FAO TRADE POLICY TECHNICAL NOTES

on issues related to the WTO negotiations on agriculture

No. 1. COTTON: impact of support policies on developing countries - a guide to contemporary analysis

CONTENTS

Introduction

This trade policy technical note[1] is intended as a guide to assist in the interpretation of the range of existing analytical studies on the impact of developed country cotton support on developing countries. A number of analytical studies will be compared, with the objective of determining the policy questions addressed, the extent of agreement on the impacts of policy change, and importantly, the reasons that estimates of these impacts vary across the studies.

A key objective is to shift the focus of policy dialogue away from the debate on which of the often widely divergent results is "correct", by improving understanding of why the findings diverge. A more informed debate is thereby promoted, grounded in a better appreciation of what the results actually do and do not tell us.

Another objective is to identify further research needs, distinguishing those approaches to the analyses and underlying assumptions that require more attention from those that are generally deemed satisfactory and would not benefit significantly from further refinement.

[1] The preparation of this paper was assisted by an informal consultation of experts involved in the analysis of cotton sector support, held from 31 May to 1 June, 2004 at FAO, Rome.

1 What is the policy question being addressed?

The overriding concern of most contemporary studies has been to estimate the impact of the use of domestic support policies on world market conditions and on the distribution of the gains and losses of the removal of these policies on cotton-producing countries.

Measuring the impact of domestic subsidy payments to cotton producers has become a central issue in the current World Trade Organization (WTO) negotiations. At the WTO Cancún Ministerial Meeting in July 2003, four African cotton-producing countries submitted requests for the elimination of all domestic subsidies to the cotton sector in industrial countries and compensation for prejudice caused by these domestic subsidies. In the WTO Framework Agreement (July 2004), the importance of the sectoral initiative on cotton was reaffirmed. Concurrently, Brazil initiated a legal process at the WTO by claiming that cotton subsidies in the United States were not consistent with WTO regulations; a WTO ruling in September 2004 upheld substantial aspects of this claim.

Quantitative estimates of how domestic subsidies have affected the world cotton market and caused damage to other producing countries have been used to underpin these submissions. The results of analytical studies are therefore becoming increasingly influential both in the disputes settlement process and ongoing negotiations. It is essential therefore that the results be seen as robust and, equally importantly, are used appropriately.

***Note*:** This is the first of a series of papers, that is part of a new FAO work programme to promote a more informed use of analytical studies related to agricultural trade policy debates and the WTO negotiations. The series will examine current research on a range of commodities and cross-cutting themes.

- *Why has this policy question attracted such significant attention?*

Developed country cotton production is inefficient. In recent years, European Union (EU) production could have been imported at one-third of the cost. In the United States, the cost of subsidies in some years of low prices (for example 2001/02), is greater than the total value of exports at "A" index prices. A decrease in domestic consumption relative to export growth at a time of increased production resulting from the latest US Farm Bill, meant that in 2003 more than 70 percent of US production was exported (accounting for 40 percent of world exports). Tariffs are not currently used in the United States or European Union and therefore reform will not result in developing countries losing from reduced preferences.

Developing countries have been increasing their production and share of world exports at a time when the opposite has been true for most other commodity exports. Increased income from cash crop production is among the best short-term measures to reduce poverty. A 10 percent increase in world prices has been estimated to result in a 20 percent increase in net farm income in West and Central Africa, and with associated multipliers, this could contribute to a substantial reduction in poverty levels.

2 What are the impacts of current support measures?

- *Subsidies maintain cotton production at otherwise unprofitable levels in industrialized countries, reducing the opportunities for developing countries to export to subsidizing country markets and displacing their exports to third countries.*

Contemporary studies unambiguously demonstrate that the removal of domestic subsidies in industrialized countries would reduce cotton production in, and exports from, these countries (see Table 1).

- *Subsidies depress world cotton prices*

The increased excess supply induced by domestic subsidies has a depressing effect on the world market price. However, as Table 1 highlights, there is significant divergence in the magnitude of this impact, with studies estimating increases of between 2 and 35 percent as a result of the removal of subsidies. In presenting results from partial equilibrium studies, it should be noted that analysts do not attach a level of statistical significance to the estimates, and in some studies, the increase may not be significantly different from zero. Additionally, the results should be interpreted as being increased from a base year price, with the *ceteris paribus* assumption invoked. As such, the estimates are informative in assessing the price that producers would have received that year in the absence of supporting policies, but should not be interpreted as suggesting that the increase will be sustained. Initial price gains are likely to be reduced in the longer term as non-subsidizing producing countries expand production.

- *Identifying the distribution of gains and losses across countries in terms of reductions in export earnings or increased import bills is problematic but critical.*

For net exporters, a key difficulty lies in determining in which countries production is likely to expand as a result of increases in world market prices. Developing countries have recently been increasing their production and their share of world exports in spite of suppressed world prices and at a time when the opposite has been true for other commodity exports. This suggests that there is the potential for a significant supply response. In addition, tariffs on cotton lint are not currently used in the United States or European Union, and therefore reform will not result in developing countries losing from reduced preferences, as may be the case with other commodities.

