The Elasticity of Export Demand for U.S. Cotton

Laxmi Paudel
Graduate Student
Dept of Agricultural and Applied Economics
The University of Georgia, Conner, 205
Athens, GA 30602
email:lpaudel@agecon.uga.edu

Dr. Jack E. Houston
Professor
Dept of Agricultural and Applied Economics
The University of Georgia, Conner, 305
Athens, GA
email:jhouston@agecon.uga.edu

Murali Adhikari
Graduate Student
Dept of Agricultural and Applied Economics
The University of Georgia, Conner, 205
Athens, GA
email: madhikari@agecon.uga.edu

Nirmala Devkota
Graduate Student
Dept of Agricultural and Applied Economics
The University of Georgia, Conner, 305
Athens, GA
email:ndevkota@agecon.uga.edu

Selected Paper prepared for presentation at the Southern Agricultural Economics Association Annual Tulsa, Oklahoma, February 18, 2004

The Elasticity of Export Demand for U.S. Cotton

Abstract

There exist conflicting views among the researchers about the magnitudes of US cotton export demand elasticity, ranging from the highly inelastic to highly elastic. An Armington model was used to analyze the export demand elasticity of US Cotton. Our analysis confirms an elastic nature of US cotton export demand.

Keywords: Armington model, Cotton, Export demand, Elasticity

The United States ranks second in world cotton production, third in world cotton consumption and size of ending cotton stocks. US cotton also represents a multi million dollars agricultural industry affecting the domestic economy and welfare of thousands of US cotton farmers. However, current situation of low cotton prices, emerging competitors, and volatile export markets make international export market hostile for US cotton producers and raise the importance of US cotton export demand elasticity.

Because of the current economic characterized by the lower commodities prices and volatile export markets; many researchers analyze the issue of price elasticity of export demands. However, there exist disagreeing views about the magnitude of US cotton export demand elasticity. Therefore, our study estimates the elasticity of foreign demand for US cotton to confirm its magnitude.

Literature Review

In spite of the critical role of export demand elasticities for policy makers, there exist different views about the magnitude of the elasticity of export demand of US cotton. Johnson (1977) uses a following formula developed by Floyd to calculate the export demand elasticity.

$$N_X = \sum_i e_i \{(Q_{di} / Q_X) N_{di} - (Q_{si} / Q_X) E_i\} \text{.....(1)}$$

Where N_x is elasticity of export demand facing the US. N_{di} is elasticity of export demand for cotton in country i. E_i is elasticity of supply of cotton in country i. Q_{di} represents demand for cotton in country i. Q_s represents production of cotton in country i. Q_x represent US exports of cotton to all countries. e_i represent the elasticity of price transmission. He assumes domestic cotton demand elasticity of –0.2, price transmission elasticity 1 and a domestic supply elasticity of 0.2 leading to export elasticity of cotton of –5.5.

Using Johnson‘s assumptions about the elasticity of domestic supply and demand and assuming unitary price transmission elasticity for all areas, Wohlgenant estimates the US cotton export demand elasticity. He estimates an export demand equation econometrically using cotton exports as a dependent variable and the deflated U.S. cotton price, deflated world cotton price, and trend variables as a exogenous variables. The study results yield an own- price elasticity of –2.24 and US cotton export demand elasticity of –2.0.

Bredahl et al assume unitary price transmission elasticity and estimate the export demand elasticity for US cotton. The findings of the study shows an estimate of –0.65 and a global free trade elasticity of –1.92.

Johnson and Sirhan use a market share model to estimate the US cotton demand elasticity in the United Kingdom (UK) and West Germany. In this analysis, estimated elasticities range from –2.70 to –9.39. Babula *et. al.* use an Armington model to analyze the US cotton exports and obtain an own price elasticity of –0.75, a considerably low elasticity in comparison to the estimates of Johnson, Sirhan and Johnson, and Wohlgenant study. However, finding seems consistent with the Bredahl et al.s' analysis.

