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Do global cotton subsidies affect the Malian economy? New evidence from a multimarket-general equilibrium model

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Abstract

The impact of the United States' and the European Union's subsidies on world cotton price has been an important subject in recent years. This paper examines the impact that the removal of these subsidies would have on Malian economy (GDP, public accounts, and households' income). The issue is addressed with a multimarket-computable general equilibrium model detailing the Malian cotton sector. The results show a positive impact on GDP as well as on households and government incomes. These results are robust to systematic sensitivity analysis taking into account parameter uncertainty.

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1. Introduction

The impact of the United States and the European Union's cotton subsidies on world cotton market has been the subject of numerous debates in recent years (Ingco and Nash, 2004; Bouët et al. 2004; Poonyth et al. 2004 etc.). The WTO sessions have put the stress on this subject recently (Doha Round) and during these debates, cotton appeared as a particular commodity. In fact many developing countries heavily depend on cotton for their exports. Countries like Mali and Burkina Faso had about half of their export earnings coming from the cotton sector for many years. In 2004, cotton exports accounted for 36% of total exports in Mali, representing a value of US$355 million [1].

Since the complaint of Brazil against the United States in 2003, many studies have attempted to assess the impact of developed countries' subsidies (essentially the United States and the European Union) on world cotton market (Araujo Bonjean et al. 2006, Poonyth et al. 2004, Goreux, 2003 etc.), with contradictory results. However, the impact that the removal of global subsidies would have on world cotton price seems to be quite limited: world cotton price would increase by 3 to 17%. Some of these studies go beyond the impact on world cotton price and try to estimate the effects (potential gains) on national economies. The study by Goreux (2003) estimates that developed countries' subsidies cause a US$ 250 million damage to West and Central African cotton producing countries exports. Another study carried out by the International Cotton Advisory Committee (ICAC, 2002) states that the loss of exports earnings for Mali is US$43 million.

Despite the profuse literature on world markets, few studies try to assess the impact of the subsidies on national economies and beyond that the potential gains in exports earnings. However, one can mention the paper by Minot and Daniels (2002) for Benin and Boccanfuso and Savard (2007) for Mali. Minot and Daniels (2002) ran a one sector microsimulation model for Benin and assessed the impact of cotton price variations on households' welfare. It is straightforward to see that this strategy ignores general equilibrium effects as well as second order ones. Boccanfuso and Savard (2007) built a micro-macro model to study the impact of cotton price variations and import prices of some cereals on households' welfare. However, the model is very standard in its structure and does not represent the Malian economy as a whole, particularly the cotton sector.

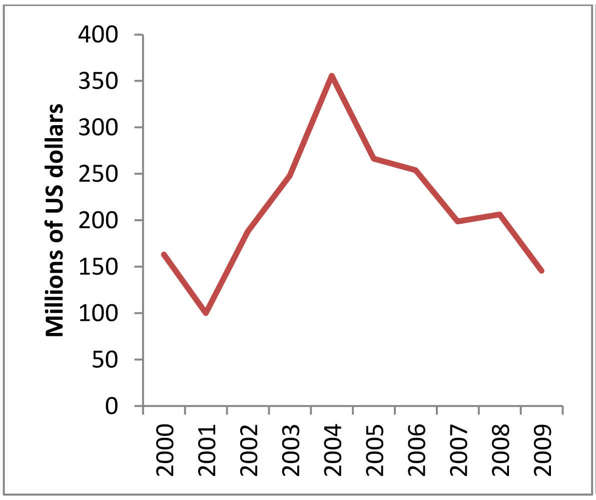
We try in this paper to seriously reconsider the question of the impact that the removal of the subsidies would have on the Malian economy and particularly on households. To this end, we start with a standard general equilibrium model (Dervis, Robinson and De Melo, 1982; Lofgren et al., 2002). This standard model is then modified essentially in the agricultural sector and the labor market. It is worth noting that cotton production in Mali is observed in households who also produce cereals. These cereals are substitutes or complements to the production of seed cotton (Nubukpo and Keita, 2005; Hugon, 2005). The choice of crops to be grown and of factors are made as part of a single income or subsistence strategy. Furthermore, the cotton sector is managed by a public monopoly with a guaranteed minimum price for producers. These two aspects are very often neglected in the literature about general equilibrium modeling in agriculture. We take into account these aspects by modeling the relationship between the public monopoly and cotton growers as it appears in reality. Following Quizon and Binswanger (1986) and De Janvry and Sadoulet (2002), millet, maize and cotton sectors are treated in a multimarket framework. Instead of standard production functions, we will work with supply functions that are derived from a generalized Leontieff profit function. We also take into account home consumption since a large part of food production in Mali is not sold on markets. Finally migration issues are introduced in an extended Harris-Todaro framework to take into account rural-urban migration flows observed in Mali.

