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## Export taxes and sectoral economic growth: evidence from cotton and yarn markets in Pakistan

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### Abstract

Pakistan used an export tax on raw cotton from 1988–1995 in order to suppress the internal price of cotton to benefit the domestic yarn industry. An analysis was conducted to estimate the impact of this policy on both the cotton and yarn sectors. These effects were simulated using the results of a structural econometric model of these sectors of Pakistan's economy. Results indicated that the export tax had a negative impact on the growth rate in the cotton sector, while having little or no impact on the yarn sector. Thus, the export tax did not achieve its objective of increasing the growth rate of value-added (yarn) production above what would have occurred naturally. © 1999 Elsevier Science B.V. All rights reserved.

**Keywords:** Economic growth; Export taxes; Pakistan; Simulation

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### 1. Introduction

The implications of growth in exports on economic growth have received much attention in the literature. Most of this literature has centered on the general growth in exports and general economic growth rather than on a sector basis. Understanding the general implications is important, but understanding the dynamics and effects of policies within specific sectors is also important.

The empirical results have been mixed on the impact of growth in exports on general economic growth. Some observations on export growth show

that such growth tends to contribute more than its own increase to national income. The beneficial effects of exports on growth include greater capacity utilization, creation of economies of scale, and more efficient management generated by competitive forces from abroad (Feder, 1982). Others argue that exports contribute to economic growth because the export sector is not only more productive than the non-export sector, but also because it generates external effects that tend to enhance productivity of the non-export sector (Chen and Tang, 1990).

Countries that have managed to shift to improved export performance by reducing export bias have managed to register acceleration in their growth rates (Bhagwati and Srinivasan, 1979). Also, countries that follow an 'open-development' approach, where exports are an element of growth, rather than 'export-

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led' strategies have higher growth rates (Adelman, 1984).

On the other side of the argument, Taylor et al. (1980) found that subsidies and incentives given to exports by the Government of Brazil have led to (income) distributional deterioration because the export mechanisms benefit the proprietors of scarce resources, thus concentrating wealth. One explanation for the fact that growth in exports does not necessarily lead to general economic growth is that the 'linkage' between exports and the extent of imperfections in the domestic economy preclude translation of export earnings into increases in total output (Corden, 1974). Others, such as King and Rebelo (1990) and Clark et al. (1993), have found important roles for taxation and government policy in growth.

Understanding the role of government policy and different types of taxation is important for evaluation of policies in less developed countries (LDCs). LDCs have (1) actively used different policies in an attempt to control or manipulate sectors of their economies and (2) actively sought to increase economic growth rates. One popular policy has been the use of an export tax on a raw product. The rationale for this policy has several dimensions. First, the export tax may be used to reserve a larger quantity of that product for internal use or to produce government revenue. At the same time, the export tax also lowers the internal price of that product for domestic processors, which induces production of processed goods, thereby ensuring that more of the added value is captured. If increases in exports of the processed goods can be generated, more foreign exchange can be earned.

While one of the objectives of this type of policy is to induce growth, the implications for growth in a sector-by-sector framework are not well understood. The objective of this paper is to analyze the effects of an export tax on sectoral economic growth. Since the processing sector is linked to the raw product sector, this analysis addresses the implications of the export tax through those linkages.

## **2. Cotton policy in Pakistan**

Government policy in the cotton and textile (primarily cotton yarn) sectors in Pakistan provides an example of an export tax for analysis. The Govern-

ment of Pakistan utilized an export tax on raw cotton fiber from 1988 to 1995, which was based on a two-price system (ICAC, 1992; U.S. Department of State, 1995). The first price was a benchmark price, which was set periodically by a government committee. It was not derived from the market, but was used in the calculation of the export tax. The second price was a Minimum Export Price (MEP), which was (1) set daily by a government committee, (2) higher than the benchmark price, and (3) highly correlated with the average world offer price of cotton (ICAC, 1992). The difference between the MEP and the benchmark was collected as a tax on cotton exports by the government.

This policy had several direct implications. First, the export tax held the internal market price for cotton below international market prices by an average US¢ 24/lb over the 1988–1991 period (ICAC, 1992, Townsend and Guitchounts, 1994) and US¢ 15/lb over the 1988–1993 period (this is approximately 21–34% below assuming a world price of US¢ 70/lb) (Hudson and Ethridge, 1997). Exports of cotton decreased significantly after the implementation of the export tax in 1988 (Fig. 1). Although cotton production continued to increase, it became more erratic after 1988, and decreased by the end of the period (Fig. 2).

As cotton is a primary input into the production of cotton yarn, the export tax on cotton had direct implications for the yarn sector as well. The cost of cotton represents about 50% of the total variable cost of yarn production (ADB, 1991). Thus, yarn spinners in Pakistan realized a total variable cost savings of US¢ 7.5/lb of cotton over the 1988–1993 period (50% of the difference between internal and international market prices). Cost savings of this magnitude have two obvious impacts. First, lower input cost induces larger output of yarn. In fact, yarn production increased significantly after 1988 (Fig. 3). Second, if yarn spinners used the lower input cost to lower export price, increased exports of yarn would result. Fig. 4 shows that exports of yarn have increased substantially since 1988.

The export tax appears to have achieved its objective of increasing the level of production and exports of a value-added product (yarns). Hudson and Ethridge (1997) showed that this policy transferred income that could be used to generate economic