Armington's Framework

Armington develops a theory of international demand for commodities, which are differentiated by its kind and origin. Armington further builds import demand equations, which are relatively sparse in parameters by making several assumptions like homogenously separable importer preferences. Armington model offers a powerful method of modeling crop exports and estimating the elasticity of import demand for a particular region. Armington model estimates a system of market share demand equations with the sigma constrained, which is supposed to be equal across all equations.

Although the Armington approach can be used in linear equations where parameters relatively easy to estimate, some efforts are needed to estimate sigma directly. Given the importance of the sigma in finding the export demand elasticity, we estimate sigma in our study.

In order to formulate appropriate model for the empirical work, Armington assumes elasticity of substitution between any two products is constant and equal to the elasticity of the substitution between any other product pair in the market. The resulting import demand equations are of the form:

$$\frac{X_i}{X_t} = b^{\sigma} \left(\frac{P_i}{P^*}\right)^{-\sigma} \text{.....(2)}$$

Where,

Xi = Demand for a product

X_t = Demand for the good of which X_i is one product

P_i = Price of X_i

P^* = World Average price in the market

σ = Elasticity of substitution between product pairs

X_i/X_t = Market share of X_i

Taking the natural logarithmic of equation (2) gives an equation where parameters are linear. This equation can be estimated by using standard regression procedures. The average price P^* is a market share weighted average of all product prices in the market.

Thus,

$$P^* = P_{US} * MS_{US} + \sum_i P_i * MS_i \text{.....(3)}$$

Where P_{US} is US price and MS_{US} is US market share in selected US cotton importing countries and P_i is prices of other cotton products and MS_i is market shares of other cotton products. The quantity of US cotton imported by region can be found by multiplying MS_{US} by X_T

$$X_{US} = MS_{US} * X_T \text{.....(4)}$$

Own price demand elasticity for US cotton was calculated by differentiating (4) with respect to the US price and multiplying both sides of the equation by P_{us}/X_{us}:

$$N_{us} = -\sigma \{1 - (\frac{P_{us}}{P^*})(\frac{dP^*}{dP_{us}})\} + (\frac{P_{us}}{P^*})(\frac{dP^*}{dP_{us}})N_t \text{.....(5)}$$

Where, N_{US} is the elasticity of demand for US cotton and N_t is the elasticity of demand for all cotton. If all competing exporters respond in a similar manner to changes in the US price then:

$$\frac{dP^*}{dP_{us}} = MS_{us} + \rho(1 - MS_{us}) \text{.....(5}a\text{)}$$

Where, ρ is the change in price of competing cotton countries with respect to a change in US price. Substituting into (5) yields:

$$N_{us} = -\sigma \{1 - (\frac{P_{us}}{P^*})(MS_{us} + \rho(1 - MS_{us}))\} + (\frac{P_{us}}{P^*})N_t(MS_{us} + \rho(1 - MS_{us})) \text{.....(6)}$$

In Armington's and other studies, the changes in other exporter's price with respect to US price is assumed to be zero. P_{us}/P^* is close to one for cotton. If changes in other cotton prices is ignored and the price ratio is approximated to be unity, equation (6) can be written as

$$N_{US} = -\sigma \{1 - MS_{US}\} + MS_{US} * N_t \text{.....(7)}$$

Where, N_{US} is the US cotton demand elasticity and N_t is the elasticity of demand for all cotton. MS_{US} represents the market share of US cotton.

By assuming sigma equal to 3, Armington and Grennes *et al*.s' estimate equation seven to calculate the US cotton demand elasticity. However, due to the importance of the sigma in the export demand elasticity, sigma was directly estimated by using equation 2 in our study.

Estimation results

In our study, yearly time series data from 1989 to 2002 were used. Some modifications of the basic Armington model were made. A lagged dependent variable and a trend variable were included in the model. All data used in the analysis were obtained from various issues of Cotton World Statistics. US cotton price is the C.I.F. Liverpool price of S.M.1-1/16 cotton.

The selected countries were grouped into five regions: (1) EU-15 (2) Major Asia (3) Mexico (4) Middle East (5) South Asia. However, due to the data unavailability and time limitation, the regional model was not fitted in this analysis. We selected major US cotton importing countries such as China, Indonesia, Thailand, Taiwan, Japan, Bangladesh, Korea, republic of, Mexico, Pakistan, and Italy for analysis. Individual country model was fitted for all countries, which consistently imported US cotton from 1989 to 2002.

