AN ANALYSIS OF EXPORT EXPANSION PROGRAMS FOR COTTON

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Abstract

This study examines the effects of export expansion programs for cotton. The success of these programs was found to depend on the level of retaliation by foreign producers. In spite of fairly substantial changes in U.S. export policy, domestic farm program provisions insulate producers from resulting changes in the international market.

An Analysis of Export Expansion Programs for Cotton

Export expansion programs are designed to either: (a) increase revenue to domestic producer through higher domestic prices and increased sales abroad at a lower subsidized export price, or (b) reduce the quantity of government owned stocks. This latter type of program is sometimes referred to as commodity "dumping." The success of either type of export expansion program will depend largely on two factors; the price elasticity of export demand and the level of retaliation by foreign producers.

This report presents an analysis of the effects of an export subsidy program and a stock removal (dumping) program on: (a) total U.S. production of cotton, (b) total U.S. exports of cotton, (c) U.S. stock accumulation of cotton, (d) cash receipts of U.S. cotton producers, and (e) the government cost of the cotton program. The model used for this analysis is composed primarily of a system of linear difference equations describing the world cotton market with special emphasis on U.S. cotton supply and diappearance.

Structure of the Model

The model consists of three major sections: (a) world excess supply and demand, (b) demand for U.S. cotton by foreign nations, and (c) supply and demand in the domestic market. While previous models of the international cotton market by French and by Monke and Taylor have used a directly estimated price equation, in the analysis presented here price is derived through export supply and demand equations.

The excess supply and demand curves for the price-responsive cotton trading nations were estimated using time-series data for the cotton marketing years 1959/60 to 1982/83. These cotton trading nations were aggregated into four strictly importing regions, four strictly exporting regions, and two regions with both imports and exports.[1]

The estimated equations for the regional imports and exports are presented in tables 1 and 2. Because production is a major determinant of exports in most of the regions, regional production equations were also estimated. These estimates are presented in table 3. The endogenous variables in the export-import system are the imports of cotton to each of the six importing regions, exports from each of the six exporting regions, and the price of cotton fiber.[2] Inclusion of endogenous price variables on the right hand side of the equations means that a simultaneous equation estimator, such as two stage least squares, is appropriate to the model. Unfortunately, insufficient data are available for the application of a simultaneous equation technique. Data for certain variables, particularly inflation indices, are unreliable prior to 1959/60. Therefore, ordinary least squares (OLS) was used to estimate the export response and import demand equations for the system.

The world average price was converted to regionalized prices through a factor that converts the nominal dollar price to a deflated price in the region. In a free-trade environment, the nominal price in the United States is equal to the nominal price in a foreign country multiplied by that by that country's exchange rate (dollars per unit of foreign currency). Longmire and Morey explored the relationship between a nominal change in the exchange rate and a real change. Following their work, the nominal dollar price was con-

[1] The four importing regions are: (a) the western Europe nations (Europe); (b) Asian free world importing nations including Japan, Korea, Taiwan, and Hong Kong (Asia2); (c) Canada; and (d) South Africa, Greece, and Spain (SGS). The four exporting regions are: (a) the United States (US), (b) Central America (CA); (c) South America (SA); and (d) Sub-Saharan Africa excluding South Africa (Africa). The two regions for which both export and import equations were estimated are: (a) North Africa and the Middle East (ME), and (b) the Central Asian cotton producing nations (Asia1).

[2] The world average price used in estimating the equations was created by taking a weighted average of seven different varietal prices expressed in cents per pound C.I.F. Liverpool. The outlook "A" index of the Liverpool Cotton Services was not used because it was not availble prior to the 1965/66 marketing year.

verted to a real regional price as follows:

(1) $\$Price*(INVXR_j/CPI_j)$ = Deflated foreign price

where $INVXR_j$ = units of currency in region j per U.S. dollar, and CPI_j is the inflation rate in region j. Because the model deals with regions rather than individual countries, regionalized exchange rates and inflation rates had to be created.

