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ECONOMICS AND MARKETING

The Impacts of U.S. Cotton Programs on the World Market: An Analysis of Brazilian WTO Petition

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ABSTRACT

This manuscript analyzed the effects of the elimination of U.S. cotton subsidy programs on the world cotton market using a partial equilibrium model of the world fiber market. Removal of U.S. programs would increase world cotton prices by approximately 2% in the initial years; however, the impacts are mitigated after a few years after program elimination as the major cotton producing and exporting countries expand their production. Overall, the results indicate that U.S. cotton production and export would decline by an average of 4.5% and 5.0%, respectively. At the same time, Brazil and Australia would expand their cotton acreage and increase exports by about 2%, and 1%, respectively. Unlike Brazil and Australia, Africa is unlikely to take advantage of the reduction in U.S. cotton exports, with less than 1% increase in their exports.

The impact of commodity programs on the world market has been subject to much debate in recent years. These debates stem from a desire by the international community to create a freer trading environment, which requires a reduction of the effects of distorting policies by exporting and importing countries. When the Farm Security and Rural Investment Act of 2002 became law, the program came under scrutiny because provisions, such as the countercyclical payments, have the potential to stimulate production (Sumner, 2003).

In the case of cotton, this was the basis of the argument that led Brazil with the support of Australia and the West and Central African (WCA) countries to file a petition challenging the U.S. cotton programs at the September 2003 meeting of the WTO settlement body. Brazil alleged that U.S. cotton subsidies, such as marketing loans, export credits, commodity certificates, direct payments, and counter-cyclical payments, were depressing world prices and were injurious to Brazilian farmers. The WCA countries of Benin, Burkina Faso, Mali, and Chad also claimed they were losing export earnings of US $1 billion a year (including both direct and indirect costs) as a result of subsidies by the United States and the European Union (BBMC, 2003). The WCA countries argued that their cotton production increased from 0.89 to 1.5 million tonnes (metric tons; Mg) and exports increased from 0.6 to 1.1 Mg between 1992/93 and 2002/03, but their export revenues declined during the same period due to lower prices. Although a combination of factors, including a sluggish world economy, higher yields, and lower polyester prices, played a role in lower cotton prices worldwide, the WCA countries perceived U.S. subsidies as the main reason for their export earning losses (BBMC, 2003). Despite mixed findings from recent studies, the WTO issued a ruling in April 2004 stating that the USA had violated its WTO obligations by granting excessive subsidies to its cotton growers between 1999 and 2002, which depressed prices at the expense of growers from Brazil and other countries.

The cotton subsidy issue has been investigated and debated since it was first proposed by Brazil on 27 Sept. 2002 (ICAC, 2002; Sumner, 2003; Tiller et al., 2003; Goreux, 2004). The International Cotton Advisory Committee (ICAC, 2002) estimated the effects of the U.S. cotton subsidy on the international cotton price using three different models: the ICAC and FAO Supply model, the ICAC World Textile Demand Model, and the ICAC Price Model. The supply model was used to estimate production levels without subsidies during the period 1999/00 to 2001/02. The lower supplies were fed into the ICAC price model to get the price increases of 6 cents (10.5%), 12 cents (28.7%), and 22 cents (43.95%) in 1999/00, 2000/01, and 2001/02, respectively.

The ICAC textile demand model was used to estimate the effects of higher prices on cotton demand, and the resulting level of demand was applied to the

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price model to conclude that a lower level of demand would lessen the initial impact by 1 cent (1.75%) in 1999/00, 2 cents (4.78%) in 2000/01, and 6 cents (11.99%) in 2001/02. In this study, the supply and demand effects do not simultaneously determine equilibrium price. In addition, supply changes in the rest of the world due to higher prices are not taken into account in this model. Watkins (2002) used the ICAC results to estimate that sub-Saharan exporters lost $302 million in 2001 as a direct consequence of the U.S. cotton subsidies.

More recently, Sumner (2003) quantified the effects of U.S. cotton subsidies using an econometric simulation model based on key supply and demand elasticities from the Food and Agricultural Policy Research Institute (FAPRI) policy simulation model. The model used by Sumner is different from the actual FAPRI model, especially in how subsidies were incorporated into the supply equation (USTR, 2003). The results suggested that during the marketing years 1999 to 2002, the USA would have exported an average of 41.2% less cotton, and the world cotton price would have increased by 12.6% without domestic and export programs for cotton. For the marketing years 2003 to 2007, the world cotton price would have increased by 10.8% with the removal of U.S. cotton subsidies. The study offered an explanation of the various cotton programs and how they were treated in the model; however, it is difficult to verify the accuracy of the results without a discussion of the structure of the FAPRI world cotton model used for the analysis. The model also does not allow for inter-fiber substitution between cotton and man-made fibers at the mill level, which resulted in the over estimation of the effects of the U.S. cotton programs. The amount of the over estimation depends on mill demand elasticity estimates.

Apart from the above mentioned studies focusing on the effects of the U.S. cotton programs, few other studies have also attempted to measure the effects of complete removal of domestic subsidies for all commodities and all countries. FAPRI (2002) measured the impacts of removal of all subsidies and tariffs using the FAPRI world crops and livestock model. The results indicated that removal of subsidies all over the world would lead to a 13% increase in average cotton price between 2001/02 and 2010/11. FAPRI results can not be accurately verified because the report does not contain information on model structure and parameter estimates. Recently, Poonyth et al. (2004) estimated the long-term impacts of the complete elimination of domestic subsidies and tariffs and found that the world price of cotton would appreciate between 3.1% and 5.0%, based on different supply and demand elasticities. The study claimed that 66% of the distortions on world cotton market are from the U.S. subsidy.

The majority of the studies discussed above used either an existing model, such as FAPRI and GTAP, or developed a reduced form model using demand and supply elasticities borrowed from the other studies to carry out the simulation. In addition, none of these studies allow inter-fiber substitution between cotton and man-made fibers at the mill level. Absence of proper linkage between cotton and man-made fiber would definitely overestimate or underestimate the policy effects.

