Poverty Effects of Expansion and Policies in Cotton Economies in Rural Mozambique: An Economy-wide Approach

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Abstract. This paper uses a Regional Computable General Equilibrium (CGE) model calibrated with a Social Accounting Matrix (SAM) for the Mozambique Zambezi Valley cotton concession sub-region to examine the economy-wide impacts and relative changes in the levels of income poverty of grower and non-grower household groups, following exogenous shocks, such as contract faming specific capital expansion, technology improvements, changes in world prices, and Government policies. Simulation results indicate that productivity gains have a broad-based income growth and poverty reduction potential, even greater than increased cotton world prices; because sustained increases in world prices are unlikely, this result is encouraging. While employment linkages are relatively weak in these economies when compared to tobacco growing areas, income diversification strategies by non-grower households, particularly through non-farm self-employment and food crop marketing, ensure that they are not left behind when interventions are focused on cotton growers. Even when impacts are limited among growers, any expansion in cotton production results in some positive effects to non-growers. The implied potential of interventions focused on increasing cotton productivity present a great opportunity for concession firms and policy makers to design strategies that are beneficial to both grower farmers, firms and the population at large. This will require public-private coordination efforts stressing better research and extension, the use of high yielding seed varieties, and emphasis on quality. Although results indicate limited negative effects of high import prices for inputs, measures aimed at reducing the costs of importation and transportation are highly encouraged as they can help minimize or counterbalance any negative effects from factors outside the control of domestic agents. While current poverty impacts of cotton cropping are relatively small, there is high potential for significant broad based gains under a more productive system.

JEL Codes: C68, C88, D31, D33, I32.

Keywords: Income poverty, regional general equilibrium, exogenous shocks.

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1. Introduction

Cotton is historically the most important cash crop for smallholder farmers in Mozambique. Though the sector has been widely perceived as a poor performer in southern Africa (Poulton *et al*, 2004; Tschirley *et al*, 2006), the crop provides crucial access to relatively secure cash income for nearly 250,000 smallholder farm families in the most densely populated areas of the country; performance of the cotton sector matters a great deal to rural poverty in Mozambique.

In this paper, we use an economy-wide framework to analyze changes in the levels of income poverty of different household groups following certain exogenous shocks to the cotton sector; these shocks include expansion of contract farming through capital injections, technology improvements, changes in world market prices, and changes in Government trade policies. These issues are addressed using a regional agricultural CGE model in the tradition of Lofgren and Robinson (1999) and Taylor *et al.* (1999) which we developed and calibrated with a regional Social Accounting Matrix (SAM). The model focuses on the Zambezi Valley area, which has received much of the new investment in the sector over the past decade.

An economy-wide approach is especially useful in this case, because previous econometric analysis in cotton concession areas of the Zambezi Valley indicates that growth in the sector can affect growers and non-growers in different ways (Benfica *et al.*, 2006). The relative magnitude of the income effects depends to a great extent on the nature of second round effects that result from employment, production and consumption linkages following shocks in the sector; our economy-wide approach is specifically

designed to capture these effects.

The paper is organized as follows. Section 2 uses survey data to illustrate a base year comparative poverty and inequality profile of cash crop and non cash crop growers in cotton and tobacco concession areas of the Zambezi Valley. Section 3 presents the data and analytical methods that include the Regional SAM, the Regional CGE model, and a conceptual framework for the Representative Household Approach to Poverty Analysis used in this study. Section 4 focuses on the definition and set up of the various policy simulations that form the basis for the analysis, and uses stochastic dominance techniques to present and discuss the results. Section 5 closes with policy implications.

2. Household Poverty and Inequality Profile

In this section, we present a profile of household income poverty and inequality for the base year using data from a household survey undertaken in the Zambezi Valley region in 2003/2004.[1] For comparative purposes, we include both cotton and tobacco concession areas of the study region. Cumulative distribution curves of household income per capita are used to undertake stochastic dominance analysis of poverty. The analysis of inequality uses coefficients of variation, Gini concentration ratios, and Lorenz curves.

Income per capita differs substantially in the region between cotton and tobacco concession areas, with the latter exhibiting a clear advantage. Figure 1 illustrates the density curves for household income per capita by concession area, including all households irrespective of their cash crop growing status.

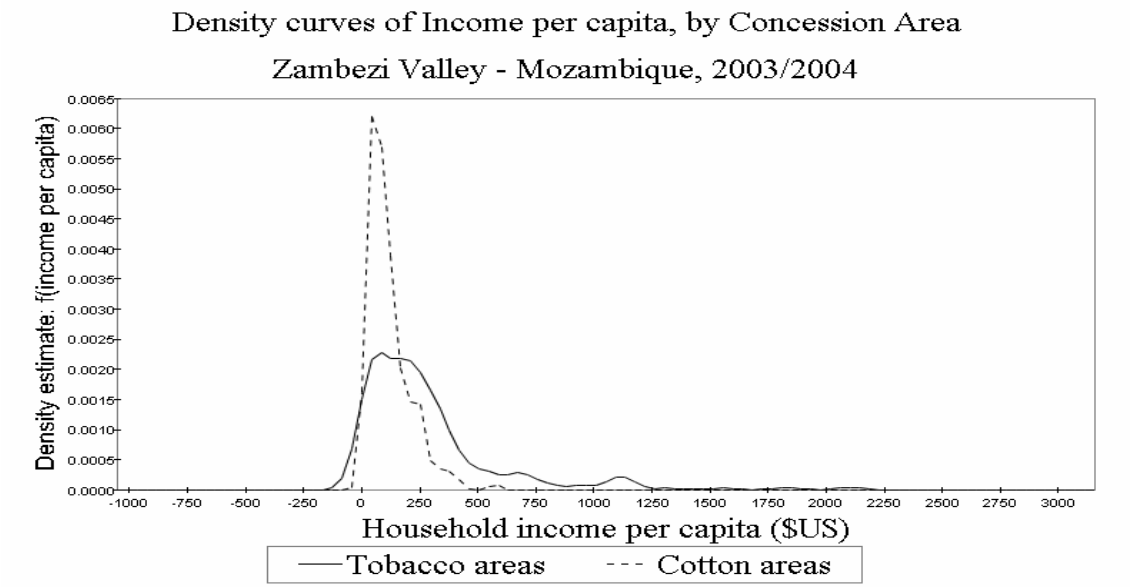
Several points are worth noting. First, as expected in a rural African economy, both curves are skewed to the right. Second, tobacco areas present a wider dispersion of

[1] Data from this survey were used to build the Social Accounting matrix used later in this paper.

income. As compared to cotton areas, tobacco areas appear to have a larger proportion of negative incomes per capita, but also a much greater share at the higher end of the income spectrum. Cotton incomes are much more concentrated around the lower end of the distribution.

Stochastic dominance analysis using Cumulative Distribution Functions (CDFs)[2] of the two concession areas in Figure 2 shows that for any relevant poverty line, households in cotton areas are poorer than their counterparts in tobacco growing areas.[3]

Figure 1



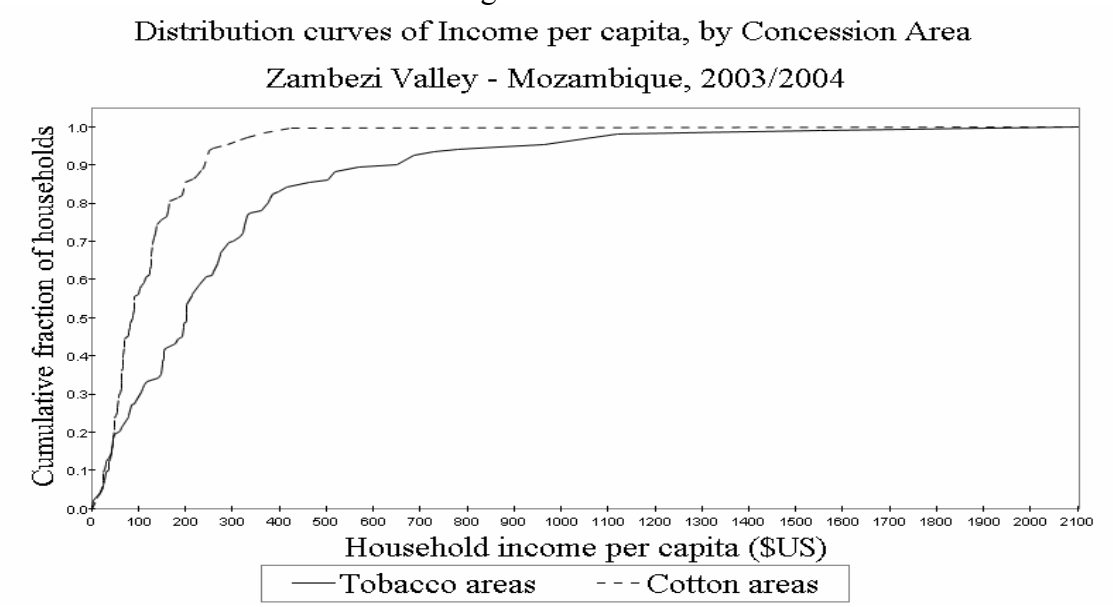
This CDF plot also confirms indications from the density curve that incomes per capita in cotton areas are significantly lower. Nearly all households in the cotton area earn incomes per capita lower than $400 per capita. More importantly, about 60% earn $100 or less, and 80% earn $200 or less. Top incomes in tobacco areas are close to

[2] If the CDF curves for different household groups do not intersect, then the group with the highest curve (to the left) is poorer than the other group. If they do intersect, then for all poverty lines below intersection, one group is poorer and for all poverty lines above the intersection, the other group is poorer.

