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Impacts Analysis of Cotton Subsidies on Poverty : A CGE Macro-Accounting Approach

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Abstract

In this paper, we construct the first country specific CGE model for Mali with a micro-simulation component to analyze the poverty and inequality changes of removing cotton subsidies in developed countries. We used the macro-accounting approach proposed by Chen and Ravallion (2004). This issue has attracted significant attention as is has contributed to stall the broader trade agenda. Research on the issue has been mainly done with partial equilibrium analysis with a few exceptions. We use the first CGE-micro-simulation model to investigate. A 17 sectors CGE model with almost 5000 households is used to demonstrate that removal of subsidies on cotton will contribute to significant decrease in poverty in Mali. Our results show that combining the cotton subsidies removal to other agricultural subsidies does not attenuate the positive effects observed. We also show that the subsidies removal would marginally contribute to decrease inequality in Mali.

Keyword: computable general equilibrium model, micro-simulation, poverty analysis, income distribution, agricultural subsidies.

JEL: D58, D31, I32, Q17

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Introduction

The importance of cotton in world trade is relatively marginal with less then 0.2% of value of world trade (Baffes, 2004). However, for a number of countries, cotton represents over 30% of its export revenues. In 1999, it represented 44% of Burkina-Faso export revenues, 39% for Benin, 32% for Chad and 30% for Mali. These four African countries are also amongst the poorest countries in the worlds. Burkina-Faso was ranked 175th out of 177 in the UNDP human development index (HDI) for 2005, Mali 174th, Chad 173rd and Benin 162nd. Moreover, for the same countries, cotton production has contributed between 5 to 10% of GDP since 1999 (Oxfam 2002) and a very large portion of the labour force in the rural area participates in cotton production with rural poverty levels being extremely high. This said, the cotton trade is one in which government interventions is very important especially in developed countries producing important distortions in this market. According to Goreux (2004), the producers of this region are the most competitive with a production cost being the lowest amongst all cotton production regions. Baffes (2004) also mentions that they produce cotton with the smallest amount of fertilizer and pesticides. The comparative advantage of these producers was well exploited after the CFA franc devaluation in 1994 which was followed by significant increases in cotton production. For example, Mali increased its production by 78% between 1994 and 1998. A study by the World Health Organization has also shown that the production expansion was accompanied by improvements of health indicators (Goreux 2004). The significant progress was compromised by the important drop in world prices in 2001/02. Developed countries and China subsidies to cotton producers were estimated at 6 billions dollars during the same period. The price of cotton decreased from an average of 91 cents per pound in 1994/95 to 42 cents in 2001/02 and has increased slightly since then to 52 cents in 2004/05 (USDA 2005). According to the Oxfam (2002) study on cotton subsidies, the negative impact on sub-Saharan producing countries is larger then United States foreign aid to these countries. For Mali, the gap between the two is approximately 6 millions USD.

Since the Oxfam study in 2002, numerous papers have been produced in an attempt to provide more elaborate estimates of the impact of the cotton subsidies in sub-Saharan Africa. To capture the impact of these subsidies on poverty level given the importance of the cotton sector in Mali, it is essential to capture the first round effects of these deflated prices which can be done in partial equilibrium analysis but also their general equilibrium effects (feedback effects) which can only by done with a general equilibrium framework. The 54% decrease in the price of cotton will have significant effects on income of cotton producers but it will also impact manufacturing sectors such as textile, sectors supplying inputs to cotton producers, sectors which compete with cotton for production factors, goods consumed by households who are cotton producers etc. All these general equilibrium effects can be significant when a production sector is as important as cotton sector for the Malian economy. To our knowledge, only two studies have used computable general equilibrium models to analyse the impact of deflated cotton price on sub-Saharan economies: one in Burkina Faso and one in Benin (see Adjovi et *al.*, 2004 for the two studies). However, both these studies were not well adapted for poverty and inequality impact analysis since only a few households are used in their respective models. As we will see herein, this type of CGE application (representative household) is not appropriate to analyze the impact of external shocks or policy reform on poverty and income distribution.

In this paper, we construct a CGE macro-micro model to analyse the impact of poverty and income distribution of an increase in the world price of cotton. We also simulate increases in world price of other agricultural sectors since the argument is often used to negate the potential positive effect to decreasing cotton subsidies. This argument says that if all agricultural subsidies are decreased in developed countries, the poor households of developing countries won't necessarily benefit as they are also consumers of agricultural products and will face higher prices for goods they consume. They will win on the production side but loose on the consumption side. The rest of the paper will be structured as follow; first, we will make a brief presentation of the Malian economy and the importance of its cotton sector. We will then present a short literature review of CGE macro-micro modeling for poverty analysis followed by some comments on our social accounting matrix and the applied model we constructed for Mali. We will then move to an analysis of the macro and micro results of the simulated world price changes and provide a few concluding remarks.

As we have already mentioned Mali is one of the poorest countries in the world. Its 2002 GDP was 2.5 times below the average GDP for all of African countries (MPAT-DNSI, 2004). Agriculture income constitutes the main source of income for 73% of the households. In 2001, Mali had a population of 10 235 202 individuals and 1 091 124 households. The primary sector accounts for 42% of the GDP, 19% of the secondary sector (mainly gold production) and the tertiary sector accounts for 39%. In 2001, the main export was mining which accounted for 65% of exports and cotton at 13% which was down from 30% in 1998 in large part due to the 54% drop in the value of exports and boycott in production by farmers as we will see in the next section. In terms of import, the main product is manufactured goods representing 64% of imports, followed by energy at 18% of imports. It is interesting to note that agricultural imports account for less then 7% of imports.

As is shown in Table 1, cotton production represented around 30% of GDP after the 1994 devaluation and dropped significantly at the end of the nineties to below 10%. Mali is the largest cotton producer in sub-Saharan Africa and had a 3.5% of world market share in 2003 (USDA, 2005) and second in Africa after Egypt. It is a public company (*Compagnie malienne pour le développement des textiles* -CMDT) that controls the market in Mali. According to CMDT estimates to approximately 28% of the population depend on cotton production of part or for all of their income (Adjovi et *al.*, 2004).