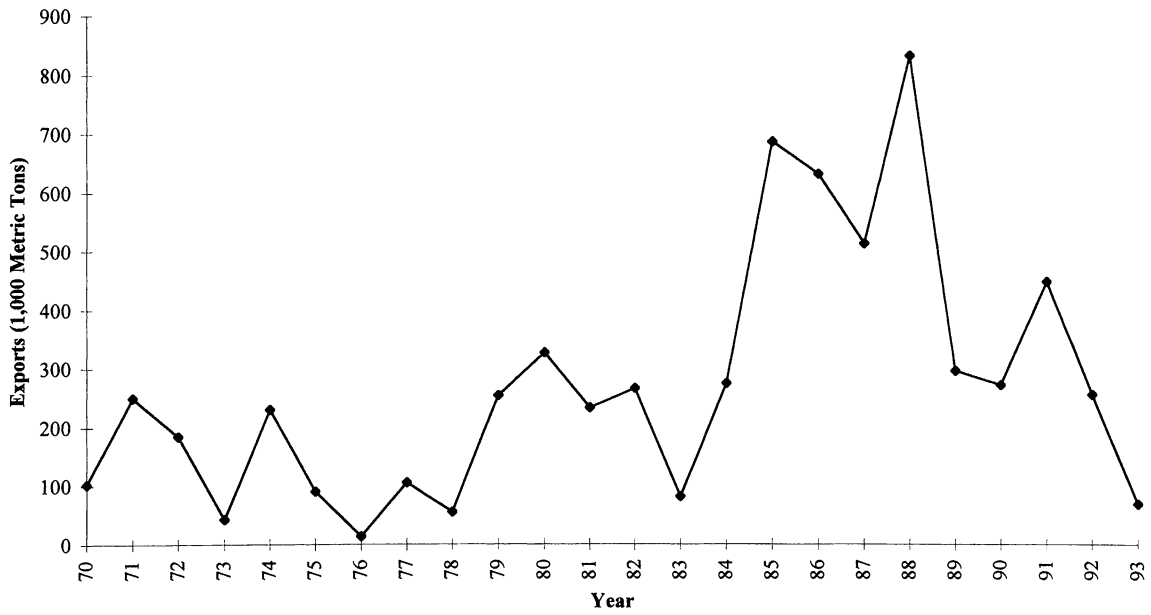


Fig. 1. Exports of cotton in Pakistan, 1970–1993.

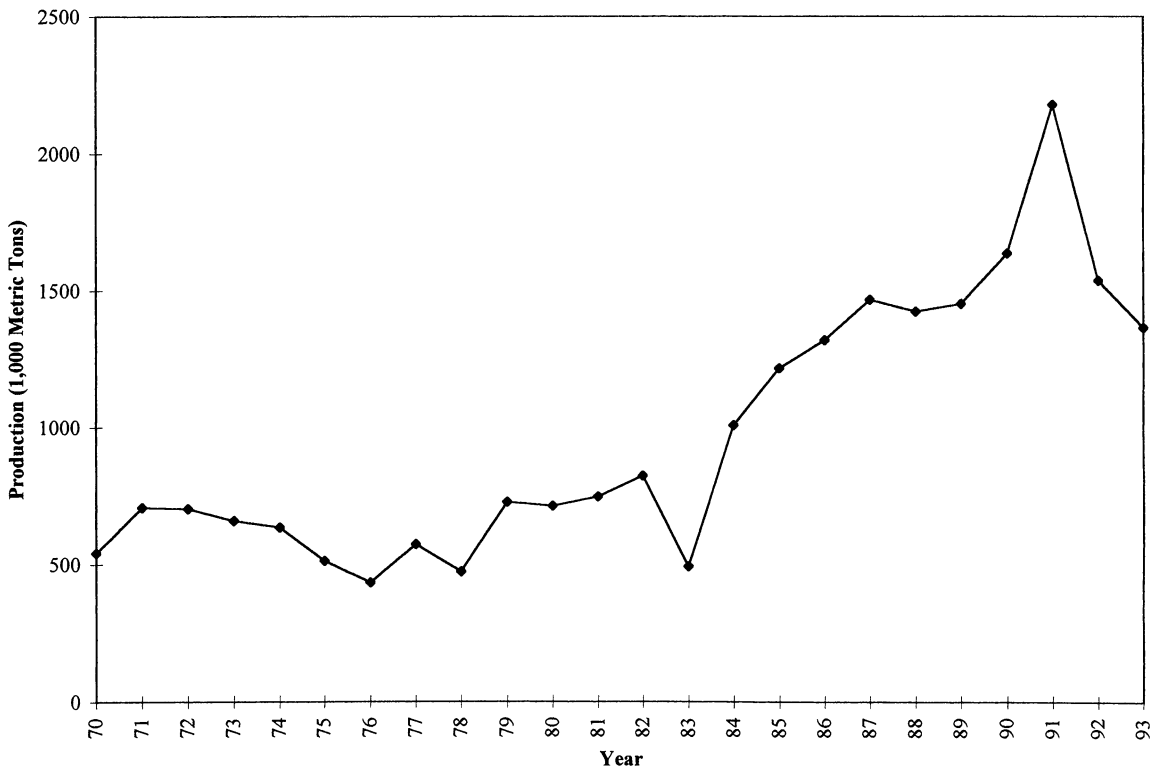


Fig. 2. Production of cotton in Pakistan, 1970–1993.

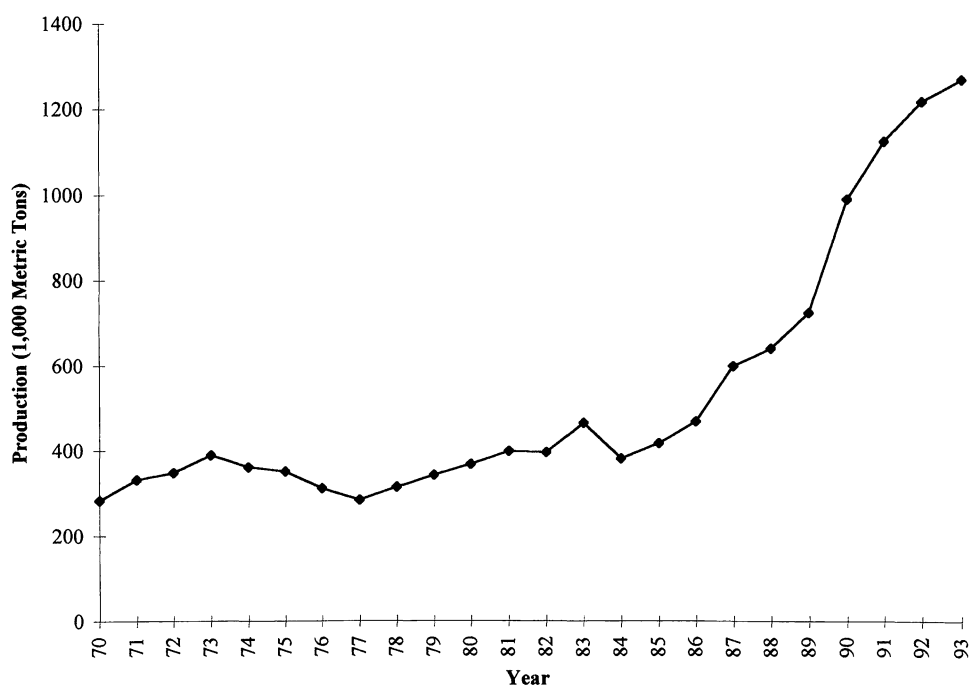


Fig. 3. Production of cotton yarn in Pakistan, 1970–1993.

growth from cotton producers to yarn spinners. However, that study also found a large transfer of income out of the yarn sector. Whether or not the export tax on raw cotton actually generated growth in the yarn sector is the subject of this analysis.