The purpose of this study is to estimate the effects of the removal of the U.S. cotton programs on the world market, particularly on international cotton prices, using a partial equilibrium structural econometric model of the world fiber market developed by Pan et al. (2004). Partial equilibrium structural policy simulation models have been extensively used in the past for policy analysis (Fuller et al., 2002; Koo, 2002; Meyer, 2002, Sumner, 2003; ICAC, 2002; Fabiosa et al., 2005). The partial equilibrium model used in this study contains three main characteristics that distinguish it from prior models. Unlike the past efforts, this model allows inter-fiber substitution between cotton and man-made fibers at the mill level and solves man-made fiber prices endogenously in the model. Secondly, major cotton producing and trading countries/regions are included in the model to avoid aggregation bias. For major countries, such as the United States, China, and India, regional supply responses within these countries are estimated in order to account for heterogeneity in growing conditions arising out of climatic differences and availability of water and other natural resources that influence the mix of crops in each of the regions. This is important because elimination of U.S. cotton programs is likely to have varying effects on cotton producing regions and aggregate supply response may overestimate or underestimate the policy effects. Finally, this model was estimated using more up to date data and recent policies, such as Chinese WTO commitments, Agreement on Textile and Clothing (ATC).

The analysis compares outcomes under a scenario eliminating major cotton programs, such as produc-

tion flexibility contract payments/direct payments, counter-cyclical payments, step-2 payments, and marketing loan benefits, to a baseline that includes current farm programs (Table 1). Following the approach used by Sumner (2003), we have assumed production flexibility contract (PFC) payments for the period 1997 to 2001, and direct payments from 2002 to 2007 to be 25% coupled, i.e. 25% of the per pound PFC or direct payments were added to the expected net returns. Similarly, counter cyclical payments (CCPs) were assumed to be 50% coupled. The domestic and export Step-2 payments enter the mill use and export equation as a subsidy which lowers the effective buying price for miller and exporters. Thus, removal of step-2 payments would reduce domestic mill use and exports. Both of these programs (marketing loan benefits and step 2 payments) were applied for the entire period (99/00 to 07/0). A brief description of each of the programs is provided.

Direct payments. Under the 2002 Farm Act, farmers and eligible landowners receive annual fixed payments. The amount of the direct payment is equal to the product of the payment rate, payment acres, and payment yield. The 2002 Farm Act sets the payment rate for upland cotton at 3.00 cents per kilogram (6.67 cents per pound) for crop years 2002 to 2007. Payment acreage is set at 85% of base acreage. Payment yields for direct payments remain at levels specified by the 1996 Farm Act.

Counter-cyclical payments. Counter-cyclical income support payments (CCP) were developed to provide a counter-cyclical income safety net to replace most ad hoc market loan assistant payments that were provided to farmers during 1998 to 2001. Payments are based on historical production and are not tied to current production. CCP are available for covered commodities whenever the effective price is less than the target price. The payment amount is equal to the product of the payment rate, the payment acres (85% of base acres), and the payment yield. Counter-cyclical payments are available to contract holders whenever the target price for a program crop is greater than the effective price. The effective price is equal to the sum of 1) the higher of the national average farm price for the marketing year, or the national loan rate for the commodity and 2) the direct payment rate for the commodity. The payment amount for a farmer is the product of the payment rate, the payment acres, and the payment yield. The upland cotton target price is 33.66 cents per kilogram (72.4 cents per pound) for the duration of the farm bill. The payment for an individual cotton farmer is determined as follows:

$$\text{Payment rate}_{\text{cotton}} = (\text{target price})_{\text{cotton}} - (\text{direct payment rate})_{\text{cotton}} - (\text{higher of commodity price or loan rate})_{\text{cotton}}$$

$$\text{CCP}_{\text{cotton}} = ([\text{Base acres}]_{\text{cotton}} \times 0.85) \times (\text{payment yield})_{\text{cotton}} \times (\text{payment rate})_{\text{cotton}}$$

Marketing assistance loan and loan deficiency payment programs. The Farm Service Agency (FSA) administers commodity loan programs with marketing loan provisions for upland cotton through the Commodity Credit Corporation (CCC). CCC loan programs allow producers of designated crops to receive a loan from the government at a commodity-specific loan rate per unit of production by pledging production as loan collateral. After harvest, a farmer may obtain a loan for all or part of the new production. These loans may be repaid in three ways: at the loan rate plus interest costs (CCC interest cost of borrowing from the U.S. Treasury plus 1%); by forfeiting the pledged crop to the CCC at loan maturity; or at the alternative loan repayment rate. The marketing loan rate for upland cotton is 23.59 cents per kilogram (52 cents per pound) for 2002-2007.

Table 1. Brief description of cotton programs in the United States

Cotton farm programs[z]	Effects on the cotton market	Removal date
Production flexible contract/direct payments (decoupled by 0.25)	Adds income directly to farms; provides security of payment	1999/2000
Marketing loan	Increases the expected net returns per acre, maintains production at relatively high levels even in low expected market prices	1999/2000
Step-2 payments	Provides a direct government payment to domestic buyers and exporter shippers of U.S. cotton	1999/2000
Target price/counter-cyclical payments	Offsets the impact of low market prices, provides additional income stabilization	2002/2003

[z] Source: USDA, Economic Research Service, as edited by the authors.

Step 2 payments. Step 2 payments, sometimes referred to as the "user marketing certificate program," are made to U.S. cotton users and exporters when U.S. prices are higher than world prices. They are intended to bridge the price gap and keep U.S. cotton competitive. Step 2 payments are issued to exporters and domestic mill users of upland cotton in a week following a consecutive 4-wk period when the lowest U.S.-Northern Europe price quotation exceeds the Northern Europe price quotation by more than 0.57 cents per kilogram (1.25 cents per pound), and the AWP does not exceed 134% of the U.S. loan rate. Payments are made in cash or certificates to domestic users on documented raw cotton consumption, and to exporters on documented export shipments, at a payment rate equal to the difference between the U.S.-Northern Europe price and the Northern Europe price during the fourth week of the period, minus 0.57 cents per kilogram (1.25 cents per pound) (the threshold). The 2002 Farm Act delayed the 1.25-cent threshold until 1 Aug. 2006. Consequently, Step 2 payment calculations for the 2002 to 2005 marketing years are based on the difference between the U.S.-Northern Europe price and the Northern Europe price.