The rest of this paper is organized as follows. The next section presents an overview of the Malian cotton sector and the third one the social accounting matrix used for calibration. The fourth section introduces the model while the fifth one displays the results and the sensitivity analysis. The sixth section concludes.

2. Overview of the Malian cotton sector

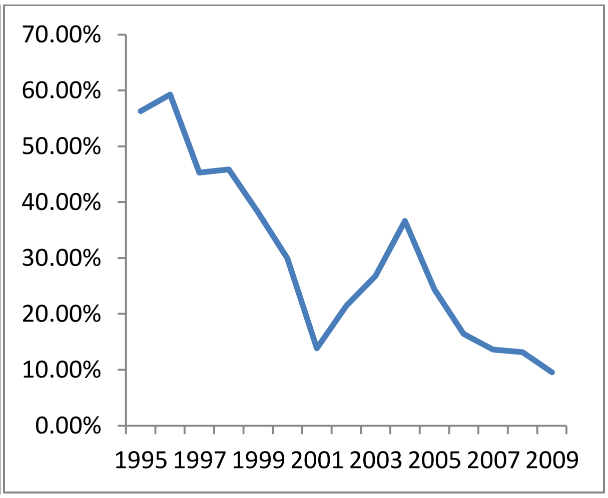
Mali is among the first cotton growers in Africa (after Egypt and Burkina Faso) with an estimated production of 600,000 metric tons. This production is made by 160,000 farms distributed in the South of the country and covering about 1,000,000 acres. 3 Typical farms are small scale family farms (5 acres on average), enrolled in producers' organizations. These organizations are directly involved in the management of the sector, by participating in the price determination mechanism. They also have to make sure that cotton seed is commercialized and lastly they provide inputs to their members. Although the number of producing farms seems to be limited, about 2 millions of people depend directly or indirectly on the cotton sector in Mali (Nubukpo and Keita, 2005). From a macroeconomic point of view, cotton accounts for 20% of the agricultural production, 7% of the GDP and represented until recent years half of the export earnings (180 billion CFAF). This significant position is now attenuated due to the recent gold boom (figures 1 and 2). In terms of public finances, the cotton sector contributes to 10 billion CFAF[1] to the Malian government tax revenues.

Figure 1: Cotton exports in value (2000-2009)



Source: BCEAO (2010)

Figure 2: share of cotton exports in total exports (1995-2009)



Source: BCEAO (2010)

Cotton was initially grown in Mali for domestic use. It became an industrial crop with the French colonization and particularly after World War I when the French cotton national

[1] 1$US = 494.6 CFAF (average rate, BCEAO, 2010).