### 3. Analytical framework

To conceptualize the effects of the export tax on growth in Pakistan, two sectors are analyzed – cotton and yarn. These two sectors are presented separately,

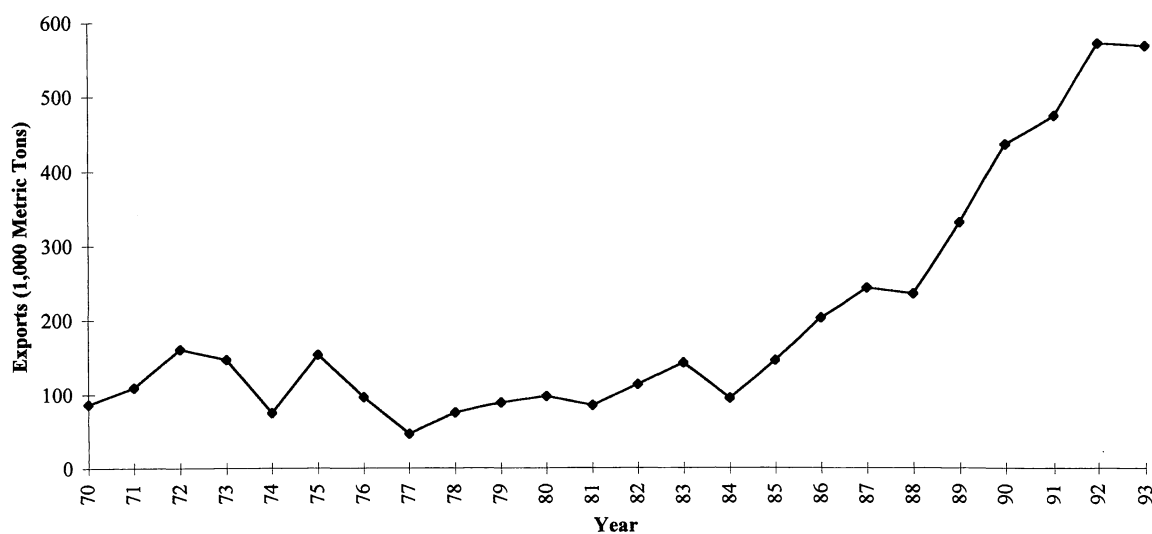


Fig. 4. Exports of cotton yarn from Pakistan, 1970–1993.

but the linkages are discussed. For purposes of this analysis, growth is assumed to be represented by expansion of the real value of the total output.

### 3.1. Cotton sector

The aggregate production function for cotton fiber is represented by

$$Y_c = f(K_c, L_c, T), \quad (1)$$

where  $Y_c$  is the production of cotton fiber,  $K_c$  is the amount of aggregate capital used in cotton production,  $L_c$  is the amount of labor used to produce cotton, and  $T$  is the amount of land planted to cotton. A profit function for the cotton sector is defined as

$$\pi = P_c Y_c - rK_c - wL_c - zT, \quad (2)$$

where  $\pi$  is real industry profit,  $P_c$  is the real price of cotton,  $r$  is the real price of capital,  $w$  is the real wage rate, and  $z$  is the real cost of land. Profit is assumed to be net after depreciation so that  $r$  represents the price of capital per unit of time.

Eq. (2) is reformulated to express real total output

$$(P_c \times Y_c) = \pi + rK_c + wL_c + zT. \quad (3)$$

All first partials are assumed to be positive so that increases in any variable lead to increases in real total output. The item of interest in terms of growth is the change in real total output, which is found by taking the total differential of Eq. (3)

$$\begin{aligned} d(P_c \times Y_c) &= \frac{\partial \pi}{\partial \pi} d\pi + \frac{\partial rK_c}{\partial r} dr + \frac{\partial rK_c}{\partial K_c} dK_c \\ &+ \frac{\partial wL_c}{\partial w} dw + \frac{\partial wL_c}{\partial L_c} dL_c + \frac{\partial zT}{\partial z} dz \\ &+ \frac{\partial zT}{\partial T} dT. \end{aligned} \quad (4)$$

The effects of the export tax on growth in real total output of the cotton industry are linked to the accumulation of capital through savings from industry profit. Consider the accumulation of capital to be specified as

$$dK_c = s d\pi, \quad (5)$$

where  $s$  is the industry savings rate. This says that the change in the capital stock (after covering depreciation) is some proportion,  $s$ , of the change in real industry profit. Substituting Eq. (5) into Eq. (4) and

simplifying results in

$$\begin{aligned} d(P_c \times Y_c) &= d\pi(1 + sr) + K_c dr + L_c dw + w dL_c \\ &+ T dz + z dT. \end{aligned} \quad (6)$$

Marginal changes in the use of capital are assumed to have no impact on the real price of capital. That is, change in the real price of capital is assumed to be zero ( $dr = 0$ ). Changes in the use of capital likely affect the nominal rate, but are not likely to affect the real rate of interest. The change in the real wage rate ( $dw$ ) is also assumed to equal zero. This appears to be a reasonable assumption for Pakistan because of the relative abundance of unskilled labor. That is, cotton production primarily requires unskilled labor. Increases or decreases in the amount of labor employed by the cotton sector are not likely to be large enough relative to the overall unskilled labor pool to affect real wage rates.

