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STUDIES IN THE DEMAND FOR U. S. EXPORTS OF AGRICULTURAL COMMODITIES

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ABSTRACT

In this report techniques for looking at the export demand for three U. S. agricultural products are brought together and summarized. The products are flue-cured tobacco, wheat and cotton. The unifying theme is that analyzing substitution relations and market share relations avoids the pitfalls that have plagued earlier attempts to derive statistical estimates in international trade. Similarly, combining cross section and time series data for direct estimation also provides estimates that are free of the previously encountered statistical problems.

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ACKNOWLEDGMENTS

The three studies that are synthesized and summarized in this report are the work of the individuals involved. Publication of the individual studies with complete details is forthcoming. The unifying theme of different methods is the concern of the present report. The hard work of digging out data, performing statistical analyses, and reporting the complete results is that of Drs. Richard Capel, Ian Reekie and Ghazi Sirhan.

STUDIES IN THE DEMAND FOR U. S. EXPORTS OF AGRICULTURAL COMMODITIES

I. Introduction

Paradoxically, the analysis of foreign markets for various products can be both easier and harder than analyzing domestic markets. For many goods, foreign markets can be taken as perfectly competitive for analytical purposes. In this case each country can be viewed as a price taker, and the implications of domestic policy changes can be inferred fairly directly by how much above or below the world price the domestic price settles as a result of the change. For other classes of goods this view of the world market is only true in the long run, if at all. The country involved may have a large enough share of the market to exercise some monopoly power in the price formation process, there are contractual agreements that extend over time, and good will and other factors may maintain price differences among suppliers over time.

This second class of products characterized by less than perfect price flexibility presents many problems of analysis. International trade abounds with distorting devices, e.g. quotas, tariffs, preferences fixed by law, as well as being at least (if not more so) as affected by exogenous shocks due to policy changes abroad, exchange crises and the weather as domestic markets.

This report represents a summary of three related studies for agricultural products where the U. S. as a supplier has a large market share, and consequently the knowledge of market response may be of some significance. The commodities are flue-cured tobacco, wheat and cotton. The basic studies represent three Ph.D. dissertations at N. C. State University by Richard Capel [2], C. I. M. Reekie [13], and Ghazi Sirhan

[14].[1] Much of the detail construed in these studies is omitted in this summary report. Although other methods are employed, a basic analytic theme common to all three of the studies is to analyze substitution relations among suppliers (or buyers). These relations are interesting in themselves, but drawing on studies by Harberger [6] and Telser [15], it is often possible to infer from these relations something about the response for the U. S. alone. The indirect method of inference is called for because of the theoretical and statistical problems that surround estimation of foreign trade elasticities.

Before turning to the individual studies, one can look at a general formulation that indicates the basic determinants of the demand for a particular product of a particular country. From this formulation a demand elasticity can be derived, and it is the size of this elasticity that would indicate whether or not the perfectly competitive market assumption was appropriate.

If we divide the world up into the country involved, here the U. S., and the rest of the world, the quantity demanded from the U. S. will be equal to the quantity demanded in the rest of the world minus that supplied by the rest of the world.

Symbolically,

$$(1) \quad X = D - S$$

where X is U. S. exports, D is quantity demanded in the rest of the world, and S is quantity supplied in the rest of the world. If this expression is differentiated with respect to price we have,

$$(2) \quad \frac{dX}{dp} = \frac{dD}{dp} - \frac{dS}{dp}$$

multiplying both sides by P/X we have the desired elasticity on the left

$$(3) \quad \eta_{us} = \frac{dD}{dp}\frac{P}{X} - \frac{dS}{dp}\frac{P}{X}$$

If we multiply and divide the demand term by D and the supply term by S, we get the well-known result:

$$(4) \quad \eta_{us} = \frac{D}{X}\eta_{w} - \frac{S}{X}\varepsilon_{w}$$

[1] Numbers in brackets refer to literature cited at the end of the report.

The elasticity of demand facing the U. S. varies directly with the elasticity of demand and supply in the rest of the world (since η_{us} and η_w are negative, all terms are negative) and inversely with the market share. That is, the larger the elasticities of demand and supply abroad the more elastic is U. S. export demand. The larger the market share of the U. S., the smaller the weights attached to the elasticities, the smaller is the elasticity of export demand and the more likely is the U. S. to affect market price.

Typically, we do not know enough about the right-hand side of (4) to make direct use of the relation, but in many instances plausible guesses about the relation are very useful and "better" than other estimates. For examples, see Harberger [6] and Johnson [9]. Also equation (4) has an implicit assumption that the product in D, X and S is homogeneous. The indirect approach can better handle the problem of differences in quality, taste, etc.