In the equation representing imports to the Asia1 region, the Durbin h statistic is "large" (greater than 2.0 in absolute value) signaling a possible autocorrelation problem. The combination of autocorrelation and lagged dependent variable is a serious problem as it results in parameter estimates which are biased and not consistent. A remedy, suggested by Wallis, was applied to the equation but the resulting estimate was not used in this study. The fix-up did not dramatically change the parameters of the equation, and when the entire system was simulated, it was found that the OLS estimate resulted in better predictions of world average price. The original specification was therefore retained.

The appropriateness of the estimates was juged primarily by the degree of accuracy with which price was predicted. "Goodness of Fit" was measured by Theil's inequality coefficient, the U coefficient.[4] The international sector was first simulated nonrecursively over the period 1963/64 to 1982/83, and the resulting U coefficient was 0.12. In the dynamic simulation of this time period, the U coefficient was 0.14.

[3] To create regional exchange rates, it was necessary to normalize the exchange rates so that unit differences between the countries would not lead to distortions. The exchange rate for each country was therefore converted to an index with 1970=100. A regional exchange rate was then developed by taking a weighted average of the countries' exchange rate indices where the weights were the average share of that country's imports relative to the region as a whole. A regional CPI was developed in a similar fashion.

[4] The U coefficient is bounded by 0 and 1. When U=0, the predicted value is equal to the actual value for all periods. When U=1, negative proportionality exists. Unlike the correlation coefficient, the U coefficient penalizes a consistent bias.

Export Demand for U.S. Cotton

The demand for U.S. cotton by foreign nations was estimated using a market-share approach similar to that used by Sirhan and Johnson in their 1971 study of the British and German markets. In the present study, market-share equations are estimated for all major cotton importing regions.[5] The market share equations are generally of the form:

$$(2) \qquad MS_t = a + bP_t + rMS_{t-1} + u_t$$

where MS_t is the market share of U.S. cotton relative to all cotton imported in a given region, P_t is the price ratio of U.S. cotton and other cotton[6], and MS_{t-1} is lagged market share of U.S. cotton. For the Asia2 region, a trend variable was included as it was found to be statistically significant at the 10% level. The estimated market-share equations are reported in table 4.

The Domestic Sector

The domestic sector is composed of four regional acreage response equations, a stocks demand equation, and a domestic mill demand equation. The domestic mill demand equation, developed by Wohlgenant in a previous study, relates per capita mill consumption to the lagged cotton-polyester price ratio, per capita deflated personal consumption expenditures, and deflated unit value of imported textile goods. A free stock demand equation, which includes production, the price of U.S. cotton in the international market, and lagged free stocks as regressors, was developed for the present study.

Acreage response was estimated as a function of both market prices and U.S. agricultural policy. The regional acreage response equations, reported in Duffy, are of the general form:

5 These regions are : (a) Western Europe (Europe); (b) Asisan price responsive importers (Asia); (c) Canada; (d) South Africa, Greece, and Spain (SGS); (e) the centrally planned nations (SOC); and (f) a residual group of nations in South America, Africa, and the Middle East (RES).

6 The U.S. cotton price used for these estimates is the C.I.F. Liverpool price of S.M. 1 1/16" cotton. The price of competitive cotton was a trade-weighted average of the C.I.F. Liverpool prices of comparable quality cotton from Mexico, Brazil, Iran, the U.S.S.R., Turkey, and Syria.

(3) $PA_{it} = a_i + b_iEPC_{it} - c_iEPO_{it} + d_i\ PA_{it-1} - e_iDP_{it} + f_iY + u_t$

where PA_i is planted acreage in region i, EPC_i is the expected cotton price in region i, EPO_i is the expected price of a competing enterprise, DP_i is the effective per acre diversion payment and Y is year. T is a subscript representing time. The expected crop prices are a weighted average of the previous year's market price and a "policy price" variable. The policy variables were constructed following Houck et. al. and the expected price formula was similar to that used by Romain. The R^2 values for these equations ranged from .68 to .95, and the t statistics, in most cases, indicated significance.

Simulation Results

The estimated economic relationships were used to simulate changes in U.S. export policy over the 5 year period 1985 to 1989. The values of the exogenous variables needed for the simulation are held constant at the last recorded values. Three policy alternatives were simulated: (a) a "baseline" policy similar to the farm program for 1985/85[7], (b) an export subsidy program, and (c) a stock removal, or dumping, program. The baseline policy was simulated to provide a basis of comparison for the export expansion programs.