[3] Note that there is no first degree stochastic dominance over the entire income range; at unreasonably low poverty lines, the curve for the cotton areas dominates the one for the tobacco areas. This is somewhat expected, as tobacco growers with low yields will incur large losses due to high input costs.

$2,000, while 60th and 80th percentile incomes are about double those in cotton areas ($200 and $400, respectively). Median per capita incomes in cotton areas are approximately $88 against $184 in tobacco areas. Computed mean incomes per capita are $120 and $280, respectively. Differences in income from the cash crop contribute substantially to these overall income differences: mean and median income from cotton is $94 and $77, respectively, while the same figures for tobacco are $731 and $364.

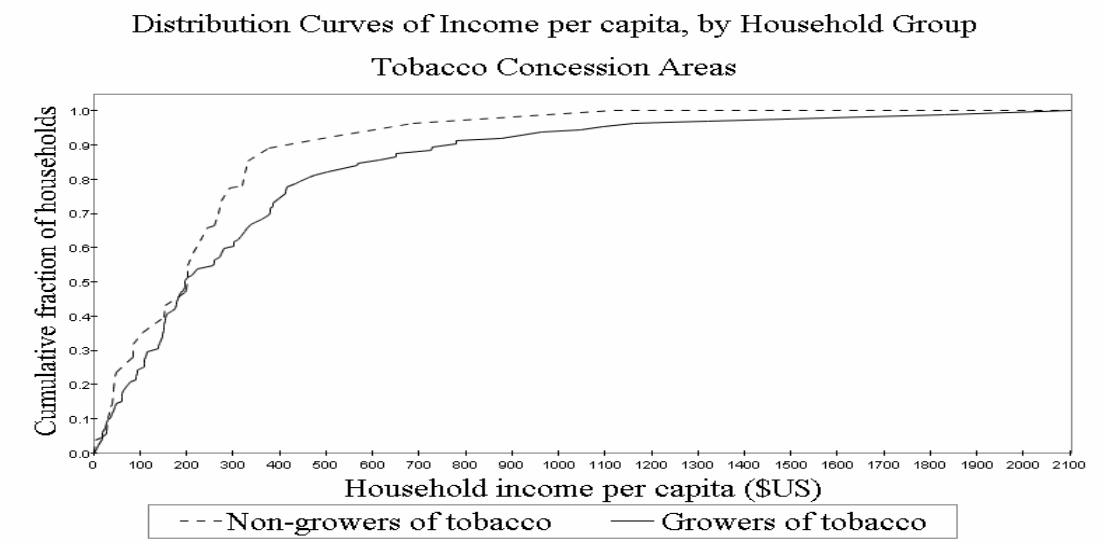
Figure 2



In Figures 3 and 4 we compare the cumulative distributions for growers and non-growers in tobacco and cotton concession areas, respectively. In both areas, for poverty lines at or below median per capita incomes, comparisons are inconclusive. Indeed, in tobacco growing areas (Figure 3), the CDFs cross at least three times, with the curves overlapping at very low levels of less than $50. At levels $50-$150 the grower households dominate the non-growers, but the situation is again unclear around poverty lines near the area's median. For poverty lines defined above the median ($184 per

capita), and more clearly above the mean ($280 per capita), grower households clearly dominate non-growers.

Figure 3



In cotton growing areas (Figure 4), poverty differences between the two groups are very unclear for all poverty lines defined below mean per capita income. For poverty lines greater than the mean, i.e., over $120, growers clearly dominate non-growers, indicating that poverty incidence is greater among non-growers.

Figure 4

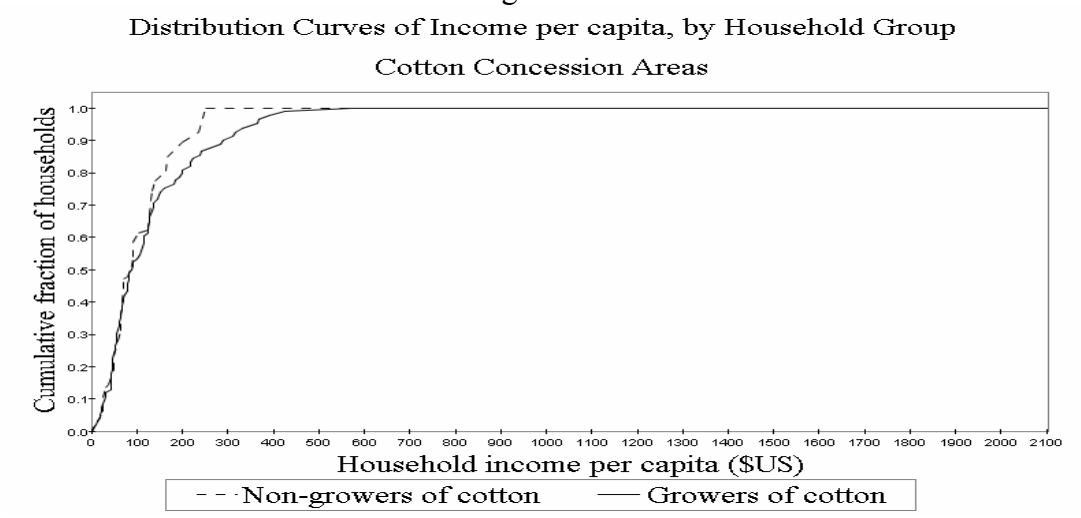


Table 1 and Figure 5 present measures of inequality in the base year. By all standards, inequality appears to be more severe in tobacco concession areas when compared to cotton areas. This is illustrated by the higher coefficient of variation, 1.17 (tobacco areas) to 0.78 (cotton areas), higher Gini concentration ratio (0.54 and 0.40), and the fact that Lorenz curves for households in tobacco areas lie everywhere outside the Lorenz curves for households in cotton areas.

Table 1. Measures of Inequality

Household Groups in concession areas	Coefficients of Variation of per capita income	Per capita Income Concentration Ratios (Gini)
Tobacco Areas		
Non-grower households	1.06 (0.165)	0.52
Grower households	1.19 (0.102)	0.56
All households	1.17 (0.104)	0.54
Cotton Areas		
Non-grower households	0.64 (0.068)	0.35
Grower households	0.86 (0.064)	0.44
All households	0.78 (0.060)	0.40
All households in the Region	1.26 (0.101)	0.53

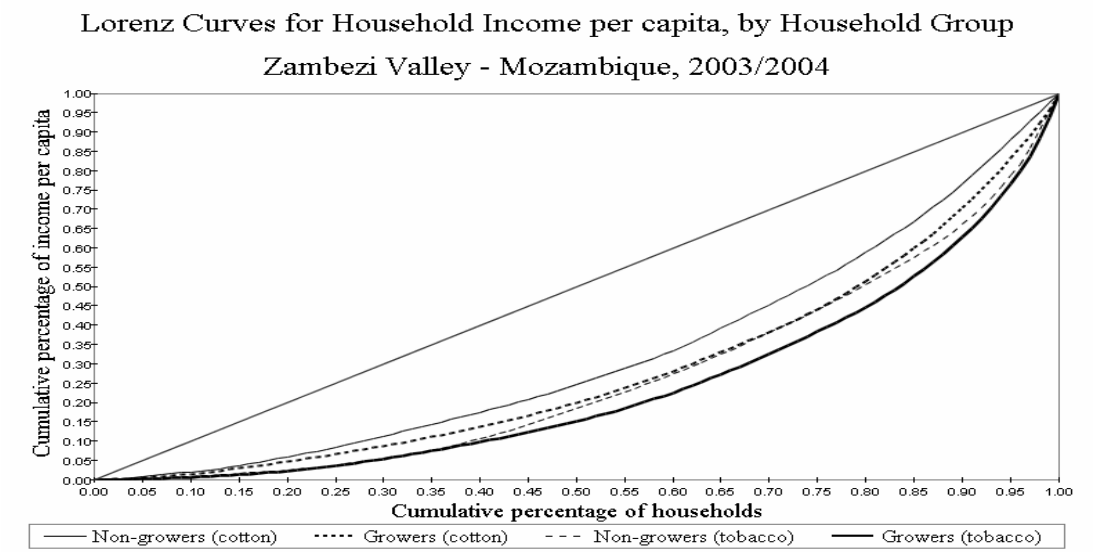
Source: Zambezi Valley Cotton and Tobacco Concession Areas Study, 2004.

