexible functional form. The use of the flexible functional form is to approximate the cost function with enough parameters so that the approximation is a reasonable estimate to whatever the true function may be (Deaton and Muellbauer, 1980b). This way the AIDS model provides a first-order approximation to any demand system. Deaton and Muellbauer take:

$$\ln a(p) = \alpha_o + \Sigma\alpha_i \ln p_i + 1/2\Sigma\Sigma\gamma_{ij} \ln p_i \ln p_j \quad (2)$$

$$\ln b(p) = \beta_o \Pi p_i^{\beta_i} \quad (3)$$

so that the AIDS cost function is then:

$$\ln m(U,p) = \alpha_o + \Sigma\alpha_i \ln p_i + 1/2\Sigma\Sigma\gamma_{ij} \ln p_i \ln p_j + U\beta_o \Pi p_i^{\beta_i} \quad (4)$$

where $\alpha_i, \beta_i, \gamma_{ij}$ are parameters, p_i is the price of good i and p_j is the price of good j.

The demand functions are derived directly from the AIDS cost function based on the property that the price derivatives of the cost function are the quantities demanded, i.e. $\partial m(U,p)/\partial p_i = q_i$ and multiplying both sides by $p_i/m(U,p)$ yields:

$$\partial \ln m(U,p)/\partial \ln p_i = p_i q_i/m(U,p) = w_i \qquad (5)$$

where w_i is the budget share of good i.

Logarithmic differentiation of the cost function (4) gives budget shares as a function of prices (p_i and p_j) aggregate expenditures (m), based on the identity in (5):

$$\partial \ln m/\partial p_i = w_i = \alpha_i + 1/2\Sigma\gamma_{ij}\ln p_j + 1/2\Sigma\gamma_{ij}\ln p_j + \beta_i U\beta_o \Pi p_i^{\beta_i} \qquad (6)$$

by imposing symmetry ($\gamma_{ij} = \gamma_{ji}$) the logarthimic differentiation then reduces to:

$$\partial \ln m/\partial \ln p_i = w_i = \alpha_i + \Sigma\gamma_{ij}\ln p_j + U\beta_o\beta_i \Pi p_i^{\beta_i} \qquad (7)$$

The last step is to express U (utility) in terms of the indirect utility function:

$$U = f(p,m)$$

where utility is a function of prices (p) and total expenditures (m). The AIDS cost function is re-specified in terms of the indirect utility function and substituted into the budget share equation. This yields:

$$\partial \ln m/\partial p_i = w_i = \alpha_i + \Sigma\gamma_{ij}\ln p_j + \beta_i(\ln m - \alpha_o - \Sigma\alpha_o - \Sigma\alpha_i \ln p_i - 1/2\Sigma\Sigma\gamma_{ij}\ln p_i \ln p_j \qquad (8)$$

where $\gamma_{ij} = 1/2(\gamma_{ij} + \gamma_{ji})$

The term $\alpha_o + \Sigma\alpha_i \ln p_i + 1/2\Sigma\Sigma\gamma_{ij}\ln_i p \ln p_j$ is the price index or price deflator composed of all prices and in simplifying notation is denoted as P. The AIDS demand function in budget share notation is expressed as:

$$w_i = \alpha_i + \Sigma\gamma_{ij}\ln p_j + \beta_i \ln(M/P) \qquad (9)$$

where α_i, γ_{ij}, β_i are parameters to be estimated.

Equation (9) is linear in estimation except for the price delator P. Deaton and Muellbauer suggest that an approximate for P, P*, can be used to derive a linear approximate AIDS model. They suggest Stone's index as the approximate. Stone's index is given by the equation:

$$\ln P^* = \Sigma\bar{w}_i * \ln p_i$$

and will be utilizied when modelling the U.S. demand for tobacco. Deaton and Muellbauer found that the introduction of Stone's index to approximate P did not affect their results, and that the use of Stone's index is desirable when prices are collinear. The literature on AIDS readily accepts the use of Stone's index in order to ease estimation (Winters, 1984; Segerson and Mount, 1985; Blanciforti and Green, 1983).

The AIDS model has been applied to model consumer demand (Blanciforti and Green, 1983), manufacturers demand for inputs (Segerson and Mount, 1985), and in modelling trade allocation (Winters, 1984). The model's popularity involves its ease in estimation and its intuitive appeal in regards to economic theory.

The properties of demand functions based on economic theory can be readily imposed on the model. Basically, theoretically sound demand functions satisfy the conditions of adding-up (Engel aggregation and Cournot aggregation), are homogenous in prices and expenditures of degree zero, and satisfy the Slutsky symmetry matrix (Johnson, Hassan and Green, 1984). The adding-up condition is automatically satisfied by the budget shares (w_i) summing to one. The adding up requirement can be denoted by the following conditions:

$$\Sigma\alpha_k = 1 \quad \Sigma\gamma_{kj} = 0 \quad \Sigma\beta_k = 0$$

Homogenity requires that:

$$\Sigma\gamma_{kj} = 0$$

Symmetry requires that:

$$\gamma_{ij} = \gamma_{ji}$$

If the homogeneity and symmetry restrictions are not explicitly imposed on the model, then AIDS can still provide a first-order aproximation. Maximizing behavior is not assumed, but rather demands are continuous functions of the budget shares and prices. The budget shares (w_i) are then unknown functions of ln p and ln m (Deaton and Muellbauer, 1980a).

Methodology

The two stage decision model using the AIDS formulation is applied to U.S. input demand for imported cigarette leaf tobacco. Demand for cigarette leaf tobacco is to be estimated in two steps using equation (9). The first step begins by estimating the aggregate demand for cigarette leaf tobacco by specifying four budget share equations. The shares to be estimated are (1) domestic flue-cured tobacco, (2) domestic burley tobacco, (3) oriental tobacco, and (4) an imported tobacco share comprised primarily of flue-cured and burley tobacco in both leaf (unstemmed) and processed (stemmed) forms. The second step of the estimation process then disaggregates the oriental and imported tobacco shares and estimates budget share equations for five individual countries. This part of the estimation process utilizes the individual countries of (1) Greece (oriental only), (2) Canada, (3) Mexico, (4) Brazil, and (5) South Korea as well as an aggregate Rest-of-Oriental equation and an aggregate Rest-of-World equation. The second step process is also estimated by decomposing the oriental and imported tobacco shares according to economic groups. That is, total imports are broken down according to whether the tobacco originated from a developed country, less developed country, or a communist country. There are actually two separate models associated with the estimation according to economic groups. One model disaggregates oriental tobacco with an aggregate imported tobacco share, and the second disaggregates imported tobacco with an aggregate oriental share. The objective in decomposing tobacco imports in such a fashion is to examine the make-up of imports and identify potential structural changes occuring within the import market.

The application of AIDS to an allocation model is based on group expenditure functions in the two-stage budgeting procedure. It is legitimate to express the demand for tobacco in terms of expenditures on its group and the within group prices when the marginal rate of substitution between two sources of tobacco is independent of the quantities consumed of goods in other groups (Winters, 1984). In estimating the demand for tobacco, this does not appear to be restrictive. Tobacco does not have any real substitutes, so it is plausible that separability between tobacco and other goods can be assumed.

Another concern in applying AIDS is the price index, P*, from the AIDS demand equation. P* is a single price index composed of the individual prices of tobacco which determines (along with expenditures and other prices) the overall expenditures on tobacco. The implication of P* is that the total allocation of tobacco is independent of individual prices (Winters, 1984). Again, this does not appear to be restrictive for tobacco since it is plausible to assume that manufactures know how much tobacco they require and allocate expenditures over the sources of tobacco with the desirable properties. The budget share equation from source i using the AIDS formulation is given by:

$$w_i = \alpha_i + \Sigma\gamma_{ij}\ln p_j + \beta_i \ln(M/P) \qquad i = 1,\ldots,n \qquad (9)$$

As discussed earlier in the theory section, the aggregate price deflator, P, can be approximated by Stone's index:

$$\ln P^* = \Sigma \bar{w}_k^* \ln p_k$$

The intercept term αi will be estimated as a function of time trend or conditioning variables:

$$\alpha_i = \Sigma \rho_{ij} d_j \qquad i = 1,\ldots.,n$$

The use of time trend variables to estimate the intercept was first suggested by Deaton and Muellbauer. They found that in their orginal model the homogeneity and symmetry conditions were rejected suggesting that variables other than prices and expenditures explain budget shares (Deaton and Muellbauer, 1980a). Blanciforti and Green added dynamic elements into the AIDS formulation through a lagged consumption intercept (the dependent variable), i.e., the previous year's quantity demanded for good i. Their results showed that this "habit" scheme explained much of the autocorrelation found in Deaton and Muellbauer's original results.

Uncompensated price elasticities for the AIDS model are given by:

$$e_{ij} = w_i^{-1} \left[\gamma_{ij} - \beta_i(\alpha_i + \Sigma\gamma_{rj}\ln p_r)\right] - \delta_{ij} \qquad (10)$$

where δ_{ij} is the Kronecker delta

The compensated price elasticities are defined by:

$$e_{ij} = \gamma_{ij}/w_i - \delta_{ij} + w_j[\beta_i/w_i + 1] \qquad (11)$$

and income elasticities are denoted by:

$$e_i = 1 + \beta_i / w_i \qquad (12)$$

The time trend variables affect the magnitude but not the sign of the elasticity estimates. This is accomplished through their influence on the budget shares (w_i's). The adding up requirement specified in the theory section stated that the intercept term must sum to zero. This can be re-specified here so that adding-up now requires $\Sigma\rho_{ij} = 0$, and $\Sigma\rho\alpha_o = 1$.

Data and Estimation Considerations

The AIDS demand function is estimated using Seemingly Unrelated Regression (SUR) since the error terms are likely to be correlated. The variance - covariance matrix for a complete system of equations is singular (due to $\Sigma w_i = 1$), and the usual procedure to render the variance - covariance matrix nonsingular is to delete one of the equations. The SUR estimate of the parameters is asymptotically equivalent to maximum likelihood, so the estimation made by SUR is invariant with respect to the equation deleted (Kmenta, 1986).

United States annual tobacco import data were obtained from U.S. Imports for Consumption and General Imports: FT246 (1971-86). This data source classifies imports based on the seven digit tariff schedule, and priovides quantity and value information on imports from each origin country. Table 9 lists the tariff schedule numbers used in the study, a description of the tobacco classification, and the years in which the classification existed or was included in the study.

Table 9. United States Tariff Schedule for Selected Tobacco Imports Used in the Estimation of U.S. Demand for Tobacco.

TSUSA#	YEARS INCLUDED	DESCRIPTION
1702800	1971-86	Oriental leaf, N/S[a], nov[c] 8.5 in.
1703210	1977-86	Flue-cured leaf, N/S
1703230	1977-86	Burley leaf, N/S
1703220	1971-76	Flue-cured and burley leaf,N/S
1703500	1977-85	Cigarette leaf, stemmed
1703510	1985-86	Flue-cured, stemmed
1703520	1985-86	Cigarette leaf, stemmed, NSPF[b]
1706000	1971-76	Scrap tobacco
1706040	1977-86	Scrap tobacco except cigar
1708045	1970-83	Tobacco manufactured or not, NSPF

[a]N/S = Not Stemmed
[b]NSPF = Not Specifically Provided For
[c]nov = not over

The data for oriental tobacco are straightforward and are consistently identified throughout the study period. In the manufacturing process for cigarettes, oriental tobacco is used in the leaf form, and U.S. imports of oriental tobacco occurred under the single tariff number. Unstemmed flue-cured and burley imports are also classified in a straightforward and fairly consistent manner. The only change is the decomposition of these imports into two separate categories in 1977. However, the data for processed or stemmed tobacco are much less consistent. From 1971-1980, stemmed tobacco was classified as scrap (1706000) and (1706040) until Customs redefined it as tobacco manufactured or not manufactured (1708045) in mid-1980. This classification was subsequently changed in August of 1983 to stemmed cigarette leaf (1703500's). Ideally, the desire is to include only flue-cured and burley tobacco in the imported tobacco equation. Yet implicitly included are various categories of scrap tobacco (including cigar leaf until 1977), undefined tobacco, and manufactured smoking tobaccos such as pipe and roll your own cigarette tobacco (1980-1983). The data could therefore be distorted from the inclusion of these "other" tobacco types; however, the majority of flue-cured and burley imports arrive in the stemmed form and its inclusion in the study is necessary. It was felt that the best method to deal with the distortion was to include scrap tobacco throughout the study period and include the manufactured or not manufactured category only during the period of 1980-1983 when stemmed tobacco entered the U.S. under this classification. The level of distortion in the data is unknown, but when stemmed cigarette leaf was reclassified, it comprised the overwhelming majority of the imports in that category.

The data for domestic flue-cured and burley tobacco were obtained from various issues of Tobacco Situation and Outlook reports and consisted of annual data on domestic dissappearance and grower prices.

Data for tobacco imports by economic group were accomplished by classifying each exporting country as either a developed country, lower income developing country, middle income developing country, upper-middle income developing country, communist country, or other (undefined country). The classification of each country was obtained from World Agricultural Trade Shares, 1962-1985 (USDA, 1987), which classifies most of the countries according to the previously described format. A few countries were not classified however, and these countries were then defined as "other" in the study. Oriental and imported tobacco shares were disaggregated according to this classification with two exceptions. Throughout the study period, the lower income developing countries exported oriental tobacco to the U.S. only twice, and therefore these imports were aggregated with imports from the middle income developing countries. Oriental imports from upper-middle income countries were low compared to other countries and was zero in one period (1984). To maximize the number of observations available, these imports were included with imports from the "other" countries in the disaggregated oriental model.

