

THE EXPORT ELASTICITY OF DEMAND REVISITED: IMPLICATIONS OF CHANGING MARKETS

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Abstract

International cotton markets have experienced many changes in the last two decades. However, the latest available estimates of the elasticity of export demand for U.S. cotton are from Duffy et al., dating back to 1982. This study represents an update of the existing estimates of export demand elasticity for U.S. cotton and the analysis of changes of these estimates over time. The results indicate that total elasticity of export demand for U.S. cotton increased from (-2.13) in the early 1970s to (-2.41) in the mid 1990s. This finding suggests that the global cotton market for U.S. cotton has become more competitive in the last two decades. For U.S. agricultural policy, the results suggest a need to consider extending funding for the export enhancement program if import quotas are maintained.

Introduction

International cotton markets have experienced many changes in the last two decades. Overall, world cotton trade has been on an upward trend since the early 1970s. During this period, world market stability may have been impacted by a number of shocks caused mainly by policy changes in major exporting countries, the United States, China, and Former Soviet Union. Among the most important were the 1986 shock caused by the change in the U.S. farm programs, and the 1992 shock triggered by the breakup of the Soviet Union. Also, the emergence and development of trade blocks, such as NAFTA¹, EU², and ASEAN³ has likely had a significant impact on the nature of cotton trade. Added to these changes, the implementation of the World Trade Organization (WTO) and the phase out of the Multi-Fiber Arrangements has likely had some impact as well (Varangis and Thigpen). Taking account of these changing conditions in the world cotton market, one might suspect that the elasticities of demand for cotton have changed as well. However, the latest available estimates of the elasticity of export demand for U.S. cotton are from Duffy et al., dating back to 1982. Given the potentially important changes that have occurred in world cotton markets and the lack of recent elasticity estimates, there is a need to reexamine the export elasticity of demand for U.S. cotton and identify potential changes in that elasticity through time.

The objective of this paper is to update the existing estimates of the elasticity of foreign demand for U.S. cotton and to examine how these estimates changed over time, considering the dynamic nature of the world cotton market. Incorporating updated data will provide a current estimate of the export elasticity. Additionally, examination of the impacts of the discrete structural changes cited above should provide additional insight on the operation of the world cotton market.

Methods and Procedures

This study examines export demand facing the U.S. cotton industry during the period from 1971 to 1996. Considering the significance of changes in the world cotton market in 1986 and in 1992, the study period was broken down into three periods: 1972-1984, 1985-1991, and 1992-1996. The analysis of possible changes in export demand elasticities in each of these subperiods may provide some insight on the possible impact of these events on U.S. cotton exports.

For this study, countries were combined into six regions, according to their membership in trade blocks. The first region (EU) represents the EU member countries plus Norway and Switzerland. Members of the ASEAN trade group form the (ASEAN) group. NAFTA member countries were analyzed within the (NAFTA) group. China was treated as a separate region because of the peculiarities of the centrally planned response to the world market signals and the significance of this region to the market. Other Asian importers were combined in the (OTASIA) region⁴, and the other cotton importing countries comprised the (OTHER) group.

An Armington approach was used to estimate elasticities in this analysis because 1) it is consistent with the previous work by Duffy et al. and thus facilitates comparison with these previous estimates; 2) it is simple to formulate and does not have significant data requirements; and 3) it is an acceptable and a reputable way to model imports and exports.