Conceptual framework. A graphic representation of the effects of the U.S. cotton programs on the world market is shown in Figure 1. Note that transportation cost effects are ignored for simplicity. Panel A presents the domestic cotton supply and demand in the United States. U.S. cotton programs include the marketing loan program, direct payments, counter-cyclical payments that use a target price, and marketing certificates through step 2 payments. The loan rate acts as a minimum guaranteed price for farmers, so farmers do not respond to market price if it is below the loan rate, causing the supply curve to be vertical at the loan rate level (P_{LR}). The loan rate does not act as a floor for the market because marketing loan and LDP payment subsidies absorb the difference between the loan rate and the world price, allowing the market price to fall to a level (P_w) to clear the market. The net effects of these programs are to expand cotton exports from free market level of LM to OQ.

In panel C, rest of the world (ROW) excess demand is shown separately for China and others. The Chinese market is separated from the rest of the world because of the relative importance of Chinese trade and policies on the world market. As part of its WTO commitments, China has established a tariff-rate-quota (TRQ) for cotton imports. In-quota import levels are set to rise from 740,000 metric tons in 2002 to 890,000 metric tons in 2004 with a tariff of 1%. The out-of-quota tariff, which was 76% above 780,000 metric tons in 2002, is scheduled to drop to 67% above 820,000 metric tons in 2003, 58% above 860,000 metric tons in 2004, 49% above 890,000 metric tons in 2005, and 40% above 890,000 metric tons in 2006 (USDA-FAS, 2002). The presence of a TRQ makes the Chinese import demand discontinuous at the quota level. The vertical line segment BC on Chinese excess demand represents the level of the TRQ, below and beyond for which there is a demand response by Chinese importers.

Panel B displays the world market equilibrium with excess supply derived from the United States and excess demand from the rest of the world. The United States faces a kinked rest of the world excess

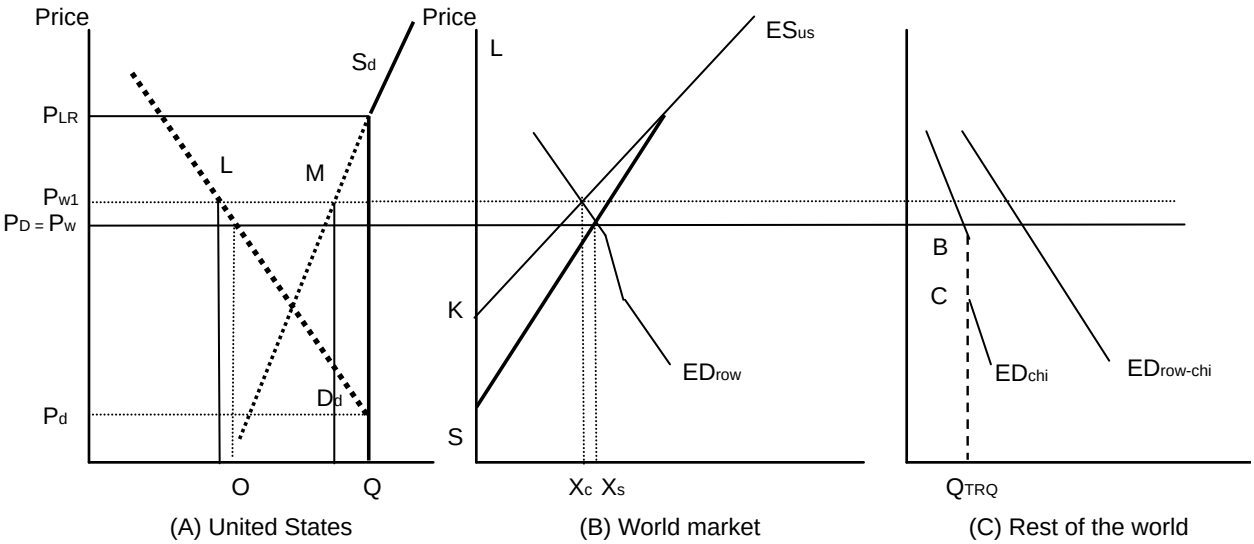

Figure 1. Graphic representation of the effect of U.S. cotton programs on (A) the US cotton market, (B) the world market, (C) the rest of the world (China).

demand function due to the presence of TRQ in China and the rest of the world faces a kinked U.S. excess supply function because of the marketing loan program in the United States.

With the representation in Figure 1, removal of the U.S. cotton subsidy programs would decrease U.S. exports from OQ to LM and raise the world price from P_w to P_{w1}. Cotton production response in the United States returns to the original supply function rather than the kinked supply function induced by policy payments. This results in upward shift of the origination of the excess supply function from S to K in panel B.

If the representation of markets depicted in Figure 1 is reasonably accurate (e.g., if P_{LR} is above world price, the U.S. is a dominant exporter in a "free trade" world, etc.), then expected effects of eliminating U.S. support programs are to increase world price, decrease U.S. production and exports, increase ROW production and excess supply, and decrease global trade and consumption of cotton. The conceptual analysis does not, and cannot, reveal the magnitude of these expected effects. The magnitudes are determined by the various supply and demand elasticities in these markets. This justifies the following model and empirical analysis.

MATERIALS AND METHODS

A partial equilibrium world fiber model (Pan et al., 2004) was used to estimate the effects of U.S. cotton programs on the world market. The unique characteristics of this model compared with others include incorporation of regional supply response of cotton, substitutability between cotton and competing fibers, and linkage between raw fiber and textile sectors. The model includes 24 major cotton importers and exporters: (1) Asia (China, India, Pakistan, Taiwan, South Korea, Japan and Other Asia); (2) Africa (Egypt and Other Africa); (3) North America (Mexico, United States, and Canada); (4) Latin America (Brazil, Argentina, and Other Latin America); (5) Oceania (Australia); (6) Middle East (Turkey and Other Middle East); (6) Former Soviet Union (Uzbekistan, Russia, and other former Soviet Union countries); (7) Europe (European Union, Central and Eastern Europe, and Other Western Europe).