Time trend variables were used to estimate the intercept term in the first stage of the estimation process. Each budget share equation included four trend variables. These variables were factors which were hypothesized to influence the demand for tobacco and included: U.S. per capita income, pounds of domestic tobacco used per 1,000 cigarettes, U.S. cigarette output, and a nicotine content indicator. Data for the first three trend variables were obtained from various issues of Tobacco Situation and Outlook reports. The most interesting time trend variable was the nicotine content indicator. Domestically produced tobacco contains higher levels of nicotine than imported tobacco, and the recent expansion of the tobacco industry towards the lower tar and nicotine cigarettes makes U.S. tobacco less suitable in the production of these types of cigarettes (Chang, Beghin, and Sumner, 1988). The nicotine content indicator in this study was an approximation to the average nicotine level per cigarette (see appendix for exact methodology in its calculation). In the two disaggregated import models, the nicotine content indicator was the only trend variable used to estimate the intercept term.

The AIDS model was run using this data from 1971-1986. The model was first run as an estimation of U.S. input demand for tobacco, and utilized the four budget share equations of (1) oriental tobacco, (2) imported flue-cured and burley tobacco, (3) domestic flue-cured tobacco, and (4) domestic burley tobacco. The two disaggregated import models were then run with each equation denoting the source of the imports as previously described. Each model was run with the theoretical restrictions of homogeneity and symmetry imposed and tests were conducted on the homogeneity restriction. Each model was also run without the homogeneity and symmetry restrictions. In the results, parameter estimates and elasticity estimates are presented for each subsequent estimation of the three basic models.

CHAPTER 5

ESTIMATION OF U.S. DEMAND FOR TOBACCO

Figure 1 on the following page illustrates manufacturers' expenditures for oriental tobacco, domestic flue-cured and burley tobacco, and imported flue-cured and burley tobacco for 1971-1986. Expenditures for tobacco steadily increased until 1982, and then began a steady decline. The relatively smooth appearance of the expenditure curve appears to lend weight to the argument that manufacturers plan their tobacco expenditures and then allocate these expenditures among the various sources of tobacco.

Figure 2 illustrates the quantity of oriental tobacco, domestic flue-cured and burley tobacco, and imported flue-cured and burley tobacco acquired by manufacturers from 1971-1986. The results in the graph illustrate the increase in the use of imported tobacco, as total tobacco use declined. This graph also shows a large jump in imports in 1983. This one-time shift was due to a change in the tariff classification for stemmed cigarette leaf. Imports of this type of cigarette tobacco increased since the change in the tariff classification would also mean an increase in the

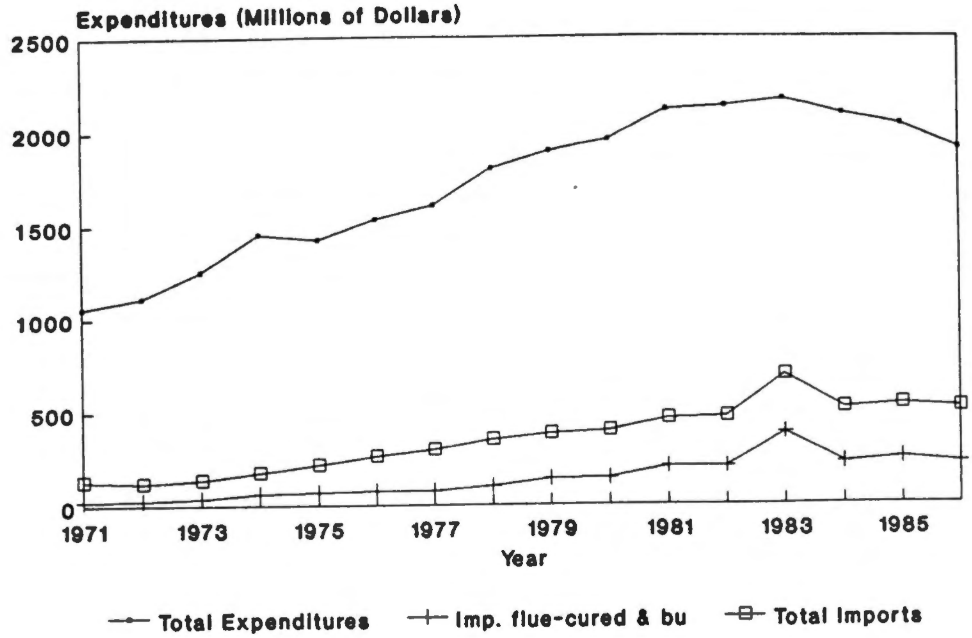

Figure 1. Manufacturers Expenditures for Cigarette leaf Tobacco,1971-1986.

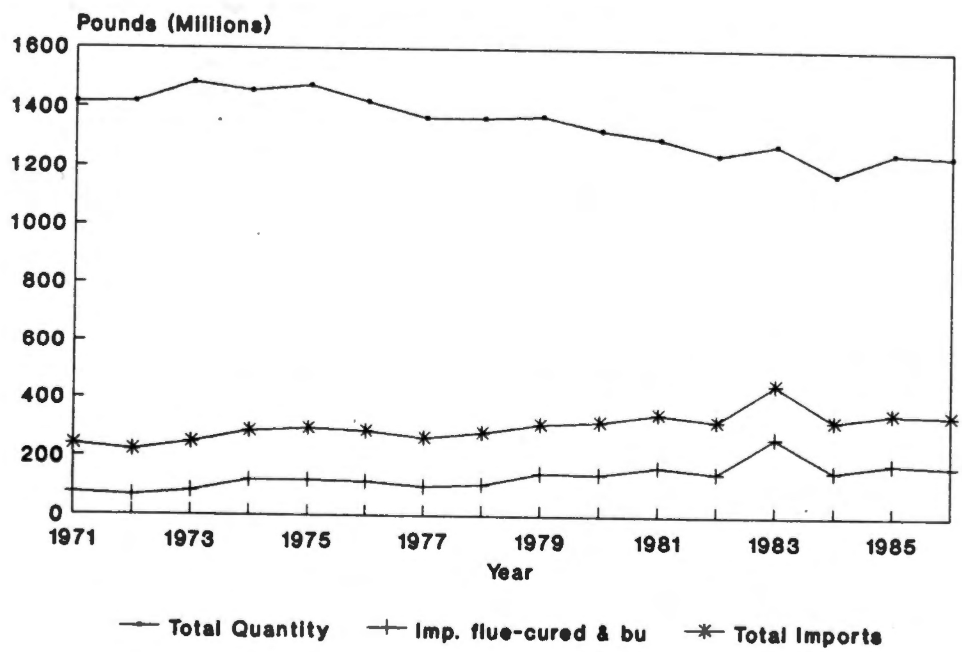

Figure 2. Pounds of Cigarette leaf Tobacco Acquired by Manufacturers.

tariff rate from 17.1 cents per pound to 32 cents per pound.[1]

Estimation of the U.S. demand for tobacco was accomplished using seemingly unrelated regression (SUR). This technique was applied to each of the three basic models described in chapter 4. The first model, model 1, estimated aggregate U.S. input demand for tobacco using the budget share equations of (1) oriental tobacco, (2) imported flue-cured and burley tobacco, (3) domestic flue-cured tobacco, (4) domestic burley tobacco. In chapter 6, the results for model 2 and model 3 are presented. The import allocation of oriental, and imported flue-cured and burley tobacco using five individual country shares, a rest-of-oriental share, and a rest-of-world share are estimated in model 2. Model 3 estimated the import allocation of oriental, and imported flue-cured and burley tobacco using the economic group of the source of the tobacco.

Model 1: Results

The market share of each kind of tobacco from 1971-1986 is presented in Figure 3. The price per ton of each kind of tobacco from 1971-1986 is presented in Figure 4.

[1]As part of the 1979 Tokyo round of GATT negotiations, the U.S. agreed to lower the tariff rate on stemmed cigarette leaf tobacco (TSUSA # 1703500) from its then rate of 45 cents per pound to 23 cents per pound by 1986. Prior to 1983 this meant little since most, if not all, stemmed cigarette leaf was clasified as scrap tobacco or manufactured or not manufactured tobacco.

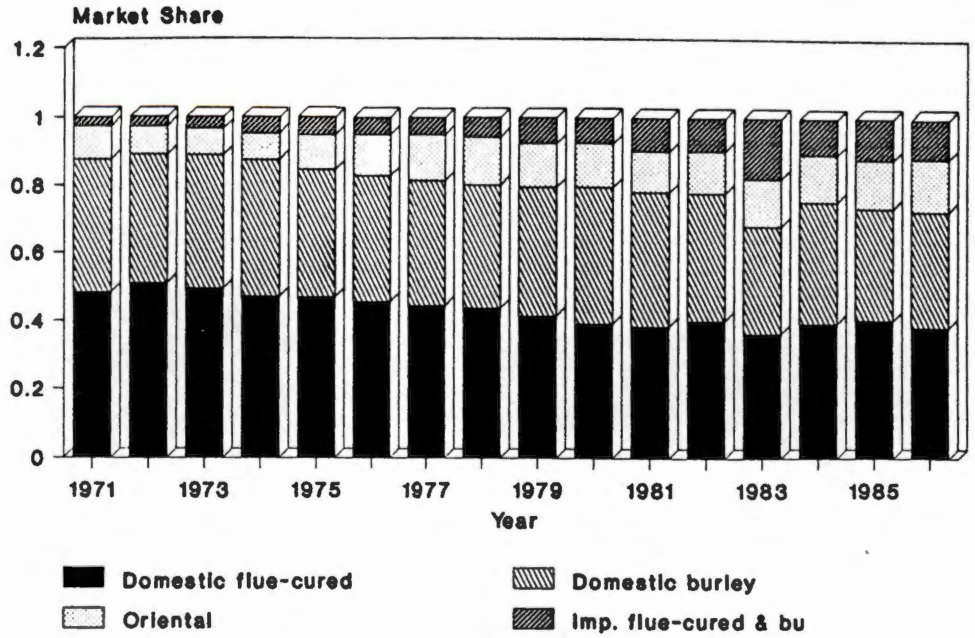

Figure 3. Market Shares of Aggregate Tobacco Types in the U.S. 1971-1986.

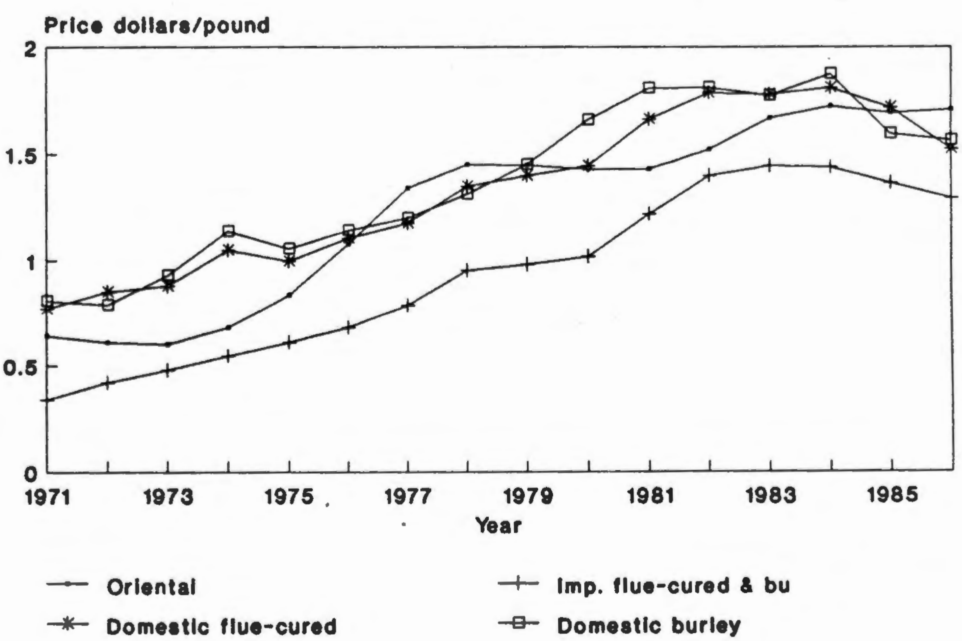

Figure 4. Price Per Pound of the Aggregate Tobacco Types in the U.S.

Model 1 was first estimated without imposing the restrictions of homogeneity and symmetry. In addition to the trend, price, and expenditure variables discussed in chapter 4, a dummy variable was included to accqunt for the change in the tariff classification in 1983. Table 10 defines each of the variables in model 1.

Table 10. Variable Names and Definitions for Model 1.

VARIABLE	DEFINITION
UST	million pounds of U.S. tobacco used in cigarette manufacturing, lagged one period
INCME	U.S. per capita income
CIGOUT	U.S. cigarette output, billion pieces
NICIND	nicotine content indicator
LORNTLPR	log of the price per ton of oriental tobacco
LIMPPR	log of the price per ton of imported flue-cured and burley tobacco
LUSFCPR	log of the price per ton of U.S. flue-cured
LUSBLPR	log of the price per ton of U.S. burley
LSTONE	log of ratio total expenditures/stone's price index

The parameter estimates, standard errors, t-values and Durbin-Watson statistics for model 1 are given in Table 11. Following Table 11, the F-values and R-square values for each equation are presented in Table 12 since SUR estimation of the model in its present format (i.e. without restrictions) is equivalent to equation by equation OLS estimation.

Table 11. Parameter Estimates, Standard errors, T-values, and Durbin-Watson Statistics for the Unrestricted Estimation of Model 1.