Comparing inequality among groups within the same area shows, first, that in both areas inequality is more severe among cash crop growers. Second, these differences are more accentuated in cotton areas, where Gini ratios exhibit a difference of eleven points as compared to only 4 points in tobacco growing areas. The coefficients of variation give the same indication.

A visual interpretation of the Lorenz curves provides further insights. It further clarifies that, in cotton areas, inequality is more accentuated among grower households,

as their curve lies everywhere below the curve for non-growers. Forty five percent of the non-growers of cotton receive about 20% of the total income received by that group, while among growers, 45% receive only 15% of the group's total income. This higher level of inequality among cotton growers persists at all percentiles.

Figure 5



The picture is a bit different in tobacco areas. For instance, at population cumulative percentiles up to 40%, there are seemingly no differences between the two household groups. At that level, in each group 40% of the population receive just over 5% of the total income of the respective group, which indicates a very high level of inequality. Inequality becomes more severe among growers as we move up the curve; 60% of non-growers receive 25% of that group's total income while 60% of growers get only 20%.

3. Data and Analytical Methods

This section presents the data and analytical methods used in the study, including the Regional SAM for the Zambezi Valley (ZVR-SAM) and the Regional CGE model (ZVR-CGE). Then, it presents a conceptual framework for Poverty Analysis within a regional CGE framework.

3.1. The Regional Social Accounting Matrix for the Zambezi Valley

A SAM is both a data system and a conceptual framework useful for policy analysis (Thorbecke, 1998).[4] SAMs have been used to model diverse economies and institutional structures across various geographical scopes. Initial applications were mostly modeling macro level issues in a national accounting context; more recently the framework has been adapted to study micro (villages and towns) and sub-national (or regional) economies. The strengths of the SAM framework are its flexibility and adaptability to model a variety of economic structures and institutional setups. As a data system, the SAM is *comprehensive* and disaggregated, as it includes transactions among sectors, factors and institutions; *consistent* in the sense that for every income there has to be an equivalent expenditure; and *complete* in that both the sender and the receiver of every transaction need to be identified. For a given year, the SAM provides a snapshot of the structure of the economy under investigation: the structure of production, inter-sectoral linkages, distribution of factor value added among socio-economic groups, and their expenditure patterns.

[4] The genesis of the SAM dates back to Sir Richard Stone's pioneering work on social accounts (1978), for which he received the Nobel Prize in Economics in 1984 (http://nobelprize.org/economics/laureates/1984/index.html). Subsequently, Pyatt and Round (1979) further formalized the SAM and showed how it could be used as a conceptual framework for policy and planning purposes.

The SAM framework consists of a square matrix of double-account, in which rows represent receipts (revenues) and columns represent expenditures (payments). As a *comprehensive*, *consistent*, and *complete* accounting method, it requires balancing of revenues and expenditures in all accounts.

The Zambezi Valley Regional SAM (ZVR-SAM) keeps all the features of a standard SAM. Some important features are: the inclusion of non-marketed home consumed commodities by farm households; the explicit treatment of marketing costs; and the separation between production activities and commodities that allows any activity to produce multiple commodities and any commodity to be produced by multiple activities.[5] In addition, the SAM has two other distinctive characteristics. First, to account for the diversity of rural production activities, demand patterns, technologies, and market structures, the SAM is highly disaggregated. Second, agricultural activities (farm types) are mapped with household types. This allows for better integration and subsequent modeling in a CGE framework of production and consumption decisions in a non-separable fashion with the relevant differentiation across farm-household types and activities (Lofgren and Robinson, 1999; and Taylor *et al*., 2005).

The 2003-2004 ZVR-SAM includes six major types of accounts: (i) activities; (ii) commodities; (iii) commodity marketing costs; (iv) factors of production: labor, land, and capital; (v) institutions: households, government, and rest of the world; and (vi) savings and investment. A schematic view of the SAM is presented in Table 2.

[5] For example, cotton growing farm activities produce cotton and a number of food crops, and the maize commodity is produced by both cotton growing farms an non-cotton growing farms.

Table 2. Schematic Standard Regional Social Accounting Matrix

		EXPENDITURES								
		Activities (ACT)	Commodities (COM)	Marketing Costs (MC)	Factors (F)	Representative Households (HH)	Local Government (GOV)	Savings/ Investment (S-I)	"Rest of the World" (ROW)	Total
RECEIPTS	Activities (ACT)		Domestically marketed output			Home consumption				Gross output
	Commodities (COM)	Intermediate inputs purchased		Transaction costs		Consumption expenditures	Government consumption	Investment demand	Exports	Commodity demands
	Marketing Costs (MC)		Marketing costs							Marketing costs
	Factors (F)	Value added: Wages and rents					Wages/rents paid by GOV		Wages/rents from ROW	Total factor earnings
	Representative Households (HH)				Factor income to households	Intra-household transfers	GOV transfers to households		Remittances from ROW	Household income
	Local Government (GOV)	Producer taxes, value added taxes	Sales taxes, tariffs, export taxes		Factor taxes	Personal taxes			Transfers from ROW and Central GOV	Government receipts
	Savings/ Investment (S-I)					Household savings	Government savings			Total savings
	"Rest of the World" (ROW)		Imports		Factor income paid to ROW	Remittances to ROW				Payments to outside region
	Total	Total costs of production	Domestic supplies	Marketing costs	Factor expenditures	Household expenditures	Government expenditures	Total Investment	Total receipts from outside region	

A detailed list of accounts and levels of dis-aggregation for the ZVR-SAM are presented in Tables 3 and 4. The SAM database is used to calibrate the ZVR-CGE model.

Table 3. Regional SAM Accounts: Activities, Commodities and Transaction Costs

Accounts	Description of Individual Accounts	
Activities	Agriculture and Livestock/Fishing:	Marketing/Export of Cotton:
	Cotton Growing Farms - C.N.A.	C.N.A - Cotton Marketing and Export
	Cotton Growing Farms – Dunavant	Dunavant - Cotton Marketing and Export
	Non Cotton Growers	
	Livestock	Transportation and Services:
	Fishing	Trading Services
		Government Services
	Processing/manufacturing:	Other Services
	Food processing	
	Beverage processing	
	Other Processing/Manufacturing	
Commodities	Cash crops:	Processed foods/beverages:
	Raw Cotton – Dunavant	Cooking Oil
	Raw Cotton – C.N.A.	Sugar
	Packed Cotton – Dunavant	Salt
	Packed Cotton – C.N.A.	Tea/Coffee and spices
		Prepared Ready to Eat Foods
	Other agricultural raw and processed commodities:	Alcoholic Beverages
		Services:
	Maize Grain and Rice	Education
	Maize Meal	Health
	Other Flours	Trading Services
	Bread/Biscuits/Pasta	Housing/Water/Electricity/Maintenance
	Beans and Groundnuts	
	Root Crops: Cassava/potatoes	Agricultural inputs:
	Vegetables, Green Leaves and Fruits	Seeds
	Coconuts	Pesticides
		Other inputs
	Animals and animal products:	
	Meat - Cow	Non-foods and other commodities:
	Meat - Goat	Firewood and Coal
	Meat - Pork	Fuel - Vehicles/Equipment/Spares
	Meat - Birds	Wood/Grass/Cane Products
	Fish and Sea/River Foods	Textiles, wearing apparels and footwear
	Milk and Eggs	Metal/blacksmithing Products
		Kitchen Utensils and other Home Apparel
		Soap and Hygiene Products
		Imported tobacco
		Other Commodities
Marketing Costs	Domestic Sales	
	Imports	
	Exports	

Source: Zambezi Valley Regional SAM

Table 4. Regional SAM Accounts: Factors, Institutions and Savings-Investment

Accounts	Description and Level of Dis-aggregation	
Factors	Land	Land
	Capital	Capital (general) Farm specific - Dunavant Farm specific – C.N.A.
	Labor	Family Labor – Pre-harvesting Family labor – Harvesting and Marketing Hired Labor – Pre-harvesting Hired Labor – Harvesting and Marketing
Institutions	Government	Local Government
	Rest of the World	Domestic and Foreign Rest of the World
	Households	Cotton areas: Non-grower households Cotton areas: Grower households
Savings-Investment	Savings-Investment	Savings-Investment

Source: Zambezi Valley Regional SAM

Given the specific nature of the research and the limited availability of data at the sub-national level, a great deal of the data used to construct the ZVR-SAM, particularly on the production and income sides, had to be collected through a sample survey. Expansion procedures using population census data were necessary to make the data representative of the study area. On the consumption side, we derived household expenditure shares using the National Expenditure Survey (IAF 2002-03) for the enumeration areas corresponding to our study region. The data were used to estimate household home consumption and expenditures across commodities in the SAM for the different household groups.