As shown in Figure 2, the representative country model includes supply, demand, ending stock, and market equilibrium for cotton and man-made fibers. Cotton production was modeled by estimating separate acreage and yield equations. Similarly, man-made

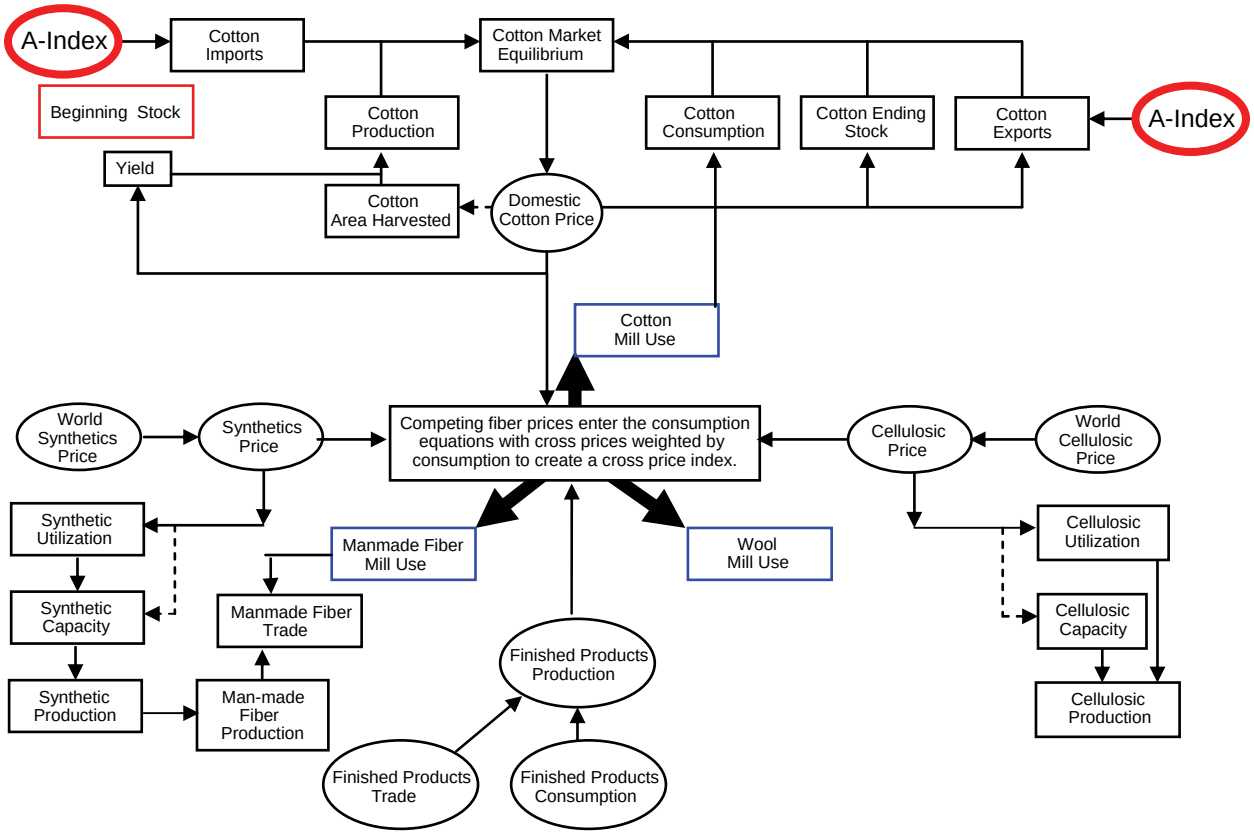

Figure 2. Schematic representation of representative country model that includes supply, demand, ending stock, and market equilibrium for cotton and man-made fibers.

fiber supply was estimated by modeling capacity and utilization separately. Following Coleman and Thigpen (1991), cotton demand was estimated following a two-step process. In the first step, total textile fiber consumption was estimated and in the second step allocations among various fibers, such as cotton, wool, and polyester (representing man-made fibers), were estimated based on relative prices. Cotton A-index and polyester prices were endogenously solved in the model by equalizing world exports and imports.

The U.S. model includes regional acreage and yield response with cotton production divided into four regions: Delta, Southeast, West, and Southwest (irrigated and non-irrigated). On the demand side, U.S. textile consumption was disaggregated into apparel, floor covering, home textiles, and others following Meyer (2002). Similarly, Chinese and Indian cotton supply responses were estimated in a regional framework. The Chinese cotton-producing area was segregated into four regions in order to account for heterogeneity in growing conditions arising out of climatic differences and availability of water and other natural resources that influence the mix of crops in each of the regions. The four regions include the Xinjiang, the Yellow River Valley, the Yangtze River Valley, and the rest-of-China. Due to the domestic policy distortion in the cotton market, both U.S. farm price and Chinese procurement price were endogenously solved. For other countries, domestic prices were transmitted by A-index. The transmission rate is as high as 0.97 for Brazil, and as low as 0.41 for Africa.

The data set used in this study was compiled from various sources, including Food and Agricultural Policy Institute (FAPRI, 2004) for the historical and projected macro variables (real GDP, exchange rate, population, and GDP deflator); Production, Supply & Demand (PS&D) database of the Foreign Agricultural Service (FAS), U.S. Department of Agriculture for cotton acreage, yield, production, mill use, ending stocks, and trade; Cotton and Wool Situation and Outlook Yearbook (USDA-ERS, 1995-2004) for U.S. cotton price, polyester price, and other fiber prices; Food and Agriculture Organization (FAO) World Fiber Consumption Survey and Fiber Organon (Fiber Organon, 1980-2004) for the fiber mill consumption and man-made fiber production data; and Chinese Statistics Yearbook (NSBC, 1980-2004a), China Industrial Economic Statistical Yearbook (NSBC, 1980-2004b), and Chinese Rural Statistical Yearbook (NSBC, 1980-2004c) for Chinese textile price index and food price index, cotton price, man-made fiber, and trade of textile and man-made fibers.

A stylized model specification for a representative country is presented in Table 2. The model specifies per capita fiber consumption as a function

Table 2. Standard specifications of behavioral equations

Variable	Behavior equation[z]
Per capita fiber consumption	$PC_f = \alpha_0 + \alpha_1 P_f + \alpha_2 I$
Share of cotton mill use	$DS_c = \beta_0 + \beta_1 (P_c / P_s)$
Share of man-made fiber mill use	$DS_m = \beta_0^m + \beta_0^m (P_c / P_s)$
Cotton supply	$S_{c,t} = \kappa_0 + \kappa_1 (P_{c,t-1} / P_{o,t-1})$
Man-made fiber supply	$S_{m,t} = \kappa_0^m + \sum_{k=1}^{5} \kappa_1^m (P_{m,t-k}) + \sum_{k=1}^{5} \kappa_2^m (P_{g,t-k})$
Cotton imports	$I_c = \phi_0 + \phi_1 (P_c / WP_c (1+T))$
Cotton exports	$E_c = \phi_{e0} + \phi_{e1} (P_c / WP_c (1-\tau))$
Cotton ending stock	$K_{c,t} = \rho_0 + \rho_1 (S_{c,t}) + \rho_2 (P_c) + \rho_3 K_{c,t-1}$
Cotton price linkage	$P_c = \gamma_0 + \gamma_1 WP_c$
Polyester price linkage	$P_m = \gamma_0 + \gamma_1 WP_m$
Marketing clearing cotton	$\sum_n I_c = \sum_n E_c$
Marketing clearing man-made fiber	$\sum_n (S_{m,t}^e + S_{m,t}^i) = \sum_n (DS_m * PC_f * PO)$