The export subsidy program involves a 5 cent a pound subsidy, paid by the U.S. government on all export sales. The baseline target price, loan rate, set-aside, and diversion program are unaltered in this scenario. Because it is assumed that no specific retaliation to the U.S. export subsidy occurs, these simulation results represent the most optimistic case for the export subsidy program.

Two export "dumping" scenarios were also simulated, one in which no retaliation is taken by the rest of the world and one in which foreign exporters also begin an export dumping policy. In these scenarios, all CCC

[7] The provisions of the baseline policy for cotton iclude an 81 cent a pound target price, a 57.3 cent a pound loan rate, a 20% set aside, and a paid diversion of 30 cents a pound on normal yield available on an additional 10% of acreage.

stocks forfeited to the government are immediately sold on the foreign market. Target price, loan rate, and diversion payments to domestic producers again remain unchanged.

The goverment cost of dumping is determined by subtracting the final international price of U.S. cotton from domestic price (held at the loan rate) and multiplying this per pound subsidy by the entire amount exported. In this scenario, the government essentially backs into providing a marketing board for cotton.

Because of limited space, the discussion of results concentrates on the final year of the horizon (1989/90) when the system of linear difference equations begins to converge. (A full set of results is available from the authors.) It should be noted that the estimated costs of the cotton program are the maximum possible costs, calculated under the assumption that all production is eligible for deficiency payments. In reality, the payment limitation provision of the farm bill along with less than 100% participation in the program would reduce these payments somewhat. However, as over 90% of all cotton farmers participate in the program and farmers are generally believed to be adept at avoiding the payment limitation restriction, this distortion should not be very large and will be consistent across policy scenarios.

To compare the export subsidy to the baseline, the model was simulated as a deterministic system. This simulation represents the most likely result of the export subsidy program as the mean paths of the endogenous variables are traced. The 1989 value of producer price increases from 58.4 cents under the baseline to 62.5 cents with an export subsidy, meaning that about 80% of the 5¢/lb. subsidy is passed to producers in terms of higher prices. This result is consistent with a previous estimate obtained by Wohlgenant. Mill consumption decreases slightly in response to higher domestic prices, while exports increase from 5,469,000 bales to 5,648,000 bales (3% increase).

A reduction in expected government cost of the cotton program occurs (from $1465 million under the baseline to $1363 million with the subsidy) because the reduction in deficiency payments brought about by higher domestic prices more than offsets the extra cost of the subsidy (about $24 per exported bale). It should be remembered, however, that these results were generated under the assumption that no foreign exporter retaliates. Retaliation could easily reverse the cost results.

Although the price of cotton increased by approximately 7%, producer receipts have increased by less than 1%, from $4985 million under the baseline to $5004 million with a subsidy. The increased price is almost entirely offset by lower deficiency payments so that the financial position of producers participating in the program will be roughly unchanged. It is therefore not surprising that total production is also relatively unaffected by the increased domestic price, remaining at about 12.2 million bales.

Because no CCC stocks are accumulated in the deterministic trial of the baseline policy, the stock removal plan was tested under stochastic conditions. The baseline and stock removal program were simulated recursively 50 times over the 1985-1989 period. In each iteration a different set of additive error terms were drawn from specified probability distributions and added to the values of the endogenous variables thought to be stochastic in nature. It should be noted that the means from the stochastic simulation will not be equal to the deterministic solutions because of the interaction of the farm program provisions with the simulated range of yields and prices.

Results for the two export dumping scenarios underscore the importance of considering the effects of international retaliation. In both dumping scenarios, U.S. exports increase relative to the baseline, but the effect on producers' incomes and government costs is quite different. When no retaliation is assumed, the export dumping plan raises the mean 1989 producer price of cotton to 63.2 cents a pound from the baseline value of 62.6 cents a pound. Averge total cash receipts in 1989 are increased slightly over the baseline, moving from \$4962 million to \$4972 million, and average government costs decrease from \$1326 million to \$1266 million.