Table 1 : Evolution of cotton production Mali

Year	Productions in metric ton	Value added of cotton	% of GDP
1994-1995	293 021	220 000	22,03
1995-1996	405 939	375 000	31,59
1996-1997	452 033	390 000	29,56
1997-1998	522 903	375 000	26,35
1998-1999	518 415	400 000	25,10
1999-2000	459 792	125 000	7,48
2000-2001	242 776	150 000	8,61
2001-2002	570 989	175 000	9,14
2002-2003	439 722	145 000	6,70

Source : CMDT, mars 2002

We also note in Table 1 an important drop in value of production in 1999-00 and 2000-01 which is a consequence of the drop in international price and the decrease in output in the year 2000-01 due to a boycott of cotton producers as a response to these strong decreases in prices. The International Cotton Advisory Committee (2002) attempted to evaluate the cotton producers losses linked to the decrease in price (in part linked to the American cotton subsidies). In Table 2, we present their results:

Table 2: Cotton export revenues loss attributed to US cotton subsidies ($m)

Country	Cotton export revenues for 2000-01	Cotton export revenues for 2000-01 if no US subsidies	Loss linked to US subsidies
Benin	124	157	33
Burkina Faso	105	133	28
Cameroun	81	102	21
RCA	9	11	2
Chad	63	79	16

Côte d'Ivoire	121	153	32
Mali	**161**	**204**	**43**
Togo	61	77	16
TOTAL	**725**	**916**	**191**

Source : International Cotton Advisory Committee (2002).
* Using ICAC model result predicting an 11¢/lb net increase in world cotton price.

From their estimates, Mali's losses due to depressed world prices of cotton are around 43 million dollars, which is equivalent to 2.2% of its annual GDP. In terms of the importance as a world producer, Mali is ranked 13th in the world as shown in Table 3.

Table 3: Main cotton producing countries (2001)

Rank	**Country**	**Production metric ton**
1	China	15 970 510
2	USA	11 180 979
3	Pakistan	5 417 097
4	India	5 099 490
5	Uzbekistan	2 840 000
6	Brazil *	2 537 150
7	Turkey	2 249 762
8	Australia	1 799 000
9	Greece *	1 205 600
10	Syria *	1 007 000
11	Egypt *	824 820
12	Turkmenistan *	559 000
13	Mali *	469 000

Source : FAOSTAT Agriculture Database (2001)
* : FAO estimates

From this table, we see that China is the biggest producer however it is a net importer (7% of world imports) of cotton mainly to produce textiles (Baffes 2004). The other important importers are Indonesia and the USA with each imports amounting to 13% of world production. The seven larger importers account for 62% of total cotton imports (Gilson et *al*., 2004).

World prices are distorted mainly from the subsidies of the United States, European Union and China. In 2000/01, total subsidies from USA, EU (for Greece and Spain) and China reached close to 6 billion US$ equivalent to the total value of world exports in cotton (Filpiak and Perrin, 2003). Subsidies for the main countries involved are presented in Table 4.

Table 4: Cotton subsidies in million dollars

Country	1997/98	2001-2002	2002-2003
USA	754	3001	1996
Greece	320	735	718
Spain	-	245	239
Other EU	320	979	757
China	2000	1196	750
All countries	**4227**	**5884**	**3800**

Source: Adjovi et *al.* (2004).

These subsidies bias the production in non competitive countries in the cotton sector and induce an artificial increase in world output. The world price has decreased by 54% as was mentioned above with the recent lowest price observed in 2001. This low price had dramatic effects in Mali and other poor countries were producers losses were such that significant number of cotton growers switched their production to food staples.

A study by Goreux (2004) concludes that the removal of subsidies would result in a price increase of 12% and ICAC (2002) study arrives at a figure of 15%. Both of these studies were done in partial equilibrium analysis and they conclude to slight losses for developing countries. A multi-country CGE analysis by MacDonald et *al.* (2003), on this impact of subsidies removal concludes that the welfare gains would be positive but marginal. The welfare gains for all developing countries would be 0.05% of their GDP but for sub-Saharan countries this gain could be up to 2 to 3%. It is important to highlight that the MacDonald et *al.* (2003) study does not isolate the cotton producing countries in sub-Saharan Africa and therefore cannot provide an accurate picture of the gains and losses for specific countries. Moreover, the mitigated positive effects found in this study have been widely used in the trade debate to minimize the relevance of reducing agriculture subsidies in developed countries. In order to perform such an impact analysis on output and poverty, a country specific macro micro CGE model is a more appropriate analytical tool. As no recent social accounting matrix (SAM) and CGE had been constructed for Mali, we had to start by constructing the SAM, followed by the CGE model. Let us first review macro-macro CGE modeling for poverty analysis before presenting the SAM and CGE model used for this impact analysis in Mali.

Macro-micro modeling approach

One of the first contribution linking a CGE model and micro data in a developing country is Adelman and Robinson (1977) for South Korea. This application was followed by that of Taylor and Lysy (1979) for Brazil, Dervis et *al.* (1982), and Bourguignon et *al.* (1983) for Venezuela. These papers were pioneer for income distribution analysis with CGE models. Later, in the early nineties, OCDE sponsored work by Thorbecke (1991), de Janvry, et *al.* (1991), Bourguignon, de Melo and Suwa (1991) and Morrisson (1991) which analysed the impact of structural adjustment programs on income distribution. The first article surveyed using poverty indices is de Janvry et *al.* (1991) with an application to Ecuador. They used the Foster Greer and Thorbecke (FGT), (1984) to measure poverty changes. Chia et *al.* (1994) also used the same indices in a CGE application to Ivory Coast.

More recently, a new wave of researchers tried to go further by making poverty analysis a central objective of research. As a result, it was possible, in particular, to highlight the relation between economic policies, poverty levels and income distribution. These researchers include Decaluwé et *al.* (1999a), Decaluwé et *al.* (1999b) and Cogneau and Robilliard (2000). These papers have been followed by a large number of applications[3].