[z] **The superscript e and i refers to a country that is assumed to export and import cotton and man-made fiber, respectively. The capital letters PC, S, D, DS, P, WP, I ,E, K, and PO represent per capita consumption, supply, share of mill use, domestic price, world price, imports, exports, ending stock, and population, respectively. The subscripts *f, c, m, w, o* represent fiber, cotton, man-made fiber, world, competing crops, respectively. The letters *t, t-1, t-k* represent current time period, one lag, and *k* lags, respectively. The tariff rate is represented by the letter T and the export subsidy rate is represented by τ. The letter n represents number of countries included in the model. The symbols α, β, κ, ϕ, ρ, and γ are estimated coefficients.**

of the fiber price and per capita income. In the second stage, total fiber production was allocated among various fibers based on relative prices. In the supply side, cotton acreage generally was specified as a function of own and competing crop expected net returns or prices, and cotton yield was dependent on cotton price and time trend to capture technological change. Expected net return (ENR) in the United States was calculated as follows:

$$ENR = E[EP_{it}]*E[Y_{it}]\text{-cost of production},$$

where $E[Y_{it}]$ is the expected yield determined by the historic relationship between yield and time trend. Following Britt (2002), the expected market price ($E[EP_{it}]$) was calculated as follows:

$$EP_{it} = PF_{it}*RP_{it}+lag(PM_{it})*PN_{it}, ,$$

where PF_{it} is effective support price for upland cotton, RP_{it} is program participation rate indicating the percentage of acreage complying with the farm program, PM_{it} was the marketing year average farm price for upland cotton, PN_{it} was program participation rate indicating the percentage of acreage not complying with the farm program. The PF_{it} were determined as follows:

$$PF_{it} = W*(PS_{it}+0.5*GP_{it})+0.25*DP_{it},$$

where $PS_{it} = LR_{it}$ if $LR_{it} \geq lag(PM_{it})$; else $PS_{i\ t} = lag(PM_{it})$. LR_{it} was the loan rate, GP_{it} was the deficiency payment rate per pound from 1974 to 1995 and counter cyclical payments from 2002, DP_{it} was the direct payments from 1996, and w represents the percentage of planted acreage on which a complying producer could receive support. Since loan deficiency payments are based on the adjusted world price, it would have been more accurate to use it in calculating the effective world price rather than farm price; however, the model does not endogenously solve for adjusted world price, which makes it difficult to include it in the effective price calculation. High correlation between the adjusted world price and farm price (0.95 for 1986 to 2004) makes the farm price an acceptable alternative to use in the expected net return calculation.

Following Meyer (2002), man-made fibers production was modeled separately as capacity and utilization. The capacity equation was specified as a function of man-made fibers and crude oil prices over the past five years, whereas utilization rate was dependent on more recent prices of man-made fibers and crude oil prices. Exports and imports equations were specified as function of domestic and international prices. For import equations, international prices were calculated by converting world price in domestic currency equivalent after adding appropriate tariffs. Similarly, for export equations, international prices were calculated by converting world representative price into domestic currency equivalent. Finally, the ending stock equation was specified as domestic cotton price, cotton production, and beginning stock. For more information on parameter estimates and diagnostic statistics, please see World Fiber Model Documentation by Pan et al. (2004).

Table 3 contains income elasticities for the per capita textile consumption equations and own and cross price elasticities for cotton mill demand equations. Income elasticities range from 0.11 to 0.69, and are lowest for South Korea and highest for China. Most of the emerging markets, such as China, India, Brazil, and Mexico, have income elasticities higher than 0.5. At the mill level, cotton was very responsive to its own price in most of the Asian and African countries/regions.

Table 3. Elasticity of income from textile consumption and elasticity of price from cotton mill use for major countries[z]

Countries	Income elasticity for textile	Price elasticity	
		Cotton	Polyester
US	0.15	-0.24	0.07
Australia	0.13	-0.05	0.00
South Korea	0.11	-0.57	0.24
Taiwan	0.11	-0.50	0.35
Japan	0.14	-0.57	0.37
EU-15	0.12	-0.39	0.15
Mexico	0.58	-0.27	0.10
Brazil	0.53	-0.15	0.12
China	0.69	-0.57	0.16
India	0.56	-0.44	0.10
Pakistan	0.52	-0.28	0.18
Africa	0.55	-0.74	0.24
World	0.30	-0.28	0.15

[z] Calculated by authors.

Table 4 reports cotton acreage response elasticities for major producing countries. The short-run elasticities of cotton acreage response range from 0.10 to 0.54, with Mexico having the highest value. The

long-run acreage response elasticities range from 0.21 to 1.15, with the highest in Australia. The relatively large elasticities for Mexico, Australia, and Brazil reflect greater flexibility and choice in alternative crops production (Coleman and Thigpen, 1991).

Table 4. Cotton price transmission and supply elasticity[z]

Countries	Regions	Domestic –price wrt A-index	Acreage response	
			Short-run	Long-run
USA	Delta		0.18	
	Southeast		0.16	
	Southwest Irrigated		0.31	
	Southwest Dryland		0.37	
	West		0.42	
Australia		0.93	0.52	1.15
Brazil		0.97	0.50	0.74
China	Yellow River		0.11	0.21
	Yantze River		0.10	0.22
	Southwest		0.11	0.30
Africa		0.41	0.11	0.58
India		0.75		
	North		0.12	0.23
	West		0.12	0.23
	South		0.16	0.17
Eu-15		0.96	0.44	1.05
Mexico		0.87	0.54	0.91
Pakistan		0.53	0.13	0.26
Argentina		0.76	0.24	0.48
Former Soviet Union		0.79	0.25	0.28

[z] Calculated by authors.