Table 1 shows results obtained from the analysis of US market share equation for the major Asian markets. Analysis yield expected signs for all variables. And all the price variables were significant at 10 percent probability level. Study results also reveal that If the price of US cotton increased in comparison with other foreign competitors' prices, consumers in the importing country could switch to cotton from other sources, resulting in a decline in the US cotton share in

the given export market. Thus, market share is a decreasing function of US cotton price and the slope of US cotton import market share is negative.

Table 1. US Cotton Share in Selected Major Asian Market: Statistical Results, 1989-2002

Country	β_0(Const)	β_1(Price)	β_2(Lagged)	β_3(Time)	RMSE	R^2
China	-9.61	-2.29*	0.08**	0.35	0.8	0.40
Indonesia	-11.33**	-2.96**	0.16**	-0.21*	0.08	0.54
Thailand	-	-3.22*	0.53**	-0.32	0.04	0.54
Taiwan	-2.91*	-3.44**	0.42*	0.05*	0.12	0.42
Japan	-2.28**	-4.99*	0.09**	0.03**	0.1	0.5

Note: ** and * indicate the significant coefficient at 10%level and 5%level respectively.

The elasticity of US cotton import share with respect to price of US cotton was negative and its estimation provides an indication of the magnitude of competition between US cotton and foreign cotton in an export market. A relatively high coefficient, in absolute term, is indicative of a high degree of competition between the US and other cotton exporters. Most of the countries' lagged market share variable is also significant at the 10 percent level. The short run and long run elasticities of US cotton market share were computed on the basis of the coefficient obtained.

Table 2 shows the short run and long run elasticities of market share with respect to price. In our analysis, the long run elasticities are greater in absolute value than short run elasticities since the coefficient of lagged dependent variables lies between zero and one. The short run market share elasticities ranges from -2.29 to -4.99, while the long run elasticities range from -2.49 to -6.85.

Such a large degree of computed elasticities of market share with respect to price shows a high degree of competition between the US and the other cotton exporting countries in the major Asian markets.

Table 2: Estimates of Short Run and Long Run Elasticities of US Cotton Share in Selected Major Asian Markets

Country	Short Run Elasticity	Long Run Elasticity	Rate of Adjustment
China	-2.29	-2.49	0.08
Indonesia	-2.96	-3.52	0.16
Thailand	-3.22	-6.85	0.53
Taiwan	-3.44	-5.93	0.42
Japan	-4.99	-5.48	0.09

Analysis of short run and long run elasticities shows that one percent increase in the relative price ratio of US cotton to that of competitors will lead to a reduction in the US cotton market share by 4.99 and 5.48 percent respectively in the short and long run in Japanese Market. A similar interpretation can be made for other US cotton export markets like China, Indonesia, and Thailand.

Table 3 shows the analysis of market share for different countries i.e. South Asian Market, Mexico, Turkey, and Italy from 1989 to 2002. Coefficients of the price variable are statistically different from zero at the 10 percent probability level and all have the expected negative sign. All coefficient of the lagged market share variable were also statistically significant. The short

run and long run elasticities of US cotton market share as well as the adjustment coefficients were calculated on the basis of the estimated regression coefficients.

Table 3. US Cotton Share in Selected South Asian Market, Mexico, Turkey, and Italy: Statistical Results, 1989-2002

Country	β_0(Const)	β_1(Price)	β_2(Lagged)	β_3(Time)	RMSE	R^2
Bangladesh	-11.34*	-2.96*	0.39*	0.35*	0.8	0.54
Pakistan	-	-3.25**	0.13**	-	0.05	0.42
Mexico	-0.86**	-2.22*	0.32*	-	0.08	0.41
Turkey	-4.39*	-1.78**	0.35*	0.08*	0.08	0.53
Italy	-0.56**	-8.52*	0.42**	-	0.04	0.62

Note: ** and * indicate the significant coefficient at 10%level and 5%level respectively

Table 4 shows the short run and long run elasticities of US cotton market share in Selected South Asian, Mexico, Turkey, and Italy. The short run elasticities ranges from -1.78 to - 8.52 and Long run elasticities ranges from -2.73 to -14.68. The relatively large estimates of the short run and long run elasticities of market share indicate the high degree of sensitivity of US cotton share in the selected import markets to price changes and substantial degree of competition in cotton imported from the US and other sources.