- *Poverty-reducing impacts of subsidy reductions are significant.*

Two studies[2] investigate the poverty impact of declines in the cotton price facing smallholders in Benin and Zimbabwe. In Benin, a 40 percent fall in the price is estimated to result in an 8 percent increase in the number of rural households in poverty and a 22 percent increase in cotton-producing households falling below the poverty line. In Zimbabwe, real incomes of cotton producers are estimated to fall by between 13 and 31 percent depending on the household characteristics, with poverty increases depending on how dependent the households are on cotton income. Both of these studies find that the impacts work through the price effect and that higher national supply elasticities do not necessarily translate into greater poverty alleviation impacts when prices are raised. This is because the increased supply of cotton in response to a price rise may result from producers shifting resources between commodities in response to *relative* price changes, rather than from additional resources being mobilized in response to the rise in prices.

[2] Minot and Daniels (2002); Poulton (2004).

Table 1: Estimated impacts of developed country subsidy removal on world prices, EU and US production levels, and the resulting increase in West and Central African (WCA) export earnings

	Estimated price without subsidies (US$/lb)	Effect on price (%)	Production fall in the United States (%)	Production fall in the European Union (%)	Prejudice to WCA farmers (US$ million)[5]
ODI (2004)[1]					
S/U	0.675	18 - 28	15.2	26.6	266.5
F/U	0.688	20	8.3	19.8	93.8
S/D	0.70	22	13.6	25.2	354.6
F/D	0.732	28	1.5	8.9	133.5
Goreux (2003)	0.589 - 0.649	2.9 - 13.4	2.2 – 14.7	10 - 48	37 - 254
ICAC (2002)	0.742	29.7	-	-	274
ICAC (2003) [2]					
2000/01	0.742	21	-	-	-
2001/02	0.738	72.4[4]	-	-	504
FAO (2004)	0.591 - 0.60	2.3.- 5.0	7.4 – 14.2	16.1 – 31.7	30
FAPRI (2002)	-	11.4	6.7	70.5	90.37
Reeves *et al* (2001)[2]	0.474	10.7	15.9	na	76
Sumner[3] (2003)	0.644	12.6	29.1	na	116
Tokarick (2003)	0.588	2.8	8.6	na	26

Source: Based on Shui (2004)

[1] The ODI studies run four model scenarios: S=Single Market; F=Fragmented market; U = Uniform elasticity; D = Differentiated elasticity. For the segmented market assumption, the world price is an average across segments.

[2]All studies use 2000/01 as the simulation year data except ICAC (2003) and Reeves (2001) which use 2001/02 data. Actual world price in 2000/01 = US$0.572/lb Actual world price in 2001/02 = US$0.418/lb.

[3] Removal of US support only

[4] The value of 72 percent reported in ICAC is considered by many to be an outlier due to the very low world price during the simulation year – see discussion on base year below.

[5] Where the prejudice to WCA farmers is not explicitly stated in a study, the value in the table is estimated by using a cotton supply equation for WCA to determine additional export earnings generated by the increase in world price.

3 Brief review of the approach adopted in existing studies[3]

The International Cotton Advisory Committee (ICAC 2002) made an early effort to quantify the effect of subsidies on the world cotton price. The simulation uses the elasticity of area with respect to cotton prices developed by the FAO/ICAC model. This model relates international cotton prices to the US area, and the ICAC analysis uses this elasticity to simulate the decline in production due to an elimination of subsidies in the United States. The ICAC simulation assumes the same elasticity found for the United States with the FAO/ICAC model for subsidizing countries other than the United States. The overall simulated decline in production is then fed into the ICAC price model to find a preliminary simulated impact on prices. Preliminary higher prices are fed into the ICAC World Textile Demand Model to obtain an impact on consumption. The impact on consumption, along with an estimated higher production response in non-subsidizing and subsidizing countries due to higher prices, is fed back to the ICAC price model in order to obtain a net impact on prices. Based on these computations and simulations, ICAC concluded that average cotton prices during 2000/01[4] and 2001/02 would have been US$0.17 to US$0.31 per pound higher, respectively, had all subsidies been eliminated. This implied that the farm subsidies had depressed the world cotton price by approximately 30 percent and 72 percent in 2000/01 and 2001/02, respectively.

Goreux (2003) took a similar approach to ICAC but made several improvements. After simulating the world cotton price without subsidies following the ICAC approach, he entered the price into the

[3] This section draws on Shui (2004).

[4] The crop year for cotton starts 1 August and ends on 31 July of the next year.

supply equation to allow all cotton-producing countries to respond to the higher world price and then re-simulated the new world cotton price. To avoid the sensitivity of the choice of base years, he used a five-year average (1997/98 to 2001/02) as the computing base. Moreover, he conducted sensitivity analyses by assuming a range of values for supply and demand elasticities. He further computed the likely gains of West and Central Africa (WCA) under different assumptions for elasticities. He found that without subsidies, the world cotton price would have been 2.9 to 13.4 percent higher than the actual price level, and WCA countries would have produced 0.4 to 11.2 percent more cotton. Consequently, the export earnings of WCA countries would have increased by US$37 million to US$254 million yearly. He also found that the subsidies' effect on the world cotton price was very sensitive to the price elasticity of demand for cotton. Under the same supply elasticity, different demand elasticities resulted in very different changes in world cotton prices. He also found that when a larger supply elasticity was assumed, WCA countries would produce more cotton.

