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The impact of domestic and trade policies on the world cotton market

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ABSTRACT

There is a long tradition in the quantification of the impact of agricultural trade distortions on global markets, trade, and individual countries, notably in the context of the ongoing multilateral trade negotiations. This paper analyses the case of cotton in this context. Recently, the issue of cotton subsidies and their likely negative effects has attracted considerable attention and controversy. There are some model-based assessments of the impact, and their results differ markedly. While the models utilized are similar in structure, the differences are in the assumptions about the levels of subsidies, as well as market parameters. This study presents some fresh estimates of the likely impact of cotton subsidies on both subsidizing and non-subsidizing countries using the UNCTAD-FAO ATPSM model. The analysis is based on official subsidies as notified to the WTO. However, the paper also reports in an annex the corresponding ATPSM simulation results based on subsidies as estimated by the International Cotton Advisory Committee (ICAC), which, although unofficial and controversial, was considered useful for comparative purposes as several recent studies assumed ICAC subsidies in their analyses. The results showed that the long-term impact of complete elimination of domestic subsidies as notified to the WTO, 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, compared with a range of 3-15 percent impact in various other studies, most of which assumed the much higher levels of domestic subsidies as estimated by the ICAC. A number of sensitivity tests were done, which verified that most of the results of other studies fall within the range of values estimated in these sensitivity runs when different assumptions about subsidy levels and supply and demand elasticities are taken into account. It was verified, and also stressed, that even when the impact on the world market price is relatively small, there could be substantial shifts in production and trade, and so substantial gains for non-subsidizing countries. The paper reports impacts on a variety of other indicators such as export earnings and welfare measures. A particularly useful contribution of this paper is an extensive review of assumptions made in some recent model-based studies on cotton, which should help to clarify the differences in views about the impact of the cotton subsidies.

Key words: Cotton, domestic subsidies, trade liberalization, model.

RÉSUMÉ

Nombreuses sont les études visant à quantifier les effets causés par les distorsions des échanges dans le secteur agricole, sur les marchés mondiaux, le commerce et les pays à titre individuel, notamment dans le cadre des négociations commerciales menées actuellement à l'échelon multilatéral. Il s'agit ici d'analyser le cas du coton à la lumière de ces éléments. En effet, la question des subventions accordées au coton et leurs effets potentiellement néfastes ont fait l'objet d'une attention et d'une polémique croissantes. Certaines évaluations à base de modèles ont été réalisées, mais avec des résultats très divergents. Certes, les modèles utilisés possèdent une structure similaire mais ils diffèrent quant aux hypothèses relatives aux niveaux des subventions, ainsi qu'aux paramètres du marché. L'étude présentée ici offre de nouvelles estimations de l'incidence probable du subventionnement du coton à la fois sur les pays qui pratiquent le subventionnement et ceux qui ne le pratiquent pas sur la base du modèle de simulation des politiques du commerce des produits agricoles (ATPSM) de la CNUCED-FAO, ainsi que des subventions officielles telles qu'elles sont déclarées à l'OMC. Cependant, cette étude présente également en annexe les résultats de la simulation réalisée suivant le modèle ATPSM des subventions telles qu'elles ont été estimées par le Comité consultatif international du coton (CCIC) qui, bien que s'agissant d'estimations officieuses et controversées, ont été considérées utiles à des fins de comparaison et ont été incorporées à plusieurs études récentes à des fins d'analyse. Les résultats indiquent que l'incidence à long terme d'une suppression totale des subventions intérieures telles qu'elles sont notifiées à l'OMC, ainsi que des tarifs, impliquerait une hausse du cours mondial du coton de 3,1 pour cent dans le scénario de base, et même de 5 pour cent sur la base d'autres hypothèses en termes d'élasticités de l'offre et de la demande. Ceci est à mettre en regard de l'incidence de 3 à 15 pour cent estimée par d'autres études, fondées ,pour la plupart, sur les niveaux nettement supérieurs de subventionnement intérieur estimés par le CCIC. Plusieurs analyses de sensibilité ont également été

menées et ont permis de déterminer que la plupart des résultats auxquels aboutissent d'autres études sont du même ordre que les valeurs estimées par ces analyses sur la base de différentes hypothèses en matière de taux de subventionnement et d'élasticités de l'offre et de la demande. Elles confirment et font également ressortir que, même en cas d'une incidence relativement faible sur les cours du marché mondial, des profonds bouleversements en termes de production et d'échanges commerciaux peuvent se produire et, partant, donner lieu à des bénéfices substantiels pour les pays qui n'accordent pas de subventions. L'étude en question rend compte de divers effets sur un éventail d'indicateurs tels que les recettes d'exportation et les mesures d'aide sociale. Un volet particulièrement utile de ce travail est une révision exhaustive des hypothèses présentées dans quelques études récentes à base de modèles sur la question du coton qui pourraient contribuer à expliquer les divergences de vues quant à l'incidence des subventions accordées au cotton.

Mots-clé: Coton, subventions intérieures, libéralisation des échanges, modèle.

RESUMEN

La cuantificación del impacto de las distorsiones relativas al comercio agrícola en los mercados y el comercio mundiales, así como en los países por separado, en especial en el contexto de las actuales negociaciones comerciales multilaterales, constituye una antigua tradición. La presente publicación analiza el caso puntual del algodón en este mismo contexto. Recientemente, la emisión de subvenciones al algodón y sus probables efectos negativos han redundado tanto en una masiva atención como en una controversia de proporciones. Al analizar algunas evaluaciones de este impacto sobre la base de modelos, cabe hacer notar que sus resultados difieren en forma ostensible. Si bien los modelos utilizados son similares en estructura, las diferencias radican en los supuestos en torno al nivel de las subvenciones y a los parámetros del mercado. Este estudio presenta estimaciones realizadas últimamente sobre el probable impacto de las subvenciones al algodón, tanto en países que conceden subvenciones como en aquellos que no lo hacen, a través del modelo ATPSM de UNCTAD-FAO. El análisis se sustenta en subvenciones oficiales que han sido notificadas por la OMC. No obstante, este estudio también da cuenta de un anexo que contiene los resultados correspondientes de la simulación ATPSM sobre la base de la estimación de subvenciones que ha llevado a cabo el Comité Consultivo Internacional del Algodón (CCIA) que, si bien es controversial y no oficial, se considera de utilidad para fines comparativos, atendido el hecho que una diversidad de estudios recientes se ha sustentado en las subvenciones de CCIA para completar sus análisis. Los resultados revelaron que el impacto a largo plazo de la total eliminación de subvenciones internas, tal y como lo ha dado a conocer la OMC, y de los aranceles sería un incremento del precio del algodón del orden del 3,1 por ciento en las perspectivas de referencia y de hasta un 5 por ciento en función de supuestos alternativos sobre elasticidades de oferta y demanda, respecto de un impacto entre 3 y 15 por ciento en una cantidad de otros estudios, muchos de los cuales supusieron los niveles considerablemente más elevados de las subvenciones internas revelados por CCIA. Se llevó a cabo una cantidad de estudios de sensibilidad, los que comprobaron que la mayor parte de los resultados de los demás estudios se encuentra dentro del rango de valores estimados en estos estudios de sensibilidad cuando se toman en consideración distintos supuestos relativos a niveles de subvenciones y elasticidades de oferta y demanda. Quedó en evidencia, así como también se hizo hincapié en que cuando el impacto en el precio del mercado mundial es relativamente reducido, la producción y el comercio pueden registrar cambios radicales, y por ende, también sería esperable que lo hicieran las utilidades de los países que no conceden subvenciones. Por otra parte, este estudio da cuenta de los impactos generados en una diversidad de otros indicadores, como son los ingresos procedentes de las exportaciones y las medidas relativas a bienestar. Cabe destacar que un aporte especialmente útil de la presente publicación es una acabada revisión de los supuestos realizados en algunos estudios recientes sobre el algodón basados en modelos, la que debería ayudar a esclarecer las diferentes perspectivas del impacto resultante de las subvenciones a algodón.

Términos clave: Algodón, subvenciones internas, liberalización del comercio, modelo.

CONTENTS

NOTES AND ACKNOWLEDGEMENTS

Daneswar Poonyth, Alexander Sarris, Ramesh Sharma and Shangnan Shui are respectively Economist, Director, Senior Economist and Commodity Specialist, all with the Commodities and Trade Division of the Food and Agriculture Organization of the United Nations (FAO).

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1 INTRODUCTION

Agricultural markets in most countries have been the object of considerable government controls and other interventions. For instance, it is well known that in the OECD countries such policies result in annual transfers to farmers in the vicinity of $290 billion, with subsidies of various types making up in some cases 60-80 percent of farmers' revenues. This is why it took so long to bring agriculture under the rules of the General Agreement on Tariffs and Trade (GATT), the international rules framework for merchandise trade of the World Trade Organization (WTO). These interventions have resulted in excess production by many subsidising countries, depressed world prices, and frequent trade disputes. The Uruguay Round (UR) succeeded in finally defining some rules for agricultural trade, quantifying the various trade restrictions, and placing some limits in the use of subsidies, both domestic as well as export related. Despite its success in bringing agriculture within the WTO, the UR, nevertheless, legitimized a variety of remaining agricultural distortions. These include high tariffs, tariff escalation, large trade distorting domestic support, vague rules on what constitutes non-trade distorting support, and considerable export subsidies. The current "Doha Development Agenda" or DDA negotiations of the WTO has again highlighted the reluctance of many countries to place strong and binding limits to their agricultural protectionist and other support policies. Agriculture was one of the reasons that the WTO Ministerial Conference in Cancun in September 2003 failed to produce an agreement.

The "cotton issue" became one of the difficult negotiating issues at the WTO Ministerial Conference in Cancun. It was claimed that cotton subsidies, both domestic and export, granted by some countries, led to artificially depressed world market prices and thus negatively impacted negatively on both export earnings as well as production levels in non-subsidizing countries. While these types of subsidies are not unique to cotton, they became an issue following the submission of a joint proposal at a special session of the WTO negotiations on agriculture on May 16, 2003 (WTO 2003a). This proposal, by four West African Countries (WACs), Benin, Burkina Faso, Chad and Mali, claimed inter alia that the elimination of subsidies to cotton would raise world market prices and make cotton production in the WACs highly profitable. This submission cited recent model-based studies by the International Cotton Advisory Council (ICAC, 2002) and Goreux (2003) to claim that these subsidies led to significant amounts of export earning losses by the four WACs, e.g. $250 million in 2001/02 in the Goreux study. It was further claimed that the combined direct and indirect negative effects would be close to $1 billion per year.

On 4 August 2003, in the run up to the Cancun Conference, the four countries made another submission to the same WTO committee (WTO 2003b), essentially reiterating the same claims, and calling for "the establishment in Cancun of a mechanism to phase out support for cotton production with a view to its total elimination". Other aspects covered in these submissions were the effects of the cotton subsidies on poverty and food insecurity at the farm level and an international mechanism for compensation for the losses. Earlier in 2002, the "cotton issue" hit headlines around the world with the publication by OXFAM of a report called *Cultivating Poverty: The Impact of US Cotton Subsidies on Africa* (OXFAM 2002), drawing upon the results from the ICAC's model-based estimates (ICAC 2002) for establishing the link between subsidies and world market prices, supplemented with additional estimates on the impact. The results have been widely quoted, and included in statements by high-level political figures.

The case of the four WACs has also received a boost from the analysis of Minot and Daniels (2002). They used household survey data to estimate the direct and indirect effects on incomes and poverty in Benin, due to falls in received cotton prices. Under the assumption that cotton prices to producers are lower by 10 percent due to world price declines (the transmission assumed is perfect), they estimate that the incidence of poverty among Benin's cotton growers goes up by 5 percentage points (from 37 percent to 42 percent), and among all farmers by 2 percentage points (from 40 percent to 42 percent, or 170 000 people more fall below the poverty line). In the longer term, taking into account indirect effects, they estimate that the impact is even larger. Larger world and producer price declines have much larger impacts.

The purpose of this paper is to contribute some fresh analysis on cotton in the above context. As the cotton issue is not only a topic of academic interest to trade policy analysts, but has also become a

politically sensitive matter, it is important that there are more studies on cotton so that the issue is debated with sound empirical basis. This study presents some fresh estimates of the likely impact of cotton subsidies on non-subsidizing countries, along with comparisons with all the previous similar studies. A particular contribution that we consider valuable is the detailed discussion of the "building blocks" of the partial-equilibrium modelling framework on which all previous analyses have been based.

There is a long and impressive tradition in the quantification of the impact of agricultural trade distortions on global markets, trade and economies of individual countries, a tradition many attribute to the work of Valdes and Zietz (1980) as the front runner. Many model-based studies were undertaken in the run up to the UR and following the conclusion of the Agreement. Similar works are appearing now in the context of the DDA negotiations, as there is a heightened demand for information on the likely impact of the reform process being negotiated. The literature provides a wide range of different assessments, in large part reflecting different approaches to modelling, assumptions made about parameters and the extent of the reform processes simulated. Quantification is indeed a difficult and imperfect task, irrespective of the analytical tools used. Notwithstanding the shortcomings and differences, various assessments have come to some fairly robust findings as well. Thus, world prices of agricultural commodities are found to increase with trade liberalizing reforms. While the absolute size of the price rise is debatable, there is a fair degree of agreement about price rises in a relative sense. In particular the impact is fairly strong on several temperate-zone food products while it is low or modest in case of tropical products and this is because of the different levels of initial distortions. Similarly, most liberalization analyses show some shift in the location of production, away from subsidizing areas to non-subsidizing countries.

There have been some recent attempts to analyse the impact on world markets and trade of cotton subsidies. ICAC (2002) estimated that 73 percent of the world production of cotton was under some kind of direct assistance. They also estimated that removal of US subsidies alone would have increased world prices in 2000/01 and 2001/02 by around 10 percent. Goreux (2003) in a report used as background for the African Countries' submission to the WTO, used a simple model to analyse the injury to African producers by the subsidies in developed countries, and concluded that world cotton prices would increase by 13-18 percent in the absence of these subsidies. Quirke (2002) estimated that removal of production and export subsidies by the United States and the EU would have increased world prices in 2001/02 by 10.7 percent. Tockarick (2003) found that multilateral trade liberalization in all agricultural products would induce a 2.8 percent increase in world cotton prices. FAPRI (2002) found that under global agricultural trade liberalization the world cotton price would increase over the baseline scenario by 12.7 percent over a ten year period and exports by Africa would increase by 12.6 percent. Finally Sumner (2003), in a report that was used by Brazil in its complaint to the WTO against the United States, used a modified version of the FAPRI model and found that the removal of domestic and export subsidies on cotton by the United States would increase world prices by 12.6 percent and reduce United States exports of cotton by 44 percent. It is clear that, while there is agreement on the overall direction of the price, production and trade changes, there is substantial divergence of empirical estimates with respect to the overall impact of the domestic and export subsidies on the world market as well as exports.