Finally, change in the real rental rate of land ( $dz$ ) is assumed to be zero. Land is not considered a constraining resource in developing countries such as Pakistan (Solow, 1969). As such, increases in land use would not lead to increases in the real rental rate. Likewise, shifts of land out of the production of cotton are not expected to lower the real rental rate of land because this land will be shifted to other crops (this assumes that net returns of other crops are comparable to that of cotton on the margin) (Memon, 1993). Given the above assumptions, Eq. (6) reduces to

$$d(P_c \times Y_c) = d\pi(1 + sr) + w dL_c + z dT. \quad (7)$$

Thus, changes in real total output are directly affected by changes in real profit, labor, and land used in cotton production. Changes in industry profit are related to changes in the price of cotton and how the costs of production respond to the quantity of cotton produced. It is assumed that total revenue decreases faster than total costs as the price of cotton decreases (i.e. demand is inelastic). Thus, profit decreases as cotton price decreases, which leads to lower rates of capital accumulation and lower real total output, *ceteris paribus*. Likewise, decreases in the price of cotton lead to decreases in the area of land devoted to cotton production and labor employed. Therefore, reduction in cotton price to the cotton grower with the export tax is anticipated to lead to smaller changes in real total output in the cotton sector, implying a slower rate of economic growth in that sector.

### 3.2. Yarn sector

The aggregate production function in the yarn sector is seen as

$$Y_y = g(K_y, L_y, C), \quad (8)$$

where  $Y_y$  is the production of cotton yarn,  $K_y$  is the amount of capital used in the production of cotton yarn,  $L_y$  is the amount of labor employed in the production of cotton yarn, and  $C$  is the amount of cotton used in the production of cotton yarn.

A similar approach to that above is used here, resulting in a general differential equation

$$d(P_y \times Y_y) = \frac{\partial \pi}{\partial \pi} d\pi + \frac{\partial r K_y}{\partial r} dr + \frac{\partial r K_y}{\partial K_y} dK_y + \frac{\partial w L_y}{\partial w} dw + \frac{\partial w L_y}{\partial L_y} dL_y + \frac{\partial P_c C}{\partial P_c} dP_c + \frac{\partial P_c C}{\partial C} dC, \quad (9)$$

where  $P_c$  is the real price of cotton. The assumption of no change in the real price of capital or real wage rates is maintained here for similar reasons as above. The assumption that  $dK_y = s(d\pi)$  is also used here. Thus, Eq. (9) reduces to:

$$d(P_y \times Y_y) = d\pi(1 + sr) + wdL_y + CdP_c + P_c dC. \quad (10)$$

Eq. (10) shows that changes in the real total output of the yarn sector are affected by changes in real industry profit, employment, consumption of cotton, and the real price of cotton. The reduced price of cotton from the two-price system (export tax) in the raw fiber market has several implications. First, decrease in cotton price leads to increased cotton consumption, *ceteris paribus*, which leads to increased yarn output. Also, decreased price of cotton leads to higher industry profits (assuming that price elasticity of demand for cotton is inelastic), which leads to larger amounts of capital accumulated and higher real total output. Increases in yarn production expected with the export tax on cotton lead to higher levels of employment in the yarn industry, which means greater capacity for increases in real total output. The net effect of the reduction in cotton price associated with the export tax policy in the cotton sector is to increase consumption of cotton, employment, and profits, thus leading to an increase in real total output in the yarn sector.

### 3.3. Overall impacts

The impacts of the export tax policy on each individual sector can be derived. However, the impacts on the economy as a whole are more complex. The linkages between these industries (fiber and yarn) and allied industries (chemical suppliers, seed dealers, electricity cooperatives, etc.) are not clearly defined. For example, if land is shifted out of cotton production into sugarcane production, an adverse impact on cotton seed dealers is expected. However, if these same cotton seed dealers are dealers of sugarcane seed, the impact on them becomes more ambiguous. As these issues are beyond the scope of this study, they are not directly addressed.

## 4. Estimation

The relationships within the cotton and yarn markets were estimated in two interrelated parts (Fig. 5). Specific equations can be found in Appendix A and a full discussion of the model can be found in Hudson and Ethridge (1997). Cotton production was modeled using separate yield and area equations in a manner similar to Evans and Bell (1978). These equations were exogenous to the remainder of the system.

Fourteen equations were used to estimate the remainder of the cotton and yarn markets. The cotton portion of the model centers around the difference between internal and external cotton price because of the two-price system (export tax). The yarn market was linked to the cotton market by the internal price of cotton. The yarn market centered around the domestic price of yarn (there was no difference between internal and export prices for yarn).

The cotton production (exogenous) models were estimated using ordinary least squares (OLS). The simultaneous equations were estimated using three-stage least squares. The models were validated using turning points, root mean percentage error, and Theil's  $U_2$ .

## 5. Simulation

Using the estimated equations from the model, the area of cotton and total cotton production were esti-