ODI (2004) adapted the Goreux model to simulate the effect of domestic subsidies on the world cotton price and world cotton production and trade, under the assumption that the world cotton market is fragmented, comprising market segments in which countries can only trade with existing trade partners. It was found that complete elimination of domestic subsidies would result in an 18 to 28 percent increase in the world cotton price, depending on the assumptions made about the market structure and supply responses in the major cotton-producing countries. It was further found that the elimination of domestic subsidies under the assumption of market fragmentation would have a larger effect on the world cotton price than under the assumption of an integrated market. Moreover, the study suggested that the impact of the removal of EU support to the cotton sector has a proportionally greater impact under the fragmented market assumption. Of the total loss of earnings attributable to protection in WCA, EU subsidies account for 38 percent under the fragmented market assumption, but only 9 percent under the unitary market assumption. EU subsidies reduce the earnings of WCA cotton producers by 4 percent under the fragmented market assumption, instead of 2 percent when assuming a unitary market. The study also attempted to estimate the supply responses in several major cotton-producing countries in the world. Further, the effects of removing domestic subsidies by China, the European Union and the United States were examined separately, and their domestic subsidies were found to have different effects on the world cotton-producing countries with and without segmentation.

Sumner (2003) used an econometric simulation model adapted from and based largely on the key supply and demand elasticities from the Food and Agricultural Policy Research Institute (FAPRI) policy modelling framework, in which relatively low demand and supply elasticities but larger export demand and supply elasticities were assigned to major cotton-producing and consuming countries. He examined the export and world price effects of removing the six major US subsidies supporting US production and export of upland cotton. He found that had all these domestic and export subsidies for US upland cotton been removed during the marketing year period of 1999-2002, US exports would have declined on average by 41.2 percent, and the world price of upland cotton would have increased by 12.6 percent, or 6.5 cents/lb. He further predicted the likely effects for marketing years 2003-2007 and found that removal of the upland cotton subsidies, provided by the 2002 Farm Security and Rural Investment (FSRI) Act and the Agricultural Risk Protection Act of 2000, would on average reduce US exports by 44 percent and increase world prices by 10.8 percent, or 5.9 cents/lb, compared to baseline projections of export quantities and world prices. According to Sumner's estimates, Brazilian cotton farmers lost US$478 million in revenues from cotton prices that were depressed through the effects of the US subsidies during 1999-2002.

Using a Computable General Equilibrium (CGE) model to measure the welfare effects of distortions in agricultural trade, Tokarick (2003) incorporated the results from a partial equilibrium model in which the world cotton price is determined by the equilibrium of net exports from countries without any support and excess supply from countries with supports, and the net import demand to measure the impact of multilateral agricultural trade liberalization on several agricultural commodities including cotton. He investigated the effects of all major types of distortions in agricultural trade including tariffs, domestic support, export subsidies and input subsidies. He found that multilateral trade liberalization in all agricultural markets was expected to induce a 2.8 percent increase in the world price of cotton with 0.8 percent coming from the removal of market price support and the remaining 2 percent coming from the removal of production subsidies. Tokarick also calculated that global reforms for cotton would lead to US$95 million in total change in welfare per annum.

FAO (2004) used the United Nations Conference on Trade and Development (UNCTAD)/FAO Agricultural Trade Policy Simulation Model (ATPSM), a standard static comparative model, to simulate the effects of removing domestic subsidies on the world cotton price and trade. Compared with many studies, they assumed a much more elastic demand, and used a dataset of domestic subsidies based on official notifications to the WTO, in which China is

reported as having provided no domestic subsidies to the cotton industry. This was in sharp contrast to the majority of studies that used ICAC data. The simulation results showed that the long-term impact of complete elimination of domestic subsidies and tariffs would be for the world price of cotton to rise by 3.1 percent in the base scenario and up to 5 percent under alternative assumptions about supply and demand elasticities. Under full liberalization, production is found to fall in all countries that reduce subsidies. Reductions of 14 and 32 percent are estimated in US and EU cotton production respectively, which are of a similar magnitude to those found in other studies. However, in contrast to other studies, Brazilian cotton production is found to fall following full liberalization. Brazil notified the use of domestic subsidies to WTO, albeit a negligible amount, in support of cotton production during the baseline period. This contrasting result is due solely to the assumption in the FAO model that Brazil was a subsidizing country and the small simulated increase in the world price was insufficient to offset the reduction in producer price following the removal of the subsidy. Non-subsidizing countries, as expected, are found to increase production when subsidizing countries eliminate subsidies. Cotton production in Benin, Burkina Faso, Chad and Mali collectively would increase by only 2.4 percent. The impact on their trade is marginally greater at 4.1 percent.

Reeves *et al.* (2001) used a simple CGE model consisting of three country groups (Australia, the United States and the rest of the world) and three sectors (fibres, textiles and clothing) to simulate the effects of US domestic and export support of the cotton industry on the Australian cotton industry. The simulation results suggested that the removal of US domestic cotton sector subsidies would have much larger impacts on the Australian cotton industry than would the reduction of quotas and tariffs on textiles. It was estimated that elimination of US subsidies on cotton production and export would induce a 20 percent reduction in US cotton production, and a 50 percent reduction in US cotton exports. As a result, world cotton prices would be 6 percent higher than their 1999/2000 levels. If trade in textiles and clothing were also liberalized, the world cotton price would increase by another 1 percent.

FAPRI (2002) has also generated measurements of the effects that removal of domestic subsidies would have on the world cotton price by using its own commodity projection models. Under global liberalization (i.e. removal of trade barriers and domestic support of all commodity sectors), the world cotton price would increase above the baseline scenario by an average of 12.7 percent over the ten-year period. The largest gains in trade would go to Africa, which would increase its exports by an average of 12.6 percent, while exports from the United States would decline by 3.5 percent.