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T-VALUE
EQUATION 1: ORIENTAL TOBACCO			
INTERCEPT	1.10355	1.20267	.918
DUM[a]	.00862	.00491	1.756
UST	.00004	.00008	.478
INCME	.000002	.000004	.670
CIGOUT	-.000003	.00007	-.039
NICIND	-.02369	.04184	-.566
LORNTLPR	.09237*	.01044	8.846
LIMPPR	-.00676	.02710	-.249
LUSFCPR	-.06000	.04513	-1.330
LUSBLPR	-.03446	.03927	-.877
LSTONE	-.06946	.07489	-.927
DURBIN-WATSON = 3.143			
EQUATION 2: IMPORTED FLUE-CURED AND BURLEY TOBACCO			
INTERCEPT	-1.53534	2.34762	-.654
DUM[a]	.07663*	.00959	7.993
UST	.00008	.00015	.531
INCME	.00002*	.000007	2.123
CIGOUT	-.000003	.00013	-.022
NICIND	-.00700	.08168	-.086
LORNTLPR	-.01301	.02038	-.638
LIMPPR	-.04642	.05290	-.878
LUSFCPR	.10745	.08809	1.220
LUSBLPR	-.01877	.07666	-.245
LSTONE	.08777	.14619	.600
DURBIN-WATSON = 1.916			

Table 11 (cont'd).

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T-VALUE
EQUATION 3: DOMESTIC FLUE-CURED TOBACCO			
INTERCEPT	-1.03542	2.06950	-.500
DUM[a]	-.04908*	.00845	-5.808
UST	-.00015	.00013	-1.157
INCME	-.00001	.000006	-1.934
CIGOUT	-.00019	.00011	-1.623
NICIND	.11204	.07200	1.556
LORNTLPR	-.04420*	.01797	-2.460
LIMPPR	.15116*	.04663	3.242
LUSFCPR	-.02568	.07766	-.331
LUSBLPR	-.08790	.06758	-1.301
LSTONE	.13564	.12887	1.052
DURBIN-WATSON = 1.953			
EQUATION 4: DOMESTIC BURLEY TOBACCO			
INTERCEPT	2.46721	3.34730	.737
DUM[a]	-.03616*	.01366	-2.646
UST	.00004	.00021	.171
INCME	-.000005	.00001	-.534
CIGOUT	.00019	.00018	1.034
NICIND	-.08135	.11646	-.699
LORNTLPR	-.03515	.02906	-1.210
LIMPPR	-.09799	.07543	-1.299
LUSFCPR	-.02177	.12561	-.173
LUSBLPR	.14112	.10931	1.291
LSTONE	-.15395	.20844	-.739
DURBIN-WATSON = 1.225			

[a] 1 if 1983, otherwise 0
* significant at the 10 percent level

Table 12. F-values and R-square Values for Model 1.

EQUATION	F-VALUE[a]	R-SQUARE
Oriental	93.819	.9947
Imported flue-cured and burley	69.538	.9929
Domestic flue-cured	106.332	.9953
Domestic burley	11.969	.9599

[a] All F-values were significant at the one percent level

The high R-squares and significant F-values, along with very few significant variables, indicates that multi-collinearity is a potentially significant problem in the estimation. Indeed, this may very well be the case since the correlation coefficient between the prices of imported flue-cured and burley tobacco and domestic flue-cured tobacco is .99106, and all of the price variables had correlation coefficients above .90. This correlation is evident in Figure 4 where a near constant margin is maintained between the prices of the various tobaccos.

In its present form, the estimation of model 1 is inconsistent with demand theory. Demand functions are required to possess the properties of homogeneity, symmetry, and negativity. Negativity cannot be imposed on the AIDS model, but the negativity conditions are satisfied if the matrix C, defined by:

$$c_{ij} = \gamma_{ij} + \beta_i\beta_j \log(x/p) - w_i\delta_{ij} + w_iw_j \qquad (13)$$

where δ is the Kronecker delta

is negative semidefinite. Although the negativity condition cannot be imposed, the homogeneity and symmetry conditions can be both imposed and tested in the AIDS model. Therefore, to derive a more theoretically consistent model, model 1 is reestimated with the homogeneity and symmetry conditions imposed on the model. Results of this estimation is are presented in Table 13 along with the system weighted MSE and R-square.

The results of the restricted estimation produced more significant variables than the unrestricted estimation. This result could be due to the restrictions limiting the effects of multicollinearity. Durbin-Watson statistics were also reduced for every equation except the imported flue-cured and burley equation which remained near two. The Durbin-Watson statistics showed some positive autocorrelation in the domestic flue-cured and the domestic burley equations, while oriental tobacco showed negative autocorrelation. The prescence of autocorrelation suggests that an important explanatory variable has been left out of the estimation. Although the presence of autocorrelation was detected, tests on the Durbin-Watson statistics were inconclusive for every equation, so that autocorrelation cannot be statistically rejected or accepted.

Deaton and Muellbauer found that the imposition of homogeneity led to the introduction of positive auto-correlation (1980a, 1980b). Their explanation of this

Table 13. Parameter Estimates, Standard errors, T-values, Durbin-Watson statistics, and System Weighted MSE and R-square for the Restricted Version of Model 1.

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T-VALUE
EQUATION 1: ORIENTAL TOBACCO			
INTERCEPT	.77887	.40779	1.910
DUM[a]	.00839*	.00331	2.536
UST	.00004	.00003	1.073
INCME	.000003	.000003	1.156
CIGOUT	-.000007	.00005	-.153
NICIND	-.02137	.03126	-.684
LORNTLPR	.09489*	.00606	15.648
LIMPPR	-.01728	.01028	-1.681
LUSFCPR	-.04227*	.00970	-4.359
LUSBLPR	-.03534*	.01028	-3.437
LSTONE	-.05100	.02886	-1.767
DURBIN-WATSON = 3.071			
EQUATION 2: IMPORTED FLUE-CURED AND BURLEY TOBACCO			
INTERCEPT	-.64838	.80895	-.802
DUM[a]	.07979*	.00670	11.909
UST	.00014	.00007	1.996
INCME	.00002*	.000005	3.395
CIGOUT	.00004	.00009	.403
NICIND	-.03211	.06150	-.522
LORNTLPR	-.01728	.01028	-1.681
LIMPPR	-.06555*	.03043	-2.154
LUSFCPR	.13835*	.03458	4.000
LUSBLPR	-.05551*	.02579	-2.153
LSTONE	.03274	.05707	.574
DURBIN-WATSON = 1.954			

Table 13 (cont'd).

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T-VALUE
EQUATION 3: DOMESTIC FLUE-CURED TOBACCO			
INTERCEPT	-1.29579	.70620	-1.835
DUM[a]	-.04903*	.00582	-8.431
UST	-.00015	.00007	-1.972
INCME	-.00001*	.000005	-2.356
CIGOUT	-.00019*	.00008	-2.346
NICIND	.11260*	.05395	2.087
LORNTLPR	-.04227*	.00970	-4.359
LIMPPR	.13835*	.03458	4.000
LUSFCPR	-.00439	.05926	-.074
LUSBLPR	-.09169*	.03491	-2.626
LSTONE	.14994*	.04949	3.029
DURBIN-WATSON = 1.801			
EQUATION 4: DOMESTIC BURLEY TOBACCO			
INTERCEPT	2.16529	1.13025	1.916
DUM[a]	-.03915*	.00913	-4.288
UST	-.00003	.00009	-.347
INCME	-.000009	.000007	-1.251
CIGOUT	.00016	.00013	1.236
NICIND	-.05912	.08502	-.695
LORNTLPR	-.03534*	.01028	-3.437
LIMPPR	-.05551*	.02578	-2.153
LUSFCPR	-.09169*	.03491	-2.626
LUSBLPR	.18259*	.03559	5.129
LSTONE	-.13168	.07987	-1.649
DURBIN-WATSON = 1.129			

SYSTEM WEIGHTED MEAN SQUARE ERROR = .88276
SYSTEM WEIGHTED R-SQUARE = .99617

[a] 1 if 1983, otherwise 0
* significant at the 10 percent level

phenomena concluded that the price variables were biased through the omission of time trend or lagged dependent variables. Table 14 presents the Durbin-Watson statistics for model 1. The table lists the statistics for both the restricted and unrestricted models and, in addition, lists the statistics when homogeneity is imposed without the simultaneous imposition of symmetry. The introduction of the theoretical restrictions does not apppear to appreciably affect the level of autocorrelation already present in the model. This implies that any omitted variables are probably equation specific variables. That is, a variable which affects oriental tobacco, for example, but has no effect on any other equation.

Table 14. Durbin-Watson statistics for Model 1.

EQUATION	UNRESTRICTED MODEL	HOMOGENEITY ONLY	HOMOGENEITY & SYMMETRY
Oriental	3.143	3.109	3.071
Imported flue-cured and burley	1.916	1.987	1.954
U.S. flue-cured	1.953	1.956	1.801
U.S. burley	1.225	1.246	1.128

In the oriental budget share equation none of the trend variables approach statistical significance, this may indicate that an important determinant of the oriental budget share is missing from the estimation. Oriental tobacco may be more accurately represented by a lagged dependent variable.

In the imported flue-cured and burley budget share equation, U.S. per capita income was the only trend variable showing significance. This may be due to the effect rising incomes generally have on imports. As income increases, the ability to pay for imports increases. In the domestic flue-cured budget share equation, the only trend variable not significant was the amount of domestic tobacco used in cigarette manufacturing. The domestic flue-cured market share has declined with increases in U.S. per capita income and cigarette output. The nicotine content indicator also shows that the declining level of nicotine in U.S. cigarettes has had a detrimental effect on domestic flue-cured tobacco. This result substantiates the results of Chang, Beghin, and Sumner (1988) who also found that reductions in the level of nicotine have had negative effects on domestic tobacco.

The domestic burley budget share equation is similar to the oriental equation in that none of the trend variables are significant. The Durbin-Watson statistic also shows that domestic burley exhibits positive autocorrelation. It is interesting to note that the two equations without significant trend variables (oriental and domestic burley) possess autocorrelation, while the equations with significant trend variables (domestic flue-cured and imported flue-cured and burley) have Durbin-Watson statistics close to two. The lack of autocorrelation in the domestic flue-cured and imported flue-cured and burley equations may indicate that these tobacco classes compete heavily, and are dependent to a significant degree on each other's prices. The budget share levels of oriental tobacco and domestic burley tobacco are evidently misspecified in this model, and may also depend on factors other than the variables utilizied in this estimation.

The price variables in each equation illustrate the relationship between the price of the tobacco and the budget shares. The results for oriental tobacco indicate that as the price of each competing tobacco type increases, the budget share of oriental tobacco declines. The oriental results also produced a positive own-price effect in that as the price of oriental increases, its own budget share increases. These results indicate that budget shares may be relatively insensitive to price movements. Zanias (1987) showed that since manufacturers attempt to maintain a constant blend of different cigarette leaf tobacco's, a price increase for a particular type of leaf does not necessarily produce a decrease in its budget share, at least in the short-run. The objective in the AIDS model is to estimate the budget share level, and this is not the same as estimating quantity demanded. Therefore, the results produced by the AIDS model seem to have plausible signs with respect to the price variables. The signs of the price variables are identical for both the restricted and unrestricted models.

The price variables in the imported flue-cured and burley equation produced slightly different results from the oriental equation. Increases in the price of imported flue-cured and burley tobacco have a negative effect on its own budget share. Likewise, increases in the prices of oriental tobacco and domestic burley tobacco have negative effects on the budget share of imported flue-cured and burley tobacco. However, increases in the price of domestic flue-cured tobacco have a positve effect on the budget share. This indicates that the level of flue-cured and burley imports is sensitive to its own price and the price of domestic flue-cured tobacco. The competition between imports of flue-cured and burley tobacco and domestic flue-cured tobacco is also evident by these results.

The effect the price variables have upon the domestic flue-cured budget share level are similiar to those produced in the imported flue-cured and burley equation. Increases in its own price, oriental price, and burley price have negative effects on the budget share of domestic flue-cured tobacco, while increases in the price of imported flue-cured and burley tobacco have a significant positve effect on its budget share. The own-price effect in the domestic flue-cured equation is not statistically significant, which may mean that the budget share of domestic flue-cured tobacco is more dependent on other prices than its own price.

In the domestic burley equation all of the price variables were significant with increases in the prices of oriental, imported flue-cured and burley, and domestic flue-cured tobacco having negative effects on the budget share of burley tobacco. The own-price effect of domestic burley was significantly positive suggesting that, as in the oriental equation, domestic burley tobacco is insensitive to price movements, at least in the short-run. One explanation for the apparent lack of price sensitivity is the omission of lags in the model. The possibility of a lag effect with respect to the dependent variable is not studied, and the effect may be significant in determining budget shares.

The β_i (LSTONE variable) coefficients reflect changes in real expenditures and are typically positive for luxuries and negative for necessities. However, this comparison is unwarranted in derived demand. The positive β_i coefficients reflect the commodities which grow (decline) more rapidly than a proportional increase (decrease) in real expenditures, and in derived demand for tobacco, refers to domestic flue-cured and imported flue-cured and burley tobacco. The negative β_i coefficients reflect the commodities which grow (decline) less rapidly than a proportional increase (decrease) in real expenditures and refers to domestic burley and oriental tobacco in the derived demand for tobacco. However, the only β_i coefficient statistically significant was in the domestic flue-cured equation.

The trend and price variables produced primarily expected signs, and the attention will now be shifted to the model itself. The model has been restricted so that it possessed the properties of homogeneity and symmetry, and these restrictions were testable. The test for homogeneity involves testing each equation using F-tests to determine the validity of the restriction. The test is normally accomplished without considering the imposition of symmetry. Table 15 lists the results of the F-tests for model 1. The table presents the results of the F-tests both with and without the symmetry restriction for comparison purposes. The hypothesis for this test is as follows:

Ho: $\Sigma\gamma_{ij} = 0$, for each i

Ha: The above statement is not true, for each i

Table 15. F-test Statistics for the Homogeneity Restriction in Model 1.