II. Flue-Cured Tobacco

Flue-cured tobacco is a product in which the United States has traditionally had a considerable degree of market power. The weights in equation (4) for this product are no greater than 4 if account is taken of differences in product quality. However, the U. S. share of the export market has declined from a high reached in the early fifties.[2] The domestic policy implications of the erosion of what is substantial market power are of some significance.

Elasticity of Substitution

The basic model used to analyze the market for flue-cured tobacco in this study is the elasticity of substitution model. Essentially what one is concerned with in such an analysis is the impact of a price change on the ratio in which two goods are consumed. Such models have been used in international trade by Harberger [6], McDougal [10],

[2] Currently (1970), the political problems of Rhodesia complicate to some extent discussion of trade in flue-cured tobacco. This complication should not be allowed to obscure the long-run tendency that would have accompanied a continuation of pre-1965 conditions.

Cohen [4], Zelder [16] and the basic studies summarized here: Capel [2], Reekie [13], and Sirhan [14]. Essentially the same model has been used to study relationships between domestic commodities as in Meinken et al. [12].

One formulation of the relationship is the following:

$$(5) \quad \left(\frac{q_1}{q_2}\right) = A \left(\frac{p_1}{p_2}\right)^{\beta} \left(z_1\right)^{\gamma_1} \left(z_2\right)^{\gamma_2} \cdots \left(z_k\right)^{\gamma_k}$$

where q_1, q_2 are quantities demanded of two goods, p_1, p_2 are the respective prices, z_i is a variable that affects the ratio (q_1/q_2) such as income, or other prices, β is the elasticity of substitution, and γ_i is an elasticity of (q_1/q_2) with respect to Z_i. Equation (5) can be derived from the basic demand equations for q_1 and q_2 if they are log linear functions of the variables on the right-hand side (see inter alios [6], [12], [14]). Further, if the income elasticities are equal for the two goods, and the cross elasticities are zero between 1 and 2 separately for all other goods, equation (5) reduces to:

$$(6) \quad \left(\frac{q_1}{q_2}\right) = A \left(\frac{p_1}{p_2}\right)^{\beta}$$

or, for statistical purposes:

$$(7) \quad \log \left(\frac{q_1}{q_2}\right) = \log A + \beta \log \left(\frac{p_1}{p_2}\right) + u$$

where u is a random disturbance.

A statistical problem that arises from the use of (7) is that there is no particular reason to suppose that the error, u, attaches only to the quantity ratio. If there are errors in both ratios, $\hat{\beta}$ in (7) is biased toward zero. Rather than adopt the Wald, Bartlett or some other method of handling errors in variables, the approach here will be to estimate equations like (7) and the alternative specification:

$$(8) \quad \log \left(\frac{p_1}{p_2}\right) = \log C + \frac{1}{\lambda} \log \left(\frac{q_1}{q_2}\right) + u'$$

The elasticity estimate from (8) will be biased away from zero. By looking at both (7) and (8), limits can be put on the estimate although the choice of a "best" point estimate is not resolved.

The use of the substitution approach for tobacco is to compare imports of U. S. tobacco with all other flue-cured tobacco in each of several importing countries. The results of estimating equations (7) and (8) for the eight leading importers of U. S. flue-cured tobacco for the years 1955-64 are shown in Table 1. As can be seen, only four of the regressions yield statistically significant elasticities. With the exception of Japan, the nonsignificant countries are minor importers. The Japanese case involves a state trading monopoly which may explain the lack of significance there.

An analysis of covariance led to the acceptance of the hypothesis that there was no difference in the estimates for the U. K., West Germany, and Benelux. Consequently, these three were combined to yield the estimates in Table 2. The 95 percent confidence interval for these estimates is shown in Table 3.

Implications

To derive implications for the export market, it is necessary to make projections of future demand and price movements. One of the outcomes of the current study was to project to 1975 the total imports of the countries under consideration. By employing various assumptions about retaliation and total market demand, it is possible to make predictions about the U. S. demand in the future.

Projections for 1975 of imports of selected countries of flue-cured tobacco are shown in Table 4. In Table 5 are shown the projected effects on imports from two possible price changes. One assumes that a 20 percent price reduction on the part of the U. S. would be accompanied by no change in price for competing tobaccos. The second assumes that the reduction would be accompanied by a 10 percent retaliation. In both cases the market elasticity of demand is assumed to be zero. That is, a unilateral price change by the U. S. while changing the average market price would not change the quantity demanded. This assumption is made to make the examples simpler but, given the low elasticity of demand for tobacco, is not a wildly unrealistic assumption.