company (CFDT[2]) was created. When Mali became independent in 1960 and until 1974, the sector was managed by the CFDT, a public monopoly. In 1975, the CFDT was replaced by the CMDT[3], a semi-public company owned by the Malian government (60%) and by CFDT[4] (40%). This new company was first in charge of collecting and transforming cotton seed into fiber. Cotton exports were under the responsibility of another public company (SOMIEX[5]). While exports were made by SOMIEX, the OSRP (another public company), was in charge of stabilizing and regulating prices and of receiving related payments. The OSRP office remunerated CMDT and SOMIEX on a fixed basis. Due to large cumulated deficits that occurred with the fall of world prices, the cotton sector was restructured in the early eighties.
In 1986, SOMIEX lost the monopoly and CMDT became an entirely autonomous entity. Nowadays, the sector is still organized through contracts between CMDT and the government. CMDT manages the cotton production by providing inputs to producers and exports the fiber on world markets. Besides organizing the production, CMDT is involved in some "development activities" (construction of rural roads, producers training etc.). To many observers, particularly advocates of privatization, these additional activities largely contribute to CMDT’s deficits.

Before the 2005 agreement between CMDT, producers and the government, cotton price was established after a direct negotiation amongst CMDT and cotton growers. The system consisted of a bottom price with a subsidy if world prices were to increase. The exact mechanism behind this procedure was relatively opaque. Furthermore, the government had to make up for the successive deficits. In 2001 world cotton prices fell down to an historic level. The value of Cotlook A index was 40 US cents/lb., the lowest level since 1973. Many cotton sectors in Africa suffered from this price decline. In Mali, CMDT reacted by drastically reducing producers prices. Producers organizations reacted by a boycott and the production fell by 50%. To come up with the crisis, the government set up large consultations which led to a new price design mechanism involving CMDT, the Government and cotton producers unions in 2005. This new mechanism fixes seed cotton price as follows:

- At the beginning of the campaign, a guaranteed minimum price is announced to producers. This minimum price takes into account costs of production of both CMDT and producers.
- At the end of the campaign, a potential bonus may be paid to producers if world prices have increased and if the gross benefit of the sector is positive. This gross revenue is calculated taking into account the evolution of the world price between March of campaign n and April of campaign n+1. In case the gross revenue of the sector is positive, 58.7% of the revenue goes to the producers and the remaining 41.30% to CMDT. In reality, only 49.6% of the revenue goes directly to producers and the remaining 8.7% is used to constitute a stabilization fund directly managed by producers and aiming at guaranteeing the minimum price. In fact, the Stabilization fund pays to producers the difference between the effective -theoretical- price of the campaign and the minimum guaranteed price. If the sector shows a deficit, the CMDT is obliged to pay to producers the minimum price. At a second stage it will be refunded by the stabilization fund.

[2] Compagnie française de développement des textiles
[3] Compagnie malienne de développement des textiles.
[4] now Geocoton
[5] Société malienne d’importation et d’exportation

With this new mechanism, cotton producers received 2.1 billion CFAF of bonus in the 2005/2006 campaign.

3. The Malian Social accounting matrix

The general equilibrium model developed in this paper uses a 2001 disaggregated social accounting matrix (SAM) for Mali built by the World Bank (Nouve et al. 2001)[6]. Initially composed of 17 sectors of production and 21 commodities, we have made an aggregation into 9 sectors[7] and commodities with five agricultural commodities which are of particular interest to us. This aggregation led to the following sectors: maize, millet, seed cotton, other agricultural products, mining commodities, cotton fiber, other industrial products, marketable services and non marketable services. The thirteen production factors in the initial SAM were aggregated into 3: skilled labor, unskilled labor and a composite factor including capital, land and formal business owners. To make it more simple the composite factor will be assimilated to capital in equations and its remuneration to gross revenue from production.

The initial SAM includes 11 household groups based on the main activity and the location of the head of the households. We do not proceed to any other aggregation since households income is a key indicator in our analysis. Households are divided into two categories: urban households (7) and rural ones (4). The 7 urban households are located in Bamako (3) and in other urban areas. Households in Bamako (the main city) are in the industrial sector, the public sector and in private services. This description works for other urban households. Rural households are in agricultural activities in the three main climatic areas of the country (Sahel and Sahara, Soudano-Sahel and Delta, Soudano-Guinean) and non-agricultural ones (other rural activities).