In this paper we discuss these empirical issues and present some fresh estimates of the impacts using the UNCTAD-FAO ATPSM model. Before the ATPSM results are discussed, it is important to understand why various models could generate different results, the source of the key controversy in this area. This is done next in Section 2 where the general framework used by all partial equilibrium models is presented in order to discuss the four key aspects that influence the results. In section 3 we discuss the four key aspects of the empirical analysis as they pertain to the cotton sector. In section 4 we briefly describe the ATPSM model. Section 5 indicates the data and parameters that are used in the simulations. Section 6 presents new estimates of the impacts of the removal of cotton subsidies based on the ATPSM model, including sensitivity tests. The final section summarizes the main conclusions of the analysis.

2 MODELLING THE IMPACT OF COTTON SUBSIDIES: THE KEY ANALYTICAL ISSUES

Virtually all model-based analyses of the cotton subsidy issue discussed in this paper – as well as the ATPSM model used here for further fresh analysis – are based on the familiar multi-region, partial equilibrium, static world trade models. Those familiar with this framework know well how these models work and what types of data, parameters and assumptions are required – the main building blocks of these models. It is important that these blocks are understood well, before discussing the ATPSM results in the next section. The following brief account of how all these models work will highlight the important factors that drive the results.

Figure 1 provides a graphical illustration of such a model, the three panels showing price-quantity graphs based on supply-demand interactions: the left panel (Figure 1a) represents a cotton-subsidizing country, the right panel (Figure 1c) represents a non-subsidizing country and the middle panel (Figure 1b) the world market as a whole.

In figures 1a, and 1c, the lines S_i and D_i (i=1,2) denote domestic supply and demand curves (domestic prices and domestic quantities) for cotton in each of the two countries. In the middle figure, the line

ES_1 denotes the excess supply of cotton of country 1, while the line ED_2 denotes the excess demand for cotton for country 2 (the lines represent functions of world prices and traded quantities). The intersection of these lines in the middle panel indicates that equilibrium in the world market in the absence of any intervention by the two countries would obtain at a price P. Under these conditions of no interventions, and under the assumption that transmission of world prices to the domestic market is perfect, the domestic prices in the two countries are equal to world prices, and the quantity traded is equal to OE in the middle figure, which is equal to exports of AB=OE from country 1 and imports of CD=OE from country 2.

Consider a policy that results in a price increase to the producers of cotton in country 1. Suppose that this policy results in a wedge between the international market price and the domestic producer price in country A which affects both producers and consumers equally. Such a policy, for instance, could be a domestic minimum price policy. Assume also that the transmission of world prices to the domestic market is only affected by this policy and nothing else. The result of this policy is to shift the excess supply curve of the exporting country to the right of its original position as illustrated by line $ES_1^{'}$. The excess demand curve of the importing country remains unaffected. The new world market equilibrium is at a lower price equal to P'. With this lower international price the domestic producer and consumer prices in country 1 are equal to $P_d = P' \cdot (1+t)$, where t is the proportional wedge between international and domestic price in the subsidising country[1]. In country 2, of course, the domestic producer and consumer prices are equal to the new depressed international prices, namely P'. Under this policy regime in country 1, production in country 1 increases from OB to OB', production in country 2 is reduced from OC to OC', and exports of country 1 increase from OE=AB, to OE'=A'B'. If there are other exporting countries (not shown here), that do not interfere in their domestic cotton market, the lower world price would result in lower production and exports. In other words the subsidy of one country increases the export share of the subsidising country and decreases it for the other non-subsidising competing exporters.

Suppose now that the support policy in country 1 affects only the producer price, leaving the consumer price unaffected. This, for instance could be so if the policy involves a producer subsidy only. Suppose that the proportional wedge between the international price and the domestic producer price in country 1 is the same as in the first example. In this case the excess supply of country 1 shifts to the right, similar to the previous case, but by a smaller amount, because the demand side of the market is not equally disturbed by the policy. In figure 1b, this reduced excess supply shift is illustrated by line $ES_1^{"}$. The consequence of this policy is that the world price is reduced to P'', which is larger than the price

[1] The price wedge does not have to be proportional, it could just as well be additive, depending on the particular type of policy.

P' that would have resulted if both producer and consumer prices were affected equally. In country 1, the domestic price to consumers is P'', which is smaller than the price P_d, while the domestic producer price is $P_d^{''} = P^{''} \cdot (1+t) > P_d = P^{'} \cdot (1+t)$. Under this policy regime, exports of country 1 would be equal to OE''=A''B'', and production in country 1 would be equal to AB'' which is larger than the production OB' achieved with the uniform price policy. Production in country 2 would be equal to OC'', which is larger than OC', but still smaller than the free trade amount OC.

The above diagram and analysis make clear the following points. First policies that increase cotton producer prices in one country tend to depress world prices as well as prices in non-subsidising countries. Second, the production of cotton is increased in the subsidising country and reduced in the non-subsidising country. Third, the subsidy policies increase world trade. Fourth, exports by the subsidising country are increased at the expense of exports by non-subsidising countries. Fifth, depending on the extent of transmission of international signals to domestic markets, domestic farm prices are reduced in all non-subsidising countries, while farm prices are increased in the subsidising country. Finally, support policies in any producing and trading country are bound to induce adjustments in all other trading countries, leading to a new world equilibrium. This new equilibrium will entail welfare gains and losses by various groups within each country, depending on the magnitude of the quantity and price adjustments.

It should be clear that reversal of some policies, such as reduction of domestic support, is bound to lead to opposite results from those that were illustrated above. The effects are symmetrically opposite to those under the supports, under the assumption that no irreversible developments have taken place because of the supports. This, however, is by no means a trivial assumption. Long term support for a product is bound to lead to induced technical innovation that may permanently alter costs of production and other supply factors in the subsidising country. These effects are much more difficult to identify, however, and are normally neglected in analyses of the effects of agricultural subsidies.

The above framework also makes clear that any empirical assessment of policy interventions will depend on the following four sets of parameters/assumptions that are key to the results in models of this type.

- The level of subsidies or other support
- Issues concerning the coupled or decoupled nature of interventions
- Demand and supply price elasticities
- World to domestic price transmission

The next section discusses these four factors with respect to cotton, and discusses their use in the recently used models that analysed the cotton subsidy issue. This review also provides the basis for the ATPSM application in the subsequent section.

3 MODELLING THE IMPACT OF COTTON SUBSIDIES: THE KEY EMPIRICAL ISSUES

3.1 The level of domestic subsidies on cotton

It is widely held that domestic subsidies are the main source of distortion for cotton, which is unlike the case with many other farm commodities where distortions at the border are also widespread. Therefore, it is important here to review the level and nature of domestic subsidies to cotton. The two main sources of information on domestic subsidies used by various analysts are official figures notified to the WTO and estimates put together by the ICAC. Tables 1 and 2 indicate this data, which show that there are some significant differences in these estimates, which are discussed below.

Note that from the standpoint of both the level of the subsidy and the size of the industry, what matters most for world market effects is subsidies in China and the United States, the two largest producing and trading countries. According to the ICAC data (Table 1), the global total subsidies to cotton averaged US$4.5 billion per year during 1997-02, with a range of US$3.8-5.3 billion. About 75

percent of the total is accounted for by China and the United States – with the share of the United States in the total rising in recent years, from 30 percent during 1997-99 to 47 percent in 2000-02, while China's share fell considerably. The share of the EU subsidies has remained more or less the same, at about 18 percent. The rest, amounting to about 6 percent, is accounted for by Brazil, Egypt, Mexico and Turkey.

The notifications to the WTO are perhaps the most official publicly available sources of information on domestic subsidies. These notifications, however, are not available for most recent years, as shown in Table 2. For example, the latest notification on domestic support measures for both the EU and the United States was for the year 1999, posted in the WTO website only in June 2002 for the EU and February 2003 for the United States. By contrast, more recent information is available from the ICAC, although these are not necessarily official figures. Since this is the information commonly used in debates on the issue and in some models, it is important to note the differences in the level of subsidies from these two sources (Tables 1 and 2).

As regards key differences in the two tables, first concerning countries other than China, EU and the United States, the ICAC data show some subsidies for all four countries reported in Table 1, while these are mostly missing in the WTO data. The differences are striking in some cases. For instance, according to ICAC data, Turkey exhibits considerable subsidies all throughout the period shown, while the WTO data indicate that there are no subsidies. Brazil's notified Aggregate Measure of Support (AMS) levels for cotton vary considerably – US$13 million in 1995/96, US$10.3 million in 1996/97 (both not shown in the table) and US$55.3 million in 1997/98, for an average of about US$32 million for these three years. For 1997/98, about 80 percent of the outlay was for production and marketing credit and the rest was market price support. Egypt has not notified to the WTO any support to cotton, as part of AMS or in other form. Mexico notified about $1.7 million AMS for 1996 and nothing for 1997 and 1998. The ICAC did not show Colombia as having granted cotton subsidies, but WTO notifications show this. The AMS levels for Colombia were US$1.1 million in 1997, less than US$1 million in 1998 and US$3.5 million in 1999, for an average of US$1.8 million. Subsidies were given in the form of both market price support and direct payments. Finally, the WTO notifications do not show any cotton subsidies by both India and Pakistan, two important countries for cotton, which some analysts have reported as having granted cotton subsidies in most recent years.

In the case of the EU, although there are some significant differences in the two sources, the EU cotton subsidies are fairly transparent. The levels reported in the WTO notifications (see Table 3 for details of the computations) are lower than in the ICAC. This could be for the reason that the ICAC estimates also include support outlays other than AMS, which could be part of some Green Box outlays and some non product-specific AMS.

Analysts studying the cotton issue face the greatest difficulty in estimating domestic subsidies for China. The differences between the ICAC estimates and official sources, including the notifications to the WTO are immense. In its accession document, China reported negative domestic subsidies (AMS) on cotton, about negative US$600 million for the base period 1996-98.[2] China has a *de minimis* limit of 8.5 percent of the value of cotton output, and so can grant AMS subsidies up to this level (about US$700 million) as and when China desires, without breaching its WTO commitment. So far, there is no information on even this support (China has yet to submit its first WTO notification on support). Experts generally agree that given China's policies, and until substantive changes were made in recent years, the cotton sector most likely received substantive subsidies, but much less so in most recent years. Huang, Rozelle and Chang (2003) estimated that during 2001 the nominal rate of protection (NRP) for cotton averaged 17 percent, while Fang and Beghin (2003) estimated that for the 1997-2000 period the same NRP averaged -20 percent, implying taxation of the sector. But these different estimates could have resulted from differences in assumptions about border measures, and not necessarily through assumptions about domestic subsidies. These conflicting estimates lend some support to the position that there may be little or no effective domestic subsidy for cotton in China, which is also the official position (see also Ke 2003).

[2] The AMS value is negative when domestic prices are below external reference prices.

Overall, far fewer countries seem to grant subsidies on cotton, according to official information provided to the WTO. It should, however, be noted that the WTO notifications are not as updated as the ICAC estimates, and indeed more countries may have granted cotton subsidies (and in larger amounts) in recent years when world cotton prices fell, a claim made by ICAC, as well as other commentators. A second point worth noting here is that some countries may not have reported to the WTO the *de minimis* levels of subsidies as these are exempted from any discipline, whereas these subsidies could play a significant role in affecting production, and hence should feature in any modelling and economic analysis. In this sense, one would expect that the ICAC figures not only indicate higher levels of subsidies relative to those from the WTO[3], but also that they are more representative of the true level of overall support, with the exception for China for which there are sharp differences.

3.2 Relationship between subsidies and incentives: The issue of coupled versus decoupled subsidies

Subsidies tend to affect production and hence trade. However, different forms of subsidies have potentially different impact on production (OECD 2000). Whenever a subsidy affects directly the total returns per unit produced, then it acts as if the price received by the producer is increased, and its effect is no different than if the market price was higher. In this sense such forms of subsidy are "coupled", as they affect directly the resources allocated to production. On the other hand there are some types of interventions that affect production cost and returns only indirectly, and some times not at all. For instance programs that directly affect farm income, such as payments for residing in a given locality, without being dependent on product specific production, tend to have lower impact on production of specific products. Such payments are considered "decoupled", and as they do not affect production are not market and trade distorting. The problem in any empirical analysis is that it is quite difficult to determine the degree to which some programs have indirect impacts on production incentives[4].

This issue applies mainly to the United States since subsidies in most other country cases are acknowledged to be coupled, i.e. similar to market price support. For reasons discussed below, it is not as easy to estimate the level of domestic subsidy that can be used in model-based analysis in the case of the United States (or other countries with a mix of various forms of subsidies). This is mainly because there are several different programmes in place not all of which could have the same impact on production and trade, i.e. programmes could differ in terms of the degree of coupled effects, and so these may not be simply summed to obtain the total subsidy. Table 4 shows United States domestic support to cotton as compiled by Baffes (2003) while Table 5 shows subsidies notified by the United States to the WTO.

Note that the estimates presented in Table 4 and 5 are somewhat different. This is because Table 5 includes only AMS measures while Table 4 seems to have included some other measures in some cases, e.g. this table includes the Production Flexibility Contract or PFC (i.e. direct income payments that are placed under Green Box measures in the WTO notifications) for the United States.

Table 4 shows that during the 1996/97 season —the first year of the *1996 Farm Bill* —support to United States cotton growers amounted $858 million, almost $700 million from the PFC contract payments and the rest from insurance subsidy. In 1997/98 the support was $745 million. When prices began declining, the emergency assistance measures were introduced, increasing the support to $1.8 billion in 1998/99, $3.2 billion in 1999/2000, $2.1 billion in 2000/01, and $3.7 billion during the 2001/02 season. According to Baffes, if cotton prices remain at their 2001/02 levels, then United States annual support to its cotton sector is expected to be in the order of $3.5 to $4.0 billion for the next six years, the period of the *2002 Farm Act*, implying that the United States cotton producers will be receiving support close to the equivalent of twice the world market price.