EQUATION	F-VALUE	CRITICAL VALUE α=.05	F-VALUE	CRITICAL VALUE α=.05
	DF numerator= 1 DF denominator= 5		DF numerator= 1 DF denominator= 18	
	HOMOGENEITY ONLY		WITH SYMMETRY	
Oriental	.0635	6.61	.0470	4.41
Imp. flue-cured and burley	.1822	6.61	.0124	4.41
Dom. flue-cured	.0120	6.61	.0075	4.41
Dom. burley	.0199	6.61	.0173	4.41

In every equation, the tests for homogeneity fail to reject the hypothesis of homogeneity. The F-values are low enough to indicate that there is little difference between the error terms of the restricted and unrestricted models. This justifies the use of a model restricted to possess the homogeneity property. The simultaneous imposition of symmetry does not appear to overwhelmingly affect the test results, although it does affect the imported flue-cured and burley equation to the greatest extent. This result may be due to the fact that imports arrive from many different countries, and thus imports can be said to possess many different tobacco products.

The acceptance of homogeneity has generally been a rare occurence in economics. Laitinen (1978) and Bera, Byron, and Jarque (1981) found rejections of homogeneity to be particularly prevalent among large demand systems with relatively few observations. The acceptance of homogeneity was found to be more likely as the number of equations decreased. As the number of equations increase, the tests for homogeneity become increasingly biased. Deaton and Muellbauer (1980a,1980b) rejected the homogeneity condition in their original results using the AIDS model, and explained the rejection as being due to the introduction of autocorrelation and the lack of trend variables in the model. The studies upon which much of this work is based comes from demand systems estimation with broad aggregate commodity groups. These broad commodity definitions may play a role in the rejection of theoretical constraints.

Symmetry is tested for the model as a whole rather than equation by equation. To accomplish this test, the ratio λ of the log-likelihood values of the restricted and unrestricted models is calculated to determine the validity of the restriction. The likelihood ratio is equal to the ratio of the maximum value of the likelihood function for the restricted model and the maximum value of the likelihood function for the unrestricted model. Errors are assumed to be normally distributed, and the test statistic used is $-2\ln\lambda$, with degrees of freedom equal to the number of restrictions. Unfortunately, SAS does not produce log-likelihood values in any printout, so this restriction was untested in this study. The test considers the validity of homogeneity and symmetry jointly, and the hypothesis tested is:

Ho: $\gamma_{ij} = \gamma_{ji}$ for all i,j, $i \neq j$ and $\Sigma\gamma_{ij} = 0$ for all i

Ha: at least one of the above statements is not true

Symmetry, like homogeneity, is often found to be rejected, and is generally rejected both without the homogeneity condition imposed and given homogeneity.

Another theoretical concern involves negativity and the concavity of the function. Deaton and Muellbauer calculated the s_{ij} matrix of equation (13) and then derived a K matrix of $k_{ij} = p_j p_i s_{ij}/x$. This matrix was evaluated each year and its eigen values were calculated. They found that in addition to the rejection of homogeneity and symmetry, negativity and concavity of the function was to be rejected.

With respect to U.S. demand for tobacco, negativity and concavity were not examined and therefore it is not known as to whether or not these conditions hold. The model does, however, show a considerable amount of promise for a theoretically consistent model of tobacco demand. The desirability of a function which is generally concave, homogeneous and symmetric would be extremely valuable in policy analysis.

Compensated and uncompensated price elasticities are presented in Table 16. The elasticities were derived from the restricted version of model 1. Own-price compensated elasticities were all negative, but oriental tobacco and domestic burley tobacco had positive own-price uncompensated

Table 16. Price Elasticities for the Restricted Version of Model 1.

Q\P	ORIENTAL	IMPORTED FLUE-CURED & BURLEY	DOMESTIC FLUE-CURED	DOMESTIC BURLEY
1. COMPENSTED PRICE ELASTICITIES				
ORIENTAL	-.1385	-.1014	-.1055	-.0807
IMP. FLUE-CURED & BURLEY	-.0588	-1.7676	2.4272	-.2039
DOMESTIC FLUE-CURED	.0633	.4216	-.8081	.2912
DOMESTIC BURLEY	-.0170	-.1000	.0342	-.5970
2. UNCOMPENSATED PRICE ELASTICITIES				
ORIENTAL	.1227	-.3018	-1.0255	.6181
IMP. FLUE-CURED & BURLEY	-.5692	-1.7137	2.5369	-1.6782
DOMESTIC FLUE-CURED	-.3559	.4490	-.4618	-.9575
DOMESTIC BURLEY	.1782	-.2786	-.8013	.2436

elasticities. This is probably due to the lack of response the budget shares have from price changes.

Wohlgenant (1984) and Eales and Unnevehr (1988) found that the AIDS model can impose restrictions on the evolution of elasticities with changes in real expenditures. They found that as income grows own-price elasticities become less elastic and that for disaggregated commodities, the signs of the elasticities cannot be specified a priori. Thus, own-price elasticities can become positive under the AIDS specification.

The elasticities derived for model 1 classify oriental tobacco as a gross complement to the other tobaccos with a slight discrepancy arising between oriental and domestic flue-cured tobacco. The cross price elasticity between flue-cured demand and oriental price indicates a substitution relationship while the relationship between oriental demand and flue-cured prices is that of complements. The magnitude of the positive cross price elasticity is such that this discrepancy is not of much significance. Imported flue-cured and burley tobacco was classified as a complement for domestic burley, while domestic flue-cured tobacco is a gross substitute to domestic burley and imported flue-cured and burley tobacco. This result appears to verify the results of the demand function estimation where domestic flue-cured tobacco was competing with imported flue-cured and burley tobacco. The elasticity estimates appear to be plausible with respect to the signs of the estimates; however, the degree of confidence in their magnitudes is uncertain. Imported flue-cured and burley tobacco had the only own-price elasticity which absolutely exceeded unity. Oriental tobacco and domestic burley tobacco were the least responsive to price changes, and domestic flue-cured tobacco resided in the middle. In addition to the difficulty of calculating elasticities from the AIDS model, many researchers have found other problems in elasticity derivation.

Deaton and Muellbauer (1980b) note that, " well-determined and credible cross price effects are few and far between," and that, " it does not seem possible to find a robust classification of substitutes and complements " (p.79). Pitts and Herlihy (1982) discuss the calculation of elasticities based upon regression coefficients in which apparently 'wrong' signs for the elasticities are derived. They note that 'wrong' signs can be derived from insignificant coefficients or from a misspecification of behavior. With respect to the estimation of the demand for tobacco, behavior can be misspecified in that since manufacturers attempt to maintain constant blends, and constraints exist on the price and substitution effects. This is further complicated due to expenditure effects. Real expenditures actually decreased throughout the study period, and this may significantly affect the elasticity estimates.

CHAPTER 6

ESTIMATION OF U.S. IMPORT ALLOCATION FOR TOBACCO

The import allocation of U.S. tobacco imports was modelled using the techniques described in chapters 4 and 5. This chapter presents the results of the estimation for models 2 and 3. Model 2 estimates the import allocation of five individual countries, an aggregate rest-of-oriental, and an aggregate rest-of-world. The individual countries are (1) Greece (oriental tobacco only), (2) Canada, (3) Mexico, (4) Brazil, and (5) South Korea. The results for model 3 are presented following the presentation of the results for model 2.

Model 2: Results

The market share of each country exporting tobacco to the U.S. is presented in Figure 5 on the following page. Figure 6 illustrates the price of each country's exports to the U.S. Note the strong growth Brazil has experienced in the U.S. market, and the strong collinearity of prices.

Model 2 was first estimated without the restrictions of homogeneity and symmetry imposed, and the parameter estimates, standard errors, t-values, and Durbin-Watson statistics are presented in Table 17, along with each equation's F-value and R-square statistic.

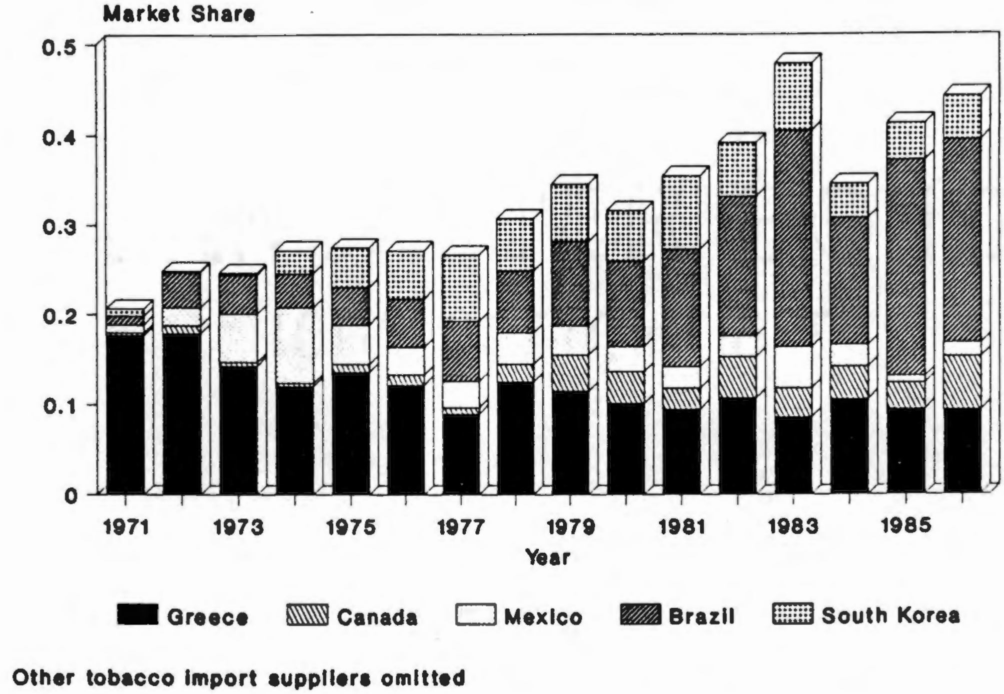

Figure 5. Market Shares of Individual Countries Exporting Tobacco to the U.S.

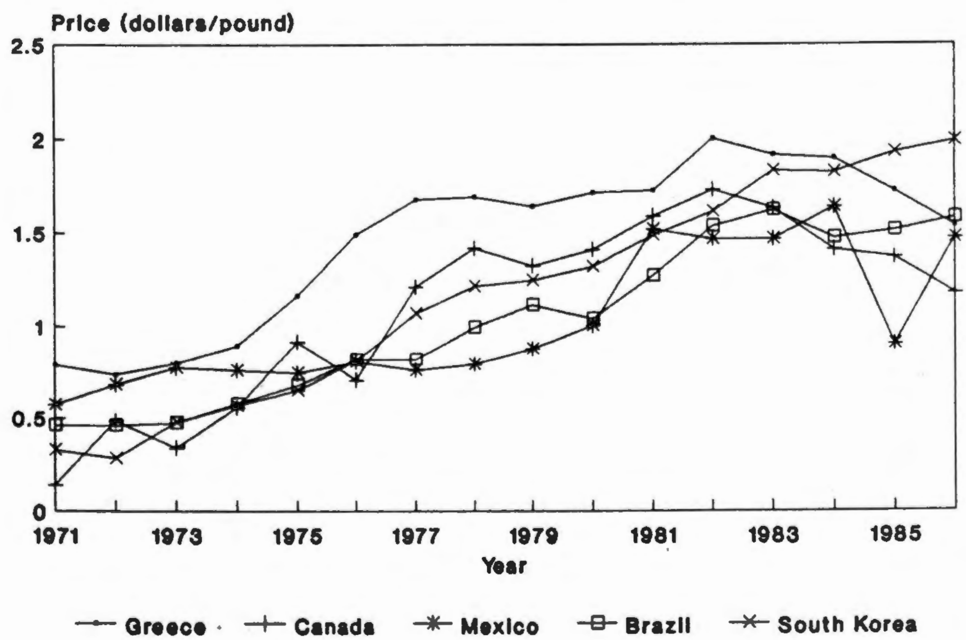

Figure 6. Price Per Pound of Individual Countries Exporting Tobacco to the U.S.

Table 17. Parameter Estimates, Standard errors, T-values, Durbin-Watson statistics, F-values and R-squares for the Unrestricted Estimation of Model 2.

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T-VALUE
EQUATION 1:GREECE			
INTERCEPT	.95525	.52463	1.821
NICIND	-.00736	.08671	-.085
LRORPR	.01770	.04107	.431
LGREPR	-.02453	.03975	-.617
LCANPR	-.01046	.01010	-1.036
LMEXPR	-.01503	.01867	-.805
LBRAPR	.07600	.04836	1.571
LKORPR	-.08481*	.02932	-2.892
LROWPR	.02976	.02644	1.126
LSTONE	-.06075	.04147	-1.465
DURBIN-WATSON = 2.938 F-VALUE = 11.488* R-SQ. = .9452			
EQUATION 2:REST-OF-ORIENTAL			
INTERCEPT	4.32995*	.50021	8.656
NICIND	-.08613	.08267	-1.042
LRORPR	.15749*	.03916	4.022
LGREPR	.16923*	.03790	4.465
LCANPR	-.01938*	.00963	-2.013
LMEXPR	.00180	.01780	.101
LBRAPR	-.19371*	.04611	-4.201
LKORPR	.01045	.02796	.374
LROWPR	-.12901*	.02521	-5.118
LSTONE	-.32092*	.03954	-8.116
DURBIN-WATSON = 2.600 F-VALUE = 92.855* R-SQ. = .9929			
EQUATION 3:CANADA			
INTERCEPT	.52258	.47598	1.098
NICIND	-.07949	.07867	-1.011
LRORPR	.00737	.03727	.198
LGREPR	-.00972	.03607	-.269
LCANPR	.00125	.00916	.136
LMEXPR	.01124	.01694	.664
LBRAPR	.06100	.04388	1.390
LKORPR	-.02014	.02661	-.757
LROWPR	-.03453	.02399	-1.440
LSTONE	-.04581	.03763	-1.218
DURBIN-WATSON = 1.868 F-VALUE = 4.808* R-SQ. = .8782			

Table 17 (cont'd).