To accommodate those data in the SAM, a matching procedure was adopted. It consisted in ranking the four household groups in the SAM by total income, then attributing to each the average expenditure pattern of the relevant quartile group from the IAF data for the Zambezi Valley: the poorest group in the SAM received the expenditure pattern of the bottom quartile from IAF, through to the richest group in the SAM, which received the expenditure pattern of the top quartile in IAF. The analysis of secondary data on production, marketing, and domestic

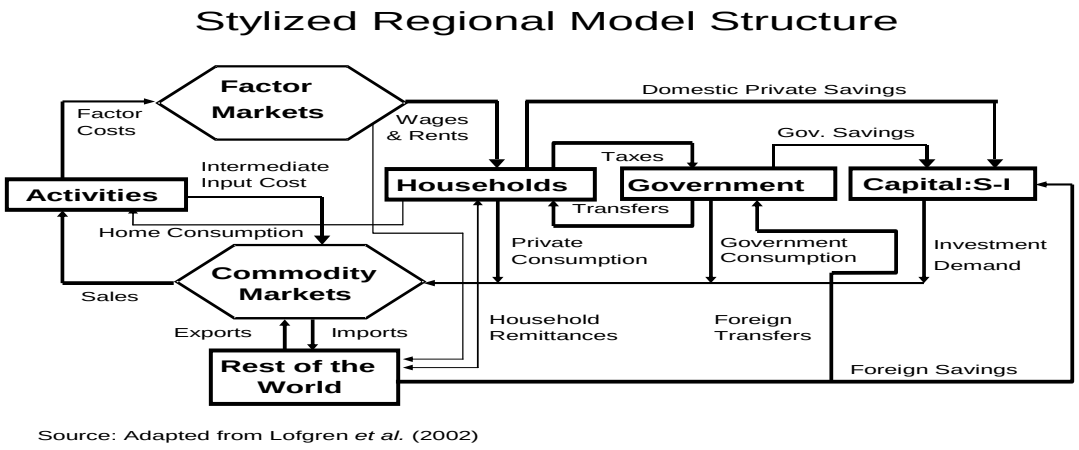
consumption allowed for the derivation of variables such as crop exports and household transfers to the rest of the world.

Despite the careful data collection, processing and cleaning, and a very interactive process in assembling the SAMs, inconsistencies remained, arising from measurement errors, incompatible data sources, and lack of data. To impose consistency, we used the Cross-Entropy Method (Robinson, *et al.,* 1998). This method is based in information theory and incorporates errors in variables, inequality constraints and prior knowledge about any part of the SAM including, but not restricted to, rows and column totals. All the necessary adjustments resulting from the procedure were within the generally acceptable bounds of less than 5%.

3.2. The Zambezi Valley Region Computable General Equilibrium Model

The Zambezi Valley Region Computable General Equilibrium model (ZVR-CGE) used in this paper is based on the IFPRI standard model of Lofgen *et al.* (2002). The standard CGE model accounts for all the payments recorded in the SAM. The calibration of the model, therefore, follows the SAM disaggregation of activities, commodities, factors and households. All the relevant features introduced in the SAM to reflect the local economy and the issues at hand are mirrored in the ZVR-CGE. Figure 6 presents a stylized structure of the model, indicating the flows between the various SAM accounts.

Figure 6



Source: Adapted from Lofgren *et al.* (2002)

The model is written as a set of simultaneous equations, most of which are non-linear. First order optimality conditions capture the behavior of producers and consumers assumed to maximize profits and utility, respectively.

On the production side, each activity represents a producer that is assumed to maximize profits, i.e., the difference between revenues earned and the cost of intermediary inputs and payments to factors. Profits are maximized subject to a production technology. The top of the technology nest contains a Leontief (LEO) function of the quantities of aggregated factor value-added and aggregate intermediate inputs.[6] Value-added is defined as a Constant Elasticity of Substitution (CES) of primary factors, and the aggregate intermediary input is a LEO function of disaggregated intermediate inputs that can be domestically produced or imported.

Household consumption covers marketed commodities, purchased at market prices, and home consumed commodities valued at their opportunity cost, i.e., the activity specific producer prices.[7] This feature accounts for the simultaneous decision making process of households as

[6] We use the LEO alternative as the default for all activities. It should be noted, however, that a CES alternative at the top of the technology nest may be preferable for particular sectors if evidence supports the idea that available techniques allow for the variation in the aggregate mix of value-added and intermediate inputs.

[7] The standard SAM only disaggregates home consumption by activity and household, not by commodity, activity, and household. In the regional SAM households consume from activities that produce multiple outputs. To

producers and consumers of certain commodities. That and the use of activity specific producer prices for home commodities and market prices for purchased commodities implicitly addresses the non-recursive nature of the household decision making process in this model. Household consumption behavior of market and home commodities is modeled according to Linear Expenditure System (LES) demand functions, derived from maximization of a Stone-Geary utility function subject to a consumption expenditure constraint.[8]

Other equations include a set of constraints that have to be satisfied by the system as a whole, but are not necessarily considered by any individual actor. Such constraints cover markets for products and factors,[9] and macro aggregates, i.e., savings-investment balance, government budget, and the balance of the current account of the rest of the world. The default closures in the regional model are chosen to best resemble the circumstances in the regional economy. For the savings-investment balance, we assume a savings driven closure, under which investment is determined from available savings from households and the local government. This implies that investment is endogenous and self-financed by the region. This is a reasonable assumption, given the missing and incomplete credit markets in rural Mozambique (Benfica, 2006). The local government account balances assuming fixed direct tax rates and flexible savings. Finally, for the rest of the world account we assumed fixed foreign savings and a flexible exchange rate regime.[10]

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accommodate that, non-SAM data are needed to allocate home consumption across the commodities produced by each relevant multiple-output activity. Shares of home consumption of household farm outputs are derived from survey data for each agricultural, fishing and livestock activity.

[8] This utility function is a generalization of the Cobb-Douglas function and incorporates the idea that certain minimum amounts of each good must be bought.

[9] The model offers alternative factor market closures, i.e., mechanisms for equilibrating supply and demand in specific factor markets (land, labor, or capital). They include full employment with full mobility, unemployment with full mobility and market segmentation. A options used in this model are discussed later in the paper.

[10] Typically, a regional (sub-national) economy relates to two government sectors (local and central) and two rest of the world accounts (domestic and foreign). The flows in the SAM capture that feature.

3.3. Representative Households and Poverty Analysis in a CGE Framework

The ZVR-CGE incorporates information on how representative household groups earn and spend their incomes. Such information, including the rules governing factor markets, and household heterogeneity with respect to factor endowments, demographic composition, consumption patterns and market access, is important to assess the impact of exogenous shocks. Lofgren et al. (2003) point out three features necessary for such a framework. First, it must include shocks that are of interest regarding their potential differential impact on household groups. Second, it should be able to capture the impact of shocks on the extended functional distribution of incomes; the distribution of incomes across disaggregated factors that remunerate the household groups on the basis of ownership. Finally, it must map from this extended distribution across factors to household incomes with enough detail to generate information about the size distribution needed to capture poverty and inequality measures.

Approaches to undertake poverty analysis in a general equilibrium framework can be aggregated into two major categories: Micro-Simulation (MS) and Representative Household (RH) approaches. Each category has many variants.[11] The essence of the MS approach is to model the behavior of the individual agents, households and/or firms, using a micro database linked to the standard CGE model through an integrated CGE/Micro-simulation model or, in a sequential fashion, with the CGE model feeding the micro-simulation model with price, income and employment data. Under the RH approach, a separate module generates, for each simulation, results for individual household income/expenditure by drawing on (1) a distribution function with known parameters and known representative household incomes; or (2) individual survey observations scaled using simulated changes in representative household income from the CGE

[11] It should be noted that no single approach dominates and the choice is predominantly dependent upon informational demands and operational constraints that vary across applications.

model simulation results. Then, the results are used to perform standard poverty and inequality analysis. In this paper, given the nature of the available data and the implied operational feasibility, we choose to use the RH approach.

Our ZVR-CGE divides the households in two groups based on their diversification into cash cropping under contract. The RH approach assumes that, following an external shock in the economy, the intra-group distributions shift proportionally with the change in mean income. This means that the variance of each distribution is considered fixed, and exogenous to the model: if a shock increases mean income by δ, the income of each household within a group is raised by δ.

Previous literature reports cases of significant changes in intra-group distributions in Asia in the mid-1980s (Huppie and Ravallion, 1991) and following the financial crisis of the 1990s. However, more recent evidence suggests that inequality increases as often as it falls during spells of growth in developing countries, and that neutrality is a defensible first-order approximation (Ravallion and Chen, 1997; Decaluwé *et al.*, 1999).[12] In the absence of compelling evidence in either direction in Mozambique, we adopt this neutrality assumption in our analysis.[13]

The procedure allows us to undertake a comparative analysis of the poverty income situation pre- and post-simulation. Such analysis can be done using (1) the Foster, Greer and Thorbecke (F-G-T) P_α class of decomposable poverty measures that allow the measurement of the proportion of the poor in the population (poverty incidence or head count ratio) and the depth and severity of poverty (poverty gap and squared poverty gap); or (2) the graphical comparative illustration on pre- and post-simulation cumulative distribution functions (CDFs) of income.