[3] In view of these differences, the effects of both estimates are analysed separately in the model-based analysis reported in this paper.

[4] Some recent attempts to quantify the production and trade impact of "decoupled" policies include Adams et. al. (2001), Dewbre et. al. (2001), Young et. al. (2001), OECD (1998), Rude (2000), Burfisher et. al. (2000) and Young and Westcott (2000).

Concerning the nature of support as far as coupling is concerned, there has been some experimentation underway in the University of Missouri's FAPRI model, towards developing supply response systems that take into account the degree of decoupling of various subsidy programmes. The approach tried is roughly as follows.[5] For each region of the United States, mixed estimation methods were used to come up with total area elasticities, where total area devoted to major crops (area planted for grains, oilseeds, and cotton) is a function of a weighted average of expected net returns from the market and the loan program plus 25 percent of "less coupled" payments (production flexibility contract payments and market loss assistance payments for the 1997-2001 period, and counter-cyclical payments (CCPs) and direct payments (DPs) for the projection period). These total area elasticities with respect to expected net returns are generally small, and the weighted average for the United States is only 0.06. A matrix of own- and cross-effects is also constructed consistent with the estimated total area elasticity. While the parameters are synthetic, the estimations are done systematically, imposing symmetry, etc.

Less coupled payments (LCPs) come into play in two ways. First, they have a non-commodity specific effect on total area. Since the total area elasticities are small and the direct and CCP payments are multiplied by 0.25, this is a very small effect. Second, 25 percent of the CCP is also included in the expected net return for individual commodities. The logic is that CCPs have a commodity-specific price risk reduction effect, and the 2002 Farm Act updating of programme bases and yields for CCPs may mean they have been more effective than a more purely decoupled payment. In total, then, $1 of DPs has 25 percent of the effect on production as would a $1 of market returns, and $1 of CCPs has 50 percent of the effect (25 percent crop-specific, 25 percent non-crop specific). The contribution of various payments to total net returns obviously depends on market prices. For example, with a market price of 60 cents/pound, the LCPs are likely to be near zero and CCPs will be less than their maximum levels[6]. Notice that the degree of coupling of the various programs is in essence assumed, and depends on the interpretation of the various programs by the analysts.

Sumner (2003) is another study that treats various United States cotton subsidies differently and assesses their separate impacts on price, production etc. In his model, planted area is determined by expected net revenue times the linear supply coefficient. The expected net revenue per acre is defined as follows:

$$\text{Expected Net Revenue} = \text{Expected } [(\text{Market Price}*\text{Yield}) + (\text{MLB}*\text{Yield}) + (b_{pfc}\text{PFC} + b_{dp}\text{DP})) + (b_{mla}\text{MLA} + b_{ccp}\text{CCP}) + \text{CIS} - \text{Cost per acre}]$$

where, besides market price and yield, MLB is marketing loan benefits (which includes both loan deficiency payments (LDP) and marketing loan gains); PFC is production flexibility contract payments (which applied during the period 1999-2001) and direct payments (DP) which apply during 2002 to 2007; MLA is market loss assistance payments (which applied during the period 1999-2001) and counter-cyclical payments (CCP) (which apply during 2002 to 2007); and CIS is the crop insurance subsidy.

A reduction in the expected amount of any of the four production subsidies affects planted acres and hence United States cotton production through the impact on expected net revenue per acre.[7] The various b_i coefficients are intended to measure the impact on cotton net returns per acre of a given form of subsidy, relative to the impact of a simple market price change, and as such they measure the degree of coupling of the various payment types. A value b=0 would imply that a particular payment has no impact on market returns, and hence is fully decoupled, while a value of b equal to 1 signifies that this type of payment is fully reflected in producer per acre returns, and hence is fully coupled. For instance, b_{pfc} and b_{dp} measure the impacts on net cotton return revenue per acre of PFC payments and DP relative to the impacts of market price changes. The same holds for the other forms of subsidies,

[5] Personal communication with Pat Westhoff, FAPRI (2003). See also Adams et al (2001) for a preliminary presentation of this approach.

[6] The CCPs (and DPs) are available whether or not the producer actually plants a crop — hence the argument about how and whether they affect production decisions.

[7] Sumner remarks that this formulation through expected net revenue per acre is the same as specified in the FAPRI cotton model and is also very similar to that applied by the USDA as, for example, in Lin et al. (2000).

namely marketing loan benefit and crop insurance subsidy. The author makes several arguments and concludes that $0< b_{pfc}<b_{dp}<1.0$. He further notes, and rightly so, that there is no conclusive evidence for specifying the magnitudes of b_{pfc} and b_{dp} precisely, as no comprehensive statistical evidence has been produced – part of the problem being that there is little time-series data available for an econometric analysis. In other words one has to essentially assume the values of the b's. The paper discusses in detail the contributions of these payments to the per-acre net revenue and the magnitude of these coefficients.[8]

Sumner states that for the PFC impacts, a value of b_{pfc} between 0.15 and 0.4 seems appropriate, considering various channels of influence discussed in his paper, but uses the lower value of $b_{pfc} = 0.15$ for his simulations. For reasons discussed in the paper, the impact of direct payments on expected net revenue is assumed to be larger than that on the PFC payments. A range of 0.25 to 0.5 was considered appropriate, but he uses the lower bound value of $b_{dp} = 0.25$. The MLA payments are assumed to have larger production incentive than PFC payments and DPs (the MLA payments were notified to the WTO as Amber Box payments), but Sumner – to be on the conservative side - assumes a value of $b_{mla} = 0.25$. He also assumed a value of $b_{ccp} = 0.40$ for CCP payments although these were deemed to be almost as trade-distorting as loan payments. No adjustment was made for crop insurance (CIS), thus assuming that these payments are fully coupled.

In summary, while a considerable number of theoretical and analytical studies are available on the extent of production and trade distortive effects of various forms of subsidies, there are very few studies that have actually measured the coefficients in a manner that global trade models can use. In large part this is because there is not enough time-series data to measure the coefficients econometrically since such programmes are of a fairly recent origin (e.g. only since 1996 in the United States, and more recently in the EU). The FAPRI and Sumner reviews show that modellers would need to essentially assume certain values for the degree of coupling for some time to come. What is important to note is that this matter cannot be ignored, namely if there are some payments that are only partially decoupled, then it would not be accurate to assume that the entire $6 billion or so of cotton subsidies as estimated by the ICAC can be treated as fully trade-distorting. In models like the ATPSM utilized here, that do not allow the treatment of various forms of subsidies differently, it would seem preferable to use somewhat lower levels than the total subsidy to reflect the fact that some of the payments are less than fully coupled[9]. The way this ambiguity about the degree of coupling can be resolved in empirical analyses, is via sensitivity analysis of the results, and in the ATPSM application in this paper (next section), sensitivity tests have been done to reflect this aspect.

3.3 Magnitudes of price elasticities of supply and demand

In the comparative statics framework presented above, the extent of the decline in cotton production in a subsidizing country and increased production in non-subsidizing countries depends on the price elasticity of supply. Similarly the extent to which prices are changed in response to policy changes depend on the assumed price elasticities of demand. The problem at hand is one of accurately pinning down these values, as empirical studies often utilize different values and various models assume different parameters. What follows is a brief commentary on these parameters, and the values assumed for the ATPSM model used for simulations in this paper.

Before we review the elasticity values utilized in previous analyses it is helpful to discuss the nature of these elasticities. In other words should one think of them as short or long run elasticities? As the objective of most analyses is to estimate the longer term impacts of any policy reforms, the correct way to think of any elasticities is in long run form, namely after producers and consumers have adjusted fully to a given policy change. Normally such adjustments take some time, and in fact it is often the case that several years are required before adjustments to any permanent price signals are fully reflected in production decisions. The exact dynamic pattern of adjustment is not the concern in

[8] Sumner's model also incorporates other subsidies, namely Step-2 programmes that affect both mill demands for US cotton in the United States itself and world demand for the US cotton.

[9] For example, one could proceed like Sumner, identifying various forms of subsidies and using FAPRI- or Sumner-like coefficients to compute a weighted average of subsidy (albeit somewhat subjectively) that is as production distorting as market price support.

this or other similar studies, but rather the overall longer term impact. This aspect of the analysis must be emphasized, and must be distinguished from the shorter term responses to any particular yearly price shock. As the world and domestic prices for cotton (and many other agricultural commodities) are highly variable from year to year, it is not always easy to discern the longer term, or more "permanent" patterns of price changes. In fact, the longer term trends, for instance in world prices, are invariably much smaller than the short term price changes, but it is those that are important from an adjustment perspective.

The ICAC study assumed – for all countries – a price elasticity of cotton supply of 0.47 and a price elasticity of demand equal to -0.1. There are two fundamental problems with these assumptions. First, their model ignores supply responses of other countries and thus overestimates the impact on the world price of the subsidy removal. Second, the demand elasticity used seems to be too low (see below) which also overestimates the price impact.

One argument often made in favour of low price elasticity of demand for cotton is that raw materials accounted for less than 10 percent of cotton clothing. However, the demand for cotton is from cotton mills, where cotton accounts for nearly 70 percent of total production cost, which means that changes in cotton prices should have considerable effect on the mill consumption decision. In fact it is the mills that decide the mix of fibres to use for producing yarn, and this mix is affected by the relative prices of cotton and other fibres. Given the high degree of substitution between cotton and other fibres, demand elasticity must be larger.

In the model used by Goreux (2003), similar elasticities as the ICAC study (i.e. 0.5 and -0.1) were used for the base case but the importance of this assumption was very much noted and therefore the author presents results for alternative values of the parameters (i.e. sensitivity analyses), with supply elasticities in the range of 0.15 to 0.9 and demand elasticities in the -0.05 to -0.6 range. In view of the importance of these parameters, Goreux reports the full range of results corresponding to these assumptions. We also discuss these results later for comparative purposes.

Goreux rightly complains about the lack of reliable estimated elasticities of supply response to world prices for African countries, his main focus of the study. Estimation of these parameters is difficult because the degree of transmission of world to domestic producer prices in Africa varies from year to year. Goreux notes in a footnote that in the CFA countries production was not very correlated to the main world cotton reference price, namely the Cotlook Index A. He also makes the important point that supply price elasticity in general would not remain constant for large price changes, as, for instance, production would respond much more strongly when prices fall substantially below production cost.[10] For lack of reliable estimates, he assumed for the model runs the same elasticity values for all countries, but reported a range of sensitivity tests to offset this limitation.

The assumption that all countries have the same supply and demand elasticities, as made by several models, is obviously questionable, in view of observed price-production trends. For example, the 2002/03 cotton plantation area in China surged 26 percent in response to a 20 percent increase in domestic and world cotton prices during the planting season, while many other cotton producing countries expanded their cotton areas by very little[11]. In some major producing countries, notably China, India and Pakistan, cotton planting area accounts for only 2-4 percent of total agricultural land, which permits production expansion significantly with small changes in relative prices (high supply response). Also, the domination of small size farms in cotton production in these countries allows them to respond to any price movement in a massive way. In particular, if prices of other agricultural crops remain unchanged, a significant increase in cotton price would induce significant shift of land from other crops to cotton, and swiftly so (i.e. even in the short-run).

[10] In this context, he states that according to the 1997 US Survey, variable costs in the US averaged 39 cents per pound; consequently, production would virtually disappear at 20 cents while it would decline by only 37percent with a constant elasticity of 0.5.

[11] In the case of China, however, the deterioration of weather in major cotton producing areas in summer and particularly in August led the government to lower forecast production from 6.2 million tonnes to 4.9 million tones – but the point about strong and swift supply response remains valid.

In summary, it seems that values for long term supply and demand price elasticities are larger than assumed in the above reviewed, and also some other models. Some studies also attest to this. For instance, price elasticities of demand in the United States estimated by Shui et al. (1993) were -0.64 in the short-run and -1.27 in the long-run. Monke and Taylor (1985) found the long-run own price supply elasticity for cotton in the United States to be as high as 2.36. The model used by Tokarick (2003) for the IMF study used trade elasticities rather than domestic supply and demand elasticities, with import elasticity of demand being -0.75 and export elasticity of 1.5, for all countries.

For the ATPSM model used in this paper, the values of the price elasticities of supply and demand for all major countries were thoroughly rechecked for correctness, using literature as the basis, as well as recent trends in price-production relationships and policy regimes.

3.4 The world to farm transmission of cotton prices

All global trade models have specifications to transmit or pass-through changes in world market prices to domestic farm and consumer levels. Where there is no transmission, there is no impact of the simulated change in world price on domestic markets, while full pass-through means that domestic prices change as much as the change in the world prices. Many studies have tried to quantify the extent of the domestic price changes in response to international price changes. The normal way of thinking about this matter is in terms of price transmission elasticity, defined as the percentage by which the domestic price changes in response to a one percent world price change. The estimates vary widely, from full transmission (elasticity equal to one) to no or little transmission (elasticity close to or equal to zero). Transmissions all the way to the farm level are often found to be less than complete, and for a number of valid reasons, notably trade and domestic policies, market structure and measurement errors. For reasons of trade and domestic policies, transmissions have often been found to be fairly weak for basic food commodities where government intervention is high and rather strong for other commodities like tropical beverages and agricultural raw materials (Sharma 2002, Rapsomanikis et al. 2003).

The ATPSM model used for this study assumes full transmission for cotton. This also has been the assumption made in the majority of cotton studies using global trade models. The assumption of full transmission for cotton in this study appears reasonable, at least for most countries, as review of policy parameters shows that there is little border distortion, that could account for imperfect transmission. Moreover, this assumption is reasonable for a study that models long-term outcomes (static equilibrium). Even in countries where there may be some blockages of transmission in the short run, the trend is towards less and less price interventions, including the move towards decoupled forms of support. At least this is the declared policy of all countries, as well as in the countries currently granting high levels of domestic subsidies. Where price transmissions are not complete, the implication is that models that assume full transmission overestimate the impacts. In the case of cotton, the chance that this is the case is small.

4 THE STRUCTURE OF THE ATPSM MODEL USED IN THE SIMULATIONS

Developed jointly by UNCTAD and FAO, the Agricultural Trade Policy Simulation Model (ATPSM) is a comparative-static, multi-commodity, multi-region, partial-equilibrium global trade model designed primarily for simulating agricultural trade policies, notably in the context of the WTO Agreement on Agriculture[12]. It can simulate the effects of a range of trade policy instruments, notably:

- Reduction of out-of-quota (or MFN) tariffs, either by a certain percentage, or with the tariff harmonizing Swiss formula.
- Reduction of in-quota tariffs
- Expansion of TRQ volumes
- Reduction of domestic subsidies

[12] A recent application of the model in this context is Poonyth and Sharma (2003).