To explicitly describe in detail cotton sectors (seed and fiber) that were aggregated with other agricultural commodities and industrial products in the initial SAM, we have used the shares in a 1997 SAM. The cotton share is relatively stable in agricultural production in Mali and the Supply and Use table that is the core of the 2001 SAM was that of 1998. We have also introduced firm~~s~~ accounts from the 1997 SAM. However as one could expect, the above mentioned operations led to an unbalanced SAM. So the original SAM had to be rebalanced by using an appropriate method. Several balancing methods exist in the literature: least squares, RAS, cross entropy…We implemented the rebalancing with the cross entropy method since it has Bayesian foundations (Zellner, 1988) and is suitable for situations with limited information and measurement errors[8].

4. The CGE model

The model developed in this paper is a single country static general equilibrium model of the type presented in De Melo, Dervis and Robinson (1982), and Löfgren et al. (2002). The model is standard in its structure apart from the agricultural sector which will be described later. Production is modeled as a Leontieff function of aggregate value added and aggregate intermediate inputs[9]. Value added for non-agricultural activities is defined as a Cobb-Douglas

[6]We ran the simulations on scenarios observed in 2003 and 2004, so a 2001 SAM is not as "old"as it seems to be.
[7] We use a simple sum (equal weights) in the aggregation procedure.
[8]This is probably the case here.
[9] By using a Leontieff function, we assume a complementarity between aggregate value added and aggregate intermediate inputs.

function of composite labor and composite capital. Composite labor is a Cobb-Douglas function of unskilled and skilled labor. Capital is specific to each sector while labor (unskilled and skilled) is mobile. Households maximize a Stone Geary utility function[10] and consume a composite good with resources coming from factors, the government and the rest of the world. Consumption is allocated across commodities according to a Linear Expenditure System (LES).

On the international markets side, we adopt the small country assumption. Mali is then a price taker on international markets. Following Armington (1969), domestic and imported commodities are imperfect substitutes and are aggregated by CES function. In the same way, production is allocated between domestic sales and exports by a Constant Elasticity of transformation function (CET). The values for elasticities of substitution and of transformation are derived from literature (Annabi et al., 2003). These two parameters are respectively 0.5 and 0.75[11].

The government receives its income by collecting taxes (direct and indirect taxes) and from transfers from the rest of the world. It conducts public spending, pays public sector workers and makes transfers to households. Public spending is assumed to be exogenous and savings to be a flexible residual.

One of the originalities of this model resides in the treatment of the agricultural sectors particularly those of maize, millet, and seed cotton. In this sector, instead of working with standard production functions, we try to better represent the Malian reality by considering supply and demand functions which are derived from joint production functions. This approach is inspired by Sadoulet and de Janvry (2002) and allows direct substitution between crops. Agricultural activities (particularly cotton production in Mali) are better characterized by this type of behavior: farmers jointly choose crops and factors as part of a single income strategy (optimization program). Malian cotton growers are also maize and millet cultivators (Nubukpo and Keita, 2005; Hugon, 2005). We opt for a generalized Leontieff profit function from which we derive supply functions of three crops (cotton, maize and millet) and demand for three factors (unskilled labor, skilled labor and an aggregate input). The generalized Leontieff function is very flexible as it can be seen as a second order approximation to an arbitrary twice differential profit function with a few numbers of parameters (Diewert, 1971). It allows us to have a system in which price elasticities are not constant and can be computed at any given level of prices and quantities[12].The system of supply functions is estimated with the technique of seemingly unrelated regressions and by imposing symmetry constraints. Demand elasticities for factors are drawn from the literature, mainly from Sadoulet and de Janvry (2002)~~,~~ who give values for elasticities for different regions of the world. To reconcile these elasticities with those of the supply functions, a least square optimization program imposing symmetry is used.