4 What are the reasons for the divergence in model results and how might the gaps be closed?

Three interrelated categories of reasons for the divergence in model results have been identified: assumptions about parameter values and market structure; the source of data used; and the analytical approach adopted. For each category, the implication of the choice of assumption or approach on the model results is set out, the factors governing the choice examined, and suggestions for further research and refinement provided.

4.1 Key parameters and assumptions

Cotton is not a final product; it is widely produced and faces fierce competition from man-made fibres. As a raw material, demand for cotton is derived from textile mills that spin and weave cotton, often blended with other fibres, to produce fabrics for textiles and clothing for final consumers. As an agricultural crop, cotton faces competition from other alternative crops and is constrained by agronomic conditions and land resources. Quantifying the effect of policy changes in major producing countries on the world market in such a complicated system is demanding because of the sensitivity and interaction of all sectors among all countries to any policy shocks in the system. This complexity is compounded by the differences in the quality of products and the inter-reaction of the agricultural sector and the textiles sectors with other sectors in the economy.

To make modelling efforts manageable, assumptions must be incorporated into the model structure and associated parameters, which will affect results of the model simulations.

Table 2 summarizes the key assumptions relating to parameter values and market structure across the range of studies.

4.1.1 Elasticities

Most studies used partial equilibrium models to simulate the effects of domestic subsidies on the world cotton price. While these models were constructed in various ways in terms of model specifications, country groups and simulation procedures, the elasticities of demand and supply of cotton had significant roles in determining the simulation results. The solutions of the models are very sensitive to the values of these parameters.

Table 2. Key assumptions made in the reviewed studies

	Demand elasticity	Supply elasticity	Simulation from base year	Market segmentation assumed	Model includes stocks
ODI (2004)	-0.1	0.36 to 0.6	2000/01	Y	N
Goreux (2003)	-0.1 to -0.5	0.15 to 0.90	2000/01[1]	N	N
ICAC (2002)	-0.1	0.47	2000/01	N	N
FAO (2004)	-0.75 to -1.25	0.2 to 1.25	2000/01	N	N
FAPRI (2002)	Not specified	Not specified	Average 2002/03 – 2011/12	N	N
Reeves et al (2001)	-0.3	0.8	2001/02	N	N
Sumner (2003)	-0.2 to -0.47	0.14 to 0.6	2000/01	N	Y
Tokarick (2003)	-0.56[2]	0.41[2]	2000/01	N	N

Source: based on Shui (2004).

[1] Goreux uses a five year average for the base period.
[2] Tokarick's elasticities are for the United States only.

- *Implications of the choice of elasticities*

Table 2 sets out the range of elasticities used in the studies reviewed. Most studies conducted sensitivity analyses over a range of values. All demand elasticities are assumed to be inelastic, ranging from the highly inelastic (ODI, Goreux, ICAC) to less inelastic 0.75 (FAO). FAO's study assumed a high demand elasticity due to possibility of substitution between cotton and man-made fibres. Sensitivity analyses over supply elasticities tend to cover similar ranges and all of the studies assume an inelastic response.

The assumption of highly inelastic demand for cotton results in significant estimated price increases when volumes entering the world market are reduced. Increasing the value of the elasticity would have a suppressing effect on the estimated world price increase. For instance, when -0.1 was used by ICAC and ODI, the simulated world cotton price increases were mostly higher than 20 percent. By contrast, when FAO's study assumed a demand elasticity ranging from -0.67 to -1.25 for major cotton-consuming countries, their simulations resulted in increases of only 3 to 5 percent in the world cotton price.

The demand elasticity is also key in determining the extent to which net importers of cotton will lose following a price increase. Although often given less consideration than the value of supply elasticities, studies that move away from the general assumption of an inelastic demand and assume a demand elasticity greater than –0.1, show a more significant impact on the model results than changing the supply elasticities by a similar proportion.

Currently used average supply elasticities may be too low to reflect long-term[5] elasticities and may be understating the quantity change in the long run. Balanced against this, if subsidies are reduced in key producing countries, research and development expenditures may also fall and costs would fall less quickly as new technology would not come on stream as rapidly; prices would therefore fall less quickly in the long term. The implication is that longer-term elasticity may not be as great as otherwise argued.

The values of the supply elasticities are of particular interest because, in addition to influencing the extent to which subsidizing countries lose and non subsidizing countries gain, they determine the distribution of gains across these countries. This is particularly important in studies that attempt to estimate the "damage" to specific countries or groups of countries.

If the benefit to non-subsidizing countries works through the price, as it does in most studies due to the significant price increases, then all that matters is that the benefiting country can continue to produce cotton. However, if the price change is limited, and benefits to producing countries are generated through quantity increases in response to more open markets, then it matters who can respond. There is a danger, however, that in assuming different values of elasticities for different countries, analysts are essentially "picking the winners".

Two alternative approaches are used: the use of the same average elasticity across all countries, and the use of different elasticities for different countries or groups of countries (as in the ODI study). If it is assumed that the supply elasticity is the same for all countries, changes in

[5] Short term is defined as transitional, medium term as the period that can be reasonably foreseen, and long term covers an unknown time period (all adjustments finished to price changes). Medium term was agreed on as to where the interest lies since it corresponds to the period where governments make decisions (10-15 year time horizon).

the value of the supply elasticity would have less significant effects on the simulated world cotton price, because a sharp decline in production in countries with subsidies would be largely offset by an increase in production from countries without subsidies. In his sensitivity analyses, Goreux found that assuming different values of supply elasticities would lead to little change when a unified supply elasticity was assumed for all cotton-producing countries.