- Reduction of export subsidies

The model explicitly covers 161 countries or country groups (the EU-15 is one such country group) and a total of 36 agricultural commodities. It allows users to define groups of countries and commodities, e.g. LDCs or SADC or cereals, and apply different reduction rates (policy reforms) to selected countries and commodities.

The model is calibrated to a base period data set, which describes a world trade equilibrium in some given period. Such a period could be the average of some years. To understand what calibration implies, consider figure 1. To make the graphical illustration empirically meaningful for simulations one has to specify explicitly functions for the demand and supply lines illustrated there. Consider then the specification of the domestic market in country 1. In any given period observed in the real world, the domestic market will equilibrate at some prices such as for instance Pd in figure 1a. In other words we can observe the values of production and demand equal to OA' and OB' in that figure, as well as the equilibrium domestic price and the world price (or the international price plus the domestic-international wedge due to policies). If we know the values of the price elasticities of demand and supply at the relevant price- quantity points on the respective supply and demand curves, then the lines D1 and S1 can be specified completely. Once they are specified for all countries, then the model can be used to simulate alternative equilibria under different policy regimes. This implies that to fully specify the model one needs base period values for all the quantities demanded and supplied by all countries, the values of all policy induced price wedges, as well as the elasticities of supply and demand.

In ATPSM, besides the usual base period quantities and values, all policy instruments are defined in ad-valorem equivalents terms. Thus, specific tariffs are converted to ad valorem rates and both domestic and export subsidies are expressed in their respective ad-valorem equivalents.

4.1 Key equations

The four key variables that are part of an equilibrium accounting relationship are quantities of production, import, export and consumption, with production plus import being equal to consumption plus export. Of these, production and consumption depend on domestic prices. Imports and exports clear the world market. Domestic prices are determined as a function of world market prices and policy variables, e.g. support measures, tariffs, subsidies and quotas. The world prices are linked to domestic prices by price transmission equations that allow world price changes not to be transmitted fully to the domestic market, if that is the reality. In the version of the model utilized here these transmissions are assumed to be complete. As domestic prices are linked to world prices, the basic equilibrium variables are world prices, with domestic prices being determined by the respective policy wedges. Both demand and supply specifications account for substitution effects among commodities.

The base period equilibrium of the model can be expressed as follows

$$\sum_{i=1}^{n}\{D_{i,j}(P_{i,j,d},P_{i,\{k\},d},Z_{i,j,d})+X_{i,j}\}=\sum_{i=1}^{n}\{S_{i,j}(P_{i,j,s},P_{i,\{k\},s},W_{i,j,s})+M_{i,j}\} \quad (1)$$

$$P_{i,j,d}=P_{j,w}\cdot(1+t_{i,j,c}) \quad (2)$$

$$P_{i,j,s}=P_{j,w}\cdot(1+t_{i,j,p}) \quad (3)$$

In the above equations, the subscript i denotes the country, the subscripts j and k denote commodities, D(.) and S(.) denote the domestic demand and supply functions respectively for the j'th commodity in country i, M and X denote imports and exports respectively of commodity j in country i, $P_{i,j,d}$ denotes the domestic demand price of commodity j in country i, $P_{i,j,s}$ denotes the domestic supply price of commodity j in country i, the group {k} in the subscripts of the second price terms in the demand and supply functions denote the prices of other commodities that substitute or compete for resources for commodity j in country i, n is the total number of countries that produce and trade the commodity in question, the vectors Z and W denote other non-price variables that affect domestic demand and

supply of the commodity j in country i respectively, $P_{j,w}$ is the world price of commodity j, and t_c t_p denote the consumption and production tariff equivalent wedges between domestic and international prices for commodity j in country i. The endogenous variables are the quantities demanded and supplied, as well as the world prices. Exogenous variables are the demand and supply policy wedges, as well as all other variables that affect supply and demand.

Equation (1) above represents the world equilibrium in the market for commodity j in some period, while equations (2) and (3) summarize the impacts of various policies on domestic consumer and producer prices respectively. Notice that time is not shown in any of the equations. This is because the model is a comparative static one. In other words the model answers the following question. Starting from world equilibrium in a given period, what would this equilibrium have looked like if there were some changes in policy and other exogenous variables in the same period as the base one. In other words the comparative static framework is atemporal, but it is appropriate for analyzing policy questions. Transforming this framework into a predictive one is a much more difficult task, that would entail detailed description of all the dynamic relationships in the market of the commodity.

In a fully specified model, the values for all variables in this equilibrium are observed in the base period. A new equilibrium, after some changes in the policy variables can be computed by estimating the proportional (or percentage) changes from the base values of all the endogenous variables of the base equilibrium indicated in (1) as follows (^ denotes a proportional change and Δ absolute change). Once these percentage changes are estimated, the new level values of all variables can be computed as follows.

Changes in domestic demand for commodity j in country j:

$$\hat{D}_{i,j} \equiv \frac{\Delta D_{i,j}}{D_{i,j}} = \eta_{i,j}\left[\hat{P}_{j,w} + \frac{\Delta(1+t_{i,j,c})}{(1+t_{i,j,c})}\right] + \sum_{\substack{k=1 \\ k\neq j}}^{K} \eta_{i,j,k}\left[\hat{P}_{k,w} + \frac{\Delta(1+t_{i,k,c})}{(1+t_{i,k,c})}\right] \tag{4}$$

where η denote demand elasticities (own and cross) in country i, and K is the number of other commodities that substitute in consumption,

Changes in domestic supply for commodity j in country i:

$$\hat{S}_{i,j} = \varepsilon_{i,j}\left[\hat{P}_{j,w} + \frac{\Delta(1+t_{i,j,p})}{(1+t_{i,j,p})}\right] + \sum_{\substack{k=1 \\ k\neq j}}^{K} \varepsilon_{i,j,k}\left[\hat{P}_{k,w} + \frac{\Delta(1+t_{i,k,p})}{(1+t_{i,k,p})}\right] \tag{5}$$

where ε denote the own and cross elasticities of supply of the j'th commodity in country i. The changes in imports and exports of commodity j in country i are expressed as follows:

$$\Delta M_{i,j} = D_{i,j}\hat{D}_{i,j} - S_{i,j}\hat{S}_{i,j} + \Delta X_{i,j} \tag{6}$$

$$\Delta X_{i,j} = \gamma_{i,j}\Delta S_{i,j} \tag{7}$$

where γ is the ratio of exports to production (assumed fixed).

There are thus four equations for the changes of the endogenous variables for each country. The export equation implies that that the change in export in each market is some proportion of the change in production. This proportion is estimated by the base year ratio of exports to production, and stays fixed for the simulations.

The solution to the model is obtained by making the sum of all changes in exports of the commodity from all countries, equal to the sum of all changes in imports. It can be easily seen that because of the linearity of the equations in (4)-(7), with respect to the world price changes, the change in the world price can be obtained simply by matrix inversion.

4.2 Impact indicators

Some of the solutions to the above equation systems are important impact indicators, notably changes in the world prices as well as the volumes of production and exports, following a simulation run. Other indicators follow from these quantity responses, such as ΔM, ΔD, and domestic price changes.

The impact on trade revenue following a policy change is computed for each country and commodity, simply as the difference between changes in export earnings and import bills for the commodity in question, namely cotton:

Change in export earnings = $(P_w^1 X^1 - P_w^0 X^0)$ (8)

Change in import costs = $(P_w^1 M^1 - P_w^0 M^0)$ (9)

where, the superscripts 0 and 1 indicate base period and simulation values respectively.

Another key indicator is total welfare and its constituent parts, namely producer and consumer surpluses and government revenue. Total welfare is the sum of the three, $\Delta W = \Delta PS + \Delta CS + \Delta NGR$[13]. For each country and commodity, changes in producer and consumer surpluses are defined as follows:

$$\Delta PS = \Delta P_s \left[S^0 + 0.5(\Delta S) \right] + c\Delta U \quad (10)$$

$$\Delta CS = -\Delta P_d \left[D^0 - 0.5(\Delta D) \right] \quad (11)$$

where cΔU is the change in quota rent received, and thus added to producer surplus.[14]

The change in net government revenue (ΔNGR), the third term of total welfare, includes changes in various government revenues, notably tariff revenue, export subsidies, domestic support expenditure and change in quota rent not received by exporters. Formally, for each country and commodity, $\Delta NGR = \Delta TR - \Delta ES - \Delta DS + (1-c)\Delta U$, where TR is tariff revenue, ES is export subsidy expenditure, DS is domestic support expenditure and (1-c)ΔU is change in quota rent forgone.

To sum up, the model generates outputs for the following variables/indicators:

- Changes in quantities - production, consumption, imports and exports
- Changes in trade values - export, import, and net trade balance
- Welfare effects - producer surplus, consumer surplus, government revenue and total welfare
- Prices - world market prices, and domestic farm and consumer prices

4.3 Data sources and limitations

The model is based on data from various sources. Quantities of production, consumption, export and imports (in metric tons) are from the FAO FAOSTAT database (Supply and Utilization Accounts and Trade Domain data). All prices are expressed in United States dollars and are assembled from various sources. The base period for the model is the average of 1996-2000 for production, imports, exports etc. while tariffs and other policy parameters are based on the final year of implementation of the UR AoA (2000 for developed and 2004 for developing countries)[15]. In-quota tariffs, out-quota tariffs and global quotas are from the AMAD[16] database and were aggregated to the ATPSM commodity levels. UNCTAD COMTRADE[17] is the main source for bilateral trade flows while applied tariffs are from the TRAINS[18] database.

Some of the model limitations include the following. All commodities are assumed to be tradable, i.e. domestic prices are determined by world market prices and policy parameters. There is little

[13] A change in net government revenue, ΔNGR, is measured as within-quota and out-quota tariff revenue less export subsidy and domestic support expenditures and quota-rent foregone.
[14] In the version of the model used here, quota rents are ignored, as they are not relevant for cotton.
[15] As noted in section 3, this general rule could not be applied to domestic subsidies because of lack of notifications to the WTO for recent years.
[16] AMAD: Agricultural Market Access Data Base, http://www.amad.org/files/index.htm
[17] COMTRADE: http://unstats.un.org/unsd/comtrade/
[18] TRAINS: http://r0.unctad.org/trains/

disagreement that agricultural commodities are tradables. What is an issue and a limitation for the model is that all agricultural commodities are assumed to be homogeneous, namely there is full substitution between imported and domestic products, and among outputs from different sources. The alternative assumption used by some models is the Armington substitution assumption. However, that approach has its limitations as well, in that one would essentially have to assume the substitution elasticities among different sources of imports. For cotton, it appears that the degree of homogeneity of most traded cotton is such as to warrant the perfect substitution assumption.

Note that while the general theoretical framework allows for the presence of other variables in the supply and demand equations, in the actual simulations, it is assumed that only prices influence demand and supply. This maybe a limitation, as the income effects on demand maybe important, particularly for those economies where cotton accounts for a large share of total domestic income.

Although this does not apply for cotton and this study, the following limitation may also be noted for the sake of completeness. An important assumption is that in-quota tariffs are not relevant even where quotas are unfilled. This means that the higher out-quota tariff or the applied rate, whichever is operative (namely lower) in a particular situation, is the key determinant of domestic price. This assumption tends to overstate the benefits of liberalization, as there may be cases where in-quota rates are the relevant determinants of domestic prices.

5 THE DATA UTILIZED IN THE ATPSM COTTON MODEL

As indicated above there is a variety of data needed to simulate the ATPSM model. In this section we indicate and discuss the cotton data related to the model. While the ATPSM is a multicommodity model, that incorporates substitution in production and consumption among many agricultural commodities, the cotton sector in ATPSM is modelled as not having any direct substitution linkages. This implies that the ATPSM-cotton submodel can be run as a stand-alone cotton specific model. This structural assumption in the model essentially implies that the effects simulated maybe stronger than in reality. For instance, if a policy change results in domestic producer price declines, then one would expect that the area devoted to cotton production would decline, and some other crops would be produced instead, even if no policy change takes place in the other sectors. The increased production of the other crops would, in turn, induce an increase in the supply of these products, and hence a decrease in their world prices. These effects should have a secondary positive feedback effect on the supply of cotton, through substitution, moderating the negative direct effect. The way in which these effects are captured in the current version of the model is by appropriate adjustments of the supply elasticities in an essentially one commodity model.

The basic data for the major cotton producing and trading countries utilized in the ATPSM for the base period are shown in Annex 1 Table 1. All production, trade and consumption[19] data are averages over the period 1996-2000. As the model includes 161 countries, it is not possible to exhibit the data for all, but they are included separately in the model.

The values of the price elasticities of supply and demand for all major cotton producing and consuming countries used for the base scenario in the ATPSM are shown in Annex 1 Table 2. These parameters were checked, drawing upon the literature and market assessment. The 29 exhibited countries account for 90 percent of world trade and production. For all other countries for which rechecking was not done the supply price elasticity was set at 0.2 and the demand price elasticity was set at -0.2. Since the only other elasticity estimates available for comparison are the ones in Sumner (2003), the table also shows the values used there. Overall, the simple average of the ATPSM supply elasticities used here is over 2.5 times the value assumed by Sumner, while the average ATPSM demand elasticities are on average twice as large as the ones used by Sumner. The likely effects of larger elasticity parameters imply that the ATPSM model can be expected to show smaller impacts on world market prices than the Sumner model, but larger quantity effects.

[19] As the supply-utilization accounts for every year also include stock changes, and as trade and production data do not always cover the same period within the year, the averages over 1996-2000 for production and imports do not always equal the sum of domestic consumption plus exports over the same period.

The final table that we exhibit here (Table 6) describes the basic policy parameters utilized for the main countries that exhibit some policy interventions in cotton. As regards tariffs20, actual applied cotton tariffs were reviewed carefully for this particular study covering all the major importing and producing countries (see Table 6 for these countries). As expected, it was found that actual applied tariffs were mostly zero. Even where there were TRQs on cotton, applied rates were found to be zero and the quota volumes were expanded often so that cotton was imported free of duty. Table 6 shows that the weighted average applied tariff on cotton imports is only 0.2 percent, the weights being import volumes for 28 countries that account for about 65 percent of global import in the base period (the corresponding WTO bound rate is 17 percent). If we included all importing countries, the weighted average would be even smaller. Even allowing for some margin of error, or policy changes, the size of the distortion in the cotton market in terms of border protection is negligible.