[12] In a cross-country setting, Gugerty and Timmer (1999) found that whether inequality raises or falls depends on the initial distribution of assets; the broader the initial distribution of assets the more pro-poor are the effects of growth.
[13] Dervis de Melo and Robinson (1982), stress that the complete endogenization of intra-group distributions following shocks remains one of the biggest modeling challenges in studying income distribution in a general equilibrium context.

Following Deaton (1997), we choose the second approach.[14] This approach allows for the visual comparison of the impact of alternative simulations relative to the base. It also allows us to depict how income differentiation changes among household groups following shocks to the economy, by looking at pairs of CDFs (e.g., for different household groups) at the base relative to post shock scenarios.

4. Policy Simulations

To assess the impact of expansion of cotton activity, and of alternative policies in the sector on household per capita incomes, we have to consider a number of alternatives with respect to the availability of resources, and their allocation and mobility across various economic activities. The ZVR-CGE accomplishes this by defining the specific mechanisms that guide factor market adjustments in the presence of exogenous shocks. In Mozambique in general, and in the Zambezi Valley economy in particular, the issue of availability and mobility of resources is important for various reasons. Post war growth in agriculture has been primarily due to area expansion (significant relative to the base, though still limited relative to its potential full employment) and growth in the labor force growth, with limited gains in crop productivity.

There are some fundamental questions in this context. First, under what endowment/ mobility scenarios can the Zambezi Valley cotton economy continue to grow? In other words, can the simple injection of additional resources by the contract farming companies, without continued growth in land and labor supply and/or gains in the productivity of the existing resources, ensure growth in cash crop production that is capable of generating broad based growth in the regional economy? Second, how do changes in world market conditions, e.g.,

[14] In a CDF, the vertical axis goes from 0 to 100 and the horizontal axis shows our income measure. Suppose that we have a sample of 100 households (or people) ordered from poorest to richest. The CDF is just the graph of the observation number (which corresponds to percentile in this case) and the income measure. Under that approach, if a shock leads the entire CDF to shift to the right then the new economic environment stochastically dominates the base.

fluctuations in import prices of inputs and export prices of outputs, affect the regional economy? Finally, how do all these changes compare to each other regarding their effects on household income poverty levels?

In this analysis, we consider the following shocks: (a) increased investment by cotton companies in support of smallholder production;[15] (b) productivity gains in cotton; (c) changes in world market conditions for tradable goods, e.g., an increase in import prices for intermediate inputs (pesticides and seeds) and an increase in cotton and maize grain export prices; and (d) changes in government trade policy with respect to the cotton sector, e.g., an export tax.

The choice of experiments was based on an assessment of their importance for the current policy debate in Mozambique, ensuring a mix of exogenously determined variables, such as world prices,[16] discretionary variables like export taxes, and variables that can be influenced by private sector actions such as productivity and the level of capital injections in cash cropping schemes. It is assumed that the Government may have the ability to influence private sector decisions through incentive mechanisms.

4.1. Base Simulation Results

We initially examine the individual simulations under each alternative endowment/ mobility scenario; then we combine simulation "a" (increased investment by the cotton company in smallholder production) with each of the other simulations. The endowment/mobility scenarios include: (a) full employment with full mobility of all factors; (b) full employment of capital with unemployment and full mobility of labor and land; and (c) unemployment and full

[15] This includes the implicit increase in activity specific capital, resulting from increased support by firms to smallholders in terms of extension assistance and other support that increases their managerial ability. In reality, it is in fixed proportion to intermediate inputs in those activities, reflecting, therefore, a proportionally similar increase in the supply of intermediates by firms to smallholders.

[16] Note that world market conditions may actually change in an opposite direction. Therefore, one should keep in mind that there can be a change in the direction of the effects shown here. For example, a drop in world cotton/tobacco/maize prices will hurt household incomes and a decrease in import prices for inputs will be beneficial.

mobility of all factors, except activity specific contract farming capital that is assumed fully employed at the post shock level. Note that the unemployment scenario (c) implies that resources can be brought into production to meet any demand from expanding activities. Results for the three scenarios are presented in Tables 5.

Table 5. Effects on Household Income of Alternative Simulations: Cotton Areas

Simulations	--- % Changes in Household Income per capita ---					
	Full Employment		Semi-Unemployment		Unemployment	
	Non-growers	Growers	Non-growers	Growers	Non-growers	Growers
Individual Shocks:						
C. Farming Capital	1.03	-1.92	4.43	1.22	14.20	13.46
Productivity	1.02	2.14	6.23	9.93	14.48	23.10
Export price – Cotton	0.64	2.06	2.21	4.07	5.71	9.33
Export price – Maize	1.80	2.12	4.71	5.42	21.44	31.06
Import price – Inputs	-0.11	-0.21	-0.32	-0.45	-1.17	-1.56
Export tax – Cotton	-0.16	-1.61	-1.02	-2.52	-2.20	-3.98
Combined Shocks:						
Productivity	1.34	0.30	6.06	5.84	31.20	40.46
Export price – Cotton	1.93	-0.25	7.81	5.70	20.54	23.71
Export price – Maize	2.84	0.06	3.38	1.30	39.83	49.94
Import price – Inputs	0.91	-2.10	4.00	0.75	12.88	11.72
Export tax – Cotton	0.65	-3.31	2.35	-1.86	11.39	8.59

Notes: The individual shocks are 15% in each case. The combined shocks include a 15% expansion in contract farming capital with another 15% shock. The Simulations use a Flexible Exchange Rate Closure. Source: ZVR-CGE Model Simulations.

We find that under full employment of all factors, scenario (a), economic expansion is very limited. Even if we assume that the existing factors are 15% more productive, the effects on household income are very limited, and we find little mobility of factors across activities. Likewise, the effects of changes in world market conditions, although of the expected sign, are small. Under closure (b) the effects are more sizable. In scenario (c), where all factors are assumed to be available for use in the expansion process, we observe that household incomes are responsive to the various shocks. This closure also shows some important indications of indirect

effects of shocks in cash cropping sectors on non-grower households in the adjustment process through the marketing mechanisms.

We argue that closure (c) is the most realistic assumption in the Zambezi Valley, for three reasons. First, there are still localities in the study area that are not part of the concession system, leaving room for further expansion of land and labor. Second, an increasing number of people from other parts of Mozambique are willing to migrate to production areas if the returns are compensating. Urban unemployment and lack of economic opportunities are very real in Central Mozambique. Finally, within each area, the proportion of arable land still uncultivated is relatively high, which means that more land can be brought into production if additional labor is available in the region and if capital is made available by outgrower companies. Therefore, in the analysis that follows, we assume that all factors are fully mobile and available for use, following an injection of activity specific capital combined with a series of other shocks.[17] Table 6 summarizes the list of shocks and the effects on incomes per capita by household type.[18]

Table 6. Effects of Simulations, assuming Unemployment and Full Mobility of Factors

Simulations	Shock (% Change)	--- % Changes in Income per capita --- Household Types	
		Non-grower Households	Grower Households
Cotton Areas			
Contract Farming Capital	15.0	14.20	13.46
+ Productivity	15.0	31.20	40.46
+ Cash Crop Export price	15.0	20.54	23.71
+ Export price – Maize	15.0	39.83	49.94
+ Import price – Inputs	15.0	12.88	11.72
+ Export tax	15.0	11.39	8.59

Source: Zambezi Valley CGE Model Simulation Results.

[17] The CGE model simulations are implemented using GAMS and the Poverty analysis using the DAD (Distributive Analysis/Analyse Distributive) Software.

[18] These results are based on a flexible exchange rate closure for the rest of the world.

For simplicity, we set all shocks at 15% of their base values. In the analysis that follows, we use the stochastic dominance approach described earlier whose outcomes mirror the results in the Table. We examine the impacts of each shock on the incomes of the two household groups and examine the mechanisms through which they arise. Model results should be taken as representative of the direction in which a system will begin to change towards a new equilibrium until some (different) shock sets it on still another path; the length of run for the impacts to take effect is therefore undefined. Population is assumed constant during the adjustment process.

4.2. Poverty Effects

Household income levels in cotton areas are relatively less responsive to economic shocks than those in tobacco areas as reported in Benfica (2006). A fifteen percent injection of activity specific capital, without changes in cotton prices and the levels of productivity, increases household incomes by about 14% for both growers and non-growers. Note that while grower income growth is predominantly attributable to direct effects, non-grower incomes grow as a result of indirect effects.[19] If that expansion is accompanied by a 15% gain in cotton productivity, income growth is substantially higher; 31.2% among non-growers and 40.5% among cotton growers. An increase in the cotton export price increases income by about 20% among non-growers and only 24% among growers. Figures 7 through 9 compare poverty impacts using CDFs for all households and separately for growers and non-growers. The CDFs are directly computed using the results presented in Table 6 and averages across all households.

[19] Increases in incomes are a result of a combination of changes (positive or negative) in quantities of factors used, and also changes (positive or negative) in wages/rents of those factors resulting from the adjustment process. Those incomes are remunerated to households in proportions corresponding to their original factor endowments.