In assuming identical supply elasticities, analysts are also implicitly side-stepping the issue of differential price transmission from world to domestic prices across the countries in the models. Econometric estimation of the degree of transmission in cotton markets is complicated by the fact that many producing countries fix the producer price each year. As a result, the analyst is faced with using annual rather than monthly data. The use of annual data over a period of 30 to 40 years, however, introduces the problem that there may have been significant structural and policy changes during the period, so that the estimate used to infer a degree of price transmission may be meaningless.

Given the different farm structures, resource constraints, and production potentials, it is more than likely that different countries would have different supply responses, especially in the long run. ODI assumed different inelastic supply elasticities between countries and found that the choice of supply elasticities would have significant effect on the simulated world cotton price, which increased by between 18 and 22 percent. Moreover, when supply elasticity differed between countries, the gain from the elimination of these subsidies varied from country to country depending on the sensitivity of each country's supply responses to changes in the world price. The larger the supply elasticity, the greater the gain would be.

The decision as to which approach to adopt relates to the question asked. If the research is investigating the world market impact, an average elasticity may be adequate. However, if looking at the distribution of net gains, where the issue of who wins and loses is critical, at a minimum, the elasticity used should be different in the key subsidizing and main non-subsidizing producing countries, and especially in those countries expecting to benefit significantly, for example, Australia[6] and Brazil.

- *What affects the choice of elasticities?*

Interestingly, with the exception of two ODI scenarios, all elasticity values are based on previous studies and/or the analyst's judgement. Most start with the ICAC assumption of a world average of 0.5. and use sensitivity analysis to test whether the results are sensitive to the magnitude in the range used. The ODI study attempted to generate estimates from data and from qualitative information.

In addition to assuming that all non-subsidizing countries react to the same extent, most studies[7] assume that subsidy reduction/removal has the same effect in subsidizing countries, irrespective of the existing support mechanism. However, the selected value of the supply elasticities also needs to be considered in relation to the type of policy or policy package that is subject to reform. For example, the impact of decoupling payments is likely to be less significant than removing them altogether. Decoupling is not the same as full removal of support. OECD (2003) demonstrates that the transfer efficiency of market price support is low in relation to that associated with direct payments, since the former are capitalized into land values and subject to leakage to input suppliers, etc. The real effect of a unit of expenditure in terms of its production impact will depend upon the type of policy used, and as such should be incorporated into analyses.[8]

Equally, a policy change directed solely at the cotton sector will have a greater effect than if a package of policies are implemented that reduce support to other crops as well. In estimating the impact of subsidy removal it is assumed, by definition in partial equilibrium models, that support to alternative crops remains unchanged. The reality is often different. For example, support to the alternative crops in the European Union will also be decoupled.

Using a simple supply equation with a constant elasticity ($\ln Q = A + \ln P$) is satisfactory for small price changes but not for large ones. Given that the elasticity will depend on the position on the supply curve, and that shifts along the curve can be significant (with world price movements of up to 35 percent), the elasticity is likely to be variable along the supply curve.

Less than full decoupling (for example, the 65 percent decoupling agreed in the European Union) could have a marginal impact on production, but after a threshold is hit, cotton production could fall off sharply. Using an elasticity of 0.5 for Spain may therefore result in underestimating the cotton production fall. The difficulty with using a variable elasticity is not knowing where the curve kinks. Some work has been done to analyse the impact of decoupling *ex ante*. Karagiannis (2004) estimates up to an

[6] Nevertheless, it has been noted that changes to water rights regimes in Australia may constrain future expansion of cotton production.

[7] An exception is Sumner (2003).

[8] The issue of the trade distortiveness of "decoupled" domestic support policies is examined in detail in a separate paper in this series.

approximate 20 percent reduction in production following implementation of the EU's 65 percent decoupling of payments.

Arguments in favour of a limited supply response suggest that EU farmers have often invested through cooperatives and therefore supply will not fall sharply. Given that ginneries will stay in the system even if the subsidy now goes to the producers, the supply response would be more muted than if assuming an atomistic structure with weak linkages to downstream industry.

Sumner (2003) used different elasticities for the different components of the package of US support measures in recognition that reductions in the level of expenditure on each component are likely to have different magnitudes on impacts on producer decisions.

- *Avenues for further research*

In most current studies, a relatively inelastic demand was assumed. One of the arguments used to justify the inelastic demand for cotton was that as a raw material, cotton accounted for only 7 percent of the value of final product. At the mill level, however, cotton accounts for around 75 percent of total cost. Given the fierce competition from man-made fibres, a mill will change its consumption of cotton in response to prices, especially in the long run.

The impact of changing the demand elasticity for key subsidizing producers such as the United States, Spain and Greece may be limited, but for India, Pakistan and China, who together consume 55 percent of world cotton, the demand elasticity needs more accurate quantification. Studies should also include analyses of the downstream industry in determining the magnitude of the price and substitution elasticity.

The FAO/ICAC database upon which most of the assumptions are founded should be updated and expanded to draw on a broader range of studies that attempt to quantify supply elasticities.

A major problem with using elasticities from other studies, which may have estimated them under different policy and institutional conditions, is that analysts lose the information contained in the probability distribution associated with the estimate. It is important to know under what conditions they were estimated and whether and how subsidies (or their removal) were modelled econometrically. It might not be appropriate to use estimates based on historical data for simulations that extend beyond the bound of historical levels. In using econometrics alone, it may be necessary to impose homogeneity, for example. The ODI (2004) study imposed non-perversity and used priors in an attempt to have estimates conform with *a priori* assumptions.