Table 1. Estimated elasticities of substitution in import demand between flue-cured tobacco from the United States and tobacco from other countries

Importing country	Estimated elasticity of substitution		Standard error of estimate for first coefficient	R^2
	Estimated with prices independent	Estimated with quantities independent		
United Kingdom	-2.47*	-3.33*	.515	.743
West Germany	-3.57*	-4.03*	.455	.885
Benelux	-2.54*	-4.43*	.775	.573
Japan	-0.81	-5.98	.722	.135
Egypt	-2.19*	-3.99*	.702	.550
Ireland	-0.99	-6.70	.840	.148
Denmark	-1.04	-3.00	.583	.347
Sweden	-0.26	-4.86	.384	.053

*Coefficient differs significantly from zero at the 5-percent probability level.

Table 2. Estimated elasticity of substitution in import demand between flue-cured tobacco from the United States and tobacco from other countries[a]

Importing countries	Elasticity of substitution		Standard error of estimate for first equation	R^2
	Quantity ratio dependent	Price ratio dependent		
United Kingdom				
West Germany	-2.92*	-3.92*	.335	.759[b]
Benelux				.904

*Coefficient differs significantly from zero at the 5-percent probability level.

[a]The results of the regressions are as follows:

$$\log\left(\frac{A}{B}\right) = .25275 - \underset{(.03203)}{.19347}\, X_1 - \underset{(.04833)}{.08607}\, X_2 - \underset{(.33516)}{2.91659} \log\left(\frac{P_a}{P_b}\right)$$

and

$$\log\left(\frac{P_a}{P_b}\right) = .09866 - \underset{(.00838)}{.06149}\, X_1 - \underset{(.01468)}{.01898}\, X_2 - \underset{(.02933)}{.25523} \log\left(\frac{A}{B}\right)$$

where

X_1, X_2 = dummy variables equal to one for observations on West Germany and Benelux, respectively; zero otherwise.

The model was reparameterized so that the sum of the coefficients for the United Kingdom, West Germany and Benelux is equal to zero.

[b]Two R^2's exist as the dummy variables affect the fit of the relations.

Table 3. The 95-percent confidence interval on the elasticity of substitution estimated using the model incorporating dummy variables

Relation	Coefficient	Standard error of coefficient	$t_{.05(26)}$	Confidence limits
Quantity ratio dependent	-2.91659	0.33516	2.056	-2.228, -3.606
Price ratio dependent	-0.25523	0.02933	2.056	-0.316, -0.195
Reciprocal of confidence limits of price ratio dependent estimate				-3.169, -5.130
Extreme confidence limits				-2.228, -5.130

Table 4. Projected imports of flue-cured tobacco from the United States by selected countries, export weight, in 1975

Country	Imports of flue-cured tobacco from the United States	
	Average 1958-1962[a]	Projections[b] 1975
	(million pounds)	(million pounds)
United Kingdom	143.5	84
West Germany	56.0	78
Netherlands	18.0	11
Belgium	13.0	8
Japan	15.4	94
Australia	19.1	8
Egypt	6.9	26
Ireland	12.9	14
Denmark	11.0	12
Sweden	7.5	8
Totals	303.3	343

[a]Sources: Commodity Trade Statistics, 1956-1965, Department of Economic and Social Affairs, Statistical Office, United Nations, New York; and Foreign Agricultural Circular, 1953-1965, Foreign Agricultural Service, U. S. Department of Agriculture, Washington, D. C.

[b]Under the assumption of no change in United States policy affecting the price of United States flue-cured tobacco.

Table 5. Effects on United States exports of flue-cured tobacco in 1975 due to reducing its price by 20 percent

Importing country	Estimated change in exports of United States flue-cured tobacco			
	Assuming no change in prices of competing tobacco[a]		Assuming prices of competing tobacco decrease by 10 percent[a]	
	(million pounds, export weight)			
United Kingdom	23.92	48.11	12.66	27.08
West Germany	25.48	53.00	13.30	28.98
Netherlands	4.13	8.92	2.12	4.71
Belgium	2.99	6.48	1.53	3.42
Japan	9.53	16.74	5.41	10.59
Australia	1.74	3.32	0.94	1.95
Egypt	3.89	7.07	2.17	4.34
Ireland	0.29	0.49	0.17	0.32
Denmark	2.99	5.85	1.60	3.37
Sweden	2.07	4.08	1.11	2.34
Totals	77.03	154.06	41.01	87.10

[a]High and low estimates are made using the 95-percent confidence limits of the elasticity of substitution.