Three main approaches have been used to link macro reforms to changes in income distribution and poverty. The first one being is the most commonly used is the representative household approach (RH), the second one is usually referred to as CGE integrated multi-household (IMH)

([3]) For an interesting review and discussion on the value of CGE macro micro approach to analyse poverty and inequality impact, the reader can consult Hertel and Reimer (2004).

approach[4] and the third is generally referred to as the top-down or micro-simulation sequential approach (MSS). The RH approach consists of using representative household subgroups in a CGE model and inferring changes in the income of all household within each groups based on the change of income of the representative household of the CGE model. With this approach the within-group redistribution of income is not taken into account and can lead to misleading conclusions as demonstrated in Savard (2005). The IMH approach first proposed by Decaluwé et *al.* (1999b), is theoretically sound since the macro and micro components are coherent and fully respect the standard CGE framework. CGE-IMH consists of including a large number of households from household survey or all households of the survey into a CGE model. However, it can raise some difficulties at implementations and resolution stage. First, according to Rutherford et *al.* (2005) data reconciliation can be very problematic and second, the numerical resolution can also be challenging (Chen and Ravallion, 2004).

The third approach is referred to as the CGE micro-simulation sequential method (MSS) which could be subdivided in two different variants. The first variant is the macro-accounting formally presented by Chen and Ravallion (2004). The second variant proposed by Bourguignon, Robilliard and Robinson (2005) consists of integrating rich micro behavior at the household level such as labor supply at the individual level, consumption behavior etc. The general idea of the MSS approach is that a CGE module feeds market and factor price changes into a micro-simulation household model. The main drawback of this approach is that the micro-feedback effects are not necessarily taken into account. In this paper, we have selected the CGE-MSS as we encountered data reconciliation problems such as raised by Chen and Ravallion (2004).

([4]) Some authors refer to this approach as a CGE micro-simulation application.

The Malian SAM and CGE MSS model

The SAM

In the case of macro-micro analysis the modeller needs to construct a sub-matrix within a standard social accounting matrix for the household's accounts. However, with the CGE-MSS approach the income and expenditure of household do not need to be balanced. The lack of complete information from household survey on the income side made it very difficult to balance without posing strong balancing hypothesis. This constraint led us to select the macro-accounting MSS approach for our analysis. We will refer to the household sub matrix as the household or micro database. It will be described in the next section.

For Mali, we had an input-output table with 17 production branches for 2001. This was quit convenient in terms of the timing as the national household survey was performed during the same year. We used the input-output table as a starting point to construct the social accounting matrix (SAM) and used secondary data sources to complete the SAM. This gave us a SAM with 17 sectors. The next step was to link the micro household data to the SAM. This was done by aggregating the information of the household database. We imported the aggregated results of the household survey for the household account in the SAM. This procedure imposed and a new balancing step to complete the SAM. Let us now describe briefly how we constructed the household database.

The Malian household survey "*Enquête malienne d'évaluation de la pauvreté*" (EMEP) is a very rich database on some aspects. It contains 4,966 households after removal of problematic households. The survey also provides information at the individual level with 54,212 individuals included in the survey. The survey is very detailed on the consumption side presenting a disaggregation at the four digit level which corresponds to more then 1,000 goods consumed. We needed to do a mapping to obtain an equivalent nomenclature between the household survey and the SAM which meant going from more then 1,000 goods to 17. The main challenge with the construction of the micro database is that we did not have complete information on the structure of income for households. The survey provides the total income for the household and we know which members of the households are working and in which sector they are working. However, we do not have information on the income generated by each member of the households. In order to distribute the total income between members, we used the average income of each type of productive activity. With this information we could construct our micro data base including the income and expenditure structure for each of the 4,966 households of EMEP.

The CGE macro-micro model

As we have mentioned, given the characteristics of the household database in Mali and the objectives of analysis, we have selected to work with the CGE multi-household sequential approach. The model constructed for this paper is the first CGE single country model applied to Mali to our knowledge[5]. We used the structure similar to the Boccanfuso et *al.* (2005) model in which they analyzed the impact of liberalization of the groundnut sector in Senegal. Some adjustments were required to reflect the specificities in the Malian SAM.

Before describing the model in more detail, it is important to highlight the key transmission mechanisms between exogenous world price changes and household welfare changes. Economic policies or external shocks are generally transmitted to household welfare mainly through variations in the prices of goods and services affecting the cost of consumer baskets and also the prices of production factor. Between the external price shock and internal price changes, a large number of interactions between productions sectors are involved where factor relocate, and

([5]) Decaluwé, Dissou and Robichaud (2004) constructed a UEMOA multi-country CGE model to analyze reforms of the custom union.

relative price change. Moreover, the structure of the economy also plays an important role as well as agents' behavior in determining the final. The macro-economic closure rules as well as free parameter values can also influence results. In order to capture the impact of policies on the individual household welfare it is important to capture the specificities of the Malian economy as much as possible and the heterogeneous income and expenditure structure of the households. We will describe some of the adaptations made to the model used in Boccanfuso et *al.* (2005) model.

The Boccanfuso et *al.* (2005) model is an extension of the Decaluwé et *al.* (2001) EXTER model. Here are the main hypotheses of our model. Production is determined in the first place through a 3-level production system: total production of the branch (*XS*) is made up of fixed shares between value-added (*VA*) and intermediate consumptions (*CI*) as is generally assumed in standard CGE modeling. The relationship determining the level of *VA* is a Cobb-Douglas type function between labor (*LD*) and capital (*KD*). Producers minimize their cost of producing *VA* subject to the Cobb-Douglas production function. Optimal labor demand equations are derived from this minimization process. We assume that capital is immobile as it is quit difficult in the short to medium term in Mali to convert capital to be used in a new production sector following an external shock. Intermediate consumptions are modeled with Leontief fixed share assumption which is also a standard CGE modeling assumption.

We assumed that Mali is a small open economy, and the world prices of imports and exports are exogenous to the model. We posit the Armington hypothesis (1969) for import demand where domestic consumers can substitute domestically produced goods with imports (imperfectly) with a sector specific elasticity of substitution[6]. In sectors where local consumers are indifferent between consuming imported goods versus local goods, we will use a high elasticity of

[6] We have performed sensitivity analysis with the trade elasticities and results were robust to reasonable parameter ranges.

substitution and inversely a low elasticity of substitution where consumers prefer one good versus the other. The relative price of the two goods is the other determinant of the ratio of imported goods versus local goods demand. On the export side, the producers can sell the goods on the local market or export their production and are influenced by relative prices on each market and by their elasticity of transformation of the good for one or the other market.