In the second export dumping scenario, it is assumed that foreign producers' in $year_t$ will place on the market an extra quantity of cotton equal to the quantity "dumped" by the United States in $year_{t-1}$. Under this assumption, the export dumping program results in rapidly declining prices. Mean U.S. producer price in 1989 drops from 62.6 cents to 59.3 cents, and government costs increase in this scenario to \$1.4 billion dollars.

The lack of a substantial change in total U.S. production in response to major changes in export policy is attributable to the provisions of the baseline program that remain unchanged. Producers continue to respond to the same target price and are therefore insulated to a large degree from changes in the international market. Cash receipts to producers are also relatively isolated from international markets as a change in domestic price is at least partially offset by a change in deficiency payments.

Summary and Conclusions

An econometric model of the world cotton economy was used to simulate the effects of changes in U.S. export policy. When there is no foreign retaliation to U.S. export expansion programs, both an export subsidy program and a stock removal program are likely to raise producer income and decrease government costs. In years of "normal" prices, the export subsidy program is more effective in raising producer income than the stock removal program.

When retaliation by other exporters is assumed, the stock removal program results in decreased producer income and increased government costs. Although the export expansion programs represent a major change in the international marketing of U.S. cotton, the programs do not appear to have a great affect on U.S. producers in terms of planting decisions or cash receipts. The target price and loan rate provision of the baseline policy partially insulate producers from these changes.

Table 1. Import Demand Equations[1]

$$EURMP_t = \underset{(0.0006)}{5053.81} - \underset{(0.07)}{32.68}\ EURPR_t + \underset{(0.26)}{0.23}\ EURMP_{t-1} + \underset{(0.006)}{9.47}\ EURPLPR_t - \underset{(0.07)}{534.55}\ DUMM$$

$$R^2 = 0.79 \qquad \text{Durbin } h = -1.85$$

$$CANMP_t = \underset{(0.13)}{195.36} - \underset{(0.75)}{0.59}\ CANPR_t + \underset{(0.03)}{0.51}\ CANMP_{t-1} - \underset{(0.26)}{43.04}\ DUMM$$

$$R^2 = .46 \qquad \text{Durbin Watson} = 2.12 \text{ (Durbin h can not be calculated)}$$

$$OFWMP_t = \underset{(0.51)}{-197.875} + \underset{(0.07)}{0.403}\ OFWMP_{t-1} + \underset{(.17)}{6.610}\ YEAR$$

$$R^2 = .36 \qquad \text{Durbin } h = .24$$

$$ASIA2MP_t = \underset{(0.31)}{3230.61} - \underset{(0.95)}{1.78}\ ASIA2PR_t + \underset{(0.67)}{0.0052}\ ASIA2FX_t + \underset{(0.03)}{0.46}\ ASIA2MP_{t-1} - \underset{(0.05)}{14.59}\ ASIA2PLPR_t$$

$$R^2 = .82 \qquad \text{Durbin } h = .24$$

$$ASIA1MP_t = \underset{(0.01)}{1018.85} - \underset{(0.30)}{2.72}\ ASIA1PR_t + \underset{(0.12)}{0.32}\ ASIA1MP_{t-1} - \underset{(0.12)}{0.44}\ ASIA1PROD_t + \underset{(0.19)}{0.0012}\ ASIA1FX_t$$

$$R^2 = .55 \qquad \text{Durbin } h = -2.60$$

$$MEMP_t = \underset{(0.002)}{-1542.18} - \underset{(0.24)}{2.12}\ MEPR_t - \underset{(0.71)}{0.10}\ MEMP_{t-1} + \underset{(0.02)}{1.46}\ MEPLPR_{t-1} + \underset{(0.001)}{24.36}\ YEAR$$

$$R^2 = .88 \qquad \text{Durbin } h = -0.08$$

Numbers in parentheses are alpha values on the coefficients.