According to the Armington framework, individual import demand functions may be specified as

$$\ln(MS_{ij}) = \sigma^* \ln(b_{ij}) - \sigma^* \ln(P_{ij}/P_i), \quad (1)$$

where MS_{ij} is a market share of imports from country j into country i , b_{ij} is the intercept term, P_{ij} is the import price of the commodity consumed by country i , P_i is the index of domestic prices for this commodity in country i , and the σ^* is the long-run elasticity of substitution. To account for the dynamic nature of export demand, a partial adjustment framework was used following Nerlove (1956). The dynamic nature of export demand is contained in the lag between sales contracts and export shipments as described by Ayuk and

Ruppel (1987). Therefore, the import demand functions were specified as

$$\ln(\text{MS}_{ij}(t)) - \ln(\text{MS}_{ij}(t-1)) = \gamma \{ \ln(\text{MS}_{ij}(t)) - \ln(\text{MS}_{ij}(t-1)) \} \quad (2)$$

where γ is the coefficient of adjustment, and t indicates the time period. Rearranging this equation leads to

$$\ln(\text{MS}_{ij}(t)) = \gamma \sigma^* \ln(b_{ij}) - \gamma \sigma^* \ln(P_{ij}/P_i) + (1 - \gamma) \ln(\text{MS}_{ij}(t-1)), \quad (3)$$

where $\gamma \sigma^* = \sigma$ is the short-run elasticity of substitution. This elasticity is the one of primary interest because of the constantly changing world economic situation. The long-run elasticity of demand can be derived by dividing the short-run elasticity by $(1 - \gamma)$.

Previous studies (Sarris, 1983, Ahmadi-Esfahani, 1989, Duffy, et al., 1990) have used a trend variable to account for possible changes over time that are unrelated to relative prices. Following these studies, a trend variable was included as a part of the intercept term:

$$b_{ij} = A_{ij} T_{ij}^\beta \quad (4)$$

Substituting (4) into (3) leads to the functional form to be estimated:

$$\ln(\text{MS}_{ij}(t)) = \gamma \sigma^* \ln(A_{ij} T_{ij}^\beta) - \gamma \sigma^* \ln(P_{ij}/P_i) + (1 - \gamma) \ln(\text{MS}_{ij}(t-1)). \quad (5)$$

Time series data for the years 1971-1996 were used in the estimation. All data were obtained from various publications of the International Cotton Advisory Committee. Market shares of U.S. exports were calculated by dividing the U.S. exports to various regions by the total imports of these respective regions. U.S. cotton price is the price of SLM 1-1/16 inch cotton. It is quoted in CIF Northern Europe terms to account for transportation costs. The Cotlook A-Index was chosen as a proxy of the world average price of cotton. Therefore, the price ratio used in the model is simply the ratio of U.S. cotton price to the Cotlook A-Index in CIF Northern Europe terms.

Empirical Models

Market share equations were estimated using the Generalized Least Squares (GLS) technique to correct for potential contemporaneous correlation across equations. Equations were also estimated using the Maximum Likelihood procedure, but no significant differences in parameter estimates were observed. Durbin-h tests suggested no autocorrelation. The results of the GLS estimation are reported in Table 1.

Estimates of the elasticity of substitution (coefficient on the price ratio) range from a low of 2.26 in the NAFTA region to a high of 14.66 in CHINA. These estimates are comparable with the previous research. The estimates of σ were statistically significant in all equations at the 10% level, and were used in the calculation of the short-run elasticities of import demand for U.S. cotton. The direct price elasticities of demand for different regions were calculated at the sample means for the different regions analyzed. The results of these calculations are presented in Table 2.

The elasticity estimates reported in Table 2 are based on certain assumptions about the total elasticity of demand for cotton (η_t). These assumptions include an upper bound of 0 (perfectly inelastic), a lower bound of -1 (unitary elastic), and an empirical estimate of -0.24 obtained from the work of Monke and Taylor. Based on the previous studies (Monke and Taylor, Babula, and Duffy, et al.), total demand for U.S. cotton was assumed inelastic, therefore 0 and -1 were chosen as probable bounds on the overall elasticity.

Consistent with the previous findings by Duffy et al., there are no dramatic changes in N_{ij} under the alternative assumptions about η_t in all regions except NAFTA. Elasticity of demand for NAFTA countries almost triples (from -0.45 to -1.287) as η_t changes from 0 to -1. This suggests that the import demand for U.S. cotton in this region is sensitive to the overall elasticity of demand for all cotton in that region. Other countries do not appear to be sensitive to changes in η_t , which suggests that U.S. cotton acts as a substitute for cotton from other regions.