We also reiterated the inclusion of all 4,966 households of survey (EMEP-I, 2001) into the micro module (bottom part) of the model so that poverty and inequality analysis can be conducted without any classification constraints. Agents' income equations are consistent with the structure presented in the SAM. In this model, factor allocations are exogenous and factor payments are endogenous. As capital is fixed by sector we have 16 rental rates of capital and one wage[7]. Dividends paid to households are also endogenous and depend of firm's after tax income. The private firm's income is the balance of capital remuneration not paid to households to which must be added government subsidies and transfers from the rest of the world.

Government revenue is made up of production taxes, customs duties, household and private firm taxes as well as transfers from the rest of the world (budgetary assistance). The government spends its budget in different forms such as consumption public produced goods, transfers to households, subsidies to private firms and transfers to the rest of the world.

The demand function by households is derived from a utility maximization process (Cobb-Douglas utility function) which leads to demand functions which are fixed value share for each goods. We also compute change in welfare for each household with the equivalent variation which captures prices and income effects as determinants of changes in welfare following the external price shocks. The household specific value share of consumption goods observed in the

[7] The public service sector does not pay its capital hence the 16 rental rate of capital for the 17 production sector.

survey is a key element in the equivalent variation computation. The household specific equivalent variation associated with the Cobb-Douglas utility function has the following form:

$$EV_h = \prod_i \left(\frac{Pqo_i}{Pq_i} \right)^{\beta_{h,i}} Yh_h - Yho_h$$

where Pqo_i and Pq_i are market prices for sector i at reference period and after simulation, Yho_h and Yh_h are the reference period household specific (h) income and after simulation and $\beta_{h,i}$ is the value share of consumption for household h of good i. This approach is different than the endogenous poverty line proposed by Decaluwé et *al.* (2005) as it captures the price effect of the simulation through specific household preference instead of basic needs approach.

Investment demand is also specified with a fixed value share function and we already described the demand for intermediate goods which are fixed volume shares based in input-output matrix shares. The price equations are quite standard. We use the GDP deflator as a price index (but is endogenous), and as we have stated earlier herein, international prices (imports and exports) are exogenous; accordingly the country has no control over the prices applied on the world market. The commodity market is balanced by an adjustment of the market price of each good. The fixed total labor supply is assumed and workers can move from one sector to the other following a simulation. Hence, there is no endogenous unemployment in the model[8]. The current account balance is endogenous and the nominal exchange rate is exogenous to reflect the prevailing situation in Mali. Moreover, the nominal exchange rate is used as the numeraire. For savings/investment equilibrium, total investment adjusts to total savings by agents in the economy.

([8]) This does not mean that we assume that there is zero unemployment in the Malian economy but simply that unemployment is exogenous to the model.

The procedure retained for poverty and inequality analysis is quit standard in the context of macro-micro CGE analysis. The CGE-MSS model generates post simulation changes in welfare which are used for poverty and inequality analysis. Target groups are defined independently of the CGE modeling exercise and poverty and inequality analysis can be performed for the base period and after simulations[9]. The poverty index chosen is the additively decomposable Foster, Greer and Thorbecke (F-G-T, 1984) P_α [10]and for inequality analysis we selected the Gini index.

The simulated world price changes

The simulation performed in the paper aims to shed some light on the impact of the deflated cotton price on poverty in Mali. However, as one of the arguments used to defend the subsidies is based on the fact that if all agricultural subsidies are removed, the developed countries will lose or gains will be weak as gains from exported agricultural goods will be attenuated by increase in cost of imported agricultural goods. In light of this, we will perform three different world price increases for agricultural goods. In the first simulation (*Sim 1*), we assume that all agricultural subsidies would be removed and an increase of 50% in world price of agricultural goods would follow. The choice of 50% increase is based on the observed price decrease between 1995 and 2001 in the cotton sector. In the second simulation (*Sim 2*), we isolate the cotton sector and only simulate an increase of 50% of world price of cotton. In the last simulation (*Sim 3*), we focus on an important production and consumption good for Mali namely

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([9])No groups are found in the CGE model but all households of the survey.

([10]) FGT poverty indexes are interesting within the framework of this analysis and make it possible to measure the proportion of the poor among the population but also of this poverty depth and severity. P_α indexes are calculated with the following equation:

$$P_\alpha = \frac{1}{\sum_{i=1}^{N} w_i} \sum_{i=1}^{q} w_i \left(\frac{z - y_i}{z} \right)^\alpha$$

(**Erreur ! Document principal seulement.**)

where α is a parameter characterizing the degree of poverty aversion; *z,* the poverty line; y_i, household income; *N*, the total number of households; w_i, the sampling weight for the household *i* and *q*, the number of poor households, in other words, below the poverty line. Generally, the higher α is the greater, the importance granted to the poorest. ([10]) For detailed information on this index family, read Ravallion (1994).

rice. With these simulations, we will be able to see if commonly circulated results stating moderate welfare gains at the household level are confirmed in the context of a single country CGE-MSS model.

Macro and sectoral results

When comparing the results from these three simulations we should keep in mind that the first simulation includes the second and third one. Moreover, we note that the effects observed for simulation 1 are dominated by simulation 2. Hence, we will focus the analysis on the second simulation before looking at the differences with the first simulation and then followed by comments on the last simulation on world price of rice. Finally, we need to highlight that the world price increase was applied on import prices and export prices. The macro results are presented in Table 5 and key sectoral results in Table 6 to Table 8[11].

Table 5: Macro results of simulations (Δ%)

Variables	Reference	Sim 1	Sim 2	Sim 3
Household income	149.55	1.15	1.08	-0.02
Wage	1.00	-5.41	-4.89	0.11
Government income	30.74	-2.12	-2.05	0.11
Public savings	2.09	0.00	0.00	0.00
Public expenditure	25.60	-2.54	-2.46	0.13
Current account balance	-0.81	793.10	700.29	-14.99
Firms' income	49.28	-3.44	-3.27	0.07
Firms' savings	31.98	-4.03	-3.83	0.09
Total investment	46.17	-16.33	-14.59	0.32
GDP	181.94	0.06	0.05	0.00

Source: Calculus done by authors with Gams Ide 2.5..

