EFFECTS OF AN EXPORT SUBSIDY ON THE U.S. COTTON INDUSTRY

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Abstract

In this study, the effects of an export subsidy for cotton are analyzed using a linear elasticity model. The study explicitly addresses the interaction of current domestic policies with the proposed export subsidy. An export subsidy may be a successful method of reducing the government costs of the cotton program.

Key words: export subsidy, farm programs, cotton

Throughout the 1980s, volatile export markets were a cause for concern for U.S. cotton producers, particularly during the 1985-1986 period when world prices reached record lows as a result of a variety of factors, including the announcement by the U.S. of the new marketing loan program. Because of the volatility of the export market throughout the last decade, the direct costs of the domestic target price program for cotton were often high, causing a renewed interest in export expansion programs as a way to increase the domestic price.[1]

This study presents quantitative estimates of the probable effects of an export subsidy on the domestic cotton industry. More specifically, the objective of this study was to provide estimates of the expected change in domestic price and direct government costs of a subsidy program. To quantify the effects, a linear elasticity model was used. The linear elasticity model used previously obtained estimates of supply and demand elasticities to simulate changes from equilibrium. (See, for example, Sumner and Wohlgenant; Lemieux and Wohlgenant.) The present study includes an explicit representation of the domestic farm programs currently in place. Because the net impact of an export subsidy is highly dependent on initial conditions, stochastic elements are also incorporated into the analysis.

COMPARATIVE STATICS OF AN EXPORT SUBSIDY

The expected changes in the cotton industry due to an export subsidy can be described by a series of equations in log differential form obtained from total differentiation of the set of equations describing initial industry equilibrium. For the purposes of this study, initial equilibrium can be described succinctly by:

(1) $Q_d = f(P_d)$

(2) $Q_x = g(P_d - S)$

(3) $Q_s = h(P_p)$

(4) $Q = Q_s = Q_d + Q_x$

where Q_d is domestic mill use, Q_x is total exports, Q_s is quantity supplied, S is the export subsidy, P_d is the domestic cotton price and P_p is the "supply-inducing" price to which producers respond. This "supply-inducing" price incorporates both market and government policy information (Shumway; Lee and Helmberger; Bailey and Womack). More specifically, following Shumway and Bailey and Womack, P_p can be described as:

(5) $P_p = P_d$ if $P_d > P_s$

(6) $P_p = P_s$ if $P_d < P_s$

where P_s is the effective government program price as defined by Houck et al.

For the subsidy to be effective in raising the domestic price, restrictions must be placed on imports of cotton fiber. Also, under current (1991) market and farm program conditions, most cotton stocks appear to be pipeline stocks, and thus only negligible changes in stocks would be anticipated in response to an export subsidy. Under more volatile conditions, stockholding could become an important

[1] With the exception of the United States, most cotton-producing nations are developing countries. The major importers of cotton are Japan, Korea, and the European nations. Because of the production and consumption patterns for cotton, there are few trade restrictions in the major cotton markets. The European nations do, however, employ a trade preference system that covers cotton and other important export crops from certain former colonies. Research indicates that this program does not adversely affect U.S. cotton imports into the European Community (Sissoko).

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short-run concern and stock demand would need to be included in the equilibrium equations. For the purposes of the present study, however, equation (4) above will represent industry equilibrium. This equilibrium framework parallels that used by Sumner and Wohlgenant.

Total differentiation of (1) and (2) yields:

(7) $dlnQ_d = N_d\, dlnP_d$

(8) $dlnQ_x = N_x(dlnP_d - a)$ with $a = dS/P_d$

where N_d is the own-price elasticity of domestic demand, N_x is the price elasticity of foreign demand for U.S. cotton, and "a" represents the change in subsidy as a percentage of the initial market price.

The change in quantity supplied is more difficult to evaluate because the change depends on the relationship between P_s, based on government programs, and P_d, the market price. Because producers respond to the higher of the two prices, three possible supply responses could occur:

(9a) $dlnQ_s = E\, dlnP_d$ if $P_d > P_s$

(9b) $dlnQ_s = 0$ if $P_s > P_d + dP_d$

(9c) $dlnQ_s = E\,(dlnP_d - R)$ if $P_d + dP_d > P_s > P_d$

where

(10) $R = (P_s - P_d) / P_d$

and E is the price elasticity of supply of U.S. cotton. Equation (9a) represents a full supply response to the change in domestic price, resulting from initial price above the effective support price. Equation (9b) represents the situation where domestic price remains below the effective support price even after implementation of the subsidy, and thus there is no change in quantity supplied. Equation (9c) represents a partial response. In this case, initial domestic price is below the effective support price, but the implementation of the subsidy results in a "final" domestic price above the effective support price; producers respond to the difference between the final domestic price and the effective support price.