Table 6 also shows the domestic support parameters used for this study. The second column shows subsidy amounts, the averages of the most recent three year period for which the notifications to the WTO were available. For the United States and the EU, for instance this is the period 1997-1999. Total base year support for all countries shown is $2.4 billion.

The last column shows subsidy rates which are the parameters that the ATPSM model utilizes. These are expressed in *ad valorem* equivalents. They are computed by first dividing the total value of subsidies by the domestic production[21] to produce a figure for the per ton subsidy. Then this amount is divided by the three year (1998-2000) average world cotton export unit value, computed from FAO trade data, to arrive at a proportional subsidy rate per unit of the product. The actual producer price wedge used in the model is this estimated ad valorem rate. In cases where there is also a tariff, the tariff rate is added to the direct ad valorem equivalent subsidy rate. For the consumer price wedges only applied tariffs are utilized, which, as was seen, are very small. The results of the model then are driven largely by the ad valorem equivalent producer subsidy rates indicated in Table 6. All domestic support data used are trade-distorting according to the WTO definition, i.e. these are Aggregate Measurement of Support and do not include other categories like Green Box measures.

6 SIMULATION RESULTS

This section describes simulation results from the ATPSM model. Moreover, as said at the outset, one important objective in undertaking this study is to clarify results from various model-based assessments of the impact of cotton subsidies. Therefore, while reporting results from the ATPSM model, we also compare results from other studies. This is done realizing fully that it is always difficult to compare results across models in view of differences in the model structure and various assumptions made. One particular difference is assumption made about China's cotton subsidies. All other models, with the exception of Tokarick/IMF, assume that China subsidises cotton, as per the ICAC data set. We do not make this assumption and so simulate the effects of removing only those subsidies that are officially notified to the WTO, which makes comparison with other results somewhat difficult. We, however, present in Annex 2 all corresponding results from a simulation run that assumes that China also subsidises cotton production as per the ICAC data set. We do this merely to facilitate comparison with other models, which is essential given the importance of "clarifying" the impact of subsidies on the world cotton market.

One of the issues discussed in Section 3, in the context of the building blocks of partial-equilibrium models, was the difficulty or uncertainty of pinning down some of the key data and parameters. The three main parameters or issues discussed there were the level of initial distortions (domestic subsidies in the context of cotton, including the issue of coupled versus decoupled effects on production and trade), supply and demand elasticities and world-to-domestic price transmission. All the tables show results from sensitivity tests for alternative values of demand and supply elasticities. A separate sensitivity test, presented at the end of this section, assesses the impact of higher domestic subsidies in the base period,

[20] The reported tariff rates are averages of the period 1998-2000

[21] The three year averages for domestic production of 1998-2000 were used

Four sensitivity scenarios were simulated by either raising or lowering the two sets of elasticities for all important cotton producing and trading nations (those listed in Annex 1 Table 1). For each scenario the relevant supply elasticities (indicated by S in the column headings) and demand elasticities (indicated by D in the column headings) were multiplied by a common factor. So, for instance the column heading S=1, D=1 indicates the base scenario (elasticity values shown in Annex 1 Table 2). All changes are measured with respect to values of the base period (not the results of the base simulation).

6.1 Impact on world market prices

Table 7 summarizes estimated impacts of complete liberalization of domestic subsidies and tariffs on world market prices for various combinations of the values of supply and demand elasticities. The impact on world market price of cotton is 3.1 percent for the base scenario with assumed best-estimate values of the elasticities (shown in Annex 1 Table 2). The highest impact was 4.8 percent under the scenario with highly response production and highly inelastic demand. Given the result for the base scenario, these alternative assessments are as expected.

One immediate question that may be raised is why the overall impact on the world cotton price is on the lower side, relative to those from some other studies for cotton as well as for other agricultural commodities in various model-based studies simulating global agricultural reform process. The answer to the question of relatively small impact on the cotton price follows from relatively low level of the initial distortion, which was estimated to be 10 percent in *ad valorem* equivalent term - almost all due to domestic subsidies as applied tariff rate on most of the traded cotton was negligible (Table 6). Indeed, the ATPSM results show fairly large impact on world market prices for several other agricultural commodities with high levels of distortions in the base period, including tariff distortions.[22]

Based on the level of distortion in the base period, about 66 percent of the overall impact on world market price can be attributed to the removal of the US subsidy, followed by the removal of the EU subsidy (about 33 percent of the total contribution). Although the EU's rate of subsidization is highest, it plays a much smaller role in world cotton production and trade. For the same reason, the domestic subsidies in Brazil and Colombia play a negligible role. The relative importance of subsidies versus border measures has attracted some analyses in the literature in the context of the WTO agricultural negotiations.[23] The purpose of these studies is to see whether developing countries gain more by focussing on one or the other "pillar" of the AoA in these negotiations. It has been established that for most commodities, there is relatively more to gain from reforms in border measures, but cotton is an exception to this pattern. Our results also confirm those findings - when all countries eliminate border restrictions on cotton trade, the impact on the world market price is only 0.6 percent versus 2.6 percent when all domestic subsidies are removed while border restrictions are maintained.

The results of the sensitivity tests are basically consistent with expectations. Thus, the impact on the world price of cotton is higher when demand is assumed to be inelastic. With demand elasticities at one fourth of their base values and base supply elasticities, the increase in the world price from full liberalization is 4.3 percent (compared to 3.1 percent in base scenario) and 4.8 percent when supply elasticities are three times the base values. The latter would amount to much stronger long term response to price increases. Similarly, world price rises by only 2.3 percent when supply elasticities are halved, keeping demand elasticities the same.

Before we proceed with more detailed analysis of the results, it is useful to compare our results with the price impacts from some other recent model-based studies, although as noted earlier direct comparisons are difficult as most other studies use the ICAC data base that show China granting

[22] For example, the ATPSM results show the following impacts on world market prices under full liberalization: 16 percent for wheat; 14 percent for sugar; 30 percent for butter; 21 percent for cheese and 23 percent for milk powder, etc.

[23] See for example Hoeckman, Ng and Olarreaga (2002) and Rae and Strut (2003).

considerable subsidies to cotton. As mentioned earlier, the ICAC (2002) estimates are important as these became the basis for some headline news that started the "cotton issue" in the WTO. The ICAC study had concluded that the average cotton prices during 2000/01 and 2001/02 would have been US$ 0.17 to US$ 0.31 per pound higher, respectively, if all subsidies were eliminated. This implied impacts on world cotton prices of 30 and 72 percent in 2000/01 and 2001/02, respectively, obviously much higher than the results from the ATPSM. A major limitation with this analysis was that the model ignored *inter alia* supply responses of other countries' to higher world prices following the elimination of the subsidies.

This limitation was dealt with in a subsequent study by Goreux (2003), which otherwise followed similar approach and used the same subsidy levels as the ICAC study.[24] He also made a number of improvements and reported a wide range of results based on sensitivity tests. The impact on world cotton price in his study ranged between 2.9 to 13.4 percent, depending on the combination of price elasticities of supply and demand assumed. He also noted that the impact of subsidies on the world price was markedly sensitive to these elasticities.

A 2002 study from FAPRI, assessing the impact of the Doha Round reforms, is another important study in this area, and is extensively quoted, including in reports such as the cotton section of the World Bank's 2004 Global Economic Prospects report(World Bank, 2004). The FAPRI study finds that the average cotton price during 2001/02 to 2010/11 period would be 13 percent higher with full reform (both subsidies and tariffs). This study also shows that the bulk of the large world price impact is due to domestic production subsidies, as world price would rise by only 4 percent if only trade distortions are eliminated.

The study by Tokarick (2003) was the basis for the cotton section in IMF's 2002 World Economic Outlook report (IMF 2002). Tokarick's partial equilibrium model estimated the impact on the world market price of cotton to be only 2.8 percent, of which 2 percent came from the removal of production subsidies and 0.8 percent from the removal of market price support. In another study, Quirke (2002) estimated that the removal of production and export subsidies by the United States and the EU would raise the world cotton price by 10.7 percent in 2001/02. His estimates were also based on ICAC policy data base.

Finally, the study by Sumner (2003) is interesting because it provides simulated world price impacts separately for the removal of six types of United States domestic subsidies, which were assumed to have different degrees of "coupling". On average, over the nine years modelled, Sumner finds that removing all the subsidies simultaneously would cause the world price to rise by about 12 percent with a range of between 8 and 18 percent.

In summary, first, the range of the impact on world cotton price assessed by various studies seems to lie between 3 percent to 15 percent. Although it is very difficult to reconcile differences among model results for a variety of reasons (see Sharma et al 1996), including the fact that only few studies spell out in detail all the assumptions made, there is some basis to conclude that our own ATPSM results are not out of line with these results. For example, our estimate of 3.1 percent price impact under the base scenario corresponds with Tokaricks' assessment, which is based only on subsidy removal in the United States. By contrast, assessed impacts from other models are fairly comparable with the ATPSM results based on the ICAC subsidy scenario, which we report in several tables in Annex 2 for the sole purpose of demonstrating this similarity. Thus, the 7 percent price impact the ATPSM ICAC subsidy scenario is very close to some of the scenarios simulated by Goreux, where he assumes supply elasticity of 0.9 and demand elasticity of negative 0.6, similar to the average values of parameters used in the ATPSM. Three of the scenarios with the ATPSM model gives the price impact of about 10 percent, in one case 12 percent, which are comparable to those from some of these studies, e.g. 13 percent of the FAPRI assessment. Sumner's results are closer to the FAPRI estimates. While details about parameters and other assumptions used in the FAPRI study are not available, Sumner claims in his paper that he used to the extent possible similar approach and parameters as the FAPRI study.

[24] Mr Goreux was indeed hired as a consultant following a decision of the Agricultural Ministerial Meeting of Western and Central Africa (AOC) in June 2002 and in the context of the submission of the cotton issue to the WTO by Benin, Burkina Faso, Chad and Mali.

Sumner provides demand and elasticity values used, citing FAPRI sources (see Annex 1 Table 2 for his values and the ATPSM values). One reason for the larger world price impacts in the Sumner and FAPRI studies (relative to ATPSM) could be the assumed values of supply and demand elasticities, in particular demand elasticities which are relatively much lower compared to the ATPSM. Lastly, all studies agree that the bulk of the impact is due to subsidy removal, and only a small part from eliminating border measures.

One final point worth noting at the end of this sub-section is that the ATPSM model is fairly stable – the world market price did not even double when supply elasticities were tripled and demand elasticities reduced to one-fourth of their original values. Had the results been unstable, this would give less confidence to the results.

6.2 Impacts on production and trade

As explained earlier, the way most of these models work is that following the removal of subsidies (or tariffs) in country A, production would shrink as per the supply price elasticity used, which in turn reduces net exports. The resulting higher world market price induces production in non-subsidizing countries and their production and trade expands. This process continues until a new equilibrium is reached. Hence, the direction of most simulation results is anticipated – the issue is mainly one of degree, and how the ATPSM results compare with others in the literature. Tables 8 and 9 show estimated impacts on production and exports for selected countries that represent both subsidizing and non-subsidizing major cotton producers and traders.

Before the results are discussed, it is useful to note that, although there is a positive relation between world price impact and the resulting impacts on production and export, the magnitude of this relationship need not be strong. Where supply responses are strong, especially in non-subsidizing countries, the change in the world price could be small but there could be marked impacts on production and trade. By contrast, with inelastic supply responses, the change in the world price could be large, but production and trade effects would be small.

Overall, the simulated effects on production and trade are consistent with expectations. Thus, under full liberalization, production shrinks in countries that reduce subsidies (e.g. EU and US), and in proportion to the base level of subsidy.[25] For example, the 14 and 32 percent reduction in the United States and EU cotton production, respectively, reflect the fact that base subsidy levels were relatively high. At the global level, the 2 percent drop in world production is due to the fact that output in non-subsidizing countries, which rises in response to the increase in the world price, does not rise enough to offset the large declines in production of subsidizing countries. Most countries gain in outputs when subsidizing countries eliminate subsidies, which is expected. Cotton production in the BBCM sub-group (total for Benin, Burkina Faso, Chad and Mali) rises by 2.4 percent.

Other results in the table show that production naturally responds to the size of the supply elasticity assumed, e.g. the impacts are generally 3-4 times higher than in the base case with supply elasticities three times higher. For countries for which initial subsidies were removed, the reduction in production is similarly higher. With higher production where this occurs, exports expand as per the model specification. For instance for the BBCM sub-group, if supply elasticities in all countries are three times the assumed base values (scenario with S=3, D=1), production under full liberalization would expand by 9.9 percent (versus 2.4 percent in the base run), and exports would expand by 14.6 percent versus only 4.1 percent in the base run. But in scenarios with inelastic demand response, consumption would not decline as much when world prices rise as in the base case, and so somewhat reduced cotton would be available for export, relative to production under that scenario.

What do other studies say about production effects? While identical results can not be expected, there are some strong similarities.[26] One of these is that the Goreux model also shows world production of

[25] For countries without domestic subsidies, e.g. Turkey, the small negative effect is the result of the removal of border restrictions.

[26] These similarities become very apparent when Goreux's and other estimates are compared with the ICAC scenario of the ATPSM run (Annex 2). That the assumption about Chinese cotton subsidies in these other studies explains bulk of the differences is also obvious.

cotton to decline by 4.3 percent. Goreux estimated that, with elasticities higher than his base values and closer to those of the ATPSM, production in the United States would fall by 19 percent, compared with 14 percent in the ATPSM result under the base scenario. While the FAPRI study showed smaller (6.7 percent) negative impact on the United States production, China's production was found to rise by 1.5 percent, closer to ATPSM's 2.8 percent. The production increase for Africa as a whole in the FAPRI study, from elimination of all cotton subsidies, was 6 percent, which is very close to Goreux's 6.7 percent under high elasticity scenario, while the impact was much smaller in the ATPSM results under the base scenario but in the 10-12 percent range under assumptions of higher supply elasticities. In contrast to all these estimates, Sumner finds that the United States production falls by as high as 27 percent on average during 1999/00-2007/08 period (12-47 percent range) under his full subsidy removal scenario.