Demand for factors is estimated at the aggregated level in agriculture so these factors are allocated between sectors according to their share in the total production. Intermediate inputs used in millet, maize and cotton sectors are treated in a particular way. We opt for a global strategy consisting in aggregating different inputs into an aggregated one. The aggregate

[10] The Stone Geary utility function is a Cobb-Douglas function with a minimum level of consumption. This function is different from the standard Cobb-Douglas function which exhibits constant income elasticity equals to 1.
[11] We proceed in next sections to a systematic sensitivity analysis.
[12] In this paper, elasticities are computed at the mean.

intermediate input is allocated between subsectors in accordance with their share in the total production. Aggregate input price is the geometric mean of the prices of different inputs included in it. This modeling strategy is not unusual and reduces significantly the number of parameters to be estimated (Fulginiti and Perrin, 1990).

The seed cotton price establishing mechanism mentioned in section 2 is explicitly introduced in the model. The minimum guaranteed ($\overline{P_g}$) serves as a bottom price. So, producers can benefit from an increase in world prices while being guaranteed that they will get at least the floor price. In case of a bonus ($B > 0$), they get a final price P_f. Thus We have a two price regime for seed cotton and the final price received by producers is:

$$P_f = max\left[\overline{P_g}; \overline{P_g} + B\right]$$

In the model we also take into account home consumption since a large part of food production in Mali is not sold on markets. For example, home consumption represents 70% of maize and millet production. The methodology used is inspired by IFPRI (Löfgren et al. 2002). We assume that, as for marketed commodities, households maximize a Stone-Geary utility function. The resulting LES function is identical to that of marketed commodities except that consumption is valuated at the activity specific producer price.[13]

Given that there is a huge migration flow from rural to urban areas in Mali, these flows are modeled in an extended Harris-Todaro framework. We assume that people will stay in rural areas when rural wages are driven up by the increase of cotton prices. We also assume that working in rural sectors and working in urban ones are imperfect substitutes and that costs are associated to that choice. We take into account this hypothesis by setting the elasticity of migration to 0.5.

Finally the closure rule adopted is the "classical" one. Total investment is endogenous (saving driven) and adjusts to total savings. Marginal propensities to save are fixed. Nominal exchange rate is fixed and foreign savings flexible.

5. Results

5.1. Macro and sectorial results

All the simulations run consist in increasing the world price of cotton fiber. Three scenarios are run regarding cotton price variation: a low one (5%), a medium one (10%) and a high one (15%). These scenarios are consistent with the results one can find in the literature (Araujo Bonjean et al., 2006, Goreux, 2003).

[13] By doing this, we assume that there is separability between production and consumption decisions at the household level.

Table 1: Results

	Sim1 (+5%)	Sim2 (+10%)	Sim3 (+15%)
PRODUCTION[14]			
Maize	-4.12	-2.17	-12.84
Millet	-2.27	-13.84	-5.02
Seed cotton	3.35	8.40	12.27
Other foods	-0.73	-1.45	-1.88
Other agricultural products	-1.15	-5.04	-5.68
Cotton fiber	3.35	8.40	12.27
Other industrial products	0.14	4.97	7.14
Marketable services	1.13	4.96	7.21
Non Marketable services	0.15	0.68	0.40
GDP	**0.58**	**0.63**	**0.78**
EXPORTATIONS			
Maize	-14.93	-13.48	-24.60
Millet	-8.23	-51.62	-46.77
Other foods	-8.23	-6.23	-7.46
Cotton fiber	6.57	8.65	15.57
Other agricultural products	-10.09	-9.10	-8.77
Other industrial products	0.51	4.65	5.78
Marketable services	2.80	12.93	16.68

A 5% increase in the world price leads to an aggregate level limited increase of GDP of 0.58%. At sectoral level, the increase in seed cotton production (the main input in fiber production) is detrimental to maize and millet (main competitor of cotton). The increase in the relative price of seed cotton leads to a movement of factors from these sectors to seed cotton's. Cotton fiber production increases significantly without surprise. The increase of other sectors production although limited is essentially due to the increase of demand resulting of the improvement of incomes as we will see later.