The approach used to incorporate changes into the model to simulate program eliminations was as follows. Following the period specified in the WTO panel report, the cotton programs were eliminated for 1999/00 to 2002/03 and a comparison between the prices and quantities implied by the model under elimination of specific cotton programs and the actual data for each year were provided. In addition, a five-year baseline was developed for the period between 2003/04 and 2007/08 assuming continuation of current farm programs, including direct payments, counter-cyclical payments, marketing assistance loans and loan deficiency payments, and Step 2 payments. For the simulation, all of the five U.S. cotton programs were eliminated starting from 1999/00, while the rest of the world was allowed to react to the resulting price signals. The effects of program eliminations were measured by comparing supply, demand, and trade indicators before and after elimination of these programs.

RESULTS

Simulation results are reported in Tables 5 through 7. Table 5 shows effects of U.S. program elimination on U.S. farm price, acreage, production, mill use, and exports. For the historical period between 1999/00 to 2002/03, U.S. cotton producers on average would have produced 5.67% less than actual production. Among regions, the Southwest non-irrigated and irrigated had the biggest drop in cotton acreage followed by Southeast and the Delta regions. Lower production raised the domestic price by 5.26% on average with highest increase in 2002/03. Higher domestic price and lower production lowered U.S. cotton exports by an average of 8.28% during the same period. The average world price of cotton (represented by Cotlook A-Index price) during the period 1999/00 to 2002/03 would have been 2.43% higher with a range between 2.22% and 3.77% (Table 6). Among the exporting countries, Brazil gained the most in percentage followed by Australia and Africa. The effects of the U.S. cotton programs on world price were found to be similar to Poonyth et al. (2004) and Tokarick (2003) but significantly lower than Sumner (2003) and ICAC (2002). For example, Sumner (2003) reported that the world price of cotton on average would have been 12.55% higher without U.S. cotton programs compared with 2.43% in this study during the period 1999/00 to 2002/03.

For the period between 2003/04 and 2007/08, the effects of the removal of U.S. cotton programs were similar but smaller in magnitude. In the absence of cotton programs, the world price of cotton in 2003/04 would have been 2.44% higher because of 8% less production in the United States in response to the low market price in 2002/03 (Tables 5 & 6). But U.S. production in 2004/05 would have been more or less the same as the baseline level (17.8 million bales compared with 18 million bales in the baseline) because of strong market prices in 2003/04. Farmers in the U.S. would have produced 17.8 million bales compared with the baseline production of 18.0 million bales in 2004/05 because of strong market prices in 2003/04. Farmers responded to weaker market prices in 2005/06

and reduced cotton acreage by more than 5% relative to the baseline level. Similar to the earlier results, the Southwest region had the biggest drop in cotton acreage followed by Southeast and Delta regions. Within the Southwest, non-irrigated acreage was estimated to decline by 8% in 2005/06 compared with a 6.7% decline in irrigated area. Harvested area in the West did not change much due to relatively high cotton prices in the region. On the demand side, elimination of the Step 2 payments reduced domestic cotton mill use, partially offsetting the effects of the production decline on domestic price.

Table 5. Effects of the elimination of U.S. cotton programs on the U.S. cotton market

		1999/00	2000/01	2001/02	2002/03	Average	2003/04	2004/05	2005/06	2006/07	2007/08	Average
		Farm price (cents per pound)										
	Base	46.32	48.05	30.81	43.39	41.73	59.34	55.72	55.51	57.14	57.39	57.02
	Scenario	47.67	51.34	32.67	47.67	43.89	64.04	56.11	58.37	59.05	59.28	59.37
	Change	2.91%	6.85%	6.03%	9.86%	5.26%	7.91%	0.70%	5.16%	3.34%	3.29%	4.08%
Region		Acreage (thousand bales)										
Delta	Base	3692.00	3878.00	4535.00	3545.00	4035.00	3485.00	3484.26	3469.83	3473.17	3468.34	3476.12
	Scenario	3574.68	3654.87	4312.16	3300.70	3847.24	3273.02	3469.57	3374.37	3379.22	3379.68	3375.17
	Change	-3.18%	-5.75%	-4.91%	-6.89%	-4.62%	-6.08%	-0.42%	-2.75%	-2.71%	-2.56%	-2.90%
Southeast	Base	3215.00	3309.00	3574.00	3465.00	3366.00	2966.00	3065.73	3030.74	3055.11	3036.94	3030.90
	Scenario	3106.38	3041.77	3329.46	3116.15	3159.20	2722.37	3026.08	2869.45	2895.03	2897.49	2882.08
	Change	-3.38%	-8.08%	-6.84%	-10.07%	-6.10%	-8.21%	-1.29%	-5.32%	-5.24%	-4.59%	-4.93%
Southwest Irrigated	Base	2063.00	2426.00	2052.00	2023.00	2180.33	2023.00	1996.77	1970.71	1970.99	1967.99	1985.89
	Scenario	1949.17	2180.17	1891.15	1747.00	2006.83	1809.91	1968.60	1837.93	1841.64	1842.55	1860.12
	Change	-5.52%	-10.13%	-7.84%	-13.64%	-7.83%	-10.53%	-1.41%	-6.74%	-6.56%	-6.37%	-6.32%
Southwest Dryland	Base	3215.00	2156.00	2383.00	2597.00	2584.67	2660.00	3042.86	3017.30	3015.97	3011.20	2949.47
	Scenario	3030.45	1913.66	2194.85	2114.32	2379.66	2340.55	3013.27	2773.59	2776.07	2775.60	2735.82
	Change	-5.74%	-11.24%	-7.90%	-18.59%	-8.29%	-12.01%	-0.97%	-8.08%	-7.95%	-7.82%	-7.37%
West	Base	953.00	1133.00	980.00	765.00	1022.00	805.00	854.33	843.88	836.02	829.74	833.80
	Scenario	923.68	1076.06	948.80	719.28	982.85	761.37	852.03	838.28	828.35	820.74	820.15
	Change	-3.08%	-5.03%	-3.18%	-5.98%	-3.76%	-5.42%	-0.27%	-0.66%	-0.92%	-1.09%	-1.67%
Total	Base	13138.00	12902.00	13524.00	12395.00	13188.00	11939.00	12443.94	12332.46	12351.27	12314.22	12276.18
	Scenario	12584.37	11866.53	12676.43	10997.45	12375.78	10907.22	12329.55	11693.61	11720.31	11716.05	11673.35
	Change	-4.21%	-8.03%	-6.27%	-11.28%	-6.17%	-8.64%	-0.92%	-5.18%	-5.11%	-4.86%	-4.94%
		Production (thousand bales)										
	Base	16968.17	17188.17	20303.20	17209.17	18153.18	17559.18	18014.62	17821.42	17758.24	17601.55	17751.00
	Scenario	16309.35	15906.08	19152.20	15339.14	17122.54	16147.56	17826.42	16999.66	16948.77	16847.07	16953.90
	Change	-3.88%	-7.46%	-5.67%	-10.87%	-5.67%	-8.04%	-1.04%	-4.61%	-4.56%	-4.29%	-4.51%
Mill use	Base	10194.10	8862.09	7696.07	7269.09	8917.42	6380.20	6160.14	5701.95	5622.66	5526.78	5878.35
	Scenario	9848.71	8502.24	7360.25	6779.52	8570.40	6054.98	6119.16	5474.06	5417.72	5354.42	5684.07
	Change	-3.39%	-4.06%	-4.36%	-6.73%	-3.94%	-5.10%	-0.67%	-4.00%	-3.64%	-3.12%	-3.30%
Exports	Base	6750.07	6740.07	11000.12	11900.11	8163.42	12003.77	12377.16	12290.91	12255.01	12190.92	12223.35
	Scenario	6459.63	5879.90	10145.54	10602.35	7495.02	10930.39	12240.49	11659.88	11634.02	11592.57	11611.47
	Change	-4.30%	-12.76%	-7.77%	-10.91%	-8.28%	-8.94%	-1.10%	-5.13%	-5.07%	-4.91%	-5.03%
Ending stock	Base	3915.04	6000.06	7448.07	5385.05	5787.72	4616.23	4154.92	4180.93	4173.65	4196.47	4264.44
	Scenario	3866.01	5890.04	7379.40	5243.14	5711.82	4469.14	4144.59	4111.15	4124.45	4148.42	4199.55
	Change	-1.25%	-1.83%	-0.92%	-2.64%	-1.34%	-3.19%	-0.25%	-1.67%	-1.18%	-1.15%	-1.49%