Knowledge or significant econometric results showing clear evidence should be used eclectically. While about one-third of world cotton output is produced from large and specialized farms where very high adjustment costs restrict their production potential, the other two-thirds of output is produced from small and diversified farms where farmers can shift between crops easily in response to price changes. Given the domination of small farms in cotton production in these countries, if prices of other agricultural crops remained unchanged, a significant increase in cotton prices would induce a significant shift of land from other crops to cotton. Moreover, with rapid adoption of Bt cotton, these small farmers, in particular those with very low yields, may be able to expand their cotton production swiftly. Supply may thus be more sensitive to changes in prices than has been assumed.[9]

In making the assumption for non-subsidizing countries, it is necessary to consider whether there are physical constraints, such as water, or quality constraints, such as whether reduced quality will prevent countries from being able to sell increased production. For example, in 2002/03, plantation areas for cotton in China increased by 26 percent in response to a 20 percent increase in the domestic cotton price during the planting season, while many other cotton-producing countries showed much less expansion.

Where data is problematic, the imposition of homogeneity across all countries in a region may be appropriate, for instance, in WCA and Central Asia. Given the level of uncertainty over the elasticity, whether or not substitution effects are incorporated may not matter much in terms of the final results. As a minimum, however, there should be a minimum price in the supply equation; this could be achieved by using the net return rather than price, so that when the net return is zero, production finishes. As a rule of thumb, a minimum price of 35 cents/lb would be reasonable in the United States. In Africa standard input costs are about one-third of the cotton selling price.

As highlighted above, it is difficult to determine the timeframe with which analysts are working from study reports. Further research is required to understand by how much the degree of supply responsiveness differs in the short, medium and longer term.

4.1.2 Quality and market structure

- *Implication of choosing a segmented or unitary market assumption*

As a raw material, demand for cotton from textile mills is derived from final consumption. The mills normally demand varying grades of cotton, not only because of cost considerations, but also the

[9] See, for example, Baffes (2004).

final requirements, which would result in different responses to changes in cotton prices.

Most studies do not distinguish between the quality of source of cotton, assuming a single unsegmented market. If the quality of cotton is roughly the same, then models assuming a single market are satisfactory. However, if the quality or source is important, then a segmented market may be more appropriate because a production decline in a certain subsidizing country or region may benefit countries producing a given type or quality of cotton.

- *What affects the choice of the assumption?*

Although there are differences in quality, in practice they are sold according to the "A" index value. An exception is US Pima, which competes with Egypt, Israel and Sudan with a 100 percent premium. It is a different market used for different end products. Most countries produce a spectrum of types. In attempting to categorize these types, however, there is a data problem: not many countries maintain eight-digit level statistics, and for those that do, staple length is only one quality variable.

The sourcing of cotton is largely based on quality, but also on reliability and cost, and as such there is some value attached to country of origin. Textile mills get a feel for the blend, and it can be costly to change to a different country of origin. For example, switching the source from the United States to Burkina Faso where the quality is similar will still require changing machinery settings.

It has been argued that state marketing organizations in Africa used to guarantee quality. Privatization in East Africa suggests that quality might have fallen, although it is difficult to give a clear assessment given that some markets are characterized by monopolies, some by cartels, and some by being dominated by multinational corporations. As an example, the Tanzanian "A" index component does not reveal much difference before and after reform, and there is some scepticism about liberalization having caused a quality reduction.

- *Avenues for further research*

Cotton is largely substitutable but imperfectly so. In the short term, even though there is some difficulty in changing from one source to another, a single market assumption is appropriate. Market structure is not considered to be an issue in the long term. While there is a case for separate analysis of the Pima market, separating out other qualities would be too tricky given the complexities of accounting for different qualities and the lack of data.

Relative to other commodity markets, the international cotton market is considered relatively competitive, so the "power" of traders in the marketing chain is not considered a priority for further research.

4.1.3 Stocks

- *Implication of the choice of treatment of stocks in the models*

Even though they are relatively significant, cotton stocks have not generally been modelled in PE or GE frameworks. Cotton stock levels have a similar pattern to production levels, but proportional changes in stocks year to year are significantly greater.

While it would be safe to ignore stocks if it can be assumed that in the short run they do not vary, this is not the case in reality. In the long term, however, the static assumption may be appropriate.

- *Avenues for further research*

It should be possible to test if incorporating stocks makes a difference econometrically. In the absence of such evidence, analysts should assume that the demand elasticity reflects consumption plus stock replenishment.

4.1.4 China's inclusion or exclusion from models

- *Implication of the choice as to whether to include China*

Given its dominance in production and consumption, accounting for over 25 percent of world cotton production and nearly 35 percent of consumption in recent years but not currently in trade, changes in China at the policy or market level are key in determining world market conditions. China accounts for about one-third of output and consumption, so there will be a potentially significant impact if it reduces subsidies to its producers. There is some dispute, however, as to whether China is currently subsidizing cotton producers; if it is not, it will increase production following a price increase. This uncertainty poses a dilemma for analysts.

According to ICAC estimates, the Chinese Government applied significant subsidies for cotton farmers during 1997/98 to 2001/02 (for example, US$0.24 per kilo in 2001/02). As China is the largest cotton-producing country in the world, the use of domestic subsidies in China would have a very significant effect on the world cotton price. Studies by ICAC, Goreux, ODI, and Reeves *et* al. estimate a very significant price change arising from the cessation of support because they all used the ICAC policy data set in which China was estimated to have had significant domestic subsidies on cotton production. According to Goreux, China's cotton production would decline by 3 to 18 percent should these subsidies be removed, based on different assumptions of demand and supply

elasticities. If China had little or no domestic subsidies to cotton farmers, however, it would increase its cotton production as the United States and the European Union removed their domestic subsidies. FAO studies using the subsidies data based on submissions to the WTO, simulated much smaller changes in the world cotton price.