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T-VALUE
EQUATION 4:MEXICO			
INTERCEPT	-.94474	.56983	-1.658
NICIND	.21275*	.09418	2.259
LRORPR	-.08403	.04461	-1.883
LGREPR	-.04300	.04318	-.996
LCANPR	.02593*	.01097	2.364
LMEXPR	.00678	.02028	.334
LBRAPR	-.03412	.05253	-.650
LKORPR	.10695*	.03185	3.358
LROWPR	.01185	.02872	.413
LSTONE	.07171	.04504	1.592
DURBIN-WATSON = 3.067	F-VALUE = 3.885*	R-SQ. = .8535	
EQUATION 5:BRAZIL			
INTERCEPT	-1.63239	1.52759	-1.069
NICIND	-.10857	.25247	-.430
LRORPR	.06276	.11960	.525
LGREPR	-.19663	.11575	-1.699
LCANPR	-.00530	.02940	-.180
LMEXPR	-.03481	.05435	-.640
LBRAPR	.18735	.14082	1.330
LKORPR	-.02228	.08539	-.261
LROWPR	-.00002	.07699	-.000
LSTONE	.16686	.12076	1.382
DURBIN-WATSON = 1.889	F-VALUE = 9.467*	R-SQ. = .9342	
EQUATION 6:SOUTH KOREA			
INTERCEPT	-1.47046*	.54282	-2.709
NICIND	.04177	.08971	.466
LRORPR	.00595	.04250	.140
LGREPR	.10458*	.04113	2.543
LCANPR	.01801	.01044	1.724
LMEXPR	.01729	.01931	.895
LBRAPR	-.03685	.05004	-.736
LKORPR	.00142	.03034	.047
LROWPR	-.05055	.02736	-1.848
LSTONE	.08099	.04291	1.888
DURBIN-WATSON = 2.164	F-VALUE = 8.391*	R-SQ. = .9264	

Table 17 (cont'd).

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T-VALUE
EQUATION 7:REST-OF-WORLD			
INTERCEPT	-.76019	.10334	-.689
NICIND	.02702	.18236	.148
LRORPR	-.16725	.08638	-1.936
LGREPR	.00006	.08360	.001
LCANPR	-.01006	.02124	-.474
LMEXPR	.01273	.03926	.324
LBRAPR	-.05967	.10171	-.587
LKORPR	.00840	.06167	.136
LROWPR	.17251*	.05561	3.102
LSTONE	.10793	.08722	1.237
DURBIN-WATSON = 2.062	F-VALUE = 4.51*	R-SQ. = .8714	

* significant at the 10 percent level

Since the objective of this research was to model demand within the context of economic theory, the discussion of the unrestricted model will be brief. The dummy variable for 1983 was included in earlier estimations of model 2; however, it failed to achieve statistical significance in any equation, and was thus omitted from subsequent estimations. The tariff classification change apparently did not benefit or harm any particular country relative to the others.

Among the individual countries, Canada and South Korea are suppliers of flue-cured tobacco, Mexico supplies burley tobacco, and Brazil exports both flue-cured and burley tobacco. Greece exports a variety of tobacco to the U.S., but only oriental tobacco is studied for Greece.

With the exception of the rest-of-oriental equation, all equations exhibited significant F-values and high R-squares with few significant variables, suggesting that multicollinearity is affecting the results once again. Negative first-order autocorrelation was present in the Greece, rest-of-oriental, and Mexico equations, while the other equations had Durbin-Watson statistics close to two. The prescence of negative autocorrelation was expected in the two oriental equations, given the results of the preceeding chapter; however, it is unclear as to why negative autocorrelation would be present in the Mexico equation. In Figure 5, the market share of Mexico climbs rapidly from 1971-1974 and then drops dramatically. This bulge in Mexico's market share is probably the primary reason for the autocorrelation. However, as in the first model, tests on the Durbin-Watson statistics were inconclusive.

Disaggregating imports distinguishes each country's exports as a separate commodity. Ideally, the domestic tobacco market would be included to provide a complete picture. However, while exporting nations may obtain significant market shares within the import market, the market share of an individual country in the total U.S. market becomes negligible in many cases. Specification of model 2 implicitly assumes that the import market is separate from the domestic market. From the results of chapter five, this is evidently not the case. The objective in evaluating model 2 is therefore concerned with analyzing the import allocation of various exporters to the U.S. Examination of the components of tobacco imports may provide additional insights into the domestic market as a whole.

Model 2 was estimated with the restrictions of homogeneity and symmetry imposed, and these results are presented in Table 18. As in the first model, a dramatic increase in the number of significant variables occurs. A second observation involves the Durbin-Watson statistics,

Table 18. Parameter Estimates, Standard errors, T-values, Durbin-Watson statistics, and System Weighted MSE and R-square for the Restricted Version of Model 2.

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T-VALUE
EQUATION 1:GREECE			
INTERCEPT	.59549	.41858	1.423
NICIND	.15128*	.03854	3.926
LRORPR	.06102*	.01376	4.425
LGREPR	-.12064*	.01962	-6.148
LCANPR	-.00318	.00724	-.439
LMEXPR	-.01568	.01134	-1.382
LBRAPR	.02435	.02848	.855
LKORPR	-.00352	.01971	-.179
LROWPR	.05764*	.01767	3.263
LSTONE	-.04895	.03356	-1.458
DURBIN-WATSON = 2.180			
EQUATION 2:REST-OF-ORIENTAL			
INTERCEPT	4.07179*	.38881	10.473
NICIND	.00945	.03283	.288
LRORPR	.22313*	.01427	15.636
LGREPR	.06102*	.01376	4.435
LCANPR	-.00285	.00654	-.436
LMEXPR	-.00471	.01074	-.438
LBRAPR	-.18756*	.02686	-6.983
LKORPR	.01852	.01447	1.280
LROWPR	-.10755*	.01591	-6.760
LSTONE	-.30655*	.03106	-9.869
DURBIN-WATSON = 2.047			
EQUATION 3:CANADA			
INTERCEPT	.57350	.37082	1.547
NICIND	-.09339*	.02620	-3.565
LRORPR	-.00285	.00654	-.436
LGREPR	-.00318	.00724	-.439
LCANPR	-.00629	.00674	-.934
LMEXPR	.02003*	.00694	2.886
LBRAPR	.00132	.01700	.077
LKORPR	.02086*	.00886	2.355
LROWPR	-.02988*	.01275	-2.344
LSTONE	-.03864	.02936	-1.316
DURBIN-WATSON = 2.033			

Table 18 (cont'd).

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T-VALUE
EQUATION 4:MEXICO			
INTERCEPT	-1.50140*	.43792	-3.429
NICIND	.14123*	.03390	4.167
LRORPR	-.00471	.01074	-.438
LGREPR	-.01568	.01134	-1.382
LCANPR	.02003*	.00694	2.886
LMEXPR	.01626	.01363	1.193
LBRAPR	-.08185*	.02585	-3.166
LKORPR	.03195*	.01401	2.281
LROWPR	.03399*	.01697	2.003
LSTONE	.11737*	.03479	3.374
DURBIN-WATSON = 1.912			
EQUATION 5:BRAZIL			
INTERCEPT	-.42658	1.18336	-.360
NICIND	-.22989*	.08610	-2.670
LRORPR	-.18756*	.02686	-6.983
LGREPR	.02435	.02848	.855
LCANPR	.00132	.01700	.077
LMEXPR	-.08185*	.02585	-3.166
LBRAPR	.42674*	.08040	5.308
LKORPR	-.08605*	.03496	-2.461
LROWPR	-.09694*	.04457	-2.175
LSTONE	.06538	.09403	.695
DURBIN-WATSON = 1.677			
EQUATION 6:SOUTH KOREA			
INTERCEPT	-.96650	.52581	-1.838
NICIND	.02325	.04940	.471
LRORPR	.01852	.01447	1.280
LGREPR	-.00352	.01972	-.179
LCANPR	.02086*	.00886	2.355
LMEXPR	.03195*	.01401	2.281
LBRAPR	-.08605*	.03496	-2.461
LKORPR	.06447*	.02848	2.264
LROWPR	-.04622*	.02260	-2.045
LSTONE	.08134*	.04180	1.946
DURBIN-WATSON = .917			

Table 18 (cont'd).

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T-VALUE
EQUATION 7:REST-OF-WORLD			
INTERCEPT	-1.34630	.86540	-1.556
NICIND	-.00193	.06181	-.031
LRORPR	-.10755*	.01591	-6.760
LGREPR	.05764*	.01767	3.263
LCANPR	-.02988*	.01275	-2.344
LMEXPR	.03399*	.01697	2.003
LBRAPR	-.09694*	.04457	-2.175
LKORPR	-.04622*	.02260	-2.045
LROWPR	.18896*	.04204	4.495
LSTONE	.13006	.06861	1.895
DURBIN-WATSON = 1.503			

SYSTEM WEIGHTED MSE = 1.7217
SYSTEM WEIGHTED R-SQUARE = .9959

* significant at the 10 percent level

and Table 19 below lists the Durbin-Watson statistics for the unrestricted and restricted versions of model 2, and for when only homogeneity is imposed.

Table 19. Durbin-Watson Statistics for Model 2.

EQUATION	UNRESTRICTED MODEL	HOMOGENEITY ONLY	HOMOGENEITY & SYMMETRY
Greece	2.938	2.940	2.180
Rest-of-oriental	2.600	2.635	2.047
Canada	1.860	1.950	2.033
Mexico	3.067	3.022	1.912
Brazil	1.889	1.941	1.677
South Korea	2.164	2.613	.917
Rest-of-world	2.062	1.701	1.503

The discussion of the results will be concentrated on the individual countries with some reference to the two aggregate equations. With the exception of the rest-of-world equation, the imposition of homogeneity does not introduce a significant degree of autocorrelation. However, once symmetry is imposed, positive autocorrelation appears to be introduced into every equation except the Canada equation, which exhibits negative autocorrelation. Greece, Mexico, and the rest-of-oriental equations receive enough positive autocorrelation to counter the negative autocorrelation found in the unrestricted model. Brazil, South Korea, and the rest-of-world equations became significantly positive autocorrelated.

The explanation of these results probably lies within the tobacco market, rather than in the model itself. The model implicitly assumes that a perfect import market is exhibited where prices and real expenditures determine market shares. In reality, the role of governments, price expectations, exchange rates and the domestic market all play important roles in how the U.S. imports tobacco. The recent expansion of government interference in international trade may explain some of the autocorrelation found once symmetric price responses are imposed on the model.

The nicotine content of U.S. cigarettes appears to have had detrimental effects on the tobacco exports of Greece, and Mexico. Countries which have significantly benefitted from the decreasing levels of nicotine include Canada and Brazil. The evidence suggets that the changing nature of cigarette demand has had an effect on the import market.

Countries with negative own-price effects, that is countries in which an increase in their price leads to a decrease in its market share, are Greece and Canada. However, only the Greece price effect is statistically significant. The other countries had positive own price effects with Brazil and South Korea having statistically significant effects.

In the Greece equation, two prices had significant parameters. Increases in the prices of the other oriental tobacco suppliers lead to an increase in Greece's market share. Likewise, increases in the price of the rest-of-world flue-cured and burley tobacco suppliers lead to an increase in the market share of Greek tobacco. The budget share level of Greece depends on aggregate price levels of flue-cured and burley tobacco, rather than any particular country's price. Of course, had oriental imports been disaggregated further, it would be expected that Greek imports would be more responsive to individual prices.

Canadian imports appear to be most responsive to the prices of Mexican and South Korean tobacco. Increases in the prices of Mexican or Korean tobacco lead to increases in Canada's market share. Canadian imports also depend on the aggregate price levels of the rest-of-world suppliers, while being unresponsive to the prices of oriental tobacco.

Increases in the price of Canadian tobacco or South Korean tobacco lead to increases in the market share of Mexican tobacco. Increases in the price of Brazilian tobacco have a negative effect on the market share of Mexico. The price effect of Brazilian tobacco on the market share of Mexico is the only non-oriental tobacco to have a negative coefficient for Mexico. Mexican tobacco was also responsive to aggregate prices and to changes in real expenditures.

Brazil, which experienced the most prevalent growth in market share, is influenced by the prices of oriental tobacco in addition to the prices of the other countries.

The negative sign on the coefficients of the non-oriental countries suggest that Brazil is relatively secure in the import market. Decreases in these prices lead to increases in the market share of Brazil. The market share of Brazil, in value terms, changes with changes in prices, but in quantity terms is relatively unresponsive to its competitors prices.

Imports from South Korea are sensitve to the prices of all the non-oriental countries in addition to being sensitive to changes in real expenditures. South Korea's market share increases with price increases in Canadian or Mexican tobacco. Price increases in Brazilian tobacco or rest-of-world aggregate prices, tend to decrease the market share of South Korea, while increases in real expenditures affect South Korea positively.

Based upon the β_i coefficients, Greek and Canadian tobacco grow (decline) less rapidly than a proportional increase (decrease) in real expenditures. Mexican, Brazilian, and South Korean tobacco grow (decline) more rapidly than a proportional increase (decrease) in real expenditures. The β_i coefficients for Mexico and South Korea were the only two that attained statistical significance.

Drawing implications from the parameters derived in the model is extremely difficult. The import market is notably imperfect in design, and this makes inferences speculative. In addition to government interference and price expectations, the market is influenced by the actions of tobacco companies. For example, Phillip Morris would buy tobacco from Phillip Morris Brazil, and as discussed in chapter 2, tobacco companies provide a considerable amount of support to Brazilian tobacco producers. South Korea, which has virtually closed its market to foreign tobacco imports, may suffer in the U.S. from the role of governments in tobacco trade. Canadian and Greek producers were also found to possess support from their governments and tobacco organizations.

The interesting aspect to consider is the extent to which the import market is consistent with economic theory, given all these exogenous factors. The homogeneity condition was tested for each equation and the results are presented below in Table 20.