Figure 7

Comparison of Poverty Effects of Simulations, Cotton Areas

Expansion, Productivity and Export Price

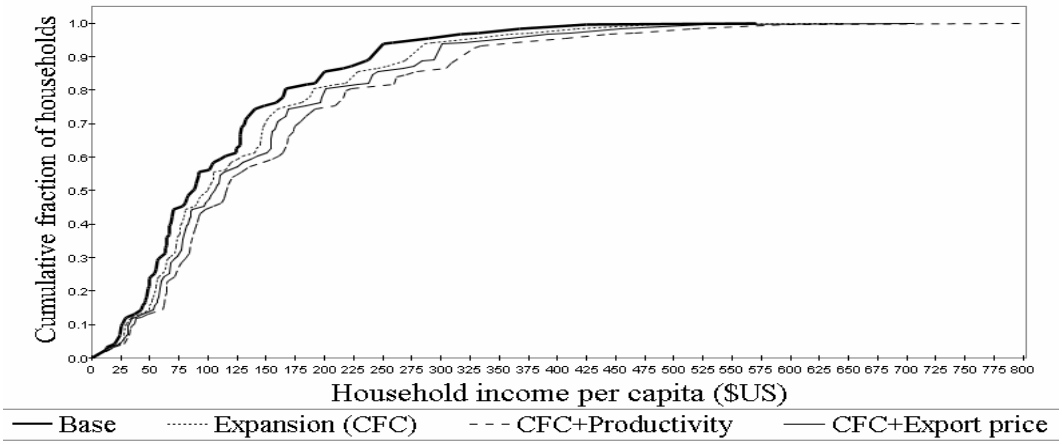


Figure 8

Comparison of Poverty Effects of Simulations, Cotton Growers

Expansion, Productivity and Export Prices

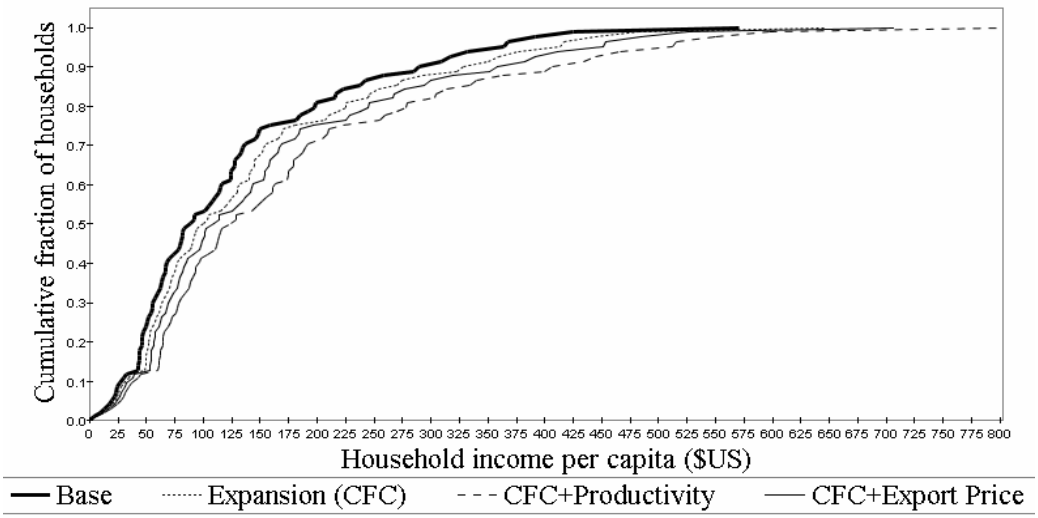
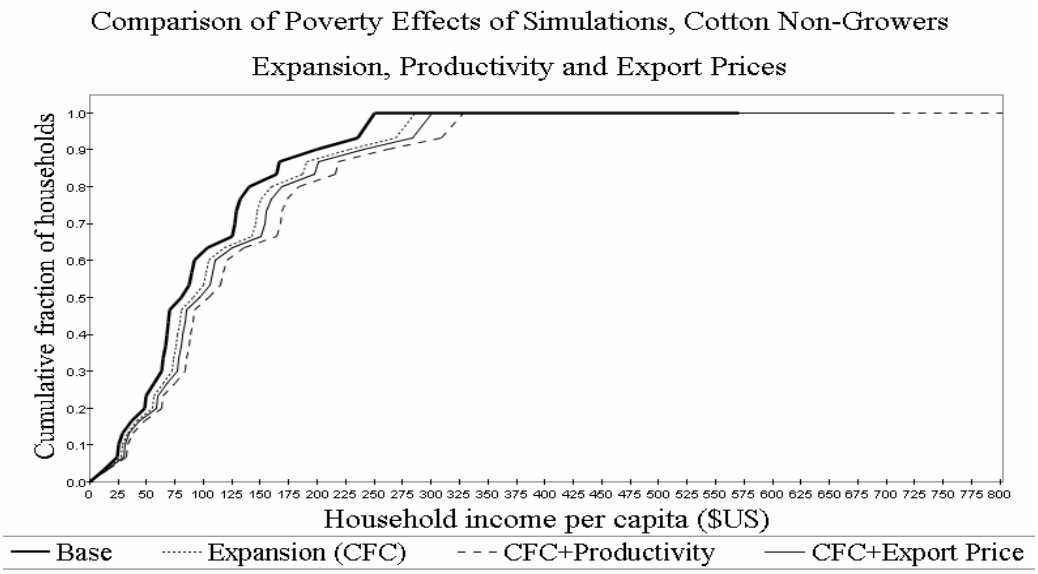


Figure 9



As expected, all these expansions generate additional demand for goods and services proportional to the increases in income for each group, but with variation across the different items reflecting household consumption demand patterns. We observe an expansion in the level of economic activity in all sectors. For example, in the case of expansion with productivity gains, direct increases in production and value-adding activities in cotton (averaging 44%) are higher than increases in activity of other sectors such as non cash cropping agriculture (32%), livestock, fishing, food processing, manufacturing, and services, that range from 34-37%. These impacts are detailed in Table 7, along with results for other simulations. The Table also shows the base period shares in economic activity.

Table 7. Base Shares and Changes in the Level of Activity by Simulation

Economic Activities	Base Activity Level (%)	Changes in Economic Activity by Simulation				
		Expansion Only	Expansion w/ Productivity	Expansion w/ Export Price	Expansion w/ Input Price	Expansion w/ Export Tax
Cotton Farms – C.N.A.	24.6	14.6	44.7	20.2	13.7	10.1
Cotton Farms – Dunavant	3.7	14.5	42.7	19.7	13.6	11.1
Non-Cotton Farms	33.9	14.7	32.4	21.3	13.2	12.8
Livestock	7.9	14.6	35.2	21.4	13.2	12.1
Fishing	5.6	14.5	35.7	22.1	13.0	11.8
Food processing	2.2	14.5	36.6	21.4	13.1	11.8
Beverage processing	1.4	16.0	34.1	15.5	15.4	14.4
Other Processing	2.7	14.4	36.4	22.2	12.9	11.6
C.N.A.–Marketing/Export	4.5	14.6	44.7	20.2	13.7	10.1
Dunavant/Marketing/Export	0.5	14.5	42.7	19.7	13.6	11.1
Trading Services	5.0	14.9	37.9	20.1	13.7	11.9
Government Services	2.4	14.4	36.2	22.4	12.9	11.6
Other Services	5.4	14.5	35.6	22.1	12.9	11.8
Total	100.0					

Source: Base year ZVR-SAM and ZVR-CGE Model Simulations

The quantity of factors demanded from cotton activities is weaker in percentage terms than the demand generated in other sectors. In fact, Table 8 shows that factor demand by cotton cropping activities increases by 26%, while demand for factors among non-cash cropping farming activities increases 32.4%; factor demand from non-farming activities it grows by 32%-38%. In contrast, an expansion without productivity gains but with an increase in cotton export prices increases factor demand by 20%-22% across all economic activities. Table 9 shows how factors are allocated across the different activities in the base period.