Reviewing the impact on trade (Table 9) should be relatively simple once the sources of change in production are understood. In the ATPSM, as in real life, trade is strongly influenced by production, as well as by some other factors. Models could differ in terms of this specification but essentially the relationship between production and trade is often strong. This is also evident when Tables 8 and 9 are compared. Overall, global export shrinks by 2 percent.[27]

The impacts on subsidizing and non-subsidizing countries are as expected. Thus, for example, United States exports fall by 14 percent. Note that in each case when a subsidizing country reforms, others benefit in trade terms, which is what is expected. Thus, under full reform, the BBCM subgroup expands cotton exports by 4.1 percent. All other non-subsidising countries also gain.

While the above results are intuitively correct and expected given the nature of the impact on production, the interesting question at this stage is how do these results compare with other studies? The impact on world export of cotton assessed by the FAPRI study (5.8 percent) was closer to the 7 percent gain in the ATPSM model under the ICAC scenario. In general, however, the results from various models on the changes in trade are not as close as those for price and production. For example, the ATPSM showed almost five times larger impact on United States exports from free trade compared with the FAPRI result (3.5 percent fall). The FAPRI analysis showed 13 percent increase in African exports versus only 3-8 percent in the ATPSM for the BBCM subgroup. Goreux does not report changes in export volumes, but he shows markedly positive impact on African export earnings. Finally, Sumner's results on trade for the United States differ the most from those of all the other studies, as is also the case with production. He found that United States exports would fall by 43 percent, with a 28-51 percent range for various years, when all US subsidies were eliminated, and this is 3-4 times the changes predicted by the ATPSM.

6.3 Impact on welfare indicators

Table 10 shows impacts on key welfare indicators for selected countries. The indicators are changes in producer surplus (PS) and total welfare (TS) as the sum of the PS and two other indicators not shown in the table, namely changes in consumer surplus (CS) and changes in government revenue (positive for subsidizing countries denote savings).[28] The results in the table are largely self-explanatory, as these follow from changes in world market prices and production discussed earlier. The numbers in the third column (changes in government revenue) are also easy to explain with reference to Table 6 on policy parameters. For the three countries with tariffs (China, Colombia and the US), a small part of the gain from liberalization is the loss of tariff revenue, but overall for these as well as other two (Brazil and the EU) most of the gains are from the elimination of domestic subsidies. For all other countries (including those not shown in the table), there are no changes in government revenues.

The main focus of this paper is on the impact of cotton subsidies on non-subsidizing countries, and hence the key indicator is producer surplus (and export earnings discussed below). The table shows

[27] By contrast, global trade expands by 6.7 percent under the ICAC subsidy scenario. The main reason seems to be that in this scenario China's production is reduced considerably, and this requires large imports to satisfy China's large domestic demand. This is what leads to the expansion of world exports. This, on the other hand, is not the case under the WTO scenario with no cotton subsidies in China.

[28] See section 4 for definitions of these measures.

that under full liberalization, the BBCM subgroup would experience PS gains of $21 million per year and TS gain of $15 million, after deducting the CS loss due to higher price of cotton. Farmers in all non-subsidizing countries gain (the PS gain), and substantial amounts are gained by cotton farmers in China, India and Pakistan, reflecting large production in the base period. However, the overall gains (TS) for these countries are much smaller because of substantive CS losses, which is explained by the fact that, unlike the BBCM case, domestic utilization of cotton is very large in these countries.

As domestic subsidies are eliminated, farmers lose in the two countries that provide high levels of subsidies (i.e. the EU and US). These countries also experience CS losses as cotton price rises. But interestingly, they gain in total welfare terms because the savings in domestic subsidies more than offset the losses in PS and CS. It is for this reason that only 4 of the 11 countries/groups shown in the table lose in total welfare terms. Overall, the gains from the reform process at the global level are substantially positive (about $900 million). By symmetry, these calculations also highlight the global and country specific losses from the current cotton policy regimes. These suggest that the gain in net government revenue could be used, under a liberalizing scenario, to compensate in a decoupled way the loss of farm income. The issue, of course, would be to institute compensatory policies that are indeed decoupled, but as yet economic analysis has not clarified how decoupled the various measures introduced in the past by some subsidizing countries have been. The issue clearly merits further research.

6.4 Impact on export earnings and trade balances

Although export earnings and import expenditures are not separate gains, namely they are not additional to gains in welfare terms, it is useful to report these statistics also in view of the widespread interest on export earnings and trade revenues. Impact on export in volume terms was already discussed earlier, and so this presentation can be short. Table 11 shows changes in export earnings. These are the sum of two components:

- Additional export earnings or import expenditures on base period exports or imports, namely base export (or import) volume times (new world price – base world price); and
- Total export earnings (or import expenditures) from additional exports (imports) following the reform process, namely (new export (import) volume-base export (import) volume) times new world market price[29].

The numbers in the table are self-explanatory and require little discussion, especially in view of the discussions earlier. For example, the gain in export earnings for the BBCM subgroup is estimated at $35 million per annum in the base scenario, but much higher - about $100 million – in scenarios with high supply elasticities. These numbers also indicate the loss in export earnings that these countries incur due to the policy regime of the base period.

The results from sensitivity tests show that if elasticities of supply are three times larger than in the base, the BBCM sub-group would obtain, under full liberalization, export earnings that are larger by about $100 million or 20 percent higher than in the base (or in other words the loss of export earnings they incur because of the subsidies is $100 million yearly rather than the $35 million in the base scenario). It can be seen that the changes in the export earnings under various elasticity assumptions are considerably different than those in the base run.

6.5 Sensitivity test - effects of higher level of domestic subsidies

Although the levels of subsidies used for the base period in this paper are all official as notified to the WTO, an additional sensitivity test is conducted assuming a higher level of US subsidies on cotton.

[29] For exporting countries that do not have domestic support, their excess supply function does not change after liberalization, and hence the sum of the above two components is equal to the difference between the simulated and the base values of export earnings. For countries that experience a leftward shift in their excess supply functions, the same holds only if exports expand post-liberalization. Otherwise there is a small second order term difference between the sum of the two components and the difference between the simulated value of export earnings value and the base value. By symmetry the same holds for imports. In any case, since tariffs are not very important in cotton trade the import demand functions do not shift much post-liberalization.

This test could have been done for any other combination of countries, but the US application has an added value in that recent cotton studies seem to focus on this aspect. Also the scenarios are useful in that the level of US subsidies that is distorting is a matter of contention, and as we saw earlier, different analysts consider various parts of the subsidies to have different degrees of coupling. Table 12 shows the results for full liberalization by all countries with the US subsidy assumed to be $2.5 billion, instead of $1.6 billion in the base scenario, keeping all other parameters and assumptions the same.

First, note the impact on world prices. If the US subsidy were $2.5 billion initially, the world cotton price would rise by 3.7 percent instead of 3.1 percent in the base scenario. This follows from an increase in the overall total distortion in the world cotton market for the base period to 14 percent in *ad valorem* equivalent term, compared with 10 percent in the base scenario. Looking at this level of overall distortion in relation to those for many other commodities in the ATPSM, it appears low, and hence the 3.7 percent impact is relatively low. The reason why the overall level of world distortion does not increase significantly when US subsidies are doubled or trebled is due to the fact that the United States accounts for only 20 percent of world cotton output. This is also the reason that world price is not expected to rise too much if the United States eliminates its subsidies.

Other results in the table follow mostly from this change in the world market price since other parameters are not changed. Thus, for example, United States cotton production is reduced by 730 000 tonnes (20 percent less). The reductions in export volumes and export earnings follow from this. Interestingly, while other countries increase production in response to higher prices, these are not adequate enough to offset the sharp decline in United States production, and so world output is lower. Clearly, as stressed throughout this section, the results depend a lot on the values of the elasticities assumed. For instance if all elasticities were increased by a factor of 3, it is clear that the reduction in US production and exports would be much larger under the new subsidy scenario, and the exports of all other competing countries would correspondingly be much larger.

7 SUMMARY AND CONCLUSIONS

One of the issues that continue to attract considerable attention in terms of analysis and debate is the impact of agricultural trade distortions on global markets, trade, and on the economies of individual countries. As was the case during 1994-96 in the context of the Uruguay Round, several analyses are appearing now in the context of the Doha Development Agenda as there is a heightened demand for information on the likely impact of the reform process being negotiated.

The purpose of this paper was to contribute some fresh analysis on cotton within the above context, namely likely effects of distortions (protection and support) in the world cotton market on non-subsidizing countries. The analytical and modelling framework used here can be applied to any commodity whose market is distorted. In the process of contributing fresh analysis, the paper also reviewed extensively the assumptions behind and results from some recent model-based studies on cotton. This comparative assessment is considered to be particularly useful since there is a fair amount of confusion about the nature and size of the impact of the distortions as models used tend to differ in terms of approach, specification, parameters and assumptions on distortions.

The two main policy parameters reflecting distortions in world cotton markets are tariffs and domestic subsidies. An analysis of recent import policies of all major cotton importing countries showed that import tariffs are negligible. As regards domestic subsidies, the results are based on the official subsidy levels (the trade-distorting or AMS component) as notified to the WTO. The paper also shows in an Annex the corresponding simulation results based on subsidies as compiled by the ICAC (the same tariff protection applied to both scenarios). While there are some other small differences, the ICAC estimates show very high levels of cotton subsidies in China. We reproduce in the Annex the ATPSM results based on the ICAC subsidy data being fully aware of the official Chinese position concerning cotton subsidies, namely that there are no cotton subsidies in China since 2000, because one major objective of this study is to compare and review various recent studies that have been the source of the debate and controversy. Most of these studies assumed ICAC subsidies in their analyses.

The two key impact indicators that the ATPSM (and other models) generate endogenously are new world market prices and quantities produced, consumed and traded – all other indicators like export earnings and welfare measures follow from these. Concerning the impact on world market price, the ATPSM results showed that the complete elimination of distortions (mostly subsidies) led world cotton market price to rise by 3.1 percent under the base scenario and as much as 4.8 percent under different assumptions about supply and demand elasticities, compared with a range of 3-15 percent impact in various other studies. Although it is difficult to reconcile all the differences, as published studies often lack full details about assumptions etc, the ATPSM results are not out of line, as we identified differences in the results between some other studies that we could review in detail and this study, as largely due to differences in parameter assumptions. Our sensitivity tests verified that many of the results of other studies fall within the range of values estimated in these sensitivity runs, when differences in initial subsidy levels and supply and demand elasticities are taken into account. The vastly different assumption about cotton subsidies in China was a major factor.

In the ATPSM, new equilibrium production and trade outcomes are determined simultaneously based on changes in world market prices and long term price elasticities of supply and demand. Overall, the simulated effects on production and trade are consistent with expectations, and supply-demand response parameters. Thus, production and export shrink in countries that eliminate subsidies (e.g. Brazil, EU and US). The impact is mainly felt by the subsidizing countries and largely in proportion to the initial level of subsidy. At the global level, cotton production falls by only 2 percent, as outputs in non-subsidizing countries do not rise enough to offset the large declines in subsidizing countries.

Other results discussed in the paper follow from these key indicators. Thus, for example, all non-subsidizing countries experience gains in export earnings and in producer surpluses (PSs). All subsidizing countries lose in PS terms but some of them gain overall in total welfare term as government expenditures incurred on subsidies initially are saved. These are fairly standards results.

One important outcome from models of this type that is often overlooked is that even where the impact on the world market price is fairly small, e.g. in this study, there could be substantial shifts in production and trade. Thus, despite only a 3.1 percent increase in world price, following complete elimination of all subsidies and other trade controls, the outputs in the United States and EU fall by 15 and 32 percent respectively. Similarly, the impact on the exports and export earnings of the four West Africa Countries can be considerable under all liberalization scenarios, especially under assumptions of higher supply elasticities.

Similarly, one of the other largely overlooked facts is that, following liberalization, it is not the case that only 1-2 countries make gains of impressive size. What happens, and this is realistic, is that many cotton producers gain, and this happens in proportion to their ability to expand production at given world prices. In other words the benefits from liberalization depend a lot on supply responses. While these effects were explored in our sensitivity tests, they mask the true importance of supply response effects, because in the sensitivity tests these parameters were changed for all major producing and consuming countries by the same proportion. If the supply elasticities are raised selectively, for example only for some countries in West Africa, then the results would show that these countries would expand cotton production much more than shown in the sensitivity results.30

The results presented above refer only to long run impacts. The world cotton market, much like the market of other agricultural products, exhibits considerable short term (namely year to year, as well as within year) instability, in both prices, as well as quantities produced, and traded. These are usually much larger than the long run effects outlined above. One should not confuse, however, the short term effects, with longer term and more permanent impacts. As noted earlier in the paper, there maybe permanent shifts in supply and demand following short term instability, for instance through induced technical innovation, or induced changes in demand for cotton in the production of fibres. There is very little known about these potentially important effects, but given that the degree of short term world cotton price instability is much larger than the secular trend, these effects could be important.

[30] In the WTO scenario, for example, if supply elasticities are trebled for the BBCM group only, their combined production would increase by 7.4 percent from the base level (versus 2.4 percent in the base scenario), and export volumes would increase by 11 percent (versus 4.1 percent in the base scenario).

Another implication that is not treated here is the potential economy wide impacts of lower prices. Given that cotton is an important commodity for some poor countries, notably the four West Africa countries that submitted the WTO complaint, the policy induced depression of world cotton prices has longer term implications for poverty and growth in such countries. As noted by Minot and Daniels (2002), these impacts can be large, even with small long term world price changes.

Before concluding, it is worthwhile to highlight some issues and caveats. As discussed in detail in Section 3, in the context of the "building blocks" of a model of this type, the initial level of subsidies is crucial in ascertaining the impact of any changes. Hence it is essential that the analysts first, and then the WTO negotiators, agree on the total level of current cotton subsidies, including the amounts that are coupled or decoupled. One of the sources of the current differences in assessed impacts has been the overall level of subsidies, with the official WTO notifications differing substantially for some countries from those compiled by the ICAC and used extensively in many empirical analyses.

Secondly, there is the issue of handling coupled versus decoupled subsidies. Resolving this aspect particularly for the EU and US subsidies is important for assessing impacts as well as for the WTO negotiations. On this issue, the modelling approach used by Sumner and being experimented on by FAPRI is encouraging, but more empirical research on both sides of the Atlantic is needed.

A third issue concerns the values of price elasticities of supply and demand. It became clear in the course of our sensitivity tests that a very large part of the impact analysis depends on these values. Unfortunately there has been not enough work to estimate these values empirically, and this will likely remain a source of differences, unless resolved through further research.