Finally, total differentiation of equation (4) yields the equilibrium condition:

(11) $dlnQ_s = K_d dlnQ_d + K_x dlnQ_x$

where K_d is the quantity share of domestic consumption, and K_x is the quantity share of exports.

Substituting (7), (8), and(9a) into (11) and solving for $dlnP_d$ yields:

(12a) $$dlnP_d = \frac{-K_x N_x a}{E - (K_d N_d + K_x N_x)}$$

which represents the percent change in price if the initial price is greater than the effective support price.[2]

If initial price is below the effective support price, and domestic price remains below the effective support price even after the implementation of the export subsidy, equation (9b) is substituted into the equilibrium condition, yielding:

(12b) $$dlnP_d = \frac{K_x N_x a}{(k_d N_d + K_x N_x)}$$

which represents the maximum possible domestic price change.

If initial price is below the effective support price but the export subsidy will push domestic price above the effective support price, then equations (7), (8), and (9c) should be substituted into (11), yielding:

(12c) $$dlnP_d = \frac{-K_x N_x a + ER}{E - (K_d N_d + K_x N_x)}.$$

Thus, the impact of the export subsidy on domestic price is greatly affected by the relationship between the announced government program provisions and the initial market price. (For a graphical treatment of an export subsidy, see Houck.)

DIRECT GOVERNMENT COSTS

When domestic price remains below the target price, total direct government costs for deficiency payments can be expressed as:

(13) $GC = \theta(TP - P_d)Q_s$

where TP is the target price, P_d is the domestic price without any export subsidy, θ is the portion of production eligible for deficiency payment, and Q_s is the initial level of production.

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[2] In this study, the effects on domestic demand of changes in the price of imported textiles due to lower foreign cotton prices is ignored because Wohlgenant found this effect to be small. If we allow for this effect, then equation (1) would become:

(f1) $Q_d = f(P_d, P_m)$

where P_m is the unit price of imported textile products. Using this new demand equation to develop equation (12a) would yield:

(f2) $$dlnP_d = \frac{-(K_x N_x + K_d N_m \lambda)a}{E - (K_d N_d + K_x N_x + K_d N_m \lambda)}$$

where N_m is the domestic elasticity of demand for cotton with respect to the price of foreign textiles and λ is the elasticity of price transmission of the imported textile price with respect to the domestic cotton price. Based on the percentage of the final textile price that can be traced to the cost of raw cotton, Wohlgenant found the upper bound of λ to be 0.3, and its probable value to be around 0.1. Even using the higher value of λ, the effect on the price change is small. For example, with $K_d = .5$, $K_m = .5$, $N_x = -2.00$, $E = 0.2$, and $N_m = 0.5$ (Wohlgenant's parameter values), equation (f2) yields a percentage price change of 14.5 percent and equation (12a) yields a percentage price change of 14.8 percent. When a more realistic value of λ is used, that is $\lambda = 0.1$, then (f2) yields a percentage price change of 14.7 percent. Given Wohlgenant's results, the choice here was not to include the imported textile effect in this study because it would complicate the mathematical exposition with no important effects on the final results of the analysis.

With an export subsidy, government costs are:

(14) $GCS = \theta(TP - P_n)(Q_s + dQ_s) + S^*(Q_x + dQ_x)$

where $P_n = P_d + dP_d$.

P_n is the domestic price after the export subsidy has been imposed, S is the per unit subsidy, $(Q_s + dQ_s)$ is the quantity supplied after the subsidy has been imposed, and $(Q_x + dQ_x)$ is the quantity of cotton exported after the subsidy has been imposed. It is apparent from (14) that increases in domestic price decrease deficiency payments and thus reduce the direct government costs of this part of the cotton program. The subsidy, which raises the domestic price, has its own direct costs, however. Thus, the net effect of the subsidy on government costs depends on the relative magnitudes of the two effects.

RELEVANT ELASTICITIES

For the analysis, estimates of the own-price elasticity of supply, demand, and export demand are required. Fortunately, a set of consistently estimated and current elasticities of supply and demand is available in the literature.