Table 4: Estimates of Short Run and Long Run Elasticities of US Cotton Share in Selected South Asian Market, Mexico, Turkey, and Italy

Country	Short Run Elasticity	Long Run Elasticity	Rate of Adjustment
China	-2.29	-2.49	0.08
Indonesia	-2.96	-3.52	0.16
Thailand	-3.22	-6.85	0.53
Taiwan	-3.44	-5.93	0.42
Japan	-4.99	-5.48	0.09

To calculate import elasticities of demand, the values of sigma and average US market share were necessary. Table 5 presents the information need to calculate elasticities of demand.

Table 5. Information Used to Calculate Elasticities

Country	Average US Market Share (1989-2002)	Sigma (σ)
Bangladesh	0.19	2.96
Pakistan	0.31	3.25
China	0.51	2.29
Turkey	0.30	1.78
Italy	0.10	8.52
Japan	0.48	4.99
Indonesia	0.28	2.96
Mexico	0.97	2.22
Thailand	0.20	3.22
Taiwan	0.30	3.44

In table 6, elasticity estimates are presented for two assumptions concerning the overall elasticity of demand for cotton in the countries. An upper bound of 0 and lower bound of –1 were assumed. The empirical evidence suggests that the total demand for cotton is inelastic. The result indicates that the elasticity of most countries is in elastic range. This paper calculates the elasticity of individual countries rather than the elasticity of region. Future work will be done to estimate regional elasticity of cotton and implication of this elasticity in the policy issues.

Table 6. Upper and Lower bound Estimates by Own-Price Elasticity of US Imports

Country	N_T=0	N_T=1
Bangladesh	-2.40	-2.59
Pakistan	-2.24	-2.55
China	-1.12	-1.63
Turkey	-1.25	-1.54
Italy	-7.67	-7.77
Japan	-2.60	-3.07
Indonesia	-2.13	-2.41
Mexico	-0.07	-1.04
Thailand	-2.58	-2.78
Taiwan	-2.41	-2.71

Conclusions:

In this study, An Armington framework was used to investigate the elasticity of export demand for US cotton. Individual country models were fitted where possible. The elasticity was estimated ranges from -0.07 to –7.67 when the elasticities of total demand were assumed to be 0, and the elasticity was ranges from –1.04 to –7.77 when it was assumed to be –1.

Overall, the elasticity of total demand for cotton did not appear to affect greatly the estimated elasticity of demand for US cotton. It was found, however, the cross price effect or the change in the price of competitive cotton with respect to US price was important in determining the elasticity. Future work needs to be done for more analysis.

REFERENCES

Bredahl, M., W. Myers, and K.Collins. "The Elasticity of Foreign Demand for US Agricultural Products: The Importance of the Price Transmission Elasticity." *Amer. J. Agri. Econ.* 61(1979): 58-63.

Floyd, John B. " The Overvaluation of Dollar: A Note on the International Price Mechanism." *Amer.Econ.Rev*.55 (1965): 95-107

Harberger, Arnold C., " A Structural Approach to the Problems of Import Demand," *Am. Econ.Rev.* 43:148-159, May 1953.

Johnson, P.R. "The Elasticity of Foreign Demand for US Agricultural Products." *Amer. J. Agri. Econ.* 59(1977): 735-36

Orcutt, Guy H., " Measurement of Price Elasticities in International Trade." *Rev.Econ.and Stat.* 32:117-132, May 1950.

Sirhan, G. and P.R. Johnson. “A market Share Approach to the Foreign Demand for US Cotton.” *Amer. J. Agri. Econ.* 53(1971): 593-599