Cotton A-index price was estimated to rise by more than 2% in 2005/06 due to lower exports of 631,030 bales (5.13%) from the United States (Table 6). The decrease in U.S. exports reflects the net change in U.S. production, consumption, and inventories. Foreign producers responded to these higher prices by expanding their cotton production and exports starting from 2006/07. Brazil was the largest beneficiary from the elimination of U.S. cotton programs, with its exports increasing by an average of more than 2%, followed by Australia. Africa and some of the former Soviet Union countries also showed some gains. Although China and India are the largest cotton producers in the world, production increases in these countries were relatively low, mainly because of land constraints.

Table 6. Effects of elimination of U.S. cotton programs on world cotton market

	1999/00	2000/01	2001/02	2002/03	Average	2003/04	2004/05	2005/06	2006/07	2007/08	Average
A-index					**Cents per pound**						
Base	52.84	57.21	41.85	55.75	50.63	69.23	61.20	60.30	60.51	61.33	62.51
Scenario	54.03	58.83	42.78	57.85	51.88	70.92	61.48	61.59	61.50	62.08	63.51
Change	2.24%	2.83%	2.22%	3.77%	2.43%	2.44%	0.45%	2.14%	1.63%	1.23%	1.58%
World production					**Thousand bales**						
Base	87499.88	88707.90	98465.00	87989.88	91557.59	94495.97	99205.99	100052.19	100872.11	101971.98	99319.65
Scenario	86921.32	87559.02	97641.99	86452.64	90707.44	93566.32	99026.08	99273.81	100317.64	101528.91	98742.55
Change	-0.66%	-1.30%	-0.84%	-1.75%	-0.93%	-0.98%	-0.18%	-0.78%	-0.55%	-0.43%	-0.59%
World trade											
Base	27326.29	26584.27	29052.30	30629.34	27654.29	30330.33	31947.29	32705.09	33280.58	33766.20	32405.90
Scenario	27262.87	25997.63	28430.18	29697.38	27230.23	29612.31	31855.22	32259.96	32849.17	33365.99	31988.53
Change	-0.23%	-2.21%	-2.14%	-3.04%	-1.53%	-2.37%	-0.29%	-1.36%	-1.30%	-1.19%	-1.30%
World ending stock											
Base	45567.45	42651.42	47190.48	37308.37	45136.45	33732.35	38081.59	39218.71	39622.60	40074.18	38145.90
Scenario	45557.79	42456.16	47053.03	37041.77	45022.33	33545.32	38011.83	39016.99	39496.30	39975.45	38009.18
Change	-0.02%	-0.46%	-0.29%	-0.71%	-0.26%	-0.55%	-0.18%	-0.51%	-0.32%	-0.25%	-0.36%
Competing exporters											
Australia											
Base	3209.03	3904.04	3101.03	2655.03	3404.70	1699.84	2145.13	2129.83	2103.61	2109.14	2037.51
Scenario	3221.85	3946.80	3157.40	2709.37	3442.02	1745.99	2148.04	2145.82	2125.69	2137.85	2060.68
Change	0.40%	1.10%	1.82%	2.05%	1.10%	2.71%	0.14%	0.75%	1.05%	1.36%	1.20%
Africa											
Base	5239.06	4693.05	4094.04	5121.06	4675.38	6644.67	6607.37	6643.10	6682.82	6740.66	6663.72
Scenario	5275.71	4744.46	4148.48	5204.66	4722.88	6736.29	6613.99	6678.93	6732.52	6791.92	6710.73
Change	0.70%	1.10%	1.33%	1.63%	1.04%	1.38%	0.10%	0.54%	0.74%	0.76%	0.70%
Brazil											
Base	12.00	315.00	674.02	489.02	333.68	1276.84	1950.43	2432.24	2832.35	3123.49	2323.07
Scenario	70.23	409.63	758.10	607.79	412.66	1398.50	1960.34	2484.49	2900.61	3201.87	2389.16
Change	485.20%	30.04%	12.47%	24.29%	175.90%	9.53%	0.51%	2.15%	2.41%	2.51%	3.42%
Former Soviet Union											
Base	6025.07	5380.05	5326.06	5390.06	5577.06	5036.62	5267.07	5408.53	5476.96	5540.71	5345.98
Scenario	6072.44	5427.92	5363.29	5468.81	5621.22	5064.80	5278.24	5457.70	5501.14	5560.61	5372.50
Change	0.79%	0.89%	0.70%	1.46%	0.79%	0.56%	0.21%	0.91%	0.44%	0.36%	0.50%

By the end of the analysis period, world cotton price changes relative to the baseline decreased from the second-year highs. Adjustment by U.S. competitors, who increased production, took away most of the price increase. For example, the increase in A-index price relative to the baseline was 1.23% in 2007/08 compared with 2.26% in 2005/06. Similarly, the increase in U.S. farm price due to program elimination mitigated over time (5.16% in 2005/06 to 3.29% in 2007/08).