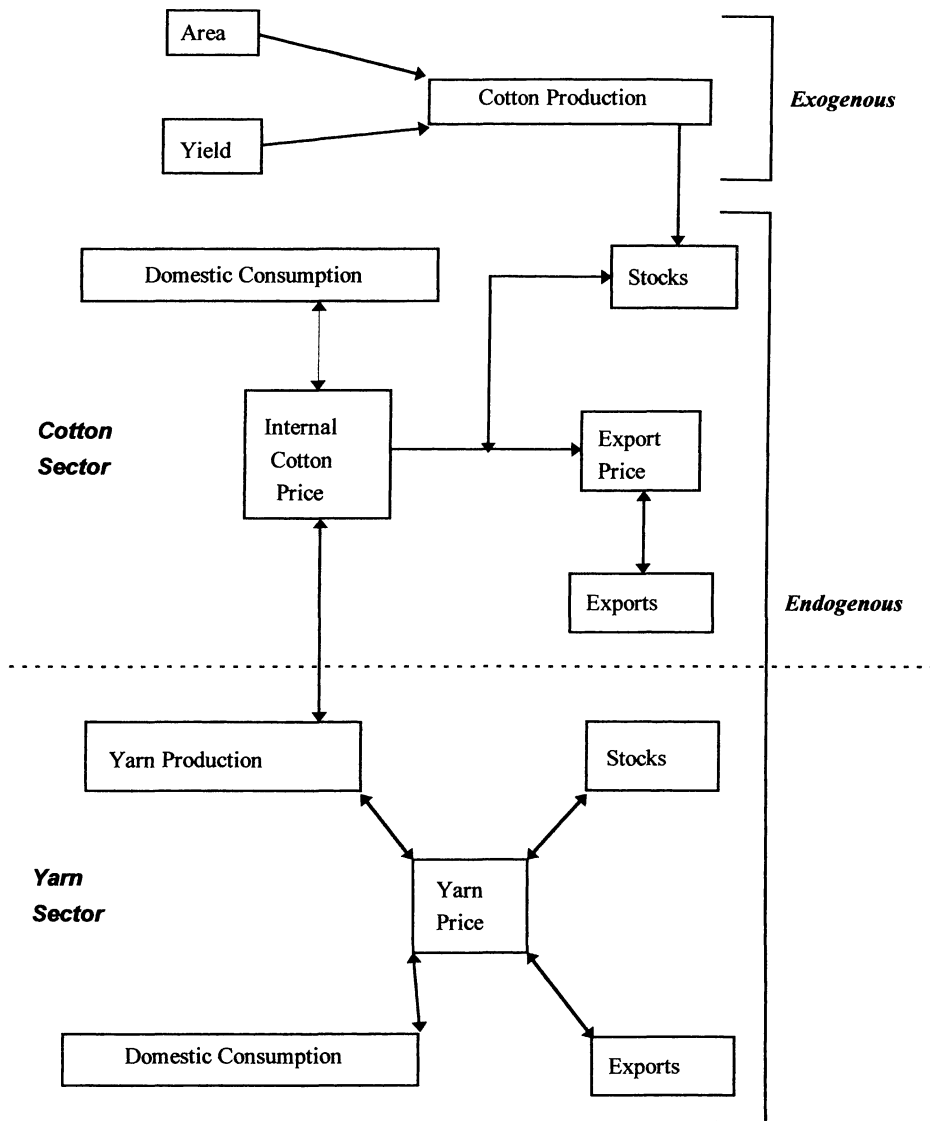


Fig. 5. General model structure of the cotton and yarn markets in Pakistan.

mated for each year. The price of cotton (PCCC, various issues<sup>1</sup>) and the total cost of production (ICAC, various issues<sup>2</sup>) were deflated using the Gross Domestic Product deflator (Ministry of Finance, var-

ious issues<sup>3</sup>). The real price of cotton ( $P_c$ ) was then multiplied by total cotton production ( $Y_c$ ), resulting in a real total output estimate for each year in the dataset.

Real total production cost per hectare (RPC/HA) was multiplied by the estimate of area (HA), resulting in an estimate of the real total cost (RTPC<sub>c</sub>) for each

<sup>1</sup>Pakistan Central Cotton Committee, various issues, Cotistics, Government of Pakistan, Karachi, Pakistan.

<sup>2</sup>ICAC, various issues, Cotton World Statistics, International Cotton Advisory Committee, Washington, DC.

<sup>3</sup>Ministry of Finance, various issues, Economic Survey, The Government of Pakistan, Islamabad, Pakistan.

year

$$\text{RTPC}_c = \text{RPC}/\text{HA} \times \text{HA}. \quad (11)$$

Industry profit was derived by subtracting real total cost from real total output for each year

$$\pi_c = P_c \times Y_c - \text{RTPC}_c. \quad (12)$$

The result of this process was a series of estimates for real total output, real profit, and area of cotton for each year in the data set.<sup>4</sup> The item of interest, however, is the change in these variables. Thus, a first difference of each series was taken, resulting in a series of changes in each of these variables ( $\Delta(P_c \times Y_c)$ ,  $\Delta \text{Area}$ ,  $\Delta \pi_c$ ). To facilitate comparison, the mean of the change in each series was taken. The result of this process was an estimate of the average change in real total output, real profit, and area devoted to cotton under existing conditions (export tax policy) in Pakistan.

The second part of the simulation of the cotton sector involved re-estimating the above series using world cotton price. That is, rather than using the internal market price to estimate area, total output, and profit, the yearly average world cotton offer price was used. The world cotton price is expressed in US\$/lb. Thus, it was converted to rupees using the average annual exchange rate from each year (Ministry of Finance, various issues).

Pakistan is a large producer/exporter of cotton so that changes in production of cotton in Pakistan can have an impact on the world price of cotton. Thus, the world cotton price was adjusted using a global price elasticity of demand for cotton of  $-0.121$ . This elasticity estimate was a weighted average of the price elasticities of demand in major consuming countries in Coleman and Thigpen (1991) (weighted by average percentage of the group of consuming countries' total consumption). Note that these were total demand elasticities, not import demand elasticities. Thus, they are necessarily more inelastic than an import demand elasticity. This approach assumes that the rest of the

world's production remains at their respective levels for that year, which is a limiting assumption.

Using the 'adjusted' world cotton price, estimates for average change in real total output, real profit, and area devoted to cotton were generated in a fashion similar to the export tax scenario. This resulted in two sets of estimates of the variables ( $\Delta(P_c \times Y_c)$ ,  $\Delta \text{Area}$ ,  $\Delta \pi_c$ ) for the cotton sector – one under the export tax and one under free market conditions.

A similar approach to the above was used to simulate growth in the yarn sector. The variables under question were real total output, real profit, labor, domestic consumption of cotton, and the real price of cotton. In the 'free-market' simulation, the real price of cotton was the 'adjusted' world price of cotton from the cotton simulation above.

Pakistan is also a large producer/exporter of cotton yarn, leading to an expectation of changes in the world price of yarn with changes in yarn production in Pakistan. No estimate of a global price elasticity of demand for yarn was available on which to base adjustments. However, the structural equations showed that no significant change in production of cotton yarn was expected with changes in cotton price (coming from the export tax) (Hudson and Ethridge, 1997) so that no adjustment to the world price of cotton yarn was necessary. On the surface, this appears to be a counter-intuitive result because cotton makes up such a large portion of the variable cost in yarn production. However, yarn spinners in Pakistan were paying between 21–34% lower prices for cotton than yarn spinners in other countries. Thus, there was no real incentive to respond to marginal increases or decreases in cotton price.