Table 20. F-Statistics for the Homogeneity Restriction in Model 2.

EQUATION	F-VALUE	CRITICAL VALUE α=.05	F-VALUE	CRITICAL VALUE α=.05
	DF numerator= 1 DF denominator= 6		DF numerator= 1 DF denominator= 51	
	HOMOGENEITY ONLY		WITH SYMMETRY	
Greece	.5840	5.99	.7942	4.04
Rest-of-oriental	.6443	5.99	2.3056	4.04
Canada	.6696	5.99	1.0810	4.04
Mexico	.0898	5.99	.5944	4.04
Brazil	.0002	5.99	.3555	4.04
South Korea	4.1561	5.99	12.1233	4.04
Rest-of-world	1.7599	5.99	3.7811	4.04

In every equation the test failed to reject homogeneity, without the simultaneous imposition of symmetry. However, when symmetry was introduced, a dramatic increase in the F-values occur. This situation is the reverse of the situation in the first model in which symmetry lowered the F-values. The explanation of this phenomena may be linked to the Durbin-Watson statistics. Deaton and Muellbauer (1980a,1980b) discussed the hypothesis that the introduction of autocorrelation may lead to the rejection of homogeneity. The test for homogeneity did reject the restriction for South Korea, once symmetry was imposed. The most likely reason for the autocorrelation is the exclusion of the domestic market from the estimation. Among the individual countries, especially the flue-cured and burley suppliers, the U.S. has been excluded from the estimation, possibly distorting the results.

The theoretical aspects of demand theory are left mainly untested here. Symmetry, negativity, and concavity were not tested due to time and difficulty constraints. A test of symmetry would prove interesting, especially when compared to the first model. The other properties would not be expected to hold given the effects symmetry has produced on the model. Negativity, as will soon be evident, need not be tested for model 2 since some compensated price elasticities are positive. This suggests that concavity as well will probably be rejected. Positive own-price elasticities are possible for the AIDS model, especialy when real expenditures increase. Real expenditures for imported tobacco did increase for most of the study period, but began to decrease in 1982, as total expenditures fell. This increases the difficulty in interpeting the elasticities since little faith can be placed in their signs or magnitudes when positive elasticities occur. The compensated and uncompensated price elasticities for the restricted version of model 2 are presented in Table 21.

The own-price elasticities for Brazil, South Korea, and the rest-of-world were all positive. This result was not surprising for Brazil, given the growth Brazil experienced in the U.S. market. The positive elasticities for South Korea and the rest-of-world are not easy to explain, but are probably linked to changes in real expenditures as well. Another possible explanation follows along that of Pitts and Herhlihy (1982). They found that positive own-price elasticities are possible in budget share equations when the buyer seeks to maintain a constant level of a certain property possessed by two or more goods. The actual reason is more than likely due to the difficulty the AIDS model has in computing elasticity estimates.

Demand for Greek tobacco is complementary with Canadian, Mexican, and Korean tobacco, while it is a substitute for other oriental tobacco, Brazilian, and the rest-of-world. The relationship between the demand for Greek

Table 21. Compensted and Uncompensated Price Elasticities for the Restricted Version of Model 2.

Q\P	ORI.	GRE.	CAN.	MEX.	BRA.	KOR.	ROW.
1.COMPENSATED PRICE ELASTICITIES							
ORI.	-.357	.166	.004	.004	-.316	.054	-.143
GRE.	.821	-1.951	-.014	-.114	.268	-.003	.578
CAN.	-.483	-.220	-1.291	.856	-.016	.879	-1.411
MEX.	2.300	.061	.740	-.338	-2.082	1.223	1.798
BRA.	-.922	.420	.049	-.718	3.183	-.735	-.662
KOR.	1.853	.252	.520	.787	-1.587	.538	-.583
ROW.	.263	.591	-.152	.162	-.432	-.215	.509

2.UNCOMPENSATED PRICE ELASTICITIES							
ORI.	1.886	.530	.279	-.808	-.756	-.508	-1.029
GRE.	2.245	-1.730	.173	-.695	-.485	-.412	-.090
CAN.	6.920	1.045	-.459	-1.416	-1.078	-.648	-3.660
MEX.	-15.605	-3.092	-1.158	4.538	-.091	4.428	6.240
BRA.	-4.328	-.202	-.285	1.604	3.424	-.241	-.054
KOR.	-7.025	-1.326	-.404	3.115	-.685	2.055	1.473
ROW.	-4.216	-.218	-.601	1.364	-.061	.479	1.401

tobacco and Canadian and South Korean tobacco prices is negligible with cross-price elasticities less than .1.

Demand for Canadian tobacco is complementary with Greek and rest-of-oriental tobacco along with Brazilian and rest-of-world tobacco. Canadian tobacco is a significant substitute for Mexican and South Korean tobacco. The relationship between Canadian and Mexican tobacco seems unusual at first since Canada produces flue-cured tobacco and Mexico produces burley tobacco. However, this result is similar to those of the first model where burley and flue-cured tobacco were found to be gross substitutes.
The cross price elasticity between Canadian demand and the price of Brazilian tobacco signifies that virtually no relationship exists. This lack of response is supported by the parameter estimates and is probably due to the close proximity and close ties the U.S. has with Canada.

Demand for Mexican tobacco is complementary with only Brazilian tobacco, and is highly linked to the price of Brazil's tobacco. Demand for Mexican tobacco appears to very responsive to the price of the other tobacco's in that four of the six cross price elasticities absolutely exceeded unity, while the Mexican own-price elasticity was inelastic.

Demand for Brazilian tobacco is complementary with rest-of-oriental, Mexican, South Korean and rest-of-world tobacco. The relationship between the demand for Brazilian tobacco and the price of Canadian tobacco appears to support the hypothesis of no real relationship between the two. The only significant substitute relationship appears to be with Greece, an oriental tobacco supplier. Brazil apparently has no real competition in the import market.

South Korean tobacco, on the other hand, appears to compete with everybody except Brazil and the rest-of-world. Why South Korean tobacco is a substitute to the oriental tobaccos is unclear. The cross-price elasticities may have 'wrong' signs or be overinflated due to the problems the AIDS model has in the calculation of elasticities from budget shares. In any case, it is difficult to have much faith in the cross price elasticities when the own-price elasticity is positive.

The last model to be examined takes a slightly different look at imports. The role of governments in influencing prices and exports has already been discussed briefly. Government interference has been used for the most part by the developed countries, and disaggregating imports by the economic group of its source may provide additional information.

The market shares of the economic groups exporting oriental tobacco to the U.S. is shown in Figure 7, while Figure 8 presents the market shares of the economic groups exporting flue-cured and burley tobacco to the U.S. The prices of each economic group's tobacco exports are shown in Figures 9 and 10.

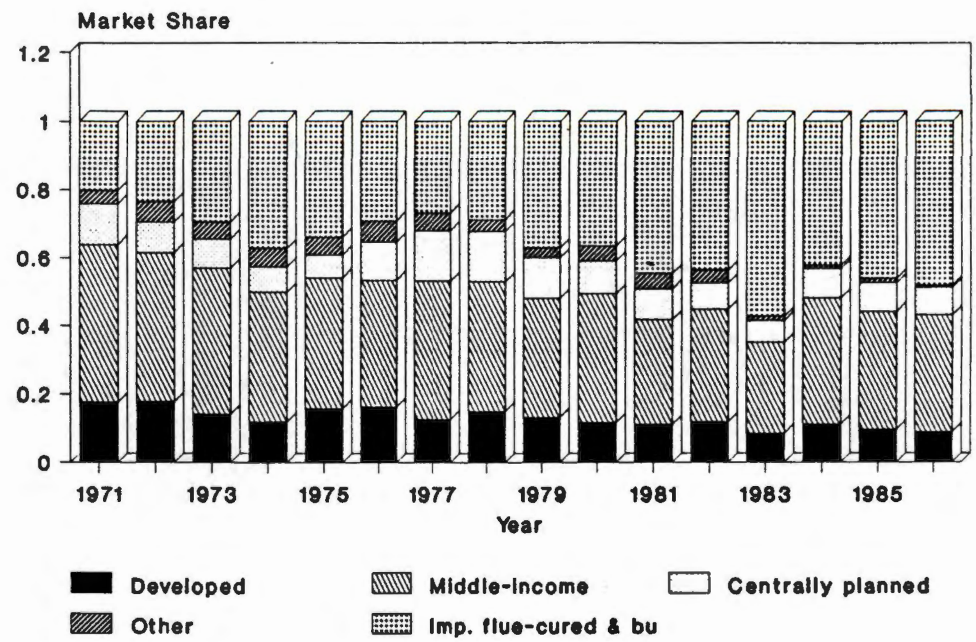

Figure 7. Oriental Market Shares by Economic Grouping.

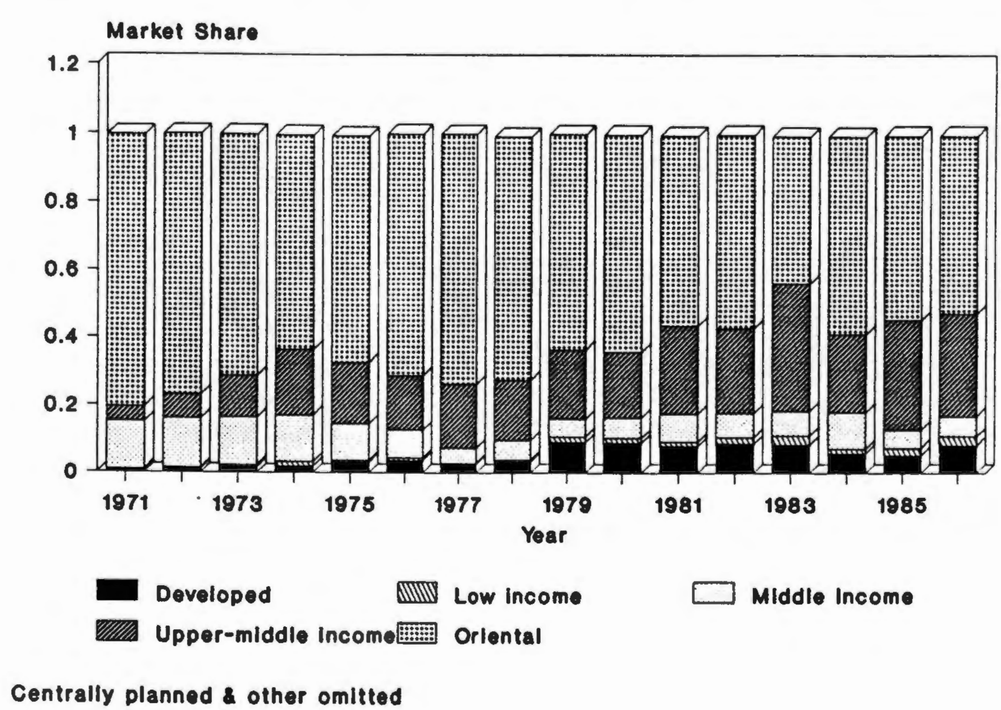

Figure 8. Imported Flue-cured and Burley Market Shares by Economic Grouping.

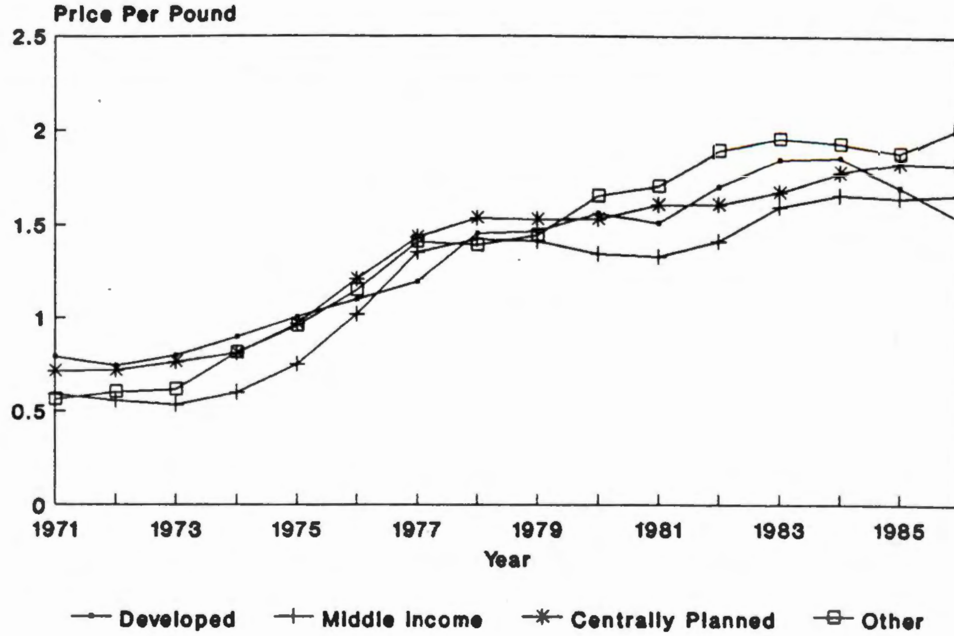

Figure 9. Price Per Pound for Oriental Imports by Economic Grouping.