From Duffy, Wohlgenant, and Richardson (1987), the short-run (one year) own-price elasticity of supply is taken to be 0.3. This estimate is in line with previous estimates by Shumway and by Gardner. From Wohlgenant, the price elasticity of domestic demand was assumed to be -0.3. This elasticity was in line with those obtained by Lowenstein and by Waugh. In developing their separate estimates of domestic supply and demand elasticities, Duffy, Richardson, and Wohlgenant (1987) and Wohlgenant used the same data sources and approximately the same data period for estimation.[3] Thus, although these elasticities come from separate studies, they were consistently estimated.

While there appears to be some concensus concerning the elasticity of domestic supply and demand, estimates of the elasticity of export demand have not been consistent. In their review of studies of price elasticities of export demand for agricultural commodities, Gardiner and Dixit report seven estimates of the elasticity of export demand for U.S. cotton, ranging from -0.02 (Taylor and Collins) to -5.5 (Johnson). Wohlgenant used both econometric estimation and calculation to derive an estimate of the elasticity of export demand. Both methods yielded an estimate close to -2.0 for the direct own-price short-run elasticity of export demand. This value is close to that obtained by Duffy, Richardson, and Wohlgenant (1990) for the direct elasticity of export demand for U.S. cotton. This direct elasticity ignores the "feedback" effect that changes in U.S. cotton price will have on the price of competitors' cotton. When this price-price effect is included, Duffy et al. found the resulting elasticity (called the full elasticity by Buse) to be close to -1.0. In the current study, an initial export demand elasticity of -2.0 was used, based on the estimates of the direct elasticity obtained by Wohlgenant and by Duffy, Richardson, and Wohlgenant (1990). The lower value of -1.0, for the full elasticity, was also used in the simulation. These elasticities represent short-run (one-year) responses of quantitity demanded to changes in price. Results of the simulation, accordingly, represent short-run, not long-run, effects of the subsidy. To estimate the long-run effects, long-run elasticities could be used in the framework set forth in (7) through (12). Because the policy environment is rarely constant over many years, it is the short-run results that are of interest here.

SIMULATION RESULTS

The relationships described in (7) through (14) were initially simulated for a 5-cent-a-pound subsidy under the assumptions of a domestic supply elasticity of 0.3, an export demand elasticity of -2.0, and a domestic demand elasticity of -0.3. Sensitivity of the results to changes in the export demand elasticity was then evaluated.

Because the relationship of market price to target price is extremely important in determining both the level of supply response and the changes in costs associated with introducing the export subsidy, a stochastic specification for beginning market price was used. Based on producer price data from 1981 to 1987, price was assumed to be normally distributed with a mean of 58 cents per pound and a standard deviation of 5 cents a pound. The initial shares, K_d and K_x, were each assumed to be 1/2, based on sales in recent years. For calculation of government costs, the initial production level was assumed to be 12,650,000 bales, a figure based on production through the 1980s. Percent change in government cost was calculated using the difference between the costs calculated in (14) and (13), where(14) represents costs with the subsidy and (13) represents costs without the subsidy. The simulation was run 100 times using different observations from the price distribution.

Two different policy options were analyzed. The 1990 provisions of the 1985 Farm Bill were ana-

[3] Data used for estimating the elasticity of supply covered the time period 1959 to 1983 (Duffy, Richardson, and Wohlgenant). Data used for estimating the elasticity of export demand also covered the time period 1959 to 1983 (Duffy, Wohlgenant, and Richardson). Data used to estimate the elasticity of domestic demand covered the time period 1965 to 1981 (Wohlgenant).

Table 1. Effects of a $0.05 a Pound Export Subsidy under a Fully Implemented Marketing Loan

	1990 Program Provisions[a]		1991 Program Provisions[a]	
Mean Percentage Change in:	N_x = -1.00	N_x = -2.00	N_x = -1.00	N_x = -2.00
Domestic Price	6.08	7.07	6.44	7.35
Domestic Mill Use	-1.82	-2.12	-1.93	-2.21
Exports	2.56	3.15	2.20	2.60
Government Costs	-5.60	-10.92	-4.76	-9.50
Percentage of Times Subsidy Reduces Government Outlays	79	100	100	100
Mean Percentage of Subsidy Received by Producers as Higher Price	70	81	74	85

[a] N_x is the elasticity of export demand for U.S. cotton. Initial price distributed normally with a mean of $.58 and a standard deviation of $0.05. 1990 program provisions (under the 1985 Farm Bill) include a target price of $.729 and an acreage reduction program of 12.5 percent. 1991 provisions (under the 1985 Farm Bill) include a target price of $.729, an acreage reduction program of 5 percent, and an additional 15 percent of acreage ineligible for deficiency payments. Results based on 100 iterations. Percentage of times the government saves money is the number of iterations (out of 100) in which the export subsidy results in a decrease in government outlays.