Total elasticity of export demand is the weighted average of the regional import demand elasticities weighted by their average share of total U.S. exports. The total elasticity of demand ranges from -3.84 ($\eta_t = 0$) to -4.21 ($\eta_t = -1$) if the elasticity of price transmission is assumed to equal one for all countries (i.e., all countries are assumed to be price responsive). However, if the elasticity of price transmission is set equal to zero for China (on the premises that China is not a price-responsive market), the total elasticity of export demand for U.S. cotton decreases to -2.20 ($\eta_t = 0$) for the lower bound and -2.54 ($\eta_t = -1$) for the upper bound. The result assuming China is price responsive is almost identical to the Duffy et al. estimate of -3.97. However, the estimate assuming China is non-responsive (-2.28) is substantially larger in absolute value than the Duffy et al.'s estimate of -1.5. This difference is likely related to the fact that Duffy et al. considered centrally planned economies to be non-price responsive, including the former USSR. The current estimate considers the former USSR as price responsive because before the breakup the USSR was exporting a share above domestic consumption based on the market prices, and after 1992 former soviet countries began moving toward market economy. Thus, the current analysis suggests that the break-

up of the USSR introduced new competition into international markets, which is reflected in more elastic export demand for U.S. cotton.

One of the objectives of this research was to examine changes in the elasticity of demand over time. The results of this analysis are presented in Table 3. The results for the EU region found here are considerably lower than Duffy et al.'s estimates. The reason for differing estimates may be differences in the definition of regions and time periods of analysis. Over time, an increase in import demand elasticity is observed through the 1992-1996 period. This can be explained by the fact that the break up of the Soviet Union in 1992 introduced Central Asian cotton as a major competitor of the U.S. cotton in the European region. Cotton from Central Asia is usually sold cheaper than U.S. cotton, therefore, the EU likely became more price sensitive to U.S. cotton imports.

Estimates for the ASEAN region are significantly higher than Duffy's results. Inconsistency in region definition and different time periods may be possible reasons for this difference as well. Over time, a sharp increase in elasticity is observed in the late 1980s from -2.879 in the previous period to -3.827 in 1985-1991. In later part of the sample period, import demand elasticity for U.S. cotton in this region decreased slightly, but remained more elastic than prior to 1985. This suggests that ASEAN countries became more price responsive through time, in general. This may be related to the proximity of ASEAN countries to Uzbekistan and Australia. That is, upon the break-up of the USSR, there was a sharp increase in the elasticity of export demand for U.S. cotton to the ASEAN region, reflecting the introduction of a substitute source of cotton. In the latter period, the market likely stabilized from the initial shock of the break-up of the USSR, thus reducing the elasticity as trade ties were reestablished. However, the elasticity ended the period more elastic than in the beginning, highlighting the importance of Uzbekistan in the ASEAN region. Another factor that may have contributed to higher elasticity in the ASEAN region is the sharp increase in cotton production in Australia.

Estimates for the NAFTA region are reasonably close to those by Duffy et al. Import demand for U.S. cotton in this region remained inelastic throughout the study period, which may be explained by the geographic proximity of the NAFTA countries to the U.S. which makes them consistent customers for U.S. cotton. A sharp increase in elasticity in 1985-1991 period (from -0.588 to -0.817) is likely a consequence of policy changes in the U.S. resulting in large quantities of cotton delivered to the world markets. The decrease in elasticity in the later period (from -0.817 to -0.567) may be interpreted as a result of stronger trade ties as a result of the implementation of NAFTA.