- *What affects the choice as to whether to include China?*

The main difficulty facing analysts is that the level of subsidy payment is unknown. The studies that do incorporate China use ICAC data and assume that subsidy levels are positive and will therefore fall with liberalization. The fact that China is not an ICAC member and thus does not report to ICAC means that ICAC subsidy numbers for China are estimated.

- *Avenues for further research*

Caution should be exercised when incorporating China in studies before further data collection and analysis are undertaken. Some agricultural economists in China have argued that the Chinese Government has not provided any subsidies to cotton farmers since 2000 when the national cotton marketing system was liberalized. They further argued that the Government actually taxed cotton farmers at the rate of 5 to 12 percent if considering various fees imposed on cotton farmers by the local governments, in particular the township and village administrations.

4.2 Data

- *Implication of choice of data set used*

A potential source of discrepancies between studies resulted from their use of different data sets. There are both definitional and value differences between FAO, ICAC, US Department of Agriculture (USDA) and UN Commodity Trade Statistics Database (COMTRADE) data. Export data is perceived to be of lower quality than production data, often because it is from different, inconsistent sources. For example, in Tanzania, three official sources of trade data differed by 30-40 percent. A key discrepancy across the studies is over the export share of WCA to Europe. Some studies suggest that 70 percent of WCA exports go to the European Union, while others suggest that the value is 20 percent, suggesting that a major market for WCA is Asia. According to recent preliminary estimates, however, no more that 15 percent of WCA exports were to Europe in 2003/04, which does not lend support to the hypothesis of a fully segmented market.

- *What affects the choice of data set?*

Production data

FAO data uses calendar years, whereas ICAC uses marketing years (the harvest season for most being August/September) which makes for a four-month difference.

Export data

FAO records exports by calendar year, and since quantities are multiplied by a price from several months prior, it is thought to systematically underestimate import and exports in comparison to ICAC. ICAC only has physical, not value data. Some studies use mirror data if export data is not available to the country or researcher.

Price data

Export prices are determined relative to the '"A" index, used by all studies reviewed as the international price. The "A" index consists of the cheapest price components and is therefore heavily influenced by African components (plus central Asia).

Policy and subsidy data

WTO data tend to be three to four years old and of limited series length, so USDA data, which are considered to be the most comprehensive, are more commonly used. The ICAC cotton policy database has been widely used in recent studies. Since China is not a member of ICAC, ICAC receives no official data from the Chinese Government. To complete the policy data set, ICAC estimated the magnitude of support under China's cotton policies. It should be noted that budgetary expenditure is not necessarily a good proxy for subsidy where the differential impact of different policy types is not incorporated into the analysis.

For WTO, *de minimis* is not reported and therefore care is needed over subsidy data. The distinction between what falls into the different domestic support boxes is confusing, although the recent WTO ruling on cotton (WTO, 2004) provides some guidance on the distortive nature of different US components of support. FAO (2004) uses the Aggregate Measure of Support (AMS) notified to WTO, with the justification that subsidies falling within the AMS calculation are by definition distortive, and those not notified should have minimal trade distorting effects.

- *Avenues for further research*

An important contribution would be to determine whether the use of different data sets produces seriously differing estimates. The percentage differences, especially for Africa, need to be established. As USDA derives some information independently via attachés and merchants, among others, one possibility for further research would be to compare this data with other sources.

For export data, a way around the FAO underreporting is to use FAO unit values and ICAC quantity data, with the justification that using FAO unit values will cancel out the under-reporting.

For policy data, issues of definition need clarification for each major subsidising country and require checking over a five-ten year average.

The calculation of a Producer Support Estimate (PSE) for cotton would be useful for analysts.

There is a need for analysts to exchange information on data and make it more accessible to independent researchers, particularly for domestic prices. Making the World Integrated Trade Solution (WITS) more accessible is one option.

When modelling the effects of domestic support on the world cotton market, many studies used the policy dataset compiled by ICAC. As discussed, one of the controversial issues regarding the ICAC policy dataset was uncertainty about Chinese policy. As the world's largest cotton producer and consumer, China's policies toward to the cotton industry have a significant impact on the world cotton market. It not only induces different changes in world cotton prices, but also different gains of other cotton-producing countries. Obviously, it is important to have more convincing data and analyses of China's cotton policies for modelling the effects of domestic subsidies in developed countries on developing countries.

Establishing a complete and detailed domestic policy dataset is also needed for major developed cotton-producing countries. In its successful challenge to the United States in the WTO, Brazil presented detailed analyses of the impacts of the various US domestic subsidies, which provided both legal and economic bases to support Brazil's case. The various programmes that have been implemented in developed countries to support their production and exports may have different trade distortion effects. Moreover, other trade and non-trade barriers and policies such as sanitary and phytosanitary measures, country of origin requirements, quality restrictions and standards should also be included in the policy dataset, because these policies and restrictions may also distort trade.