Table 8. Changes in Demand for Factors from Activities by Simulation

Economic Activities	% Change in Demand for Factors by Simulation				
	Expansion Only	Expansion with Productivity	Expansion with Export Price	Expansion with Input Price	Expansion with Export Tax
Cotton Farms – C.N.A.	14.6	27.4	20.8	13.5	9.8
Cotton Farms – Dunavant	14.5	25.7	20.4	13.4	10.8
Non-Cotton Farms	14.7	32.4	21.3	13.2	12.8
Livestock	14.6	35.2	21.4	13.2	12.1
Fishing	14.5	35.7	22.1	13.0	11.8
Food processing	14.6	36.6	21.4	13.1	11.8
Beverage processing	16.0	34.1	15.5	15.4	14.4
Other Processing	14.4	36.4	22.2	12.9	11.6
C.N.A.–Marketing/Export	14.6	44.7	20.2	13.7	10.1
Dunavant/Marketing/Export	14.5	42.7	19.7	13.6	11.1
Trading Services	14.9	37.9	20.1	13.7	11.9
Government Services	14.4	36.2	22.4	12.9	11.6
Other Services	14.5	35.6	22.1	12.9	11.8

Source: Base year ZVR-SAM and ZVR-CGE Model Simulations

Table 9. Base Factor Use Shares by Activity, Cotton Areas

Economic Activities	Use of Production Factors (Allocation across Activities) ---- % of Total Base Year ----					
	Land	Family labor PreHarvest	Family labor PostHarvest	Wage PreHarvest	Wage PostHarvest	Capital
Cotton Farms – C.N.A.	37.9	23.1	23.8	13.4	46.6	20.4
Cotton Farms – Dunavant	4.9	4.8	2.0	4.4	3.9	4.2
Non-Cotton Farms	57.2	41.1	19.0	41.5	15.8	44.9
Livestock	0.0	11.3	12.9	3.9	3.3	0.0
Fishing	0.0	7.4	11.5	6.6	5.0	10.7
Food processing	0.0	1.1	2.3	4.0	0.3	1.0
Beverage processing	0.0	2.0	3.7	0.0	0.1	0.7
Other Processing	0.0	4.1	7.9	0.7	1.3	4.8
C.N.A.–Marketing/Export	0.0	0.0	0.0	0.3	0.8	0.8
Dunavant/Marketing/Export	0.0	0.0	0.0	0.0	0.1	0.1
Trading Services	0.0	1.1	2.6	9.1	8.6	10.0
Government Services	0.0	0.0	0.0	13.1	9.9	0.0
Other Services	0.0	3.9	14.3	2.9	4.4	2.4
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: ZVR-CGE Model Simulations.

The resulting changes in factor remunerations (additional value of factor payments at market wage/rents) under the productivity gain path are fairly balanced, reflecting variations in

wages/rents; remuneration increases about 30% to land, 33% to family labor (31% for pre-harvesting labor and 33% for harvesting and post harvesting), and 32% for wage labor (33% for pre-harvesting labor and 31% for harvesting and post harvesting). Returns to activity specific capital average 200%, reverting exclusively to grower groups (see Table 10). While land is evenly distributed, non-growers, as the most populous group, have most of the labor available in the economy, and benefit from wage labor, particularly in the first part of the season (pre-harvesting) when this group supplies over half of the wage labor used on cotton. In the post harvest period, the initial employment between the two groups is quite similar with each group supplying about half of the labor.

Table 10. Base Shares and Changes in Factor Remunerations, by Simulation

Households and Factors	Base Structure (%)	Changes in Factor Remunerations by Simulation				
		Expansion Only	Expansion with Productivity	Expansion with Export Price	Expansion with Input Price	Expansion with Export Tax
COTTON HOUSEHOLDS						
Land	27.2	14.7	30.2	21.1	13.3	11.6
Family Labor, Pre-harvesting	25.4	14.7	31.9	21.1	13.3	11.8
Family Labor, Harvesting/Marketing	13.9	14.6	32.9	21.2	13.3	11.6
Wage Labor, Pre-harvesting	11.0	14.6	33.1	21.3	13.2	11.9
Wage Labor, Harvesting/Marketing	14.5	14.6	31.3	21.1	13.3	11.0
Capital	1.7	14.7	34.2	21.2	13.2	12.4
Activity Specific Capital	6.4	10.5	200.0	85.0	0.75	-24.0
TOTAL	100.0					
NON-COTTON HOUSEHOLDS						
Land	18.2	14.7	30.2	21.1	13.3	11.6
Family Labor, Pre-harvesting	29.5	14.7	31.9	21.1	13.3	11.8
Family Labor, Harvesting/Marketing	16.8	14.6	32.9	21.2	13.3	11.6
Wage Labor, Pre-harvesting	13.4	14.6	33.1	21.3	13.2	11.9
Wage Labor, Harvesting/Marketing	9.8	14.6	31.3	21.1	13.3	11.0
Capital	12.3	14.7	34.2	21.2	13.2	12.4
TOTAL	100.0					

Source: Base year ZVR-SAM and ZVR-CGE Model Simulations

This is a clear indication that productivity increases in cotton production improve prospects for expansion not only in the sector itself, but also in other sectors of the economy where resources can be productively employed, which leads to greater possibilities for increased household incomes irrespective of cash cropping status. As pointed out in the beginning of this section, any expansion in cotton production results in some indirect employment effects to non-growers, even when benefits to growers are limited.

A somewhat surprising result in cotton areas is that the effects of adverse circumstances are less severe than in tobacco areas, although, as indicated in the Figures for both groups, poverty is more severe as compared to other scenarios. For example, an increase in import prices of inputs (combined with the 15% increase in capital) reduces income growth in cotton areas from 14% to an average of 13% among non-growers and 12% among growers and barely affects the poverty results; simulations for tobacco (Benfica, 2006) show larger reductions in income growth, from 18% to an average of 9% among non-growers and 6% among growers, and in poverty reduction. A likely reason for these differential effects across crops is that the cotton input package is much cheaper than the package for tobacco. The export tax has also a relatively small impact on poverty, but as expected grower households are relatively more negatively impacted. Cumulative distribution functions comparing effects of the various simulations are presented for all households in cotton areas (Figure 10), as well as for growers (Figure 11) and non-growers (Figure 12).

Figure 10

Comparison of Poverty Effects of Simulations, Cotton Areas

Expansion, Import Price of Inputs and Export Tax

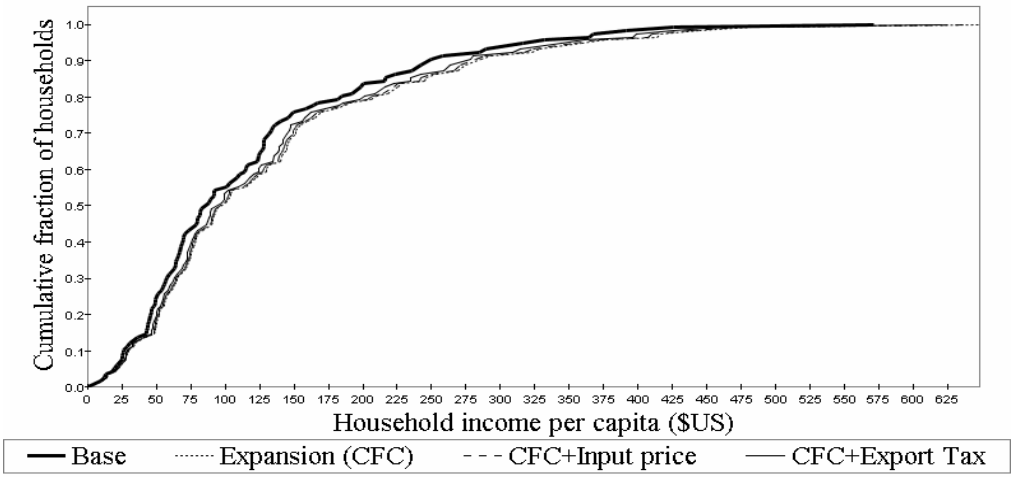


Figure 11

Comparison of Poverty Effects of Simulations, Cotton Growers

Exoansion, Import Price of Inputs and Export Tax

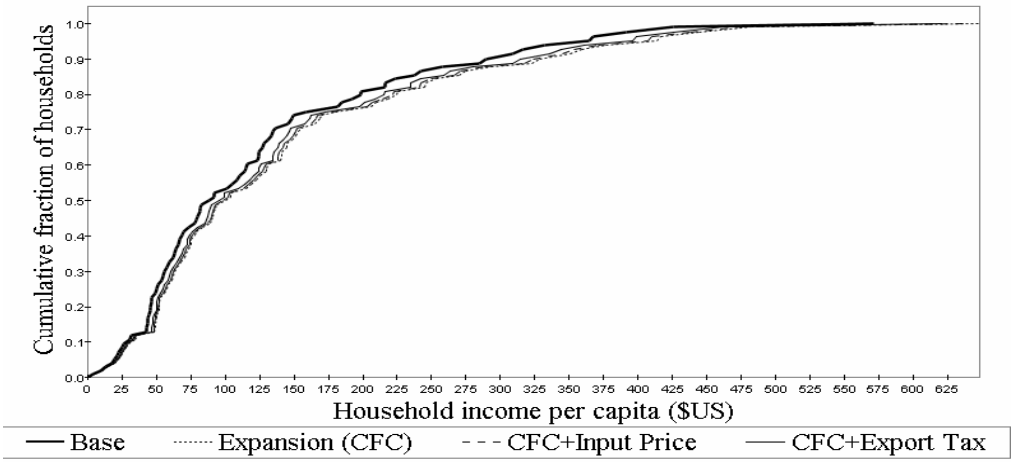
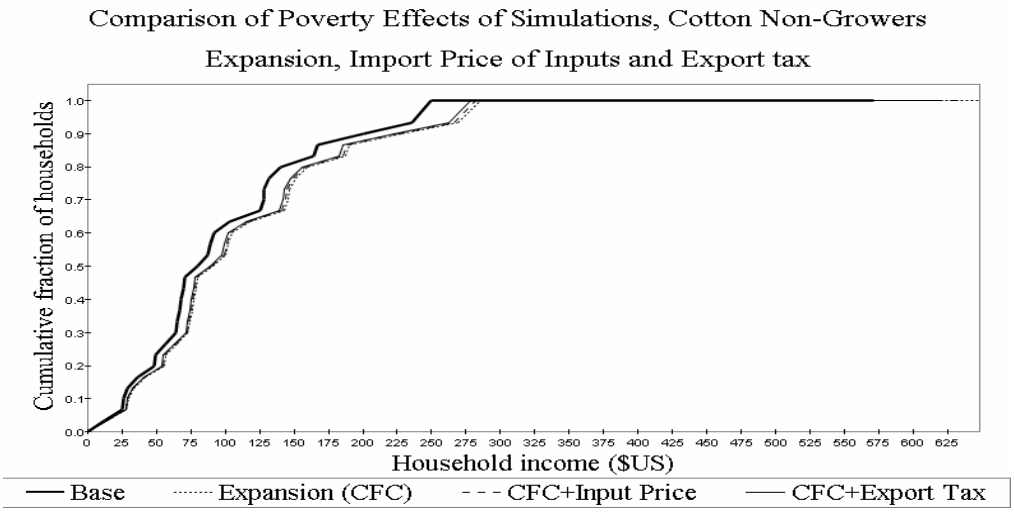