For example, the first entry in Table 5, 23.92 for the U. K. indicates that U. S. exports would increase that much over the 84 million pounds shown in Table 4 from a 20 percent price reduction if the elasticity of substitution is -2.228. The 48.11 million pound increase is calculated using an elasticity of substitution of -5.130. Applying the same procedure to the total 343 million pounds, the percentage increase in U. S. exports (to these particular markets) would increase 22.7 to 45.3 percent with no price retaliation and 12.1 to 25.7 percent with a 10 percent price change for other tobacco. The implied elasticities of demand for U. S. tobacco from these calculations are -1.13 to -2.27 for the first price assumption, and -.61 to -1.28 for the second assumption.

While the elasticity estimates are greater than one and imply an increase in gross receipts from a unilateral price reduction, net receipts would decline if the cost structure stayed the same (Capel [2]). Conversely, the small size of the elasticities would imply considerable market power and an increase in net revenue from a unilateral price increase. A fuller discussion of this latter case is contained in Johnson [8]. The increase would only be expected to hold in the short run.

III. Wheat

Two models were used for analyzing the wheat market, an elasticity of substitution model as in tobacco and a direct method employing dummy variables for countries and years to avoid the specification problem that usually affects statistical studies in international trade.

Elasticity of Substitution

The elasticity of substitution model was used for eight countries for the years 1951-63. During this period the market shares of the four major exporters were: Canada--29.6, U. S.--26.8, Argentina--7.5, and Australia--11.7. A potential problem for this period was that almost 60 percent of U. S. sales abroad for wheat were concessional sales through P.L. 480 and similar programs. The current study concentrates on commercial sales and on those countries which only imported on a commercial basis. It seems reasonable that the two markets, i.e.,

concessional and commercial, can be separated. Sales under P.L. 480 and other concessional programs would seem to affect supply conditions in the underdeveloped countries and the U. S. more than the demand conditions of commercial importers. Another potential problem was that most of the world's exporters and importers were signatories of the International Wheat Agreement. Fortunately, during most of the period relative price fluctuations took place within the limits of the agreement and a potential exogenous factor did not come into play.

The estimated elasticity of substitution between Canada and the U. S. for eight countries and 13 years was -3.38 where the quantity ratio was dependent and -56.12 where the price ratio was dependent. The former is biased towards zero, and the latter away from zero. The -56.12 figure seems much too large both from the standpoint of a priori reasoning and related studies. Therefore, implications are derived only for the lower -3.38 figure.

Table 6 shows the predicted results of a 1 percent decrease in the price of U. S. wheat under various assumptions about the total market and Canadian behavior. As in the case of tobacco, these changes clearly increase gross revenue, but for any substantial price change, a decrease in net revenue to wheat exporters, ceteris paribus, would be predicted.

Direct Estimation of the Elasticities

Direct estimates of the elasticity of demand for U. S. and other wheat were made using the following model:

$$(9)\quad q_{ij} = a_o + b_1 p_{ij} + b_2 Y_{ij} + b_3 S_{(i-1)j} + \sum_{i=1}^{T} a_i T_i + \sum_{j=1}^{C} a_j C$$

where q_{ij} is the logarithm of the quantity of wheat imported in the i^{th} year by the j^{th} country, p_{ij} is the logarithm of the price for that country for that year, Y_{ij} is an income proxy for that country and that year in the form of the logarithm of per capita net product, $S_{(i-1)j}$ is the logarithm of lagged domestic production of wheat in the j^{th} country, T_i is a dummy for years that take the value 1 when i = 1, ... t, and zero otherwise, C is a dummy for country that takes the value 1 when j = 1, ... C and 0 otherwise.

Table 6. Estimated aggregate increase in United States wheat exports for years of high, average and low sales to a group of eight selected countries in response to a 1 percent reduction in the price of United States wheat[a]

Item	Aggregate demand elasticity zero		Aggregate demand elasticity = -.5	
	No Canadian retaliation	Canadian price cut of 1/2 percent	No Canadian price retaliation	Canadian price cut of 1/2 percent
	(thousands of metric tons)			
High sales year	121	60	139	69
Average sales year	97	49	112	57
Low sales year	78	39	90	45

[a]Elasticity of substitution between United States and Canadian wheat = -3.38.