The first item of interest for simulation 2 is the income of the aggregate household in the CGE model module increases by 1.08%. This happened while the wage decreases by 4.89% but it is accompanied by an increase in rental rates of capital which will be analyzed below. We also note that government revenues and firms’ income have decreased by 2.05% and 3.27% respectively. The households are the clear winners at the national level. We also observe a negligible increase

([11]) We do not present complete results of the model but these can be provided upon request to the authors.

in GDP which is a direct consequence of the hypothesis in the model whereas the total stock of production factors in the economy is held constant[12]. As for the total investment, it decreases significantly with the decrease in firms savings which constitutes 70% of the total savings. We also observe important percentage change in the current account balance but this is linked to the fact that the reference value is close to zero. When we look at the first simulation, we note that the effects are almost the same with a marginal increase in amplitude of the effects. As for the third simulation, the effects of the increase in price of rice, we observe almost no impact on the macro variables. This comes from the fact that very little trade occurs for rice in Mali which is quit different then what is observed in the neighbouring Senegal. This situation isolates Mali to a certain extent from important world price changes at least in the short to medium term.

Moving to the other interesting sectoral variables (in view of the following poverty and inequality analysis) we will analyse three variables of which value added (implicitly output given the Leontief hypothesis), market prices and rental rate of capital. The last two variables are the key variables affecting the households' welfare.

One of the first order effects of the external shock is to have local cotton producers export a larger share of cotton versus selling on the local market to the textile industry. There is also some labour movement to the sector which induces an increase in output of the sector by 2.21%. As we have explained this increase is certainly a minimal case figure as capital is immobile between sectors and total capital if fixed. Moreover, import price increase should impact the consumers of cotton but Mali does not import cotton and hence this does not negatively affect the agents in the country.

([12]) In all likelihood an important increase in price of Cotton would lead to an increase in culture in the medium to long term. This is what was observed in the sub-region following the cfa franc devaluation in 1994. This would amplify or add positive effects on the whole economy and likely increase the number of cotton producers which is not captured in this model. We do not analyze this aspect and our results could be interpreted and minimal bound for the effects generated.

Table 6: Simulation results of value added (Δ%)

Variables	branches	Reference	Sim 1	Sim 2	Sim 3
Value added	Food crop	21.52	1.09	0.70	-0.01
	Rice	6.47	0.67	0.79	-0.22
	Rent agriculture	2.13	0.58	0.21	0.00
	Cotton	6.35	2.24	2.21	0.00
	Fishing and livestock	21.26	0.27	0.25	-0.01
	Logging and timber	10.01	0.29	0.27	-0.01
	Mining industries	20.64	0.74	0.67	-0.01
	Food industries	5.52	1.55	2.19	-0.06
	Textile industries	0.96	0.35	0.17	-0.04
	Other manufacturing	4.33	-0.73	-0.63	0.01
	Water/electricity/energy	5.93	1.18	1.06	-0.02
	Construction	11.62	-10.92	-9.70	0.20
	Commercial services	30.87	0.13	0.12	0.00
	Transport and telecom	9.38	2.64	2.39	-0.05
	Other services	9.56	-1.92	-1.66	0.04
	Financial services	1.79	3.33	3.04	-0.06
	Public services	13.62	1.50	1.18	0.04

Source: Calculus done by authors with Gams Ide 2.5.

The impact on labour demand for the cotton sector is quit strong as it increases by 75%. As we have seen the impact is positive on the aggregate households with an increase of 1.08%. This increase comes mainly from the increase in rental rate of agricultural capital (Table 8) where three out of four sectors experience strong increases. Not surprisingly the strongest increase is in the cotton sector (66.68%). This will directly produce a positive welfare effect on cotton producers. The decrease in the wage (-4.89%) is mainly the consequence of the strong decrease in production of the construction sector (-9.70%) which is very labour intensive. This sector decreases in response to the strong total investment decrease. As we have mentioned this is a consequence of the decrease in firms' savings and to a lesser extent the decrease in government savings.

Table 7: Simulation results of market prices (Δ%)

Variables	branches	Reference	Sim 1	Sim 2	Sim 3
Market price	Food crop	1.01	0.99	-0.30	0.01
	Rice	1.02	4.77	-0.10	4.94
	Rent agriculture	1.09	22.08	-0.06	0.00
	Cotton	1.00	45.91	46.13	-0.02
	Fishing and livestock	1.01	-2.31	-2.03	0.04

	Logging and timber	1.00	-1.91	-1.66	0.03
	Mining industries	1.00	-4.86	-4.32	0.09
	Food industries	1.11	-0.59	-0.98	0.03
	Textile industries	1.37	0.20	0.23	0.01
	Other manufacturing	1.15	-1.27	-1.12	0.02
	Water/electricity/energy	1.04	-1.93	-1.73	0.04
	Construction	1.02	-4.85	-4.34	0.09
	Commercial services	1.02	-0.99	-0.81	0.02
	Transport and telecom	1.05	-3.63	-3.25	0.07
	Other services	1.04	-7.82	-6.98	0.16
	Financial services	1.01	-2.86	-2.57	0.06
	Public services	1.00	-3.92	-3.54	0.09

Source: Calculus done by authors with Gams Ide 2.5.

The production increases in most other sectors with the exception of other services and manufacturing. In these two cases, the decrease is much smaller then what is observed for the construction sector. The most favoured sectors following this external shock are financial services, (+3.04%), transport and telecom (+2.39%) and cotton (+2.21%). Now moving to another key variable for change in welfare, we have only two price increase namely in the cotton (+46.13%) and textile industries (+0.23%). The price of textile increase as a result of the cotton price increase since it is an important input in its production process. The two prices that decrease the most are the other services price at -6.98% and the construction price -4.34%.

Table 8: Simulation results of rental rate of capital (Δ%)

Variables	branches	Reference	Sim 1	Sim 2	Sim 3
Rental rate of capital	Food crop	1.00	2.86	0.43	-0.01
	Rice	1.00	-0.38	1.12	-1.57
	Rent agriculture	1.00	9.73	0.39	-0.01
	Cotton	1.00	66.78	66.68	-0.02
	Fishing and livestock	1.00	-1.76	-1.55	0.03
	Logging and timber	1.00	-1.48	-1.26	0.03
	Mining industries	1.00	1.94	1.72	-0.04
	Food industries	1.00	-2.40	-0.58	-0.01
	Textile industries	1.00	-5.00	-4.70	0.05
	Other manufacturing	1.00	-9.74	-8.66	0.19
	Water/electricity/energy	1.00	-2.65	-2.37	0.06
	Construction	1.00	-19.75	-17.72	0.39
	Commercial services	1.00	-0.10	0.01	0.00
	Transport and telecom	1.00	-1.53	-1.37	0.03
	Other services	1.00	-10.50	-9.34	0.22
	Financial services	1.00	-1.90	-1.66	0.04

Source: Calculus done by authors with Gams Ide 2.5.