The result of the simulation of growth in cotton yarn resulted in two sets of estimates for the variables — one under the export tax on raw cotton and one under free-market conditions. The results of both sets of estimates (raw cotton and cotton yarn) under the export tax scenario were compared to their respective free-market estimates to determine what impact the export tax on raw fiber was having on growth in the raw cotton and textile sectors of Pakistan.

## 6. Results

Table 1 shows the estimated elasticities resulting from the econometric model. The most intriguing

<sup>4</sup>Casting the effects of the tax in terms of price and quantity (producer and consumer surplus) has been addressed by Hudson and Ethridge (1997). The lack of reliable data on employment in the cotton sector prevented explicit treatment of changes in employment in empirical models.

Table 1  
Estimated elasticities from structural equations of the cotton and yarn sectors of Pakistan

Attribute	Own-price elasticity
<i>Cotton</i>	
Yield	0.66
Area	0.25
Production	0.62
Consumption	0
Exports	
Europe	−0.73
Asia	N/A
Hong Kong	−0.74
Japan	−0.85
<i>Yarn</i>	
Production	0.13
Consumption	−0.55
Exports	
West	−1.01
Asia	−1.12
Hong Kong	N/A
Japan	−0.33

feature was the finding of no own-price impact for cotton. This suggests that cotton consumers did not respond to cotton price. This is further reinforced by the finding that the elasticity of yarn production with respect to changes in cotton price was not statistically different from zero. This result appears surprising, but yarn mills in Pakistan have a low degree of substitutability between cotton and other fiber products in production. Also, the price of cotton was held so low relative to world prices that domestic spinners had little incentive to alter cotton consumption in response to marginal changes in the internal price of cotton.

Table 2 shows the simulated effects of the export tax on the raw fiber sector. Under the export tax, the area devoted to cotton production increased by an average 40,980 hectares (1.8%) per year. This indicates that cotton was still a competitive crop in terms of net revenue despite the export tax. Average real profit, however, decreased (−834 million rupees or −37.6% per year). Some of this loss in real profit is attributable to the high inflation rate in Pakistan. That is, nominal profit increased slightly over the period. However, high inflation rates resulted in a decrease in real profit. Also, input prices increased substantially during the later part of the study period due to a decrease in government input subsidies.

Table 2  
Summary of growth effects of the export tax in the raw fiber sector

Variable	Average change	Change (%)
<i>Under two-price policy</i>		
Area	40,980 hectares	1.8
Real profit	−834,100,000 rupees	−37.6
Real total output	1,766,460,000 rupees	16.6
<i>Under open market conditions</i>		
Area	188,362 hectares	4.6
Real profit	5,720,388 rupees	14.4
Real total output	6,317,967,000 rupees	15.2
Difference between estimate real total output	−4,551,507,000 rupees	
Percentage difference (%)	−72	

Real total output increased, on average, over the period (about 1.8 billion rupees or 6.6% per year). This indicates that Pakistan experienced some positive growth in the value of cotton production over the period, which is consistent with what was found by Thigpen et al. (1995).

Under open market conditions, the area of cotton is expected to have increased by an average 188,362 hectares (4.6%) per year. This is over three times the average change in area compared to the export tax scenario, which is logical because the internal price of cotton was substantially lower than the international price. If growers were receiving international prices, a large increase in the area of cotton would be expected. It should be noted that the linear specification of the simultaneous equations used by Hudson and Ethridge (1997) creates limitations in these interpretations. That is, linearity problems and extrapolation beyond the range of data limit the specificity one can attach to these results. It is clear, however, that area under cotton would increase in the absence of the export tax. This caveat applies to all of the following.

Real profit was also expected to have increased over the period under the open market scenario, in contrast to the export tax scenario, indicating that the export tax caused a decline in industry profits. Real total output was expected to increase at an average 6.3 billion rupees (15.2%) per year, 72% more than under the export tax scenario. Thus, the export tax resulted in a substantially slower rate of growth in raw fiber sector relative to a free market situation, which is consistent with a priori expectations. Note that real total output

Table 3

Summary of the growth effects in the yarn sector of the export tax in the cotton sector

Variable	Average change	Change (%)
<i>Under the export tax</i>		
Real cotton price per kilogram	49.427 rupees	5.5
Domestic cotton consumption	54,610 metric tons	7.6
Labor	1,254,182,000 spindle hours	4.6
Real profit	4,055,437,000 rupees	100
Real total output	6,050,042,000 rupees	30
<i>Under open market conditions</i>		
Real cotton price	46.91 rupees	5.2
Domestic cotton consumption	54,172 metric tons	7.5
Labor	1,254,182,000 spindle hours	4.6
Real profit	4,080,051,000 rupees	100
Real total output	6,094,403,000 rupees	30
Difference between estimate real total output	–44,361,000 rupees	
Percentage difference (%)	–0.70	

increased even under the export tax, although at a slower rate. Under existing conditions (the export tax), a cursory observation would have revealed a positive growth rate in the cotton sector, which could have led to the false conclusion that the export tax did not have a detrimental effect on the cotton sector.

The question now becomes whether the export tax in the raw cotton sector stimulated growth in the yarn sector. The simulations show that there is essentially no difference between the export tax scenario and the open market scenario (Table 3). In fact, the results show that the export tax lowered the average change in real total output under the export tax on raw fiber compared to the open market situation, although the difference is small in percentage terms. This result likely stems from the fact that the structural model showed no significant effect of cotton price on yarn production (Hudson and Ethridge, 1997). Thus, lowering the price of cotton (or raising it to international levels) has no appreciable effect on yarn production, and thus, on real total output.

The result from the yarn sector indicates that the export tax on raw cotton had no beneficial effects on the growth in real total output in the yarn sector. This implies that the growth in real total output experienced by Pakistan in the latter part of the study period (1988–1993) would have occurred without the export tax policy in the raw fiber market. This is important for two reasons: (1) the policy operated at a substantial net loss to these sectors in Pakistan (Hudson and Ethridge,

1997) and (2) despite the cost, it achieved only that increase in growth that would have occurred naturally.