This formulation has the implicit assumption that the b's are the same for all countries and all years. For instance, the price response for all countries is the same but the level of the response differs. In this way data from several countries and time periods can be pooled. One can thus avoid dependence on short time series which fail to reveal long-run type responses and so yield underestimates of relevant elasticities. One of the reasons for the traditional low elasticity of demand that have been estimated in international trade is thus eliminated.[3,4]

The results for fitting equation (9) for Canada, the U. S., Argentina and Australia are shown in Table 7. The parameter estimates for Argentina and Australia are not satisfactory. The coefficients on the price variable have the wrong sign, as does the income variable for Argentina. The three variables shown do not contain much of the explanatory power of the model so the fairly satisfactory R^2 in each case is not useful either. Two reasons for this state of affairs are that the samples are smaller for these two than for the U. S. and Canada, there being fewer cross section and one or two fewer time series observations; and the data may not be strictly comparable with the North American data. The data are reported by the importers and thus the sources are different for different sets of importers. No attempt has been made to find new data or respecify the model for Argentina or Australia.

The regressions for the U. S. and Canada, on the other hand, yield plausible looking estimates. As equation (9) is linear in the logarithm, the values shown in Table 7 are elasticities. The price elasticity of export demand for both U. S. and Canadian wheat is estimated to be -3.8, with both coefficients significant at the 5 percent probability level. These estimates are much more elastic than those found by Meinken [11] based largely on prewar data. In fact Meinken's estimates would imply

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[3]The question of biased coefficients because of errors in variables is not taken up with this model.

[4]A statistical problem for the model is that the matrix of sum of squares and cross production is singular. The restrictions $\Sigma T = 0$, and $\Sigma S = 0$ were imposed to estimate the parameters.

Table 7. Estimated coefficients of demand equations for imports of United States, Canadian, Argentinian and Australian wheat by selected countries[a]

Exporter	Variable[b]	Coefficient	Standard error of coefficient	R^2	d.f.
United States				.77	78
	X_1	-3.82*	1.73		
	X_2	.07	1.41		
	X_3	-1.69**	.34		
Canada				.90	66
	X_1	-3.81*	1.86		
	X_2	1.90	1.00		
	X_3	-1.21**	.27		
Argentina				.81	30
	X_1	6.43**	2.39		
	X_2	-3.22	4.69		
	X_3	- .38	.23		
Australia				.89	21
	X_1	7.67	4.26		
	X_2	.21	1.93		
	X_3	-2.47*	1.15		

[a]From the United States and Canada: United Kingdom, Japan, West Germany, Holland, Denmark, Norway, Italy and Venezuela. From Argentina: United Kingdom, West Germany, Holland, Denmark, Norway, Italy and France. From Australia: United Kingdom, Japan, West Germany and Ireland.

[b]X_1: price, X_2: index of per capita product in importing country, X_3: wheat production in importing country in year (i-1).

*Coefficient significantly different from zero at the 5 percent level of probability.

**Coefficient significantly different from zero at the 1 percent level of probability.

that the price system was malfunctioning. The estimates are more in line with those found by Horner [7] for Australia. These elasticities probably overstate the market power of either Canada or the United States, but they show that this model, which combines the long-run response implicit in the cross section with the short-run response implicit in the time series, yields elasticities directly that are more consistent with a priori expectations about magnitudes than time series regressions of aggregate exports.

The coefficient for income is not significant for either Canada or the United States. Probably the dummy variables for the various importers are picking up the income effect among countries to explain this result. The domestic supply (of importers) variable in each case is significant with postulated sign and plausible magnitude. A given change in domestic output leads to a slightly larger than proportionate change in imports in the next period. In each case a 90 percent confidence interval would include an elasticity of minus one, and this seems to be the most plausible value, ceteris paribus.

IV. Cotton

Again, for cotton two models were used, the elasticity of substitution model and a market share model. The former is roughly the same as in the previous two studies while the latter is new.

Elasticity of Substitution

For cotton the elasticity of substitution model was used to calculate elasticities between the United States and competitive exporters into each of two markets--Great Britain and West Germany. The time period involved was 1955 to 1966. While quarterly data were also used for West Germany, only the annual data analysis is reported here. In general, the quarterly data yielded estimated elasticities that were larger than those shown here.