[1] EURMP is European Imports of raw cotton fiber in 1000's of bales. CANMP is canadian imports of raw cotton in thousands of bales. OFWMP is imports of raw cotton for South Africa, Greece, and Spain. ASIA2MP is raw cotton imports to the Asia2 nations. ASIA1MP is imports of cotton fiber for the Asia1 nations. MEMP is imports of cotton fiber in the Middle-East and North Africa.. EURPR = Real value of world average price in Europe (and similarly for other regions). EURPLPR = Real value of polyesther fiber in Europe (and similarly for other regions). ASIA1FX is the total of cotton yarn and cotton fabric exports from Asia1 expressed in metric tons (and similarly for Asia2). ASIA1PROD is production is Asia1.

Table 2. Export Supply Equations[1]

$$USXP_t = -6039.18 + 39.56\ USPR_t + 0.11\ USXP_{t-1} + 3206.43\ USDUM + 86.84\ YEAR + 0.19\ USPROD_t$$
$$\quad (.06) \qquad (.15) \qquad (.48) \qquad (0.007) \qquad (.03) \qquad (0.05)$$

$R^2 = .72$ Durbin h = -1.04

$$ASIA1XP_t = 1689.60 + 1.89\ ASIA1PROD_t + 0.03\ ASIA1XP_{t-1} + 789.70\ ASIA1DUM - 57.62\ YEAR$$
$$\quad (0.03) \qquad (0.0002) \qquad (0.84) \qquad (0.002) \qquad (0.003)$$

$R^2 = .77$ Durbin h = .63

$$L1XP_t = 467.19 + 2.86\ L1PROD_t + 0.22\ L1XP_{t-1} + 230.70\ L1DUM - 9.73\ YEAR$$
$$\quad (0.56) \qquad (0.0001) \qquad (0.06) \qquad (0.06) \qquad (0.22)$$

$R^2 = .89$ Durbin h = -.87

$$MEXP_t = 5053.38 + 2.45\ MEPROD_t + 0.13\ MEXP_{t-1} - 73.03\ YEAR$$
$$\quad (0.02) \qquad (0.07) \qquad (0.58) \qquad (0.03)$$

$R^2 = .41$ Durbin h = -1.50

$$L2XP_t = 2420.45 + 1.62\ L2PROD_t + 0.31\ L2XP_{t-1} - 40.16\ YEAR$$
$$\quad (0.05) \qquad (0.06) \qquad (0.13) \qquad (0.02)$$

$R^2 = 0.49$ Durbin h = -0.04

$$AFXP_t = 1237.60 + 9.86\ AFPR_t - 21.49\ YEAR + 3.23\ AFPROD_{t-1}$$
$$\quad (0.006) \qquad (0.08) \qquad (0.003) \qquad (0.0001)$$

$R^2 = .77$ Durbin Watson = 2.2

Numbers in parenthesis are alpha values.

[1] USXP is total U.S. exports of cotton in thousands of bales. ASIA1XP is total exports of cotton from the Asia1 region in thousands of bales. L1XP is thousands of bales of cotton exports from Central America. L2XP is exports of cotton from South America in thousands of bales. MEXP is exports of cotton from the Middle-East in thousands of bales. AFXP is exports of cotton from Africa in thousands of bales. USPROD is production in the U.S. expressed in thousands of bales. L1PROD is production in Central America expressed in metric tons. L2PROD is production in South America expressed in metric tons. MEPROD is production in the Middle-East expressed in metric tons. ASIA1PROD is production in the Asia1 region expressed in metric tons. AFPROD is production in Africa expressed in metric tons. USPR is the world average price of cotton in deflated ¢/lb. AFPR is the world average price of cotton converted to a deflated currency for the African region. ASIA1DUM is a dummy variable as are USDUM, and L1DUM. YEAR is a trend variable where 1960=60 and so on.