4.3 Base year

- *Implications of the choice of the base year*

The simulation results regarding the changes in world cotton prices and harmful effects on other cotton-producing countries are highly sensitive to the base year chosen. The subsidies often amounted to a very high level when the world market price was low, but were much lower when the world price was high. Moreover, the price distortion caused by the subsidies, measured as a percent of the world cotton price, was very high when the world market price was low. As an example, the 2002 US Farm Bill introduced a cotton target price of 72.4 cents/lb, by increasing Step 2 payments, and by increasing the marketing loan rate for cotton. On the basis of 2001 prices, the resulting distortion level was about 43 percent, but only 34 percent if 2002 was selected as the base year.

As most quantitative simulations took the elimination of subsidies as the starting point, the magnitude of the percentage changes in farm prices in these countries with subsidies would have significant effects on the final simulation results. This may be the reason that ICAC found that the world cotton price would be 74 percent higher in 2001 if all subsidies were removed, while Goreux, who used a similar model and approach to ICAC, found only a 13 percent increase when selecting a five-year average as the simulation base year.

The problem of selection of a base year is highlighted by the fact that in 2001/02 record low real world prices were observed and the estimated impact of subsidy removal was therefore greatest. It is important, therefore, that estimated increases in the order of 70 percent (i.e. the ICAC study) be strongly qualified, since the estimated impacts are often used without reference to this fact.

The choice of the base year has a very significant effect on the final simulation in these static comparative models because removal of domestic subsidies (the percent change of the domestic farmers' price) was the only shock in the model.

- *What affects the choice of base year?*

A key determinant is the availability of data, as discussed above. For analysts using subsidy data notified to the WTO, there is an implicit delay requiring a less recent base year than might be used in studies drawing on ICAC data.

4.4 Analytical approach

- *Implication of choice of analytical approach*

Partial equilibrium models tend to be used more frequently than general equilibrium models due to their relative simplicity and limited data demands. In interpreting the results of partial equilibrium models, however, users need to be aware of how well they capture the key characteristics:

- *Substitutability of cotton with other crops*. Models that assume changes in other commodity markets are potentially superior. While there is not much substitutability between cotton and other export crops in WCA, there is in the United States and Brazil.
- *Substitutability of cotton with man-made fibres*. In addition to quality requirements, the demand and supply responses of man-made fibres should be taken into account. With technological advances, the substitutability of man-made fibres for cotton has been increasing substantially

over the past decades. Man-made fibres are produced in a manufacturing process, and do not face the restrictions of the agricultural production process. Since the utilization ratio of capacity in the world man-made fibre industry is around 85 percent, production of man-made fibres can respond swiftly to changes in the market. Most current studies, however, have ignored any possible responses of man-made fibre production to a change in the cotton price.

- *Textile demand for clothes*. The role of textiles in the economy differs significantly between countries. The world man-made fibre industry and other agricultural sectors among all major countries should be included in the model to reflect the complexity of the cotton sector and its relations with the textiles and clothing industries. The interactions would then be captured between cotton and man-made fibres at the demand level and with other crops at the supply level, as well as the responses of textiles and clothing industries to changes in the cotton price and among all countries. Including these responses may make the quantitative analysis more realistic and convincing.
- *Intermediate input linkage*. To understand intermediate input linkage, which could prove important, models with more than just the cotton sector would be required. The transmission of the impact of cotton prices into price of textiles is key. An inward shift in the supply curve of textiles could result due to an increased world cotton price.
- *Multipliers*. When investigating growth or poverty reduction impacts, it is especially useful to be able to determine the magnitude of multipliers. A PE approach is limited in its ability to do this, although running price changes through an I/O table could substitute for a full GE to some extent.
- *Disaggregation*. GE are more limited by their degree of aggregation across sectors and across countries. For example, the Global Trade Analysis Project (GTAP) does not have a cotton sector. A key advantage of PE is the ability to disaggregate across and within countries.

- *Avenues for further research*

To a large extent, the most appropriate approach will depend on the question being asked. Researchers should consider *ceteris paribus* results whichever approach is used. For example, the impact of reduced substitutability into other crops on world prices would be to decrease the price impact. Equally, the order of magnitude of supply response and price effect would be much greater if other commodity support remains while cotton support is reduced.

The results of structural models cannot be tested and a more explicit link to empirical evidence is needed. Although sensitivity analyses have been conducted in PE and GE models, it should be possible to improve on them by linking theoretical models and econometric models. This would give an idea of the confidence intervals around model results.

One approach would be to use structural models but to incorporate econometric approaches to test the assumptions made. The aim would be to identify the important assumptions, for example:

- the value of the elasticity being used;
- the extent of substitution effects (i.e. testing of substitutability of cotton and fibres econometrically);
- Granger causality between subsidies and prices;
- the permanence of price shocks, which influence investment decisions, for example;
- whether non-linearity is as important as the decision to invest or to disinvest.

5 Concluding remarks

Models provide a useful indication of the impact of policies, but are very sensitive to the range of assumptions used in their construction. This technical note has reviewed the assumptions likely to be most significant and upon which more research is required to close the gap between the different predictions and to improve the robustness of the results.

An overriding issue for further research is to identify the most significant reasons for the differences in model results. Is using accurate elasticity values more important than incorporating stocks, for example? This would help in prioritizing issues for further research listed within each subsection.

For further information:

A shorter policy brief [10]and other papers in this series are available at:

www.fao.org/trade/index_en.asp.

A collection of studies relating to cotton sector analysis can be found at:

www.fao.org/es/esc/en/20953/22215/highlight_47647en.html.

[10] *FAO Trade Policy Brief No. 1. Cotton: impact of support policies on developing countries - why do the numbers vary?* Rome, 2004.

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