lyzed, as well as the 1991 provisions of the 1990 Farm Bill. Under the 1990 provisions, the target price was 72.9 cents per pound and the acreage reduction requirement was 12.5 percent. Using the Houck method of determining effective support price, this resulted in an effective support price of 63.79 cents per pound. (See Duffy et al., 1987, for detailed information on how the Houck method was used under recent farm program provisions.) Under the 1990 provisions of the 1985 Farm Bill, virtually all production was eligible for deficiency payment. Hence, the parameter θ in equation (14) was set equal to one. The 1991 provisions of the 1990 Farm Bill include a 72.9-cent-a-pound target price and a 5 percent acreage reduction requirement. In addition, the 1990 Farm Bill designates another 15 percent of program acreage as ineligible for deficiency payment. Thus, the parameter θ in equation (14) would be less than one. Because this acreage, called normal flex acreage, can be planted in a variety of crops, including, but not limited to, cotton, the actual percentage of 1991 cotton that will be eligible for deficiency payment is difficult to determine. Given the specialized equipment needed for cotton production, however, it was hypothesized that very little of the normal flex acreage would be planted to crops other than cotton.[4] Thus, θ was set equal to 0.85. The effective support price for cotton under the 1991 provisions of the 1990 Farm Bill was calculated as:

$$P_s = .80*72.9 + .15*58 = 67.02$$

Thus, 80 percent of each program acre is eligible for the target price of 72.9 cents and 15 percent is expected to receive the mean market price. The remaining 5 percent of the acre is idled.

Under the 1985 Farm Bill, there were different options for the loan program. If the marketing loan was implemented, and formulae adjusted to correctly account for transportation differentials, CCC stock accumulation should not have been problematic regardless of the market price. Under the 1990 Farm Bill, a full marketing loan system is the only loan option. Knutson, Penn, and Boehm state that "the marketing loan effectively removes the floor price set by a loan rate that is 'too high.'" They also state that the marketing loan "is very effective at clearing out government stocks." Thus, in the initial simulation, government stock accumulation was not considered, and the distribution of market price was not truncated by a loan rate. The marketing loan provision essentially results in a two-tiered deficiency payment, with the government paying the difference between market price (even if it is below the loan rate) and the target price. Thus, marketing loan costs are incorporated into equations (13) and (14) of this paper. (See Knutson et al. for detailed descriptions of the various farm program provisions.)

Results from simulation of the subsidy under the 1990 and 1991 program provisions are reported in Table 1.[5] When demand elasticity was assumed to be -2.00, and the 1990 farm program provisions

[4] Preliminary results of a mixed integer programming model of representative southeastern cotton farms appear to verify this assumption.

[5] Because normal flexed acres may be planted to crops other than cotton, it is possible that there will be supply response even when the market price remains below the effective support price. The 1991 provisions were therefore evaluated under a model in which 15 percent of the acreage was assumed to respond to market price, regardless of the relationship between market price and effective support price. Given the relatively low elasticity of supply, the results of these simulations did not differ substantially from those reported in Tables 1 and 2.

Table 2. Effects of a $0.05 a Pound Export Subsidy under a Traditional Nonrecourse Loan

	1990 Program Provisions[a]		1991 Program Provisions[a]	
Mean Percentage Change in:	$N_x = -1.00$	$N_x = -2.00$	$N_x = -1.00$	$N_x = -2.00$
Domestic Price	5.83	6.83	6.20	7.10
Domestic Mill Use	-1.75	-2.05	-1.86	-2.13
Exports	2.79	3.60	2.43	3.05
Government Costs	-5.15	-10.49	-4.30	-9.07
Percentage of Times Subsidy Reduces Government Outlays	75	97	96	97
Mean Percentage of Subsidy Received by Producers as Higher Price	67	79	72	82

[a] N_x is the elasticity of export demand for U.S. cotton. Initial price distributed normally with a mean of $.58 and a standard deviation of $0.05. 1990 program provisions (under the 1985 Farm Bill) include a target price of $.729 and an acreage reduction program of 12.5 percent. 1991 provisions (under the 1985 Farm Bill) include a target price of $.729, an acreage reduction program of 5 percent, and an additional 15 percent of acreage ineligible for deficiency payments. Nonrecourse loan of $0.50 a pound in both program years. Results based on 100 iterations. Percentage of times the government saves money is the number of iterations (out of 100) in which the export subsidy results in a decrease in government outlays.

were assumed to be in place, the 5 cent subsidy resulted in an average domestic price increase of 7.1 percent and a decrease in average government cost of 10.9 percent. In 100 percent of the runs, government costs decreased. On average, 81 percent of the subsidy was passed through to the producers in terms of higher market price.