The results for Britain are shown in Table 8 and for West Germany in Table 9. Several two by two comparisons were made in each case, and the last entry is the comparison of the United States with the aggregate of other importers. As expected the aggregate elasticities, -8.3 for

Table 8. Estimated elasticities of substitution between cotton from the United States and cotton from other countries in the British importing market[a]

Period	Countries compared	Constant term	Regression coefficients: Substitution elasticity	Regression coefficients: Coefficient of trend	Standard error of estimate	R^2
1955/56-1966-67	U.S.-Mexico	0.832	-17.081** (2.594)		0.1699	.812
1956/57-1966/67	U.S.-Nicaragua	1.158	-11.389** (4.858)		0.2580	.379
1955/56-1966/67	U.S.-Syria	1.435	-19.346** (4.600)		0.2715	.638
1955/56-1966/67	U.S.-Iran	0.604	-15.896** (5.225)	-0.054** (0.015)	0.3004	.623
1955/56-1966/67	U.S.-Pakistan	0.142	-13.096** (4.372)		0.3339	.473
1953/54-1966/67	U.S.-aggregate of other sources	-0.257	- 8.282** (3.730)	-0.024** (0.008)	0.2286	.458

[a]United States cotton of staple length 1 to 1/8 inches is compared to Mexican, Nicaraguan, Syrian and Iranian cotton growth; and United States cotton of staple length less than 1 inch is compared to Pakistanese growth.

**Coefficient differs significantly from zero at the 5 percent level of probability.

Table 9. Estimated elasticities of substitution between cotton from the United States and cotton from other countries in the West German importing market

Period	Countries compared	Constant term	Regression coefficients: Substitution elasticity	Regression coefficients: Coefficient of trend	Standard error of estimate	R^2
1953/54-1966/67	U.S.-Mexico	0.430	-18.420** (2.938)		0.2156	.766
1955/56-1966/67	U.S.-Nicaragua	0.090	-13.887** (4.244)		0.3817	.517
1955/56-1966/67	U.S.-Iran	1.444	-17.837** (4.588)	-0.065** (0.015)	0.3025	.712
1953/54-1966/67	U.S.-aggregate of other sources	-0.410	-10.359** (4.2650)		0.3281	.329
1953/54-1966/67	U.S.-aggregate of other sources	-0.376	-12.893**	-0.027** (0.008)	0.2471	.651

**Coefficient differs significantly from zero at the 5 percent level of probability.

Britain and -10.3 or -12.9 for Germany, were less than the two country elasticities. In the case of Britain only an equation containing a trend term gave significant elasticities.[5]

The trend term has a plausible interpretation. The negative sign indicates a declining market share for the United States through the time period. Such a decline was the case, so that one can conclude that some institutional factors as well as prices were affecting the market.

Data on imports of rayon are available for Britain but not for Germany. An elasticity of substitution model for British imports of raw cotton and rayon was fitted for 1953-66. The resulting equation was:

$$(10) \quad \log (q_1/q_2) = 3.09 - \underset{(1.34)}{3.69} \log (p_1/p_2) - \underset{(0.01)}{0.16T}$$

$$R = 0.98$$

where q_1 is cotton, q_2 is rayon fiber, p_1 is U. S. middling 1 and cotton price, p_2 is "list" price of rayon. The trend term emphasizes the technical and economic factors displacing cotton, and the significant elasticity indicates a sizable shift between fibers for given price changes.

The Market Share Model

Another way of looking at substitution possibilities is to ask what happens to the share of the market going to a particular exporter when his price is changed. Telser [15] has used a market share model for brand switching in certain consumer goods. Telser derives an equation similar to (11):

$$(11) \quad Ma = f(P_a, P_o)$$

where Ma represents (say) the U. S. share of the cotton imports in a market, P_a is the price of U. S. cotton, and P_o is the average price of cotton from other suppliers. Telser derives his model from a more

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[5] Only regressions of quantities on price ratios are made. As noted earlier this will yield biased estimates from error in p_1/p_j. The major focus of the cotton study was on the market share model and so the alternative estimates (which will be larger, in general) were not made.

fundamental behavior assumption that brand switches are a first order Markov stochastic process. The shares then are derivable from transition probabilities.

The elasticity of market share is $\frac{\partial M_a}{\partial P_a} \cdot \frac{P_a}{M_a}$. This elasticity will be negative, the greater P_a the smaller M_a. The greater the elasticity (in absolute terms), the greater the switching to other sources. The relationship between the elasticity of foreign demand and the elasticity of market share is given by:

$$(12) \quad \frac{dq_a}{dp_a} \cdot \frac{P_a}{q_a} = \frac{dM_a}{dp_a} \cdot \frac{P_a}{M_a} + \frac{dQ}{dp_a} \cdot \frac{P_a}{Q}$$

where the term on the left is the price elasticity of demand, the first term on the right is the market share elasticity and the second term is the elasticity of total demand with respect to the price of a.[6] The price elasticity of demand is thus larger than the market share elasticity by the magnitude of the second term in (12).