When it comes to a 10% and a 15% increase, GDP grows monotonously (0.63 then 0.78%). The preceding results are reinforced. The fiber and seed cotton production which increases by 8.40 then by 12.27% is more and more detrimental to cereals. These sharp decreases are essentially due to unskilled labor movements between sectors and to capital movements in the agricultural sector. Other sectors are less affected by the cotton price increase because they are intensive in skilled labor, which is not used in cotton sector.

According to the scenarios, cotton fiber exports increase by 6.57 to 15.57%. Exports rise more than production due to the fact that the average producer price (including domestic sales) increases less than the export price. Exports for other sectors follow the pattern of the production.

These results are more significant than those obtained by Boccanfuso and Savard (2007) where no impact was observed (neither at the aggregate level nor at sectoral level) with an increase of the world price by 50%. The introduction of unemployment at medium term and the introduction of direct substitution possibilities between crops explain these results. For

[14] Including home consumption

example, taking into account the possibility of allocating a fraction of capital or land to other crops reinforces the substitution effects compared to a situation where factors are specific.

5.2. Factors remunerations and income

Table 2: Results (Cont.)

	Base level[15]	Sim1 (+5%)	Sim2 (+10%)	Sim3 (+15%)
FACTORS REMUNERATION				
Wage (skilled labor)	1	0.79	1.40	1.60
Wage (unskilled labor)	0.75	4.00	6.67	13.33
Remuneration of the agricultural composite factor	1	1.69	4.25	4.57
HOUSEHOLDS INCOME				
Bamako in industrial sector	40.663	0.76	1.04	1.47
Bamako in public services	72.162	0.68	0.78	0.91
Bamako in private services	206.667	0.62	0.69	0.68
Other urban industrial sector	49.465	0.74	0.91	1.41
Other urban public services	99.165	0.70	0.77	0.83
Other urban private services	172.558	0.69	0.75	0.77
Other urban activities	78.104	0.71	0.85	1.23
Rural-Agriculture (Sahel & Sahara)	51.481	0.82	1.29	1.83
Rural-Agriculture (Soudano-Sahel & Delta)	248.286	0.74	1.18	1.24
Rural-Agriculture (Soudano-Guinean)	389.639	0.64	0.71	0.90
Other rural activities	370.279	0.73	0.95	1.30
GOVERNMENT				
Income	311.519	0.24	1.40	1.73
Public savings	-25.395	-5.01	-43.6	-43.01

On average, the increase of the fiber price leads to an improvement of the unskilled labor wage which is intensively used in the sector as well as the remuneration of the composite factor (capital and land). Skilled labor wage also increases but less than unskilled one. This situation is reinforced when the increase in cotton price is important and when the economy approaches full employment.

Households' income increases according to scenarios by 0.64 to 1.83%. Generally, households' income increase monotonously with increased wages. Rural households in Soudano-Sahel & Delta and in Soudano-Guinean regions are those who produce seed cotton. Their income comes in large part from unskilled labor wage and from capital. So they benefit from the improvement of unskilled labor wage. In the same way, urban households benefit from the remuneration of the skilled labor wage and of the fixed urban wage rate for unskilled

[15] Billion CFAF except for wages and the agricultural composite factor that are at their reference prices.

workers. When the cotton price is increased by 15% and when the economy approaches full employment, all the above mentioned impacts are reinforced.

The government income increases by 0.24 to 1.73% according to the assumptions. This increase in income is essentially due to the increase in taxes (direct and indirect) on households' income and on consumption and on activities (production). In reality this increase in fiscal revenues is a net effect given that production increases in some sectors while it decreases in others. Finally, since public spending and other transfers are exogenous, government savings that represent 6% of its income increase more than the income.