If we compare this second simulation with the first one, we note as previously mentioned that amplitudes are generally stronger. In terms of output, the sector suffering the most between these two simulations is the food industries which since its inputs are agricultural products and all prices increase. Its output increase is 2.19% for simulation 2 compared to 1.55% for simulation 1. The sector loses more than a quarter its gains between the two simulations. As for market prices, the biggest differences are for rice sector with an increase of 4.77% and rent agriculture (+22.08%) when both sectors experienced slight reduction in market prices for simulation 2. The sectors affected differently for the rental rate of capital are the other three agricultural sectors since they are the ones directly affected by this simulation.

Finally, the last scenario (increase in world price of rice) only produce weak effects since Mali only imports 11.3% of the total rice consumption and does not export rice. The price of rice increases by 4.94% and the rental rate of capital of the rice producers decreases by 1.57%. The rice producers will be negatively affected and the consumers of rice will also be negatively affected given this increase in price of rice. Other prices and rental rate of capital only change slightly. The change in price of rice sector and rental rate of capital will dominate the effects on welfare.

Poverty analysis

In 2001, about two thirds of the population (64%) was below the poverty line in Mali (Table 9). The regional poverty decomposition reveals important differences between groups. For example, the urban area exhibit a poverty rate of 31% and 77% in rural area (Table 10). Moreover, 90% of the poor work in the primary sector (mainly agriculture and livestock) of the economy. In this sub-section and the next one, we will perform the poverty and inequality impact analysis at the national level and on sub-groups of the population by comparing results of the three simulations with the reference period. The decomposition was done independently of the CGE modeling exercise. We selected two decomposition criteria. On the first hand, we decomposed households based on the education of the head of household (five sub-groups) and then on a rural-urban dichotomy. Our tables show the results at the national level and for the two decompositions criteria selected.

Our first observation is that our three simulations produce differentiated effects on the specific sub-groups. This is the result of heterogeneous income and expenditure structures of households. For the education decomposition, group 1 includes the households where the head did not attend school, group 2, the head completed primary education, group 3 secondary education, group 4 a university degree and group 5 professional training schools. We present the variations of FGT indices (for α = 0, 1 and 2) in Table 9 through Table 12.

Table 9: FGT variations at the national level.

National				
Index	**Reference**	**Sim 1**	**Sim 2**	**Sim 3**
FGT-0	0.64	-2.27	-2.13	0.00
FGT-1	0.29	-6.06	-5.44	0.12
FGT-2	0.16	-8.90	-8.01	0.19

Source: Calculus done by authors with DAD 4.3.

Before looking at the poverty changes at the national level, we can reiterate that the household aggregate income increases by just over 1% for simulation 1 and 2 and almost no change is observed for simulation 3. At the national level, the first comment we can make is that the simulation 3 produces no change in terms of poverty incidence (FGT-0) and slight negative effects for poverty depth (+ 0.12) and poverty severity (+ 0,19). On the other hand, the poverty reduction for the price increase of cotton (Simulation 2) is quit strong for all indices with the smallest effect at 2.13% for poverty incidence (FGT-0) and -8.01% for the poverty severity (FGT-2). It is important to note that these positive effects are obtained without increasing total factors in the economy and therefore limiting the possible positive effects. Moreover, the increase in price of all agricultural sectors (Simulation 1) does not attenuate the positive effects observed for simulation 2 but increases the positive effect and this for all three indices. These results tend to confirm the affirmations made by regional trade negotiators on the benefits of the removal of cotton subsidies in developed countries on poverty in Mali. Let us refine the analysis and look at the sub-groups that benefit the most and verify if all groups gain.

Table 10 : FGT-0 poverty incidence variations

Group #	Definition	Reference	Sim 1	Sim 2	Sim 3
1	No education	0.70	-2.20	-2.06	0.00
2	Primary	0.38	-5.49	-5.49	0.00
3	Secondary	0.20	0.00	0.00	0.00
4	University	0.04	3.57	3.57	0.00
5	Profes/technical	0.12	1.79	1.79	0.00
1	Urban	0.31	3.30	3.30	0.00
2	Rural	0.77	-3.20	-3.04	-0.01

Sources: EMEP and computation from authors results with DAD 4.3.

The groups gaining the most are the ones which exhibit the highest poverty levels at the reference period (i.e. the non educated and primary education groups). For simulation the poverty incidence decreases by 2.06% for the non educated group and 5.46% for the primary education group. For the secondary educated group, we do not see a change and we have increases of 3.57% for the university group and 1.79% for the professional group. We also note that the rural group is a clear winner with a decrease of 3.04% and the urban group loses with an increase of 3.30%. When comparing to simulation 1, we only have differences for two groups compared to simulation 2 (no education and rural households). This comes from the fact that the empiric distribution is used for computation and with the poverty headcount index this approach is not very sensitive[13]. In these two cases, we have an improvement of the situation namely for the rural group and for the non educated group. When analyzing the effects of the third

([13]) For a detailed discussion on this issue see Boccanfuso et *al* (2003). In this context as we will see, the poverty depth and severity are more sensitive and provide a better indicator of the effects.

simulation, we do not observe any effects other then for the rural group which experiences a very slight decrease of 0.01%.

The analysis of the poverty depth is more informative as it is more sensitive than the poverty headcount. In this case the trend is similar insofar as the poorest groups at the reference period benefit the most and the gap (difference between the positive effect for rural and negative effect for the urban) for between rural and urban groups increases. It is also interesting to note that the group benefiting the most has changed and it is now the least educated group that become the biggest gainer (-5.59%) followed by the primary education group (-2.28%). The biggest loser is still the university group (+6.22) and the negative effect is almost twice as strong as with the FGT-0 index.