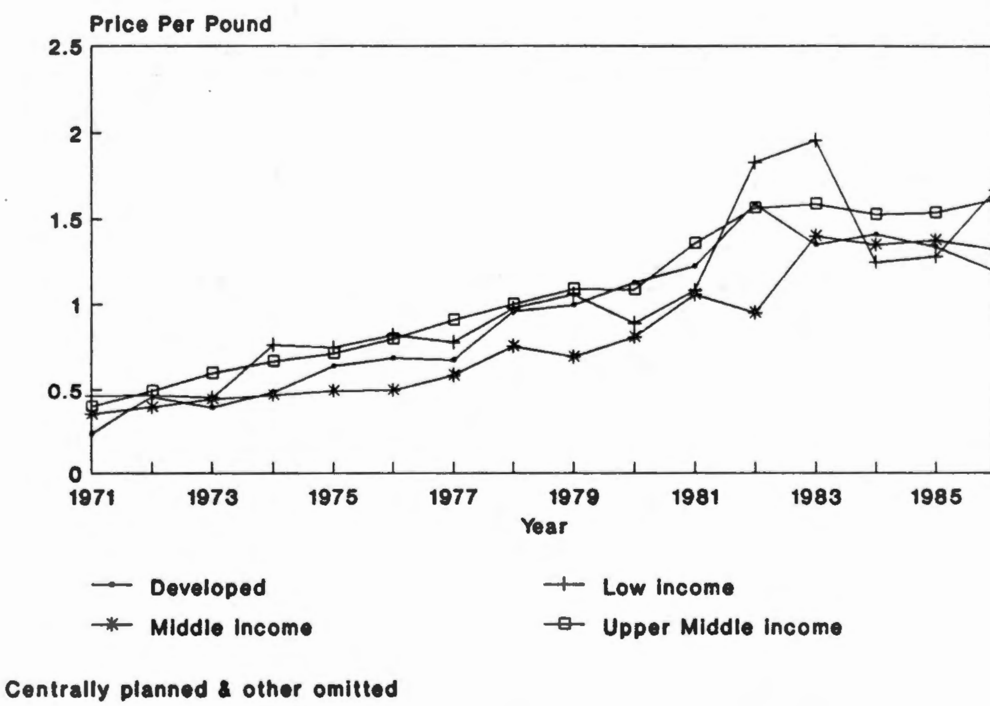

Figure 10. Price Per Pound of Imported Flue-cured and Burley Tobacco by Economic Group.

Oriental imports are dominated by one country, Turkey, a middle-income developing nation. Significant imports of oriental tobacco also arrive from developed and centrally planned countries. Flue-cured and burley imports are dominated by the upper-middle-income countries such as Brazil, Mexico, and Argentina. Middle-income countries and developed countries also export considerable amounts of flue-cured and burley tobacco.

Prices of the economic groups are highly correlated as in the other two models. The developed countries exported oriental tobacco only slightly cheaper than the centrally planned countries, the most expensive oriental imports. The prices of oriental imports were similiar between the economic groups, and it doesn't appear that developed countries have a price advantage in the U.S. market. A similiar situation exists for flue-cured and burley imports. The price differences were slightly more pronounced for flue-cured and burley imports, and the developed countries export price is at the lower end of the spectrum, with only exports from middle-income countries being cheaper.

The use of subsidies by the developed countries for agricultural production has become a matter of intense debate. Many developed countries themselves are beginning to question the increasing burden taxpayers face for subsidized production. Agricultural development has been considered as an important component for industrial growth. The case may be that developed countries maintain market shares at the expense of developing countries. The debate on agricultural policy reform will more than likely continue for some time since agriculture continues to maintain a favored position in many of the developed countries.

Model 3:Results

Model 3 is actually composed of two models. The first model disaggregates oriental tobacco, while the second model disaggregates imported flue-cured and burley tobacco. The economic groups for oriental tobacco are (1) developed, (2) middle-income developing, (3) centrally planned, (4) other oriental exporters, and (5) aggregate imported flue-cured and burley tobacco. The second version of model 3 utilizes the economic groups of (1) developed, (2) lower-income developing, (3) middle-income developing, (4) upper-middle-income developing, (5) centrally planned, (6) other flue-cured and burley suppliers, and (7) aggregate oriental tobacco. These models will be discussed jointly.

The discussion of the results for model 3 will be considerably shorter compared to the other two models. Only the results of the restricted estimation will be presented, and the discussion will focus on the developed countries.

Parameter estimates, standard errors, t-values, and the system weighted MSE and R-square statistics are reflected in Table 22 for disaggregated oriental tobacco, and Table 23 presents the results for imported flue-cured and burley tobacco. In both models, no variable was significant for the developed countries equation, a condition not repeated in any other equation. As a group, the market share of the developed countries is not dependent on the prices of the other groups. Wide variances of individual country prices could explain this result. The equations in which the model appears to work best include those equations which are dominated by only a few countries, and also the aggregate tobacco type equations.

Overall, the model does not appear to work very well, with generally weak price links between the price variables. One interesting result from the disaggregated oriental model is the comparatively strong price reaction between middle-income countries and the centrally planned countries. A price increase in one of these groups leads to a strong increase in the budget share of the other. These suppliers of oriental tobacco apparently compete, and their budget share levels are dependent on the other's price.

In the disaggregated imported flue-cured and burley model, the results were similiar in that only weak price links occur. Most equations were dependent on oriental

Table 22. Parameter Estimates, Standard errors, T-values, and System Weighted MSE and R-square values for the Oriental Version of Model 3.

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T-VALUE
EQUATION 1:DEVELOPED COUNTRIES			
INTERCEPT	.83724	.59857	1.399
NICIND	.02740	.05541	.494
LDEVOPR	.07550	.05663	1.333
LMIDOPR	.04395	.04563	.963
LCPOPR	-.03591	.04599	-.781
LOTOPR	-.01270	.02965	-.428
LFCBPR	-.07084	.04999	-1.574
LSTONE	-.06345	.04726	-1.343
EQUATION 2:MIDDLE-INCOME DEVELOPING COUNTRIES			
INTERCEPT	2.86329*	.77411	3.699
NICIND	-.08929	.06134	-1.456
LDEVOPR	.04395	.04563	.963
LMIDOPR	-.03846	.06951	-.553
LCPOPR	.19308*	.05815	3.320
LOTOPR	-.07758	.03963	-1.957
LFCBPR	-.12099*	.04561	-2.653
LSTONE	-.20574*	.06134	-3.354
EQUATION 3:CENTRALLY PLANNED COUNTRIES			
INTERCEPT	.91839	.54368	1.689
NICIND	-.00551	.04893	-.113
LDEVOPR	-.03591	.04599	-.781
LMIDOPR	.19308*	.05815	3.320
LCPOPR	-.07336	.08126	-.903
LOTOPR	-.00829	.04012	-.207
LFCBPR	-.07551	.04572	-1.651
LSTONE	-.06846	.04333	-1.580
EQUATION 4:OTHER ORIENTAL COUNTRIES			
INTERCEPT	.47863	.40600	1.179
NICIND	.05268	.03551	1.483
LDEVOPR	-.01224	.02950	-.415
LMIDOPR	-.07790	.03939	-1.977
LCPOPR	-.00815	.04001	-.204
LOTOPR	.15191*	.03172	4.789
LFCBPR	-.05362	.03209	-1.671
LSTONE	-.04423	.03223	-1.372

Table 22 (cont'd).

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T-VALUE
EQUATION 5:AGGREGATE FLUE-CURED AND BURLEY IMPORTS			
INTERCEPT	-4.09929*	.55881	-7.336
NICIND	.01451	.05368	.270
LDEVOPR	-.07084	.04499	-1.574
LMIDOPR	-.12099*	.04561	-2.653
LCPOPR	-.07551	.04572	-1.651
LOTOPR	-.05355	.03235	-1.655
LFCBPR	.32089*	.05389	5.955
LSTONE	.38204*	.04432	8.621

SYSTEM WEIGHTED MSE = .89232
SYSTEM WEIGHTED R-SQUARE = .96499

* significant at the 10 percent level

Table 23. Parameter Estimates, Standard errors, T-values, and System Weighted MSE and R-square values for the Imported Flue-cured and Burley Version of Model 3.

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T-VALUE
EQUATION 1:DEVELOPED COUNTRIES			
INTERCEPT	-.47985	.61836	-.776
NICIND	-.06343	.05823	-1.089
LDEVPR	.02782	.02972	.936
LLIDPR	-.00431	.00799	-.540
LMIDPR	-.00058	.02073	-.028
LUMDPR	-.00533	.04375	-.122
LCPPR	.00054	.00432	.124
LOTPR	-.00214	.00230	-.932
LORIPR	-.01599	.02064	-.775
LSTONE	.04484	.04202	1.067
EQUATION 2:LOWER-INCOME DEVELOPING COUNTRIES			
INTERCEPT	-.00648	.21532	-.030
NICIND	-.02526	.01932	-1.308
LDEVPR	-.00431	.00798	-.540
LLIDPR	.01017	.00866	1.174
LMIDPR	.01873*	.00749	2.497
LUMDPR	-.00517	.01394	-.371
LCPPR	.00389	.00475	.818
LOTPR	.00112	.00141	.795
LORIPR	-.02443*	.00789	-3.095
LSTONE	.00423	.01469	.288
EQUATION 3:MIDDLE-INCOME DEVELOPING COUNTRIES			
INTERCEPT	.92348	.54454	1.696
NICIND	.08868	.04948	1.792
LDEVPR	-.00058	.02073	-.028
LLIDPR	.01873*	.00750	2.497
LMIDPR	.10045*	.02613	3.844
LUMDPR	-.02119	.04329	-.490
LCPPR	.00931*	.00467	1.996
LOTPR	-.00330	.00243	-1.360
LORIPR	-.10341*	.01827	-5.660
LSTONE	-.06545	.03703	-1.767

Table 23 (cont'd).

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T-VALUE
EQUATION 4:UPPER-MIDDLE-INCOME COUNTRIES			
INTERCEPT	-4.31175*	1.00238	-4.301
NICIND	.04365	.09254	.472
LDEVPR	-.00533	.04375	-.122
LLIDPR	-.00517	.01394	-.371
LMIDPR	-.02120	.04329	-.490
LUMDPR	.13962	.08909	1.567
LCPPR	-.00667	.00824	-.809
LOTPR	.00205	.00443	.463
LORIPR	-.10330*	.03454	-2.990
LSTONE	.33364*	.06817	4.894
EQUATION 5:CENTRALLY PLANNED COUNTRIES			
INTERCEPT	-.12693	.10365	-1.225
NICIND	.01133	.00997	1.137
LDEVPR	.00053	.00432	.124
LLIDPR	.00389	.00475	.818
LMIDPR	.00931*	.00466	1.996
LUMDPR	-.00667	.00824	-.809
LCPPR	-.00310	.00332	-.932
LOTPR	-.00026	.00092	-.288
LORIPR	-.00370	.00427	-.867
LSTONE	.00901	.00704	1.279
EQUATION 6:OTHER FLUE-CURED AND BURLEY COUNTRIES			
INTERCEPT	.03648	.05878	.621
NICIND	-.00170	.00564	-.301
LDEVPR	-.00214	.00230	-.932
LLIDPR	.00112	.00141	.795
LMIDPR	-.00329	.00242	-1.360
LUMDPR	.00205	.00443	.463
LCPPR	-.00026	.00092	-.288
LOTPR	.00276*	.00055	4.979
LORIPR	-.00022	.00237	-.094
LSTONE	-.00233	.00399	-.585

Table 23 (cont'd).

VARIABLE	PARAMETER ESTIMATE	STANDARD ERROR	T-VALUE
EQUATION 7:AGGREGATE ORIENTAL COUNTRIES			
INTERCEPT	4.96505*	.63426	7.828
NICIND	-.05328	.05699	-.935
LDEVPR	-.01599	.02065	-.775
LLIDPR	-.02443*	.00789	-3.095
LMIDPR	-.10341*	.01826	-5.660
LUMDPR	-.10330*	.03454	-2.990
LCPPR	-.00370	.00426	-.867
LOTPR	-.00022	.00237	-.094
LORIPR	.25106*	.02565	9.789
LSTONE	-.32394*	.04319	-7.500

SYSTEM WEIGHTED MSE = 1.08425
SYSTEM WEIGHTED R-SQUARE = .961769

* significant at the 10 percent level

prices, their budget share levels decreasing with increases in the price of oriental tobacco. The middle-income developing countries were the most reactive to prices having significant responses to its own-price, the price of lower-income imports, and imports from centrally planned couhntries.

The results of model 3 seem to indicate that the economic group of a country's exports play a minor, if any, role in the level of exports. The lack of significant price responses could be due to a variety of reasons, political and economic. Governments may interfere with free trade by subsidizing exports or through political pressure. The most likely explanation is that each country, regardless of economic standing, has essentially a different tobacco commodity creating wide price and quality differences.

The homogeneity constraint was examined for each version of model 3 and the results are presented in Table 24. In the oriental version of model 3, the hypothesis of homogeneity was rejected in the middle-income and centrally planned equations, until the imposition of symmetry. The exclusion of appropriate trend variables is the primary reason for the rejection of homogeneity. The cross equation restriction of symmetry led to a failure to reject homogeneity in every equation. The reduction in F-values is a situation similiar to that found in model 1. However, the introduction of symmetry into disaggregated flue-cured

Table 24. F-Statistics for the Homgeneity Restriction in Model 3.

EQUATION	F-VALUE	CRITICAL VALUE α=.05	F-VALUE	CRITICAL VALUE α=.05
	HOMOGENEITY ONLY		WITH SYMMETRY	
1. DISAGGREGATED ORIENTAL TOBACCO				
	DF numerator= 1 DF denominator= 8		DF numerator= 1 DF denominator= 38	
Developed	.2563	5.32	.0896	4.10
Middle-income	8.7052	5.32	2.9305	4.10
Centrally-planned	6.4147	5.32	3.5912	4.10
Other	3.7100	5.32	.2085	4.10
Flue-cured & bur.	.3653	5.32	.0136	4.10
2. DISAGGREGATED IMPORTED FLUE-CURED AND BURLEY TOBACCO				
	DF numerator= 1 DF denominator= 8		DF numerator= 1 DF denominator= 51	
Developed	.2706	5.99	.9776	4.04
Lower-income	.8455	5.99	.9956	4.04
Middle-income	.2604	5.99	3.0659	4.04
Upper-middle-inc.	.0002	5.99	2.3539	4.04
Centrally planned	.8236	5.99	.8133	4.04
Other	.0254	5.99	.6269	4.04
Oriental	1.3587	5.99	.0213	4.04

and burley imports increased F-values as in model 2. The primary focus of these two models is on flue-cured and burley imports, and in both models F-values for the homogeneity restriction increase. This is probably due primarily to the exclusion of the domestic market. Dramatic increases in these F-values may mean that domestic prices are a primary determinant to the budget share levels. The combination of the results for models 2 and 3 suggest that Mexico, Brazil, and South Korea, along with other middle-income and upper-middle-income developing countries are the most dependent on U.S. prices. The developed countries also appear to be dependent on U.S. prices to a significant degree, but not as dependent as the developing countries. This may be due to governments maintaining stable prices in the developed countries, while prices in the developing countries fluctuate more widely.