Table 3, World Region Production Estimates[1]

$$L1PROD_t = \underset{(0.006)}{1166.49} + \underset{(0.007)}{8.92}\ L1PR_{t-1} - \underset{(0.002)}{14.83}\ YEAR - \underset{(0.12)}{0.32}\ L1PROD_{t-1}$$

$$R^2 = .65 \qquad \text{Durbin } h = .67$$

$$L2PROD_t = \underset{(0.007)}{591.68} + \underset{(0.013)}{10.03}\ L2PR_{t-1} + \underset{(0.06)}{0.38}\ L2PROD_{t-1} - \underset{(0.03)}{116.94}\ L2SPR_{t-1}$$

$$R^2 = .41 \qquad \text{Durbin } h = 1.00$$

$$MEPROD_t = \underset{(0.12)}{411.26} + \underset{(0.23)}{5.12}\ MEPR_{t-1} + \underset{(0.008)}{0.61}\ MEPROD_{t-1}$$

$$R^2 = .51 \qquad \text{Durbin } h = .51$$

$$ASIPROD_t = \underset{(0.05)}{1197.16} + \underset{(0.01)}{10.57}\ ASIA1PR_{t-1} + \underset{(0.14)}{11.47}\ YEAR - \underset{(0.003)}{129.16}\ ASIRPR_{t-2}$$

$$R^2 = .78 \qquad \text{Durbin Watson} = 2.9$$

$$AFPROD_t = \underset{(0.18)}{156.55} + \underset{(0.65)}{0.96}\ AFPR_{t-1} + \underset{(0.001)}{0.64}\ AFPROD_{t-1} - \underset{(0.81)}{3.1}\ AFRPR_{t-1}$$

$$R^2 = .53 \qquad \text{Durbin } h = 1.81$$

Numbers in parenthesis are alpha values.

[1] L1PROD is production in South America, expressed in metric tons. L2PROD is production in Central America, expressed in metric tons. MEPROD is production in the Middle-East expressed in metric tons. ASIA1PROD is production in the Asia1 region expressed in metric tons. AFPROD is production in Africa expressed in metric tons. L1PR is the world average price of cotton converted to a deflated currency for the Central American regions, and similarly for L2PR, MEPR, ASIA1PR, AND AFPR. L2SPR is the price of grain sorghum converted to a deflated currency for South America. ASIA1RPR is rice price converted to a deflated currency for the ASIA1 region, and similarly for AFRPR.

Table 4 Market-Share Equations for Demand for U.S. Cotton[1]

$$MSLEFT_t = \underset{(0.0001)}{3.079} - \underset{(0.07)}{0.918}\ CPR1_t + \underset{(0.0001)}{0.026}\ YEAR$$

$R^2 = 0.81$ Durbin Watson d = 2.09

$$MSSOC_t = \underset{(0.12)}{0.613} - \underset{(0.13)}{0.578}\ CPR1_t + \underset{(0.0006)}{0.720}\ MSSOC_{t-1}$$

$R^2 = .48$ Durbin h = 0.32

$$MSOFW_t = \underset{(0.25)}{0.855} - \underset{(0.32)}{0.731}\ CPR1_t + \underset{(.02)}{0.481}\ MSOFW_{t-1}$$

$R^2 = .25$ Durbin h = -4.70

$$MSCAN_t = \underset{(0.006)}{2.462} - \underset{(0.01)}{2.083}\ CPR1_t + \underset{(0.002)}{0.585}\ MSCAN_{t-1}$$

$R^2 = .49$ Durbin h = 0.60

$$MSEUR_t = \underset{(0.05)}{0.633} - \underset{(0.08)}{0.571}\ CPR1_t + \underset{(0.006)}{0.598}\ MSEUR_{t-1}$$

$R^2 = .47$ Durbin h = -2.05

$$MSASIA2_t = \underset{(0.20)}{0.640} - \underset{(0.13)}{0.665}\ CPR1_t + \underset{(0.12)}{0.322}\ MSASIA2_{t-1} + \underset{(0.009)}{0.005}\ YEAR$$

$R^2 = .41$ Durbin h = -1.90

Numbers in parentheses are alpha values on the coefficients.

[1] MSLEFT is Share of U.S. imports relative to all cotton imports (market-share) for the group of Countries designated as "Left." MSSOC is the market-share for the Socialist countries. MSOFW is the market-share for Greece, Spain and South Africa. MSCAN is the market-share for Canada. MSEUR is the market-share for Europe. MSASIA2 is the market-share for the Far East free world importers. CPR1 is the price ratio of U.S. cotton to the average price of competing cottons. YEAR is a trend variable representing the year where 1960=60 and so on.

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