Table 11: FGT-1 poverty depth variations

Group #	Definition	Reference	Sim 1	Sim 2	Sim 3
1	No education	0.32	-6.23	-5.59	0.13
2	Primary	0.12	-2.4	-2.28	0.06
3	Secondary	0.08	1.76	1.67	-0.04
4	University	0.01	6.78	6.22	-0.12
5	Profes/technical	0.03	4.38	4.02	-0.08
1	Urban	0.09	2.74	2.43	-0.04
2	Rural	0.37	-6.96	-6.25	0.14

Sources: EMEP and computation from authors results with DAD 4.3.

The comparative analysis between simulation one and simulation two reveals stronger positive effects for the no education, primary and rural groups and stronger negative effects (poverty increases more) for the other groups. As for the last simulation, we have reversed effects where the poorest groups (no education, primary and rural groups) see their poverty depth increase and the other groups benefit from poverty depth decreases, albeit these changes are very small. The poverty severity analysis follows the same trends as the poverty depth analysis with one exception in terms of qualitative effects. The secondary education group (group 3) have reversed effects for the three simulations.

Table 12: FGT-2 poverty severity variations

Group #	Définition	Reference	Sim 1	Sim 2	Sim 3
1	No education	0.18	-9.06	-8.15	0.19
2	Primary	0.05	-3.96	-3.60	0.10
3	Secondary	0.04	-1.26	-1.10	0.03
4	University	0.00	6.35	5.74	-0.10
5	Profes/technical	0.01	0.96	0.91	-0.01
1	Urban	0.04	2.13	1.86	-0.02
2	Rural	0.21	-9.73	-8.76	0.20

Sources: EMEP and computation from authors results with DAD 4.3.

Quantitatively we can say that the positive effects (poverty reduction) are stronger with poverty severity index and the negative effects (poverty increases) are weaker.

To summarize the poverty impact analysis we can say that the first two simulations have a positive effect on poverty reduction at the national level and for the poorest groups of the populations for the three indices used. This is a strong result in favour of suppressing cotton subsidies in developed countries to improve the welfare of poor cotton producers.

Inequality analysis

Let us move on to the inequality impact of the world price increases. At the reference period, we have a Gini index of 0.41 at the national level and the group with the lowest inequality in the education decomposition is the technical education group and rural inequality is slightly higher than urban inequality (Table 13). First, we note that the inequality effects are not small as is often is the case in CGE-macro-micro modeling context with exogenous production factors. Starting once again with simulation 2, we observe a relatively important reduction (-2.47%) in inequality at the national level. Moreover, we have the strongest reduction (-1.93%) in inequality for the non educated group and only on increase in inequality (i.e. for the secondary group).

Table 13: Gini index variation

Group #	Définition	Reference	Sim 1	Sim 2	Sim 3
	National	0.41	-2.70	-2.47	0.06
Educ	Inter-group	0.15	-5.98	-5.41	0.12

	Intra-group	0.26	-0.88	-0.83	0.02
1	No education	0.39	-2.09	-1.93	0.05
2	Primary	0.33	-0.91	-0.83	0.02
3	Secondary	0.32	0.21	0.21	0.00
4	University	0.35	-0.82	-0.7	0.02
5	Profes/technical	0.31	-0.07	-0.05	0.00
Region	Inter-group	0.22	-5.34	-4.84	0.11
	Intra-group	0.19	0.36	0.29	0.00
1	Urban	0.35	-0.21	-0.23	0.01
2	Rural	0.37	-1.36	-1.27	0.03

Sources: EMEP and computation from authors results with DAD 4.3.

As for the rural-urban decomposition, we have a stronger decrease in inequality in the rural groups (-1.27%) compared to -0.23% for the urban group. The first simulation produces stronger decreases in the Gini index than the second simulation for all but one group and no change for the secondary education group (+0.21%). Results are quit similar to simulation 2 for the rural-urban decomposition but we have a slightly bigger gap between the two groups.

If we analyse the inter-group inequality changes, we note that simulation 1 and 2 generate an important reduction for the two types of decomposition analysis performed. In other words, when we assume that the incomes are equal to the average income of each group for all households of the group, the remaining inequality decreases. However, the intra-group (within group) inequality has a tendency to increase with the regional decomposition analysis as opposite to the educational decomposition analysis. Finally, the last simulation produces very weak distributional effects with increases for all groups and at the national level. The biggest effect is observed for the non educated group (+0.05%) and at the national level (+0.06%).

Conclusions

In this paper we have constructed the first single country CGE model for Mali and have applied the CGE multi-household sequential approach proposed by Chen and Ravaillon (2004) to perform poverty and inequality impact analysis of world price of agricultural goods with emphasis on the cotton given its importance in the Malian economy. Our application does not take into account all the potential positive effects of reducing developed countries subsidies on cotton such as increasing the production factors (land). However, our results can be interpreted as a measure of gains from factor reallocating, and other general equilibrium effects of the world price increase for cotton. We also look at general price increase of agricultural goods to see if the positive effects of cotton price increase are attenuated as suggested by other studies.

Our analysis shows that cotton subsidies removal would produce significant positive effects on poverty indices for the poorest household and help reduced inequality in Mali. The results on the other agents are negative but these have to be interpreted in light of our fixed factor hypothesis. If would look at stylized facts of cotton production in Mali following the CFA franc devaluation (implicitly a similar effect for cotton producers) we observed an important increase in factor utilisation in the cotton sector. Hence, if a dynamic model would be used or if we would relax the fixed factor hypothesis, this negative effect on other agents our likely disappear. Since our objective was to demonstrate that the impact of subsidy remove could be positive for the poor households in Mali we did not pursue this possible outcome which will be dealt with in a extension to this paper.

Our results also demonstrate that a country with important agricultural exports with minimal agricultural imports such as Mali could gain significantly in terms poverty reduction from the removal of developed countries subsidies on agricultural goods. A neighbouring country such as Mauritania where they have little agricultural exports and strong agricultural imports would likely produce reversed poverty effects of such an external shock. Hence, the aggregation of developing countries into one large region as is done in MacDonald et *al.* (2003) can lead to misleading conclusion when one country can make significant gains and others can suffer significant losses. It is essential in our view to refine this type of analysis at the country level.

In future research, we plan to enrich the agricultural sector modeling in addition to endogenizing production factors. Will these hypotheses we could verify if the positive effects observed here would be amplified or attenuated.

Références

Adelman I and S. Robinson, (1977) Income Distribution Policy in Developing Countries: A Case Study of Korea, Stanford, Stanford University Press.