When the full elasticity of export demand (N_x = -1.00) is used to account for induced changes in the price of competitors' cotton resulting from a lowered U. S. export price, the export subsidy is slightly less effective in raising domestic price and reducing government expenditures. In this case, the government saves money 79 percent of the time when the 1990 provisions are in place.

The results of the simulation under the 1991 farm program provisions are similar to those obtained under the 1990 provisions. Regardless of the assumed elasticity of export demand, the export subsidy, on average, reduces government expenditures. Under the 1991 farm program provisions, the export subsidy always saves money, even when the elasticity of export demand is assumed to be -1.0.

SIMULATION RESULTS UNDER A TRADITIONAL LOAN PROGRAM

As can be seen by the periods of increase in government stocks during the last decade, the marketing loan provision of the 1985 Farm Bill is not always effectively enforced. Accordingly, the simulation was also done under the assumption that a traditional loan program was in effect, using a loan rate of 50¢ per pound.

Incorporation of the traditional loan program is done in the following manner. If the initial price is below the loan rate, the initial price is set equal to the loan rate and stocks are accumulated so that

$$(15)\quad Q_{ccc} = \frac{-(K_xN_x + K_dN_d)\,(P_d^o - LR)}{P_d^o}$$

where Q_{ccc} is the quantity of CCC stocks, P_d^o is the price that would have prevailed in the absence of a loan rate, and LR is the loan rate.

With the export subsidy in place, the market price that would prevail in the absence of the loan is calculated using (12). If this price is above the loan rate, no stocks are accumulated. If the domestic market price under the export subsidy is still below the loan rate, then the domestic market price is once again set to the loan rate and the new quantity of stocks accumulated is calculated using (15). Because of increased export sales with the subsidy, this quantity will be less than that which would have accumulated without the subsidy.

In Table 2, results are reported for the export subsidy under a traditional loan program under both the 1990 and 1991 cotton program provisions. In calculating government cost, a storage cost for cotton in the loan program was included. For this analysis, a storage cost of approximately three cents per pound per year, based on 1990 storage charges, was used. Outlays for the commodity itself are not generally considered a direct cost of the program because, in theory, the commodity will be sold at some future date. In reality, however, expensive PIK programs have often been implemented to reduce unwanted stocks.[6] Thus, the reduction in cost of the

[6] PIK, or payment in kind, programs involve farmers idling acreage in exchange for payment with government owned commodities. (See Knutson et al., chapter 10.)

domestic programs resulting from an export subsidy is probably underestimated in this study.

Even with a traditional loan program in effect, the export subsidy usually reduces government expenditures. Under the 1990 provisions, even when the elasticity of export demand is assumed to be -1.0, the subsidy reduces expenditures 75 percent of the time, with average savings of 5.6 percent of the original costs. With a more elastic export demand, the subsidy reduces expenditures 97 percent of the time.

Under the 1991 program provisions, the export subsidy reduces government expenditures 96 percent of the time when the elasticity of export demand is assumed to be -1.00, and average savings are 4.3 percent. With an export elasticity of -2.00, the subsidy saves money 97 percent of the time, and average savings are over nine percent.

CONCLUSIONS

An export subsidy may be a method to reduce the costs of the cotton program when market prices are expected to be below the target price. When a traditional loan rate is in effect, the export subsidy is not quite as effective at reducing direct costs of the farm program, but still results in reduced government costs most of the time. Another consideration in designing an export subsidy is the possibility of retaliation. Although this study used both a high and low estimate of the elasticity of export demand, no specific retaliation was involved. Retaliation by foreign competitors could make the program very costly.

Finally, the impact of the export subsidy on consumers was not considered. In the final analysis, the gains to domestic producers and taxpayers must be weighed against anticipated losses to consumers caused by higher domestic prices brought about by the export subsidy. Studies in measurement of welfare losses in this case are non-trivial, however, because of existing distortions due to government intervention (see Just, Hueth, and Schmitz, chapter 4). Therefore, the question of the measurement of net welfare changes is a topic for future work.

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