Estimates for CHINA are comparable with Duffy et al.'s. However, it is important to note that Duffy et al.'s estimates were based on Centrally Planned Economies including the USSR and Eastern Europe, while the current estimates only include Mainland China. According to current estimates, over the last twenty years, the import elasticity of demand for U.S. cotton in China has decreased from -18.41 to -9.34. This fact may reflect the trade liberalization efforts that have been taking place in China in recent years. Through political changes and reforms, China is moving closer to a market economy with better reaction to the world price situation. It is difficult to say how accurate prior estimates of the import demand elasticity for China were given the bureaucratic nature of price response. However, if market reforms continue, it is expected that China's import demand elasticity for cotton will become less elastic and more closely resemble other countries' price response. This appears to have been the trend in the current sample.

Other Asian countries demonstrated a stable and slightly increasing demand elasticity for U.S. cotton imports. The movement to more elastic demand suggests an increasing degree of price competition in this region. Given these Asian countries' proximity to Uzbekistan and the similar pattern observed in the OTASIA and ASEAN regions, it is reasonable to assume that these regions were responding to similar forces.

In general, the total elasticity of demand for U.S. cotton exports slightly increased in 1985-1991 period (from -3.99 to -4.24) and then decreased in 1992-1996 (from -4.24 to -3.35). This change was more subtle if China is assumed not to respond to price. Under this assumption, the elasticity rose from -2.13 in the 1973-1991 period to -2.45 in 1985-1991 period and decreased to -2.41 in 1992-1996 period.

A broader look at the results suggests a general trend towards more elastic demand from the beginning compared to the end of the period. This implies that foreign customers for U.S. cotton have become more sensitive to price over time. The implementation of the 1985 Farm Bill with its competitiveness provisions and the Inventory Protection Certificate (IPC) period in 1986 appeared to significantly increase price sensitivity for U.S. cotton. This is plausible because the 1985 Farm Bill brought U.S. prices in line with world prices and the IPC liquidated a large portion of U.S. stocks, thus lowering world prices.

At the same time, the period following the break-up of the Former Soviet Union showed a general movement to less elastic demand for U.S. cotton, although it ended the period with more elastic demand as compared to the 1973-84 period. This may be reflecting some consolidation of trade ties in the world market. That is, during the 1992-1996 period, major trading blocks were implemented such as NAFTA, thereby

solidifying trading relationships through preferential tariffs. This may help explain why NAFTA, for example, ended the period with more inelastic demand than in the beginning of the period.

In general, the shock of the 1985 Farm Bill and IPC likely increased price sensitivity towards U.S. cotton in the short run. Over time, institutional structures such as trading blocks have solidified trading relationships, thus making trade less price sensitive. With China considered price responsive, this result appears more pronounced.

Summary and Conclusions

A knowledge of elasticities of demand is critical in designing agricultural policy. In the situation of a constantly changing market environment, it is essential that these elasticities be checked and updated. In the last two decades, several changes in agricultural policies by the major cotton exporters significantly reshaped the world cotton market. This study represents an update of the existing estimates of export demand elasticity for U.S. cotton and the analysis of changes of these estimates in the dynamic environment of the cotton market.

According to the results of the estimation, total elasticity of export demand for U.S. cotton increased from (-2.13) in the beginning of the period to (-2.41) at the end of the study period. This finding suggests that the global cotton market have become more competitive in the last two decades. Increased total elasticity suggests that U.S. cotton exports face more substitutes on the world market. This is consistent with the trend toward trade liberalization.

This finding may also have important implications for the U.S. agricultural policy. That is, import quotas in the U.S. allow the possibility that U.S. prices can move above world prices. In an era of increased price sensitivity for U.S. cotton, this could have an adverse impact on U.S. cotton exports. There is a provision within U.S. farm legislation that pays U.S. exporters and domestic users the difference between world and U.S. prices if certain conditions are met. This program keeps U.S. prices competitive with world prices. However, this program has exhausted its funding two years into the seven year budget cycle. If import quotas are maintained as a policy priority, the results of this analysis suggest a need to consider extending funding for the export enhancement program.