In the initial year, world cotton trade declined by approximately 450,000 bales (1.36%) from the baseline level. The trade effects were somewhat mitigated towards the later period. By the end of the projection period, the decline in trade was 1.19%. Similarly, the decline in world cotton production was estimated to be 778,000 bales in 2005/06 compared with 443,000 bales in 2007/08.

Table 7 presents projected gains in export earnings by major exporters due to the elimination of U.S. cotton programs. On average, Brazil gained $30 to 35 million per year (3.77% to 4.33%) in additional export earnings. Similarly, Australian export revenue was projected to rise by $16 to $18 million per year (2.61% to 2.91%). African countries appear to gain on average 47 million dollars per year. These estimates are much smaller than those in the Oxfam study (Watkins, 2002; Goreux, 2004).

A sensitivity analysis was conducted to ascertain the limit of variation of the results due to changes in the elasticity estimates. Two scenarios were considered: first, the estimated elasticities were doubled; and second, the elasticities were reduced by half of their estimated values. Overall, the simulation results changed little by changing the value of the elasticities. By doubling the elasticities, the average A-index price increase was slightly less than the one reported. For example, the average A-index price would have increased by 1.22% by doubling the elasticities compared with current value of 1.48% during the period 2003/04 to 2007/08. Similarly, reducing the elasticities by one-half would have increased the average A-index price by 1.84%.

Table 7. Gains and losses in exports for main exporting countries after elimination of U.S. cotton programs

	Export gains and losses (thousand dollars)										
	1999/00	2000/01	2001/02	2002/03	Average	2003/04	2004/05	2005/06	2006/07	2007/08	Average
United States											
Base	1712033	1850875.67	2209708.00	3184477.00	1924205.30	3988901.31	3636095.58	3557414.87	3559344.96	3588686.36	3666088.62
Scenario	1675149	1660354.70	2083347.00	2944156.00	1806283.32	3720706.98	3612242.89	3447000.22	3434225.41	3454626.98	3533760.50
Change	-2.15%	-10.29%	-5.72%	-7.55%	-6.06%	-6.72%	-0.66%	-3.10%	-3.52%	-3.74%	-3.55%
Brazil											
Base	3043.98	86502.49	135397.80	130863.40	74981.42	424297.85	572987.46	703973.43	822628.11	919473.70	688672.11
Scenario	18213.16	115671.34	155673.20	168776.10	96519.24	476050.61	578506.93	734488.46	856227.02	954168.00	719888.20
Change	498.33%	33.72%	14.97%	28.97%	182.34%	12.20%	0.96%	4.33%	4.08%	3.77%	2.81%
Australia											
Base	813913.70	1072079.40	622936.40	710487.80	836309.83	564864.27	630183.55	616445.74	610972.68	620875.10	608668.27
Scenario	835508.60	1114489.00	648359.60	752361.90	866119.07	594334.93	633899.03	634367.45	627477.16	637088.02	625433.32
Change	2.65%	3.96%	4.08%	5.89%	3.56%	5.22%	0.59%	2.91%	2.70%	2.61%	2.81%
Africa											
Base	1328793.00	1288748.10	822412.7	1370399.00	1146651.25	2208051.61	1941077.64	1922742.50	1940959.3	1984273.70	1999420.94
Scenario	1368128.00	1339730.20	851873.3	1445277.00	1186577.14	2293034.62	1951827.39	1974484.50	1987361.00	2024015.30	2046144.56
Change	2.96%	3.96%	3.58%	5.46%	3.50%	3.85%	0.55%	2.69%	2.39%	2.00%	2.30%
Former Soviet Union											
Base	1528150.00	1477405.40	1069901.00	1442383.00	1358485.21	1673688.393	1547331.548	1565416.40	1590729.80	1631040.80	1601641.40
Scenario	1574741.00	1532725.80	1101329.00	1518629.00	1402931.84	1724060.337	1557639.425	1613453.40	1623872.20	1657082.30	1635221.53
Change	3.05%	3.74%	2.94%	5.29%	3.24%	3.01%	0.67%	3.07%	2.08%	1.60%	1.98%

SUMMARY AND CONCLUSIONS

This study analyzed the impacts of eliminating U.S. cotton programs on the world cotton market through time using a partial equilibrium world fiber model that allows substitution among various fibers, such as cotton, man-made fibers, and wool, at the mill level and endogenizes man-made fiber prices by modeling its supply component. The analysis examined changes in U.S. and global cotton production, consumption, trade, and prices from 1999/00 through 2008/09, allowing market adjustments to "settle out" from the initial adjustment of eliminating U.S. programs.

Overall, the results showed much smaller impacts of the U.S. cotton programs on the world market than previously reported by ICAC (2002) and Sumner (2003). The results from this study indicated that the elimination of U.S. cotton programs would initially increase world cotton price by an average of 2%, but the price effect, *ceteris paribus*, would fade away in a few years due to supply response from other major cotton producing countries. The analysis also showed some effects, though limited, of the elimination of these programs on cotton exports for various countries and regions. Brazil was the main beneficiary, followed by Australia, Africa, and the Former Soviet Union.

The conclusions from this study are that several countries, notably Brazil and Australia, would gain by elimination of U.S. cotton programs, with the gains being relatively small. The primary effect would be to shift acreage and production out of the United States to a few other countries, and the long-run impact on global prices, if any, would be small. There would likely be a small decline in global trade in cotton.

This analysis was conducted assuming a continuation of U.S. farm programs for competing crops and no changes in commodity programs or trade policies of other countries. If other U.S. crop programs were eliminated with cotton, it is likely that the effects on U.S. cotton production would be somewhat moderated. Also, an elimination of trade restrictions and/or alteration of commodity programs by other countries would also impact the global trading system. This study analyzed the effects of unilateral elimination of the U.S. cotton program, leaving all other programs and policies in place.

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