The view taken here is that shares that do not go either to zero or 100 percent from price changes can be supported by three attributes of the market involved. Importers identify quality (and other attributes) of particular countries from whom they buy. Related to the first reason is the assumption that cotton imports are close but not perfect substitutes. The third assumption is that responses to prices are gradual rather than instantaneous. The attenuation of the response can be due to institutional arrangements, uncertainty as to the permanence of the price change, and various other reasons.

These assumptions lead to a standard distributed lag system:

$$(13) \quad M^*_{at} = f(P_A, P_O)$$

$$(14) \quad M_{at} - M_{at-1} = \gamma(M^*_{at} - M_{at-1})$$

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[6] This result is gotten from differentiating $q_a = M_a Q$ with respect to P_a. (See Telser [15] and Sirhan [14].) The second term in (12) as derived by Telser is in terms of average and total observed prices and is equal to $\frac{\bar{P} - (1 - Ma)\bar{P}_a}{Q} \frac{dQ}{d\bar{P}}$ where $\bar{P}$ is the average price, $\bar{P}_a$ is the average price without P_a.

where M^*_{at} is the desired or long-run market share, relation (14) represents the partial adjustment mechanism where only the fraction γ of the desired adjustment is accomplished in a period.

The high collinearity between P_A and P_0 requires those variables to be collapsed into a single variable P_t. The standard reduced form for the system is then:[7]

$$(15) \quad M_{at} = a\gamma + \gamma b P_t + (1 - \gamma) M_{at-1} + u$$

In this form γb is the short-run response parameter, γ is the adjustment parameter and b/γ is the long-run response. The elasticity of market share with respect to price is $\frac{\partial M_{at}}{\partial P_a} \cdot \frac{P_a}{M_{at}}$. When the price variable is collapsed, the elasticity will be taken with respect to P_t and since P_t is already in ratio form, the elasticity for (15) will be $\gamma b P_{t/M_{at}}$.

The results from fitting relation (15) are shown in Table 10 for the British import market, and for the West German import market in Table 11. The elasticities are shown in Table 12. The short-run elasticities are greater than 2 in all cases, and are quite large for the West German market. The long-run elasticities, of course, are larger than the short-run estimates. The implied losses of market share from fairly small price changes are thus quite large.

Attempts to estimate statistically the elasticity of total British imports with respect to P_a were not successful. However, from other sources an estimate of a $\frac{dQ}{dP_a}$ was made,[8] and the implied $\frac{dQ}{dP} \cdot \frac{P_a}{Q}$ was -0.11. This amount would be added to the British market share elasticities to get the implied price elasticity.

V. Summary and Elasticities of Export Demand

A model developed by Harberger [6] can be used to place all of the elasticity of substitution estimates on the same footing. No attempt

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[7] This brief treatment does not consider the statistical and specification problems of this model. The problems are well known; a complete survey is to be found in Griliches [5].

[8] Derived from Cathcart and Donald [3].

Table 10. United States cotton share in the British import market: Statistical results (1953-54-1966-67)[a]

Equations	Dependent variable: $M_{at} = (q_a/Q_T)_t$	Constant term b_0	Regression coefficients of: Price variable, when $P_t = P_{at}/\bar{P}_{ot}$ b_1	Lagged market share M_{at-1} b_2	Trend, T b_3	Standard error of estimate	Coefficient of determination R^2
Linear	Where						
1	Q_T = aggr. imports from all sources	2.7282	-2.3171 (0.8116)	0.4451 (0.2534)	-0.02166 (0.0080)	0.10730	.566
2	Q_T = aggr. imports from all sources	2.8177	-2.6158 (1.3003)	0.5693 (0.3015)		0.1286	.311
3	Q_T = aggr. of imports from 5 sources[b]	2.1638	-1.9005 (.7743)	0.7205 (0.2953)		0.1008	.402
Logarithmic							
4		0.0592	-2.8859 (1.1436)	0.7391 (.2959)		0.04382	.412

[a]Numbers in parentheses are standard errors.

[b]Includes the United States, Mexico, Nicaragua, Syria and Iran.