A couple of words of caution should be noted when interpreting these results. First, Fig. 3 clearly shows a substantial increase in yarn production after the 1983 period. The export tax likely had some impact, but there are also confounding factors such as indirect subsidies for machine imports. It would seem logical that increasing the internal price of cotton by 21–34% (raising it to world price) would induce a decrease in yarn production. However, the price elasticity of demand is very inelastic (0 in the Hudson and Ethridge (1997) model), suggesting little change in the domestic consumption of cotton. Previous elasticity estimates, including those presented here, are based on situations where Pakistan's markets were not open. The estimated effects of the tax presented here should be viewed as lower bound/short-run estimates. In the short run, movement to world cotton prices would have little impact on cotton consumption because of the lack of substitutability cited above. In the longer-run, movement to higher input (cotton) price would drive less efficient mills out of production, thus lowering yarn output.

Conversely, the reduction of cotton price as a result of the export tax would not be expected to have a substantial impact, but those results may be different if a longer period were considered. Given the relatively short time frame in which this policy was in place (1988–1993 for this study), the finding of the highly

inelastic demand would suggest that the policy had only a marginal impact on the growth rate in yarn production.

## 7. Conclusions

The results of this analysis suggest some general conclusions. First, the export tax had a significant adverse impact on the cotton sector, suggesting that ‘surplus extraction’ (Adelman, 1984) through export taxation decreases growth potential in the raw product sectors. Second, the positive contribution of the indirect subsidy (from the tax) towards increasing growth rates in the yarn sector was marginal at best. This suggests that the export tax, which may carry high social costs, does not necessarily induce growth in the processing sector.

There are a couple of potential reasons for this result. First, the finding of highly inelastic demand for cotton suggests that yarn spinning mills do not significantly alter consumption decisions with marginal changes in cotton price. Relaxing the interpretation of the elasticity of demand for cotton to allow for less inelastic demand would improve the viability of the performance of the export tax in generating growth in the yarn sector. Thus, the efficacy of the export tax in generating growth in the processing sectors appears to hinge on the demand relationship between the raw product and the processing sector.

A second reason for the finding of a limited effect of the export tax on growth in the yarn sector could lie in two facts. First, Pakistan exports a large portion of its yarn production (from a low of around 30% in the early 1970s to a high of around 70% of yarn production in the early 1990s). Second, yarn production is a globalized, high volume/low margin industry. During much of this period, countries such as the United States, Japan, and those of Western Europe significantly modernized yarn production by adopting cost-saving technology. Pakistan may have seen the export tax on cotton and the resulting indirect subsidy to yarn production as a means to maintain competitiveness in the face of lower labor productivity and more inefficient technology.

The above underscores an implication of the export tax not explicitly treated in the simulation. That is, indirect subsidy sheltered Pakistan’s yarn spinners

from paying world market prices for cotton. While this may have allowed Pakistan to maintain or even enhance competitiveness in the short run, it reduced the incentive for Pakistan to modernize equipment. Pakistan dismantled the export tax policy in 1995, meaning that Pakistan’s yarn spinners must now pay world prices for cotton. Their failure to invest in the spinning industry (compared to other nations) as a result of this policy may mean they are not competitive in a global setting. Thus, the export tax may have been detrimental to the long-term growth potential of Pakistan’s yarn sector.

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## Appendix A

An econometric model was developed to estimate the demand and supply relationships for the cotton and yarn sectors in Pakistan (Fig. 5). The exogenous portion of the model included the area and yield response functions for cotton, which is similar to the formulation used by Evans and Bell (1978). The area of cotton ( $AR_t$ ) in thousands of hectares was specified as:

$$AR_t = f(P_{t-1}^c, RS_{t-1}, \varepsilon_t), \quad (A.1)$$

where  $P_{t-1}^c$  is the relevant<sup>5</sup> price of cotton to the producer (in rupees/40 kgs) at time  $t-1$ ,  $RS_{t-1}$  is the ratio of the per hectare revenue of cotton to the revenue of sugarcane (the primary competitive crop) per hectare in the previous period, and  $\varepsilon_t$  is the stochastic error term. The per hectare yield of cotton ( $YLD_t$ ) function was specified as:

$$YLD_t = g(P_t^c, TP_t, DRAT_t, \varepsilon_t), \quad (A.2)$$

where  $P_t^c$  is the relevant price of cotton (rupees/40 kgs) at time  $t$ ,  $TP_t$  is total production cost (rupees)

<sup>5</sup>The relevant price of cotton is the benchmark price or the internal market price, whichever is higher.

of cotton per hectare,  $DRAT_t$  is the departure of rainfall from the period average (mm per year), and  $e_t$  is the error term. The  $DRAT$  variable is used to account for the sensitivity of cotton production to rainfall.

Total production ( $PC_t$ ), then, can be defined as Eq. (1) multiplied by Eq. (2):

$$PC_t = AR_t \times YLD_t. \quad (A.3)$$

Given that  $AR_t$  is a function of the previous year's price,  $PC_t$  is exogenous to the system (Fig. 5). Thus, Eqs. (A.1) and (A.2) were estimated using ordinary least squares (OLS).

The endogenous portion of the system begins with the domestic consumption ( $DC_t$ ) of cotton in '...000' metric tons, which was specified as:

$$DC_t = h_1(LP_t^c, PY_{t-1}, Policy_t, u_1), \quad (A.4)$$

where  $LP_t^c$  is the internal price of cotton lint (rupees/40 kgs) at time  $t$ ,  $PY_{t-1}$  is the total production of cotton yarn (millions of metric tons) at time  $t-1$ ,  $Policy_t$  is a binary indicator for the existence of the export tax (1 = years the policy is in place; 0 otherwise), and  $u_1$  is the error term. The domestic consumption of cotton is linked to the rest of the system through the internal price of cotton (Fig. 5).