In our analysis we assumed that all international price signals are fully transmitted domestically. While this appears reasonable in the case of cotton, and in a longer-run context, it is by no means certain that the assumption is a correct one. There does not appear to exist any empirical analysis of this issue.

While it is unlikely that models used by different agencies and individuals, and the parameters and assumptions made, will ever be identical, many of the above areas of disagreement and confusion can be resolved to some extent. One possible way to achieve this would be for the authors of the various studies to meet and discuss the models, assumptions, results etc.

Finally, although cotton is not an exception as a commodity that receives high levels of subsidies in some countries at the cost of non-subsidizing countries, the "cotton issue" became a controversial subject in the run up to the WTO Cancun Conference and continues to be so. With the WTO negotiations expected to resume in the middle of 2004, there is a need for more analysis of the issue in order for these negotiations to proceed on the basis of facts and figures rather than conjectures. The fact that this is a sensitive issue makes sound empirical analysis all the more important. That was the main purpose of this study and hopefully it is a contribution to the small amount of literature that exists concerning model-based assessments of the various distortions in the world cotton market.

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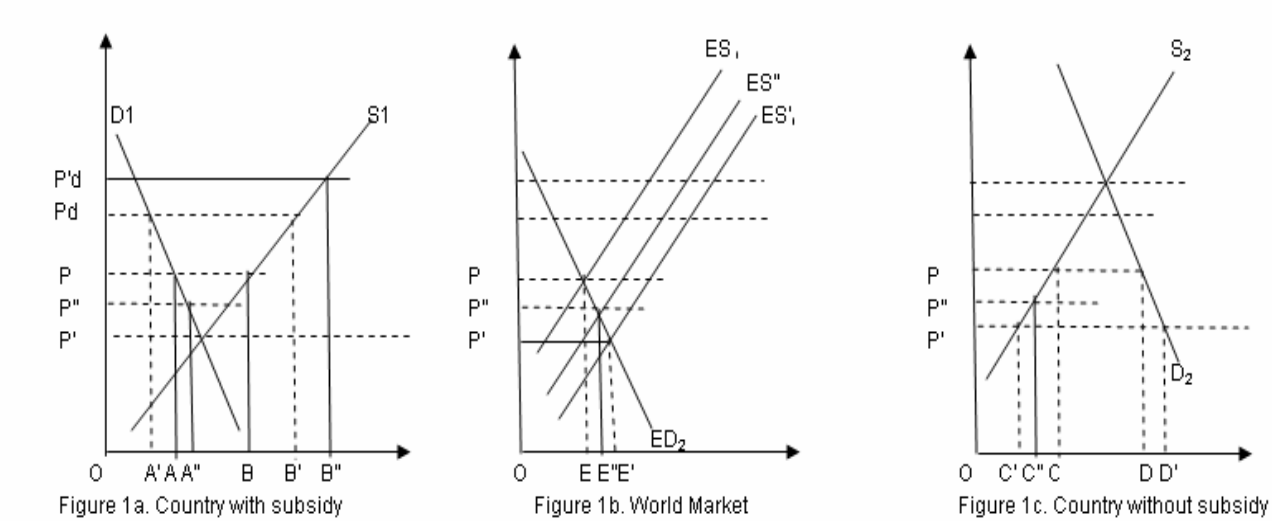
FIGURE 1

Figure 1: Graphical illustration of the effects of cotton subsidies in a two-region world trade model



TABLES

Table 1: Subsidies on cotton as compiled by ICAC/Baffes

	1997/98	1998/99	1999/20000	2000/01	2001/02	2002/03
Brazil	29	52	44	44	10	n.a.
China	2 013	2 648	1 534	1 900	1 196	750
Egypt	290	na	20	14	23	33
EU	870	864	795	716	980	957
Mexico	13	15	28	23	18	7
Turkey	na	220	199	106	59	57
US	597	1 480	2 056	1 020	3 001	1 996
Total	**3 812**	**5 279**	**4 764**	**3 822**	**5 287**	**3 814**

Source: Table F11 from Baffes (2003), which itself is reported to be based on ICAC sources (ICAC 2002 and 2003). All numbers are expressed in $ million. 2001/02 and 2002/03 are preliminary estimates. The original ICAC data show estimates for Greece and Spain separately; they are added here for EU total.

Table 2: Subsidies on cotton as notified to the WTO

	1997	1998	1999	2000	2001	2002
Brazil	55.3	n.n.	n.n.	n.n.	n.n.	n.n.
China	-	-	-	-	-	n.n.
Colombia	1.1	0.817	2.3	n.n.	n.n.	n.n.
Egypt	0	0	n.n.	n.n.	n.n.	n.n.
EU	718	654	627	n.n.	n.n.	n.n.
India	0	n.n.	n.n.	n.n.	n.n.	n.n.
Mexico	0	0	n.n.	n.n.	n.n.	n.n.
Pakistan	0	0	0	n.n.	n.n.	n.n.
Turkey	0	0	0	0	0	n.n.
United States [1/]	466	1 244	2 955	n.a.	n.a.	n.a.
Total	**1 240**	**1 899**	**3 584**	**-**	**-**	**-**

Notes: A "-" means not applicable (e.g. China was not a member of WTO in that year), and n.n. indicates "not notified", as of January 2004

[1/] For the United States, these figures include cotton-specific AMS as well as an estimated portion of Market Loss Assistance (MLA) payment (see Table 5 below for various support measures). The United States has notified the MLA payments as AMS but under non product-specific category and so the share to cotton is not explicit. For this paper, this share has been assumed to be 11 percent of the total MLA payment, which is the same proportion as the share of cotton AMS in total product-specific AMS. Our estimate is very close to the outlay shown in Table 4 by Baffes.

Source: Compiled from notifications to the WTO, as of January 2004.

Table 3: Cotton subsidies in the EU

Marketing year [1/]	Applied Administered Price (Euro/tonne)		Production eligible to receive Applied Administered Price (000 tonnes)		Equivalent measurement of support (million euro)		Total support (million euro)
	EC-14	Greece	EC-14	Greece	EC-14	Greece	
1997/1998	831	903	379	1085	189	620	809
1998/1999	874	772	338	1211	183	532	715
1999/2000	721	676	410	1351	159	464	624

[1/] September-August. Source: WTO notifications.

Table 4: Details of US subsidies on cotton as compiled by Baffes (in million US$)

Forms of assistance	1996/97	1997/98	1998/99	1999/2000	2000/01	2001/02
Loan Deficiency Payments	0	6	321	687	151	732
Marketing Loan Gains	0	26	240	860	390	1 513
Forfeitures	2	0	3	1	17	0
Production Flexibility Contract	699	598	637	614	575	474
Market Loss Assistance	0	0	316	614	613	524
Insurance	157	148	155	223	216	266
Step-2	20	467	214	486	253	125
Total	**858**	**929**	**1 790**	**3 179**	**2 048**	**3 706**

Source: Table 2 in Baffes (2003), which is said to have been compiled from USDA and ICAC sources.

Table 5: Details of the United States AMS to cotton as notified to the WTO (in million US$)

Forms of assistance	1997/98	1998/99	1999/00	2000/01	2001/02
Loan defiance payments	3	303	685	n.n.	n.n.
Marketing loan gains	26	230	815	n.n.	n.n.
User marketing payments	416	280	446	n.n.	n.n.
Storage payments	24	78	144	n.n.	n.n.
Commodity loan interest subsidy	0	35	77	n.n.	n.n.
Miscellaneous	-3	8	187	n.n.	n.n.
Market loss assistance 1/	0	309	601	n.n.	n.n.
Total AMS	**466**	**1244**	**2955**	**n.n.**	**n.n.**

Source: Compiled by authors from US notifications to the WTO. Note that compared with the Baffes table above, this shows only AMS values subject to reduction – the former also includes some Green Box measures and non product-specific support estimated to be accrued to cotton (discussed in the text). The user marketing payments are the same as the Step-2 payments in table 4.

Table 6: Policy parameters used in the ATPSM runs [1/]

	Applied tariff [2/] (percent)	Domestic subsidies $ million [3/]	Ad valorem subsidy rate (percent) [4/]
Brazil	0	33	6.2
China	1	0	0.0
Colombia	10	2	4.4
Egypt	0	0	0.0
EU	0	794	129.7
Mexico	0	0	0.0
Turkey	0	0	0.0
United States	1.6	1 555	33.2
Weighted average/total [5/]	0.2	2 384	10.1

[1/] The table only shows those countries that have one or more positive parameters (tariff and subsidy). For all the rest of the countries in the ATPSM both import tariffs and domestic subsidies on cotton were zero.
[2/] As mentioned in the text, these are actual tariffs that cotton imports face, and are either applied MFN rates or in-quota tariffs where there are tariff quotas that are known to be not binding.
[3/] The levels of domestic subsides are AMS values from WTO notifications, shown in Table 2. These are averages for the latest three years for which the data were available, typically 1997-99. For Brazil, the average is based on 1995-97 data.
[4/] These are *ad valorem* equivalent subsidy rates computed as the ratio (in percent) of per unit subsidy rate to world market price of cotton, as explained in the text.
[5/] The second column is the sum of the individual values, and the first and third columns are weighted averages. The weights used are import volumes (for 28 countries with 65 percent share of global import) for tariffs and cotton production shares for subsidy rates.

Table 7: Impact on world market price of cotton of complete elimination of domestic subsidies and import tariffs

	Base scenario	Alternative assumptions about price elasticities of supply and demand [1/]			
	S=1, D=1	S=3, D=1	S=3, D=0.25	S=1, D=0.25	S=0.5, D=1
Change in world cotton price (percent)	3.1	4.1	4.8	4.3	2.3

[1/] The numbers next to S and D indicate multiples of the elasticity values in the base scenario. For example, under S=3, D=0.25, the assumed supply and demand elasticities are 3 and 0.25 times their base values, respectively.
Source: ATPSM simulation results.

Table 8: Impact on production of full trade liberalization, WTO subsidy scenario

	Base production (000 tonnes)	Base scenario S=1, D=1	Assumptions on supply and demand elasticities [1/] S=3 D=1	S=3 D=0.25	S=1 D=0.25	S=0.5 D=1
		.....percentage change from base.....				
Australia	709	2.4	9.9	11.5	3.4	0.9
BBCM [2/]	530	2.4	9.9	11.5	3.4	0.9
Brazil	421	-3.1	-5.5	-3.2	-1.7	-2.0
China	4 311	2.8	12.2	14.6	4.2	1.0
Egypt	275	1.2	6.2	7.8	2.2	0.3
EU	488	-31.7	-92.5	-90.9	-30.7	-16.1
India	1 991	3.7	14.8	17.2	5.1	1.4
Mexico	190	3.1	12.4	14.3	4.2	1.2
Pakistan	1 678	3.7	14.8	17.2	5.1	1.4
Turkey	834	-1.9	-1.9	0.5	-0.5	-1.4
United States	3 736	-14.2	-40.2	-38.6	-13.3	-7.4
World total	**18 813**	**-1.9**	**-2.7**	**-0.8**	**-0.7**	**-1.3**
Memo item: percentage change in world cotton price		**3.1**	**4.1**	**4.8**	**4.3**	**2.3**

[1/] The numbers next to S and D are multiples of the elasticity values for the base scenario; the results under the column S=1, D=1 are those for the base scenario.
[2/] BBCM sub-group indicates four West African countries (Benin, Burkina Faso, Chad and Mali).
Source: ATPSM simulation results.

Table 9: Impact on exports of full trade liberalization, WTO subsidy scenario

	Base export (000 tonnes)	Base scenario S=1, D=1	Assumptions on supply and demand elasticities [1/] S=3 D=1	S=3 D=0.25	S=1 D=0.25	S=0.5 D=1
		---------- percentage change from base ----------				
Australia	608	3.1	11.9	13.5	4.1	1.3
BBCM [2/]	384	4.1	14.6	16.1	4.9	1.8
Brazil	7	-3.1	-5.5	-3.2	-1.7	-2.0
China	116	2.8	296.1	291.3	4.2	1.0
Egypt	61	1.2	13.8	18.4	2.2	0.3
EU	328	-31.7	-92.5	-90.9	-30.7	-16.1
India	90	22.7	290.1	290.0	18.7	1.4
Mexico	53	3.1	12.4	14.3	4.2	1.2
Pakistan	105	32.3	226.7	218.3	23.8	1.4
Turkey	53	-1.9	-1.9	0.5	-0.5	-1.4
United States	1214	-14.2	-40.2	-38.6	-13.3	-7.4
World total	5394	-2.0	8.4	9.5	-1.3	-1.7
Memo item: percentage change in world cotton price		**3.1**	**4.1**	**4.8**	**4.3**	**2.3**

Notes: [1/] and [2/] - Same as in the above table.
Source: ATPSM simulation results.

Table 10: Impact of complete liberalization on welfare measures, WTO subsidy scenario [1/] (base scenario and two others with extreme values)

	------ Base scenario (S=1, D=1) -------				Alternative assumptions on elasticities S=3, =0.25		S=0.5, D=1	
	Δ PS	Δ CS	Δ GR	Δ TS	Δ PS	Δ TS	Δ PS	Δ TS
	---------- million US$ ----------							
Australia	28	-4	0	24	45	39	21	18
BBCM [2/]	21	-6	0	15	34	25	16	11
Brazil	-15	-31	34	-12	-6	-21	-19	-9
China	128	-129	4	-5	235	4	87	-5
Egypt	5	-1	2	2	12	3	3	1
EU	-368	-42	795	385	-233	496	-406	357
India	78	-76	0	2	129	10	59	1
Mexico	7	-17	0	-9	12	-14	6	-7
Pakistan	66	-62	0	3	109	11	49	2
Turkey	-19	34	26	-11	-1	-18	-26	-8
United States	-1014	-95	1556	447	-816	589	-1084	401

[1/] Change in total welfare (ΔTS) = change in producer surplus (ΔPS) + change in consumer surplus (ΔCS) + change in government revenue (ΔGR), which is savings resulting from the policy reform. Details are shown for the base scenario only because ΔGR is same for other scenarios also; so, given the ΔGR, the remaining difference between ΔTS and ΔPS is ΔCS.
[2/] BBCM sub-group includes Benin, Burkina Faso, Chad and Mali.
Source: ATPSM simulation results.