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Table 1. GLS Estimates of the Market Shares of U.S. Cotton in Foreign Markets (1972-1996)

	EU	ASEAN	NAFTA	CHINA	OTASIA	OTHER
Constant	-1.275 (-2.447)	-0.500 (-2.147)	-0.204 (-1.422)	-2.106 (-1.595)	-0.528 (-4.412)	-2.491 (-3.943)
Price ratio	-4.507 (-3.270)	-4.258 (-6.071)	-2.262 (-3.962)	-14.659 (-1.787)	-3.756 (-8.319)	-2.858 (-2.226)
MS _{t-1}	0.270 (1.305)	0.118 (0.923)	-0.095 (-0.592)	0.344 (1.693)	0.129 (1.199)	0.112 (0.549)
Trend	-0.005 (-0.302)	-0.260 (-1.800)	0.007 (0.796)	0.085 (1.073)	-0.003 (-0.544)	0.041 (2.389)
R ²	0.367	0.714	0.566	0.241	0.795	0.377

Note: Equations estimated in loglinear form. Numbers in parenthesis are t-values.

Table 2. Calculation of Elasticities of Substitution (σ) and Export Demand Elasticities.

Region	Average U.S. Market Share		Average % all U.S. Exports 1973-1996	Elasticity		
	1973-1996	σ		$\eta=0$	$\eta=-.24$	$\eta=-1$
EU ^a	0.135	-4.509	0.117	-3.900	-3.933	-4.035
ASEAN ^b	0.347	-4.991	0.120	-3.258	-3.341	-3.605
NAFTA ^c	0.837	-2.766	0.056	-0.450	-0.651	-1.287
CHINA	0.335	-24.416	0.101	-16.232	-16.312	-16.567
OTASIA ^d	0.442	-3.864	0.495	-2.158	-2.264	-2.599
OTHER	0.104	-2.543	0.115	-2.280	-2.305	-2.384
TOTAL				-3.84	-3.93	-4.21
TOTAL w/o CHINA				-2.20	-2.28	-2.54

^a Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and United Kingdom.

^b Indonesia, Malaysia, Philippines, Singapore, Thailand.

^c The NAFTA region was comprised of Canada and Mexico.

^d Taiwan, Hong Kong, Japan, and South Korea.

Table 3. Changes in Export Demand Elasticities in Different Time Periods ($\eta_i = -.24$)

Region	Duffy's Estimate			
	1977-1982	1973-1984	1985-1991	1992-1996
EU ^a	-7.106 ^e	-3.904	-3.793	-4.199
ASEAN ^b	-1.238 ^f	-2.879	-3.827	-3.770
NAFTA ^c	-0.696 ^e	-0.588	-0.817	-0.567
CHINA	-14.448 ^h	-18.410	-17.698	-9.341
OTASIA ^d	-1.892 ⁱ	-2.073	-2.502	-2.386
OTHER		-2.344	-2.302	-2.215
TOTAL	-3.97	-3.99	-4.24	-3.35
TOTAL w/o CHINA	-1.50 ^k	-2.13	-2.45	-2.41

^a Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and United Kingdom.

^b Indonesia, Malaysia, Philippines, Singapore, Thailand.

^c The NAFTA region was comprised of Canada and Mexico.

^d Taiwan, Hong Kong, Japan, and South Korea.

^e Austria, Belgium, Denmark, Finland, Germany, Ireland, Italy, Netherlands, Norway, Sweden, Switzerland, U.K., Yugoslavia, Spain, and Greece.

^f Japan, Hong Kong, Philippines, Thailand, Malaysia, Republic of China, and Indonesia.

^g Canada.

^h USSR, Eastern Europe, and People's Republic of China.

ⁱ Japan.

^k Total without Centrally Planned Nations (h).

Endnotes

1. NAFTA is U.S., Canada, and Mexico.
2. EU is Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, and United Kingdom.
3. ASEAN is Indonesia, Malaysia, Philippines, Singapore, Thailand.
4. OTASIA is Taiwan, Hong Kong, Japan and South Korea.