Table 11. United States cotton share in the West German import market: Statistical results (1953-54-1966-67)[a]

Equations	Dependent variable: $M_{at} = (q_a/Q_T)_t$	Constant term b_0	Regression coefficients of: Price variable, when $P_t = P_{at}/\bar{P}_{ot}$ b_1	Lagged market share M_{at-1} b_2	Trend, T b_3	Standard error of estimate	Coefficient of determination R^2
Linear	Where						
1	Q_T = aggr. of imports from all sources	2.0734	-1.8456 (0.8566)	0.3119 (0.3035)		0.1458	.317
2	Q_T = aggr. of imports from all sources	2.7971	-2.2761 (0.6130)	0.1110 (0.2206)	-0.02819 (.0 083)	0.1021	.699
Logarithmic							
3	Q_T = aggr. of imports from all sources	-0.4594	-8.9853 (3.8015)	0.1692 (0.2997)		0.2586	.372

[a]Numbers in parentheses are standard errors.

Table 12. Estimates of elasticities of the U. S. market share of cotton in the British and West German markets

Equation (from Tables 10 and 11)	Short-run response	Short-run elasticity	Long-run elasticity
Britain			
1	-2.32	-7.48	-13.59
2	-2.62	-8.42	-19.57
3	-1.90	-2.63	- 9.39
4		-2.81	-10.78
Germany			
1	-2.68	-7.40	-10.72
2	-2.60	-9.12	-10.36
3		-8.72	-10.50

is made here to repeat the complete logic underlying the Harberger model. The basic idea is that under certain assumptions a direct link exists between the elasticity of substitution and the demand elasticity for each of the goods in question. If two goods are the only significant substitutes, i.e., each is unrelated to third (and other) goods, then a simple relationship exists between the elasticity of demand and the elasticity of substitution.

$$(16) \quad E_{11} = \frac{V_2}{V_1 + V_2} B_{12}$$

where E_{11} is the elasticity of demand, B_{12} is the elasticity of substitution and V_1 and V_2 are expenditures on the two goods. If good 1 is a net substitute for other commodities (the most likely case), then equation (16) will underestimate the true elasticity.

For cotton and tobacco the elasticities of substitution are for the U. S. product versus essentially all competitors in various import markets. For wheat the elasticity is between exports of the U. S. and Canada in eight countries, so that wheat has a different kind of interpretation than cotton and tobacco.

The relevant elasticities are shown in Table 13. The market shares shown in the second column are averages over the periods used to estimate the substitution elasticities. The bracketing values for the tobacco estimates of the elasticity of substitution are both shown, while for wheat and cotton only the quantity ratio dependent estimate is shown.

All of the elasticities are greater than one in absolute value. One does not get the nonsensical result that individual countries are facing an inelastic demand for their goods that has been quite common in empirical studies in international trade. One would expect the tobacco elasticity to be fairly small as this is the commodity for which the U. S. has the strongest monopoly position. The cotton elasticities appear reasonable. Given the alternative supply sources, and the alternative fibers, one would expect the demand facing U. S. cotton to be quite elastic.

The wheat elasticity is probably an underestimate. Only about three-fifths of all exports are being considered. The comparison between only Canada and the U. S. probably understates the true

Table 13. Estimated elasticities of U. S. export demand from elasticity of substitution calculations

Commodity	U. S. market share (percent)	Elasticity of substitution	Implied elasticity of demand
Tobacco (low)	54.9	- 2.92	-1.32
Tobacco (high)	54.9	- 3.92	-1.77
Wheat	47.5[a]	- 3.38	-1.77
Cotton (Eng.)	25.0	- 8.28	-6.21
Cotton (Germany)	20.0	-10.36	-8.29

[a]This is the share of the market for U. S. and Canadian wheat alone.

elasticity. The elasticity found directly earlier was also higher than this estimate.

Overall, the results for all three commodities are encouraging for the methods used. In all cases and for various estimating procedures, the implications are that the price elasticities of demand are elastic. Some of them are low enough that substantial monopoly power is implied, but none is so low as to imply irrational behavior. Earlier studies, such as Meinken [11] for wheat, which show a price elasticity less than one do imply such behavior.[9] The methods used here of combining cross section and time series, specifying market shares rather than direct quantities, and looking at substitution responses all have the advantage of utilizing international trade data so that reasonable looking results are obtained.

[9]It is possible that some observations for the earlier studies such as Blakely and Meinken taken from the 1930's and 1940's were from markets that were constrained in various ways so that "expected" elasticities might not be realized. Therefore, direct (and certainly invidious) comparisons may not be appropriate.

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