On account of the managed nature of cotton export prices in Pakistan (although they were correlated with world prices), they were explicitly modeled to bring the bureaucratic decision-making process into the system. Thus, the export price of cotton lint in Pakistan ( $USEXC_t$ ) in \$US/lb was specified as:

$$USEXC_t = h_2(CBI_t, ASUPC_t, u_2), \quad (A.5)$$

where  $CBI_t$  is the Cotlook 'B' world index average offer price of cotton (in US\$/lb) at time  $t$ ,  $ASUPC_t$  is the available supply of cotton (thousands of metric tons) for export in Pakistan, and  $u_2$  is the error term. As Pakistan exports its residual supply of cotton above domestic consumption, the committee monitoring export prices was hypothesized to respond to the size of that residual ( $ASUPC_t$ ) in setting export prices.

Eq. (5) enters into the final two estimated equations in the cotton sector in the following manner. The first is stocks of cotton ( $SC_t$ ) in '...000 metric tons, which was specified as:

$$SC_t = h_3(PD_t, PC_t, SC_{t-1}, u_3), \quad (A.6)$$

where  $SC_{t-1}$  is the stocks of raw cotton fiber (thousands of metric tons) at the end of the previous period.  $PD_t$  is given by the identity:

$$PD_t \equiv USEXC_t - USLPC_t, \quad (A.7)$$

where  $USLPC_t$  is the internal lint price of cotton in Pakistan expressed in \$US/lb.

The final general equation in the cotton sector is the export equation ( $EX_{t,i}^c$ ), which was specified as:

$$EX_{t,i}^c = h_i(USEXC_t, IMP_{t,i}^c, ASUPC_t, u_i), \quad (A.8)$$

where  $EX_{t,i}^c$  are the exports of cotton from Pakistan to region  $i$  at time  $t$ ,  $IMP_{t,i}^c$  are the total imports of cotton by region  $i$  at time  $t$ , and  $u_i$  is the error term for the  $i$ th equation. The regions/countries modeled were Europe (EEXC), Asia (ASEXC), Japan (JEXC), and Hong Kong (HKEXC). Total exports of cotton from Pakistan were represented by the identity:

$$EX_T^c \equiv \sum_{i=1}^N EX_{t,i}^c \quad (A.9)$$

As the Government of Pakistan attempts to reserve all domestic production for domestic use, with the residual available for export, the closing identity for the cotton sector was expressed as:

$$EX_T^c \equiv PC_t - DC_t + SC_{t-1} + IM_t^c - SC_t. \quad (A.10)$$

The production of cotton yarn ( $PY_t$ ) in millions of metric tons was endogenous to the system, and it was specified as:

$$PY_t = h_4(DPY_t, LP_t^c, PP_t, PY_{t-1}, u_4), \quad (A.11)$$

where  $DPY_t$  is the price of cotton yarn (rupees/metric ton) at time  $t$ ,  $PP_t$  is the price of polyester (\$US/lb) at time  $t$ , and  $u_4$  is the error term. The internal price of cotton ( $LP_t^c$ ) links the yarn sector to the cotton sector (Fig. 5). The domestic consumption of cotton yarn ( $DY_t$ ) in millions of metric tons was specified as:

$$DY_t = h_5(DPY_t, PP_t, PF_{t-1}, u_5), \quad (A.12)$$

where  $PF_{t-1}$  is the total quantity of fabrics produced in Pakistan at time  $t-1$  and  $u_5$  is the error term.

Stocks of cotton yarn ( $SY_t$ ) were specified as:

$$SY_t = h_6(SY_{t-1}, DPY_t, PY_t, u_6), \quad (A.13)$$

where  $SY_{t-1}$  is the stocks of cotton yarn (millions of metric tons) at the end of the previous period, and  $u_6$  is

the error term. The general equation for the exports of cotton yarn ( $EX_{t,j}^y$ ) was specified as:

$$EX_{t,j}^y = h_j(DPY_t, IMP_{t,j}^y, Mills_t, u_j) \quad (A.14)$$

where  $EX_{t,j}^y$  is the exports of cotton yarn from Pakistan (millions of metric tons) to region  $j$  at time  $t$ ,  $IMP_{t,j}^y$  is the total imports of cotton yarn by region  $j$  at time  $t$ ,  $Mills_t$  is the number of operating mills producing cotton yarn in Pakistan at time  $t$ , and  $u_j$  is the error term for the  $j$ th equation. The  $Mills$  variable was used as a proxy for the productive capacity of Pakistan to produce cotton yarn. It was hypothesized that the productive capacity lent support to exports by boosting importers' confidence that Pakistan could fill their orders. The regions/countries modeled were Capitalist Western Economies (CAPEXY), Asia (ASEXY), Japan (JEXY), and Hong Kong (HKEXY).

The total quantity of exports of yarn from Pakistan ( $EX_T^y$ ) were represented by the identity:

$$EX_T^y \equiv \sum_{j=1}^N EX_{t,j}^y \quad (A.15)$$

The closing identity for the yarn sector was represented by:

$$DY_t \equiv PY_t - SY_t + SY_{t-1} - EX_T^y + IM_t^y \quad (A.16)$$

The system of simultaneous equations was estimated using two-stage least squares (2SLS) and three-stage least squares (3SLS)<sup>6</sup>. All equations were estimated using linear and additive functional forms. The structural equations were validated using Theil's  $U_2$ , turning points, and the root mean percentage error (RMPE).

A complete dataset for analysis was available for the 1971–1993 period. Data on cotton consumption, production, stocks, exports by country of destination from Pakistan, yarn production, and fabric production were obtained from Documents of the ICAC on CD-ROM (ICAC, 1995). The remainder of the cotton and yarn data were obtained from *Cotistics* (Pakistan Central Cotton Committee, various issues). Where available, data were cross-checked for consistency. Gross Domestic Product, prices of competing crops,

and data on the number and type of textile mills in Pakistan were obtained from *Economic Survey* (Government of Pakistan, various issues). Production costs for raw cotton fiber were obtained from the *Survey of Costs of Production* (ICAC, various issues). Data on polyester prices were obtained from Cotlook, Ltd., and from the *Cotton and Wool Situation and Outlook Yearbook* (U.S. Department of Agriculture).

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<sup>6</sup>There were slight differences between 2SLS and 3SLS estimates. The 3SLS estimates were used because they are known to be more efficient.

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