Compensated price elasticities are presented in Table 25. Uncompensated price elasticities have been omitted due to the poor performance of the model. Several of the own-price elasticities are positive, probably due to the increases in real expenditures, and the lack of significant variables. The discussion of the elasticities is accordingly brief. One positive own-price elasticity was found in the oriental version of model 3, and three of the six own-price elasticities in the imported flue-cured and burley version were positive.

Table 25. Compensated Price Elasticities for Model 3.

Q\P	DEV.	MID-INC.	CENT.-PLAN.	OTHER
1. ORIENTAL TOBACCO				
DEV.	-.3534	-.4079	-.0131	1.1862
MID.-INC.	.1763	-.9375	.5627	-.1927
CENT.-PLAN.	-.3363	2.1091	-1.7321	-.0734
OTHER	-.3435	-2.1109	-.2302	2.9914

2. IMPORTED FLUE-CURED AND BURLEY TOBACCO

DEV.	-.3537	-.0610	.1601	.2798	.0165	-.0385
L-INC.	-.2672	-.1939	1.5724	-.1296	.3056	.0898
M-INC.	.0077	.2096	.1305	-.1761	.1033	-.0357
U-INC.	.2134	.0087	.1356	.2218	-.0245	.0155
C-PLA.	.3700	1.3020	3.3518	-1.3519	-1.9857	-.0772
OTHER	-1.0350	.5373	-1.5943	.9592	-.1275	.3236

The own-price elasticities of the developed countries economic group are inelastic, and the most elastic response of any economic group is among the centrally planned countries. This was intuitively expected since centrally planned countries exhibit rather variable behavior in international trade with democratic countries. The cross price elasticities for the oriental tobacco suppliers was primarily that of complements, which was not expected. One exception was between the centrally planned countries and the middle-income countries. Another exception was between the demand for middle-income countries tobacco and the price of developed countries tobacco. Oriental tobacco may itself be differentiable so that two types of oriental tobacco become complements.

Among the imported flue-cured and burley suppliers, the cross-price elasticities showed generally substituterelationships. The complementary relationships occurred between the developed countries and the lower-income countries, and between the centrally planned countries and the upper-middle-income countries. Assuming the signs of the elasticities are accurate, this illustrates the level of differentiation between tobaccos of the same type.

In retrospect, many more questions have been raised by this research than answered. The actual role government subsidies and trade interference have had on the level and allocation of imports remains a matter of debate. Prices are an important determinant of imports, yet other factors also play a crucial role.

CHAPTER 7

SUMMARY AND CONCLUSIONS

Summary

The growth in the use of imported tobacco for domestic cigarette production was a primary factor in prompting the recent changes in the tobacco program. Tobacco producers, faced with lower quotas and declining demand for their product, found tobacco production economically difficult. Most tobacco producers are small farmers with limited options in alternative farm enterprises, and are dependent upon tobacco production to provide cash flow. Thus, the legislature enacted several key provisions in the tobacco program to make the tobacco production industry more market oriented, and increase the market share of U.S. tobacco in both the domestic and export markets.

Past research into demand in the domestic market and imports of tobacco (Sumner and Alston,1987; Chang, Beghin and Sumner, 1988) have examined the demand for tobacco by concentrating on aggregate tobacco types. This study examines the demand for tobacco by concentrating on aggregate tobacco types and for the individual components of imports within a theoretically consistent econometric model.

The objectives of this study were:

1. To produce a model capable of estimating the derived

demand for tobacco in a manner consistent with the properties of economic theory.

2. Test the nature of tobacco demand with respect to the properties of demand theory.

3. Compute elasticity estimates from the estimated parameters.

4. Identify those factors, both price and trend, which have significantly affected the structure of demand for tobacco.

The Almost Ideal Demand System of Deaton and Muellbauer (1980a,1980b) was utilized to model the U.S. input demand for tobacco and to model the U.S. import allocation of tobacco. The model has the capability of imposing and testing the theoretical restrictions of homogeneity and symmetry with only linear constraints on the parameters. The approach used in this study was to specify three separate models in order to provide a complete picture of the nature of tobacco demand and the price linkages occuring within the market. The first model estimates U.S. derived input demand for tobacco utilizing four budget share equations. The budget share equations estimated were (1) oriental tobacco, (2) imported flue-cured and burley tobacco, (3) domestic flue-cured tobacco, and (4) domestic burley tobacco. The model encompasses several trend variables which were hypothesized to influence the demand for tobacco. The second model estimates U.S. import allocation with budget share equations for five individual countries, and includes the trend variable of the average nicotine content of U.S. cigarettes. The individual countries were (1) Greece (oriental tobacco only), (2) Canada, (3) Mexico, (4) Brazil, and (5) South Korea. The third model examines the import allocation of the economic groups of developed economies, less developed economies, and centrally planned economies which export tobacco to the U.S., and also utilizes the average nicotine content as a trend variable. Each model was estimated as a system of budget share equations as given in the AIDS model specification. The homogeneity restriction was imposed and tested in each model, and the symmetry restriction was imposed but could not be tested with the statistical computing method.

Major Conclusions

In the first model, domestic flue-cured tobacco was found to compete with imported flue-cured and burley tobacco, and domestic burley tobacco. The average nicotine content of domestic cigarettes was found to have had a detrimental effect on domestic flue-cured tobacco.

Domestic burley tobacco was found to compete to a small degree with domestic flue-cured tobacco, but was basically a complement to the other tobacco types. The equation for domestic burley tobacco was also found to be underspecified in that the prescence of autocorrelation indicated a significant variable may have been excluded from the estimation.

The model was able to satisfy homogeneity and the results suggest that symmetry may also be satisfied. The ability of U.S. input demand for tobacco to satisfy the remaining restrictions of economic theory should be an important objective of future research. Chang, Beghin and Sumner (1988) found that under a translog specification, the model failed to satisfy negativity and concavity, but they did not test homogeneity or symmetry. The AIDS specification may be a more appropriate model for tobacco, and thus could prove to be a more powerful estimation technique. This research suggests that it may also be plausible to model exports using the AIDS model, by estimating demand within an individual country or region and including U.S. exports as a separate equation.

The model generated consistent results and the implications of these results suggest that domestic flue-cured tobacco may gain in volume terms in the domestic market from changes occuring in the tobacco program. Domestic burley tobacco also stands to regain domestic market share, but not as significantly as domestic flue-cured tobacco. Domestic flue-cured tobacco may not gain very significantly from policies designed to increase the price of imported flue-cured or burley tobacco. The cross price elasticities suggest that increases in the price of imports does not have a very substantial effect on the demand for domestic flue-cured tobacco. However, increases in the price of domestic flue-cured tobacco appreciably increase the demand for imports. The different cross-price elasticities appear to suggest an asymmetric price response; however, while the AIDS model can restrict the price parameters to exhibit symmetry, the elasticities are not restricted.

Domestic burley tobacco and oriental tobacco appear to be relatively secure in the U.S. market, since they are primarily complements to the other tobaccos, and have inelastic demand. The implications of this research provide some insight into the nature of the demand for tobacco in the domestic market. The homogeneous model has been accepted and additional research needs to focus on the other properties of demand functions. The research suggests that the AIDS model has considerable promise in the estimation of demand for tobacco. The model could potentially be improved by increasing the number of observations, improving the data source, and investigations into more accurate trend determinants for domestic burley tobacco and oriental tobacco.

The import market has undergone some changes in recent years. Some notable changes include the loss in market share suffered by Greek tobacco, the expansion of Brazilian tobacco in the U.S. market, and the general growth of

imports. The apparent demise of Greek tobacco has been linked in this study to the nicotine level of U.S. cigarettes and its relatively high price. The countries of Canada and South Korea have experienced moderate growth in the import market, while Mexico's share of the import market grew rapidly at first, but has since declined to its approximate 1971 level. In the total market, most countries have benefitted somewhat from the increase in imports. It is Brazil however which has reaped the most significant gains, to the detriment primarily of countries outside the scope of this study. It's growth has also been linked to the nicotine level of U.S. cigarettes. Other factors which have aided Brazilian imports could not be captured by this study. The devaluation of the Cruzeiro, Brazil's national currency, may explain much of it's growth. Another determinant may be quality. Given the support manufacturers supply Brazilian producers in technical advice and seeds, the quality of Brazilian tobacco has probably improved significantly.
In addition, the elasticity estimates appear to suggest that Brazil has no real competition in the tobacco import market, being classified as a complement to most of the other countries.

The exclusion of the domestic market appears to have had a detrimental effect on the estimation of the second model. Homogeneity was satisfied for model 2, however, once symmetry was imposed autocorrelation was introduced and this led to the rejection of homogeneity for South Korea. This occurred primarily for countries exporting flue-cured and burley tobacco to the U.S., and this was the basis for the hypothesis that excluding the domestic market from the import market misspecifies the model.

The results indicate that tobacco is subject to differentiation by origin. Future research in the components of tobacco demand needs to include the domestic market in the estimation. The domestic market may itself be differentiated by states, and this may spread out the budget shares so that individual countries could be included. The primary barrier to such research is data. The data used in this study are admittedly lacking in content and definition, and the number of observations required may be overwhelming.

In the third model, only weak price links were found between the economic groups. Many equations had only one or two significant variables, and the two developed countries' equations had no significant variables. Wide price and quality differences are felt to be the primary reason for this result. However, other factors such as political ties and government subsidies may influence the budget share levels. Centrally planned countries had the most elastic price response, while the developed countries and the lower-income counties had the most inelastic price response.

The U.S. will undoubtedly remain a leading importer of tobacco, regardless of the policy measures made in the tobacco program. Domestic tobacco may regain market share in the domestic market, but its growth is limited by the nature of demand for lower nicotine cigarettes and the significant amount of complementary relationships existing between the various tobaccos.

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APPENDIX

Methodology for the Calculation of the Nicotine Content Indicator

The nicotine content indicator is a proxy variable for the average nicotine level in U.S. cigarettes. It is calculated as the weighted average of the nicotine content per cigarette brand (FTC measures) for the top eighteen cigarette brands in terms of sales. The FTC data on the nicotine level of each cigarette brand includes each variety of the parent brand. However, the sales data included only the parent cigarette brand name. To include the light or "low nicotine" cigarettes, calculation of the variable was conducted in the following manner:

-For each parent cigarette brand, the relevant type of brand was assumed to be the 100mm cigarette.

-In the absence of a 100mm brand, standard or regular size was assumed to be the relevant cigarette.

-Once a 100mm "light" brand appeared in the FTC data, then the nicotine nicotine level of the parent brand was assumed to be the weighted average of the regular 100mm (60 percent weight) and the "light" 100mm (40 percent weight).

The calculation becomes complicated even further due to the data. FTC data is available for each year from 1971-1984. No data could be found for 1985 or 1986, so the weights on the "light" and regular brands were .5 for 1985 and 1986. The sales data is derived from Businessweek in an annual article on the tobacco industry (the article generally appears in mid-December, but varies some appearing in October and November as well). These data contained a few missing observations however, and no sales data were available for 1972, 1975, or 1976. In these cases, sales were assumed to be the average of the sales immediately preceding and after the missing year(s).

FTC data

1971-1978 "Report of 'Tar' and Nicotine Content of the Smoke of n* varieties of Cigarettes" by the Federal Trade Commission (FTC).

Publication Date	Reported Period
Jan. 1973	1971,1972
Mar. 1974	1973
Sept. 1974	1974
May 1978	1975,1976,1977
Dec. 1979	1978

1979-1984 Federal Trade Commission Report, "'Tar', Nicotine, and Carbon Monoxide of the Smoke of n* varieties of Domestic Cigarettes."

Publication Date	Reported Period
Mar. 1981	1979
Dec. 1981	1980
Mar. 1983	1981
Feb. 1984	1982
Jan. 1985	1983,1984

Table 26. Expenditure Elasticities.

EQUATION	ELASTICITY FOR RESTRICTED MODEL	ELASTICITY FOR UNRESTRICTED MODEL
MODEL 1.		
Oriental	.5740	.4197
Imp. Flue-cured & burley	1.4371	2.1718
Domestic Flue-cured	1.3475	1.3143
Domestic burley	.6477	.5882
MODEL 2.		
Rest-of-oriental	.4114	.3838
Greece	.5859	.4860
Canada	-.6875	-1.0008
Mexico	4.7024	3.2620
Brazil	1.6145	2.5682
South Korea	2.7798	2.7723
Rest-of-world	1.8429	1.6995
MODEL 3: ORIENTAL		
Imp. flue-cured & burley	2.0504	1.9991
Developed	.5127	.6251
Middle-income	.4463	.3327
Centrally Planned	.2906	.5301
Other	-.1641	-.4413
MODEL 3: IMPORTED FLUE-CURED AND BURLEY		
Oriental	.4909	.3424
Developed	1.8880	2.0353
Low-income	1.3283	2.4177
Middle-income	.2799	.6815
Upper-middle-income	2.6347	2.8165
Centrally Planned	3.9001	3.6407
Other	-.1192	-.0222

VITA

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