Table 11: Impact on export earnings of complete liberalization, WTO subsidy scenario

	Base values (million $)	Base scenario S=1, D=1	Assumptions on supply and demand elasticities 1/ S=3, D=1	S=3, D=0.25	S=1, D=0.25	S=0.5, D=1
		----------	percentage change from base values		----------	
Australia	763	6.3	16.6	18.9	8.5	3.7
BBCM 2/	482	7.2	19.3	21.6	9.4	4.2
Brazil	9	-0.2	-1.6	1.4	2.5	0.3
China	145	5.9	312.4	309.9	8.7	3.3
Egypt	76	4.3	18.5	24.1	6.5	2.7
EU	412	-29.6	-92.2	-90.5	-27.8	-14.2
India	112	26.5	306.2	308.6	23.8	3.8
Mexico	67	6.2	17.0	19.8	8.7	3.5
Pakistan	132	36.4	240.2	233.5	29.1	3.8
Turkey	67	1.1	2.2	5.3	3.7	0.9
United States	1522	-11.6	-37.7	-35.7	-9.6	-5.2

1/ and 2/: See Table 10 for the notes.
Source: ATPSM simulation results.

Table 12: Sensitivity analysis – effects of assumed higher levels of US domestic subsidies on cotton (assumed higher level = $2..5 billion)

	Production		Export volume		Export earnings	
	Base scenario [1/]	Sensitivity scenario [2/]	Base scenario	Sensitivity scenario	Base scenario	Sensitivity scenario
	---------- percentage change from base period values ----------					
Australia	2.4	3.0	3.1	3.8	6.3	7.7
BBCM [3/]	2.4	3.0	4.1	4.9	7.2	8.8
Brazil	-3.1	-2.3	-3.1	-2.3	-0.2	1.3
China	2.8	3.6	2.8	3.6	5.9	7.4
Egypt	1.2	1.8	1.2	1.8	4.3	5.5
EU	-31.7	-31.2	-31.7	-31.2	-29.6	-28.6
India	3.7	4.5	22.7	52.0	26.5	57.7
Mexico	3.1	3.7	3.1	3.7	6.2	7.6
Pakistan	3.7	4.5	32.3	55.2	36.4	60.9
Turkey	-1.9	-1.1	-1.9	-1.1	1.1	2.6
United States	-14.2	-19.5	-14.2	-19.5	-11.6	-16.5

[1/] Base scenario results are from previous tables (with US subsidy of $1.6 billion).
[2/] Sensitivity scenario refers to the scenario with US subsidy of $2.5 billion, all other parameters being the same as in the base scenario.
[3/] BBCM sub-group includes Benin, Burkina Faso, Mali and Chad.
Source: ATPSM simulation results.

ANNEX 1

Annex 1 Table 1: The base period (1996-2000) data for cotton in the ATPSM model

Country	Base production	Base exports	Base imports	Base consumption	--- Share in global --- Production	Export
	---------- 000 tonnes ----------				--------- % ---------	
Australia	709	608	0	101	3.8	11.3
Bangladesh	15	0	185	200	0.1	0.0
Benin	149	125	0	24	0.8	2.3
Brazil	421	7	391	804	2.2	0.1
Burkina Faso	119	51	0	68	0.6	0.9
Cameroon	96	96	0	0	0.5	1.8
Chad	77	62	0	15	0.4	1.1
China	4311	116	338	4533	22.9	2.1
Colombia	40	0	59	99	0.2	0.0
Cote d'Ivoire	192	192	0	0	1.0	3.6
Egypt	275	61	11	225	1.5	1.1
EU	488	328	950	1111	2.6	6.1
India	1991	90	102	2003	10.6	1.7
Indonesia	9	5	561	565	0.0	0.1
Iran, I.R.	150	0	0	150	0.8	0.0
Japan	0	0	275	275	0.0	0.0
Korea Rep.	4	4	315	315	0.0	0.1
Mali	185	146	0	38	1.0	2.7
Mexico	190	53	313	450	1.0	1.0
Nigeria	147	0	9	156	0.8	0.0
Pakistan	1678	105	78	1651	8.9	2.0
Russia	0	0	297	297	0.0	0.0
Syria	360	241	0	119	1.9	4.5
Taiwan	0	0	271	271	0.0	0.0
Thailand	13	0	380	392	0.1	0.0
Turkey	834	53	349	1130	4.4	1.0
Turkmenistan	189	176	0	13	1.0	3.3
United States	3736	1214	60	2583	19.9	22.5
Uzbekistan	1066	820	1	247	5.7	15.2
Zimbabwe	167	167	0	0	0.9	3.1
Total of the above	17611	4721	4943	17834	93.6	87.5
Rest of the world	1202	673	969	1497	6.4	12.5
World total	18813	5394	5912	19331	100	100
BBCM 1/	530	384	0	146	2.8	7.1

Source. ATPSM. The ATPSM has 161 countries/country groups; only the data for selected major producers and traders of cotton are shown here.

[1/] This sub-group includes Benin, Burkina Faso, Chad and Mali.

Annex 1 Table 2: Cotton price elasticities of supply and demand in the ATPSM model and in Sumner (2003)

Country	Price elasticity of supply		Price elasticity of demand	
	ATPSM	Sumner [1/]	ATPSM	Sumner
Australia	0.80	0.30	-0.60	-0.47
Bangladesh	1.20		-0.60	
Benin	0.80		-0.60	
Brazil	1.20	0.40	-0.60	0.31
Burkina Faso	0.80		-0.60	
Chad	0.80		-0.60	
China (mainland)	1.20	0.14	-1.00	-0.26
China Taiwan Province	0.80		-0.60	
Colombia	0.80		-1.30	
Cote d'Ivoire	0.80		-0.60	
Egypt	0.80		-0.60	
EU	0.80	0.60	-0.60	
India	1.20	0.13	-0.80	-0.16
Indonesia	0.80		-0.60	-0.20
Iran, Islamic Republic	0.80		-0.60	
Japan	0.74		-0.60	-0.33
Korea Rep.	0.80		-0.60	
Mali	0.80		-0.60	
Mexico	1.00	0.50	-1.30	-0.14
Nigeria	0.80		-0.60	
Pakistan	1.20	0.30	-1.00	-0.24
Russia	0.80		-0.60	
Syria	0.80		-0.60	
Thailand	0.80		-0.60	
Turkey	1.20	0.30	-0.60	-0.25
Turkmenistan	1.20		-0.60	
United States	0.80		-0.60	
Uzbekistan	0.80	0.30	-0.60	-0.25
Zimbabwe	0.80		-0.60	

Source: Authors' for ATPSM parameters and Sumner (2003).
Note: In the ATPSM model, for the remaining countries cotton demand elasticities are set at -0.20 and supply price elasticities at 0.20. Blanks mean that relevant elasticity is not reported.
[1/] These are reported by Sumner as planted area elasticities

ANNEX 2: SIMULATION RESULTS WITH ICAC SUBSIDY SCENARIO

Annex 2 Table 1: Policy parameters used for the base period for the ICAC subsidy scenario [1/]

	Applied tariff [2/] percent	Domestic subsidies ($ million) [3/]	Ad valorem subsidy rate [4/] percent
Brazil	0	47	8.98
China	1	2 027	37.5
Colombia	10	2	4.4
Egypt	0	17	6.0
EU	0	792	129.3
Mexico	0	22	9.1
Turkey	0	175	16.7
United States	1.6	1519	32.4
Weighted average/total [5/]	0.2	4 601	19.8

[1/] The table only shows those countries that have one or more positive parameters (tariff or domestic subsidy). For all the rest of the countries in the ATPSM, both import tariffs and domestic subsidies on cotton were zero.
[2/] As said in the text, these are actual tariffs that cotton imports face, and are either applied MFN rates or in-quota tariffs where there are tariff quotas (that are assumed – based on a review of recent policies – not to be binding).
[3/] The levels of domestic subsides are based on the ICAC estimates and are simple averages for the period 1998-2000 from Table 1 in the text.
[4/] These are *ad valorem* equivalent subsidy rates corresponding to the level of subsidies in column 2 and were computed as the ratio (percent) of per unit subsidy to world market price of cotton (see text for details).
[5/] The second column is the sum of the numbers while the first and third columns are weighted averages. The weights used are import volumes (for 28 countries with 65 percent share of global import) for tariffs and cotton production shares for domestic subsidy rates.

Annex 2 Table 2: Impact on world market price of cotton following complete elimination of domestic subsidies and import tariffs, ICAC subsidy scenario

	Base scenario	Alternative assumptions about price elasticities of supply and demand [1/]			
	(S=1, D=1)	S=3, D=1	S=3, D=0.25	S=1, D=0.25	S=0.5, D=1
Change in world cotton price (percent)	7.0	9.7	11.4	10.0	5.1

[1/] The numbers next to S and D indicate multiples of the elasticity values in the base scenario. For example, the elasticities for the base scenario (S=1, D=1) are the same as in Annex 1 Table 2, while in the scenario S=3, D=0.25, the supply and demand elasticities assumed are 3 and 0.25 times their base values, respectively.
Source: ATPSM simulation results.

Annex 2 Table 3: Impact on production of full trade liberalization, ICAC subsidy scenario

	Base production (000 tonnes)	Base scenario S=1, D=1	Assumptions on supply and demand elasticities [1/] S=3 D=1	S=3 D=0.25	S=1 D=0.25	S=0.5 D=1
		---------- percentage change from base ----------				
Australia	709	5.6	23.4	27.4	8.0	2.0
BBCM [2/]	530	5.6	23.4	27.4	-18.1	2.0
Brazil	421	-0.5	8.4	14.5	767.3	-1.4
China	4 311	-19.1	-47.2	-41.1	-93.4	-10.7
Egypt	275	1.0	9.7	13.8	31.3	-0.3
EU	488	-28.6	-79.0	-74.9	356.7	-15.0
India	1 991	8.4	35.1	41.2	-90.3	3.0
Mexico	190	-1.3	4.4	9.5	887.4	-1.6
Pakistan	1 678	8.4	35.1	41.2	-53.8	3.0
Turkey	834	-10.7	-22.1	-16.0	310.5	-6.5
United States	3 736	-10.9	-25.9	-21.9	-84.7	-6.2
World total	**18 813**	**-4.9**	**-7.0**	**-2.2**	**-1.9**	**-3.4**
Memo item: percentage change in world cotton price		**7.0**	**9.7**	**11.4**	**10.0**	**5.1**

[1/] See the note in the previous table.
[2/] BBCM sub-group includes Benin, Burkina Faso, Chad and Mali.
Source: ATPSM simulation results.

Annex 2 Table 4: Impact on exports of full trade liberalization, ICAC subsidy scenario

	Base exports (000 tonnes)	Base scenario S=1, D=1	Assumptions on supply and demand elasticities [1/] S=3 D=1	S=3 D=0.25	S=1 D=0.25	S=0.5 D=1
		---------- percentage change from base ----------				
Australia	608	7.2	28.2	32.3	9.6	2.9
BBCM [2/]	384	9.3	34.4	38.5	-98.0	3.9
Brazil	7	-0.5	8.4	14.5	1210.7	-1.4
China	116	-19.1	-47.2	-41.1	-45.4	-10.7
Egypt	61	1.0	41.7	48.9	297.7	-0.3
EU	328	-28.6	-79.0	-74.9	-18.4	-15.0
India	90	196.7	839.8	852.4	-39.4	44.6
Mexico	53	-1.3	4.4	9.5	408.6	-1.6
Pakistan	105	167.9	636.1	625.6	-52.9	53.7
Turkey	53	-10.7	-22.1	-16.0	1982.5	-6.5
United States	1 214	-10.9	-25.9	-21.9	-64.6	-6.2
World total	**5 394**	**6.7**	**32.4**	**36.0**	**8.9**	**1.1**
Memo item: percentage change in world cotton price		**7.0**	**9.7**	**11.4**	**10.0**	**5.1**

[1/] and [2/] - see previous two tables for explanation.
Source: ATPSM simulation results.

Annex 2 Table 5: Impact of complete liberalization on welfare measures, ICAC subsidy scenario[1/] (base scenario and two others with extreme values)

	----- Base scenario (S=1, D=1) -------				S=3, D=0.25		S=0.5, D=1	
	Δ PS	Δ CS	Δ GR	Δ TS	Δ PS	Δ TS	Δ PS	Δ TS
	---------- in million US$ ----------							
Australia	64	-9	0	55	116	101	45	39
BBCM [2/]	48	-12	0	35	86	66	34	25
Brazil	-5	-69	46	-29	19	-49	-15	-20
China	-1108	-341	2021	571	-781	641	-1257	525
Egypt	3	-12	15	5	20	10	-3	4
EU	-354	-95	795	346	-241	396	-393	333
India	181	-170	0	11	344	60	128	4
Mexico	-5	-37	23	-19	6	-34	-9	-14
Pakistan	153	-139	0	14	290	57	108	6
Turkey	-118	-21	148	9	-72	-8	-140	14
United States	-837	-217	1520	466	-602	555	-944	418

[1/]Change in total welfare (ΔTS) = change in producer surplus (ΔPS) + change in consumer surplus (ΔCS) + change in government revenue or savings (ΔGR), which is savings resulting from the policy reform. Details are shown for the base scenario only because ΔGR is same for other scenarios also; so, given the ΔGR, the remaining difference between ΔTS and ΔPS is ΔCS.

[2/] BBCM sub-group includes Benin, Burkina Faso, Chad and Mali.

Source: ATPSM simulation results.

Annex 2 Table 6: Impact on export earnings of complete liberalization, ICAC subsidy scenario

	Base values (million $)	Base scenario (S=1, D=1)	Assumptions on supply and demand elasticities [1/]			
			S=3 D=1	S=3 D=0.25	S=1 D=0.25	S=0.5 D=1
		---------- percentage change from base period values ----------				
Australia	763	15	41	47	21	8
BBCM [2/]	482	17	48	54	-98	9
Brazil	9	6	19	28	1342	4
China	145	-13	-42	-34	-40	-6
Egypt	76	8	56	66	338	5
EU	412	-24	-77	-72	-10	-11
India	112	217	931	961	-33	52
Mexico	67	6	15	22	460	3
Pakistan	132	187	708	708	-48	61
Turkey	67	-4	-15	-6	2192	-2
United States	1 522	-5	-19	-13	-61	-1
World total	**6 763**	**14**	**45**	**52**	**20**	**6**

Notes [1/] and [2/]: See previous tables for explanation.

Source: ATPSM simulation results.

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