Adjovi, E., C. Wetta, O. Sanogo (2004), Cotons D'Afrique face aux subventions mondiales, REPA, 108 pages.

Armington P. S. (1969) A Theory of Demand for Products Distinguished by Place of Production, *IMF Staff Paper,* nº 16, p. 159-176.

Baffes, J. (2004) Cotton: Market Setting, Trade Policies, and Issues, Policy Research Working Paper Series nº 3218, World Bank, Washington.

Boccanfuso, D. B. Decaluwé and L. Savard, (2003) Poverty, Income Distribution and CGE modelling: Does the Functional Form of Distribution Matter? CIRPEE Working Paper n° 0332, Quebec City.

Boccanfuso, D., F. Cabral and L. Savard (2005) Une Analyse d'Impacts de la Libéralisation de la Filière Arachide au Sénégal : une Application EGC Multi-ménages, Perspective Afrique, Vol. 1, nº 1 p. 32-58.

Bourguignon F, G. Michel and D. Miqueu (1983) Short-Run Rigidities and Long Run Adjustments in a Computable General Equilibrium Model of Income Distribution and Development, Journal of Development Economics, vol. 13, n° 1-2, p. 21-43.

Bourguignon F., J. de Melo, and A. Suwa, (1991) Modelling the Effects of Adjustment Programs on Income Distribution, World Development, vol. 19. nº 11. p. 1527-1544.

Bourguignon F., A.S. Robilliard and S. Robinson (2005) Representative Versus Real Households in the Macroeconomic Modelling of Inequality, in T. J. Kehoe, T.N. Srinivasan and J. Whalley (eds.) Frontiers in Applied General Equilibrium Modelling, Cambridge, Cambridge University Press.

Chen S. and M. Ravallion (2004) Welfare Impacts of China's Accession to the World Trade Organization, The World Bank Economic Review, vol 18, n° 1, p. 29-57.

Chia N.-C., S. Wahba and J. Whalley (1994) Poverty-Reduction Targeting Programs: A General Equilibrium Approach, Journal of African Economies, vol 3, n° 2, p. 309-338.

Cogneau D. and A.-S Robillard (2000) Income Distribution, Poverty and Growth in Madagascar: Micro Simulations in a General Equilibrium Framework, IFPRI TMD Discussion Paper n°. 61, Washington.

Decaluwé B., A. Patry, L. Savard and E. Thorbecke (1999a) Poverty Analysis Within a General Equilibrium Framework, Working Paper 99-09, African Economic Research Consortium, Nairobi.

Decaluwé B., J.-C. Dumont and L. Savard (1999b) How to Measure Poverty and Inequality in General Equilibrium Framework, Université Laval, CREFA Working Paper #9920 Québec.

Decaluwé B., A. Martens and L. Savard (2001) La Politique Economique du Développement et les Modèles d'Equilibre Général Calculable, Montréal. Presse de l'Université de Montréal.

Decaluwé B., Dissou,Y. and V. Robichaud (2004), Regionalism and Labour Market Structure: A CGE Analysis of UEMOA Customs Union, Journal of African Economies, vol 13, n° 2, p. 302-332.

Decaluwé B., L. Savard and E. Thorbecke, (2005), General Equilibrium Approach for Poverty Analysis: With an Application to Cameroon, African Development Review, vol 17, n° 2, p. 213-243.

de Janvry A., E. Sadoulet and A. Fargeix (1991) Adjustment and Equity in Ecuador, OECD Development Center, Paris.

Dervis K., J. de Melo and S. Robinson (1982) General Equilibrium Models for Development Policy, London, Cambridge University Press.

Foster J., J. Greer and E. Thorbecke (1984) A Class of Decomposable Poverty Measures, Econometrica, vol. 52, n° 3, p. 761-766.

Filipiak E. and S. Perrin (2003) Agriculture et Commerce : Quels enjeux pour l'aide au développement, mimeo Agence Française de Développement, Paris.

FAOSTAT Agriculture Database (2001), http://faostat.fao.org/faostat/

Gillson, I. C. Poulton K. Balcombe and S. Page (2004), Understanding the impact of Cotton Subsidies on developing countries, ODI Working Paper, London.

Goreux, L. (2004) Prejudice caused by industrialized Countries Subsidies to Cotton Sectors in Western and Central Africa. Mimeo UEMOA, Ouagadougou.

Hertel T. and J. Reimer (2004) Predicting the Poverty Impacts of Trade Reform, World Bank Policy Research Working Paper n° 3444, World Bank, Washington.

International Cotton Advisory Committee (2002) Reports on Injury due to Low Cotton Prices, Washington.

MacDonald S., L. Meyer and A. Somwaru (2003), *Perspectives on cotton global trade reforms*, Economic Research Service, mimeo, US Department of Agriculture, Washington.

Ministère du plan et de l'aménagement du territoire (MPAT-DNSI), (2004) *Enquête malienne sur l'évaluation de la pauvreté (EMEP) : Principaux résultats,* Bamako.

Morrisson C. (1991) Adjustment incomes and Poverty in Morocco, World Development, vol. 19. n° 11. p. 1633-1651.

Oxfam, (2002) Cultivating Poverty: The Impact of US Cotton Subsidies on Africa, Oxfam Briefing Paper n° 30, London.

Ravallion M. (1994) Poverty Comparisons, Reading, Harwood Academic Publisher.

Rutherford T., D. Tarr and O. Shepotylo (2005) Poverty Effects of Russia's WTO Accession: Modeling "Real" Household and Endogenous Productivity Effects, World Bank Policy Research Working Paper n° 3473, World Bank, Washington.

Savard, L. (2005) Poverty and Inequality Analysis within a CGE Framework: a Comparative Analysis of the Representative Agent and Microsimulation Approaches, Development Policy Review, vol. 23, n° 3, p 313-332.

Thorbecke, E. (1991) Adjustment Growth and Income Distribution in Indonesia and Equity in Indonesia, World Development, vol. 19. n° 11. p. 1595-1614.

Taylor, L. and F. Lysy (1979) Vanishing Income Redistributions: Keynesian Clues about Model Surprises in the Short-Run, Journal of Development Economics, vol 6, n° 1, p. 11-29.

United States Department of Agriculture - USDA (2005) Cotton World Markets and Trade, Circular Series FG-03-05, Washington.