To sum up, whatever the privileged scenario, the removal of cotton subsidies will have a positive impact on the Malian economy. This result depends however on the assumptions behind the model and particularly the free parameters values. So we proceed afterwards to a sensitivity analysis on these parameters.

5.3. Sensitivity analysis

In this section, contrary to the traditional approach consisting in varying the values of one parameter or one group of parameters and keeping the others at their base values, we set up the "systematic sensitivity analysis" of Abler et al. (1999). Following, Harrison and Vinod (1992) and Jensen, Rutherford and Tarr (1998), this new approach is based on Monte Carlo experiments. Parameters are treated as random variables drawn from specified distribution in a reasonable range. This range could be the range found in the literature.

For each elasticity of substitution and of transformation, we take 100 times a random draw from a uniform distribution within the range found in the literature. We assume that parameters are generated by a uniform distribution to reflect the equiprobability of different values. The ranges for parameters are respectively [0.2,2.4] and [0.4,3] for elasticity of substitution and of transformation. The results for Sim2 and for households' income are presented below:

Table 3: Sensitivity analysis results: households' income

Households' income	Sim3 (+15%)	Lower bound	Upper bound
Bamako industrial sector	1.47	1.45	1.57
Bamako public services	0.91	0.89	1.01
Bamako public services	0.68	0.66	0.78
Other urbans industrial sector	1.41	1.38	1.50
Other urbans public services	0.83	0.81	0.93
Other urbans private sector	0.77	0.75	0.87
Other urbans	1.23	1.21	1.33
Rurals-Agriculture (Sahel & Sahara)	1.83	1.81	1.93
Rurals-Agriculture (Soudano-Sahel & Delta)	1.24	1.22	1.35
Rurals-Agriculture (Soudano-Guinean)	0.90	0.89	1.01
Other rural activities	1.30	1.28	1.40

Results found in previous sections appear robust when accounting for parameter uncertainty. The ranges of variation are very close to the results found in the base simulation. However, given that we are not making inference, these bands are not treated as confidence ones. Probably a better way to take into account uncertainty would consist in differentiating parameter values according to sectors given that technologies may differ across sectors.

6. Conclusion

The removal of the United States and the European Union cotton subsidies are expected to have substantial effects on African economies. These effects appear positive and significant for Mali. The increase in world price that would occur with the removal of subsidies would have a non-negligible impact on the economy contrary to previous studies (Boccanfuso and Savard, 2007). GDP would grow by 0.58 to 0.78% and households income would increase significantly by 0.64 to 1.83%. In the same way, government income would increase as well as public savings.

Sectors that would benefit from cotton price increase are obviously those of seed cotton and fiber. On the opposite, sectors that are substitutes for cotton (essentially cereals) could have a sharp fall in production due to competition for factors use (land and capital). The import bill for these commodities could be huge particularly in period of food crisis. These issues have to be analyzed with care. Abler et al. (1999) type systematic sensitivity analysis indicates that the effects are robust to parameter uncertainty. A better way to take into account this parameter uncertainty in the future will consist in assuming different values for parameters for each sector.

In terms of policy implications, our results show that a lot progress could be made in Malian cotton sector. These results could be reinforced if the government could help the producers by improving their access to credit and increasing the transmission of world price improvements. A better price setting mechanism which favors producers' profits could potentially increase cotton production. A sound exchange rate policy could also help increase the price transmission from international markets to producers. In fact Mali suffers from a fixed exchange rate policy. As cotton is sold in US dollars and given that the CFAF that Mali shares with eight countries in West Africa is pegged to the euro, any appreciation of the euro relative to the dollar is harmful to Mali.

The work undertaken in this paper should be continued. Ongoing research should first consist in updating the social accounting matrix. Then the CGE model should be enhanced with a microsimulation model in order to assess distributional issues (poverty and inequality). However this CGE-microsimulation approach raises serious issues such as reconciling national accounts and households' surveys (Robilliard and Robinson, 2003).

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