Figure 12



5. Policy Implications

Cotton contract farming provides about 250,000 households – over a rural million people – with a secure source of cash income in areas where alternative income generating activities are limited. The cotton sector is currently faced with a number of pressing issues. In this section we look at those issues as they relate to the analysis presented in the paper and the relevant implications for poverty reduction in the study region. Such issues include the implications of a cotton sector recovery that relies on enhanced productivity, and trade issues including the import prices of inputs, export prices of maize and tobacco, and government export taxes.

Several studies in the cotton sector have emphasized low prices and poor productivity at the farm level as factors leading to the stagnation of cotton farmer incomes in Mozambique (World Bank, 2005; Tschirley *et al.*, 2005). [20] This study documents the low profitability of the

[20] In fact, Mozambique pays the lowest prices in the region; the 1998-2002 average producer prices were $0.16 per kilogram, compared to $0.22 in Zambia and Tanzania and $0.25 in Zimbabwe (Poulton *et al.*, 2004). Likewise, yields are amongst the lowest in Africa; 0.51 tonnes per hectare in 2003/04, compared to 0.9 tonnes in Zimbabwe

crop relative to tobacco in the Zambezi Valley region. The concession model as applied in Mozambique, which precludes competition among companies and does not balance this with any effective performance monitoring system, must be considered an important contributor to the problem of low prices and also low productivity (Tschirley et al, 2006; Poulton et al. 2004); management subjected to little or not competitive discipline will be able to transfer inefficiency costs to farmers through low prices.

Economy-wide simulation results indicate that, although limited when compared to tobacco areas, expansion in the cotton sector, even when benefits to growers are small, generates some expansion in non-cotton sectors where resources are productively employed. When that expansion is accompanied by productivity gains in cotton there is a much stronger broad-based income growth and poverty reduction effect, even greater than increased world prices. From a policy standpoint, because sustained increases in world prices are unlikely, this result is encouraging. All this suggests that continued expansion efforts in cotton focused on dealing with institutional issues and productivity enhancing technologies, as they succeed, will increase those benefits significantly. Interventions to improve the business environment for the emergence and sustained growth of non-farm businesses are also important to fuel further growth.

Lastly, a set of additional policy considerations are worth pointing out. First, although results indicate limited negative effects of high import prices for cotton inputs, measures aimed at reducing the costs of importation and transport are highly encouraged, as they can help minimize any negative effects from factors outside the control of domestic agents. Second, maize is important both as a food security crop and a cash crop in these areas. Simulation results

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and over 1.0 tonne in West Africa (Lemaitre et al., 2001). Tschirley et al (2006) assess the impacts of the sector's regulatory structure on this performance.

indicate that better export prices for maize reduce poverty across all groups. Therefore, continuation of the current open borders policy is important.[21]

Finally, it is important to emphasize the need for complementary research in key aspects that fall outside the scope of this paper but which are crucial for the advancement of the sector and for its sustained positive impact on broad based income growth and poverty reduction. We suggest that strategies that emphasize improved coordination for facilitating investments in research and extension combined with area expansion and increased productivity and quality at the farm level should be identified and encouraged.[22] Research needs to continue focusing on the analysis of the implications of the current market and regulatory structure for competition and sector coordination, and suggest ways to overcome current constraints to maximize the effects of interventions on rural poverty.

REFERENCES

Arndt, C. (2002). *HIV/AIDS, Human Capital, and Economic Prospects for Mozambique*. International Food Policy Research Institute, TMD Discussion paper # 88.

Arndt, C. (2005). *The Doha Trade Round and Mozambique*. World Bank Policy Research Working Paper No. 3717 http://ssrn.com/abstract=821406

Benfica, R. (2006). An Analysis of Income Poverty Effects in Cash Cropping Economies in Rural Mozambique: Blending Econometric and Economy-wide Models. Ph.D. Dissertation. Michigan State University.

Benfica, R., D. Tschirley, and Duncan Boughton (2006). *Contract Farming in Cotton Economies: The Determinants of Farmer Participation and Performance in Rural Mozambique*. (Forthcoming).

[21] Episodes of trade restrictions, particularly in border areas, have been more common as local practice than as an official central government policy; the latter is openly favorable to free trade. It is, therefore, important that government be more active in ensuring that local authorities do not inhibit maize trade.

[22] That can be achieved with high yielding quality seeds, the strengthening of extension systems for disseminating good field practices and grading standards, and sufficiently remunerative producer prices to ensure a continued and increasing participation of farmers in the sector.

DAD 4.2 : Distributive Analysis/Analyse Distributive – User's Manual (2003). Software developed by Jean-Yves Duclos and Araar Abdelkrin, and Programmed by Araar Abdelkrin and Carl Fortin (Université Laval – MIMAP Project)

Deaton, A. (1997). *The Analysis of Household Surveys: A Microeconometric Approach to Development Policy*. Published by The John Hopkins University Press for The World Bank.

Decaluwé, B., A. Patry, L. Savard and E. Thorbecke (1999). *Poverty Analysis Within a General Equilibrium Framework.* Working Paper 9909, CRÉFA 99-06.

Delgado, C., J. Hopkins and V. Kelly (1998). *Agricultural Growth Linkages in Sub-Saharan Africa.* IFPRI, Research Report Number 107.

Dervis, K., J. de Melo and S. Robinson (1982). *General Equilibrium Models for Development Policy*. Part II: Computable General Equilibrium Models. Cambridge University Press.

Gugerty, M., and C.P. Timmer (1999). *Growth, Inequality and Poverty Alleviation: Implications for Development Assistance*. Mimeo.

Huppie, M. and M. Ravallion (1991). *The Structural Structure of Poverty During an Adjustment Period: Evidence for Indonésia in the Mid-1980s.* World Development 19 (12).

Lemaitre, P., Fok, M. and Jeje, J.J. (2001). *Cotton Sub-sector Study*. Final Report. Maputo: IAM.

Lofgren, H., R. Harris and S. Robinson (2002). *A Standard Computable General Equilibrium (CGE) Model in GAMS*. IFPRI - Microcomputers in Policy Research, No.5.

Lofgren, H., S. Robinson, and M. El-Said (2003). *Poverty and Inequality Analysis in a General Equilibrium Framework: The Representative Household Approach*. Chapter 15 - The World Bank toolkit.

Lofgren, H., and S. Robinson (1999). *Non-separable Household Decisions in a computable General Equilibrium Model*. American Journal of Agricultural Economics, Vol. 81 (3): 663-670.

Poulton, C., P. Gibbon, B. Hanyani-Mlambo, J. Kydd, W. Maro, M. Larsen, A. Osorio, D. Tschirley and B. Zulu (2004). *Competition and Coordination in Liberalized African Cotton Market Systems*. World Development Vol. 32, No. 3, pp. 519–536.

Pyatt, G. and J. Round (1979). *Accounting and Fixed Price Multipliers in a Social Accounting Framework*. Economic Journal Volume 89 (356): 850-873.

Ravallion, M., and S. Chen (1997). *What Can New Survey Data Tell Us About Recent Changes in Distribution and Poverty*. The World Bank Economic Review, 11.

Robinson, S., A. Cattaneo and M. El-Said (1998). *Estimating a Social Accounting Matrix Using Cross Entropy Methods*. International Food Policy Research Institute, TMD Discussion paper # 33.

Stone, R. (1978). *The Disaggregation of the Household Sector In the National Accounts*. World Bank Conference on Social Accounting Methods In Development Planning, Cambridge.

Tarp, F., C. Arndt, H. Jensen, S. Robinson and R. Heltberg (2002). *Facing the Development Challenge in Mozambique: An Economywide Perspective*. IFPRI Research Report # 126.

Taylor, J. Edward, G. Dyer and A. Yunez-Naude (2005). *Disaggregated Rural Economywide Models for Policy Analysis*. World Development, Volume xx, No. xx, xxx-xxx (In the Press).

Taylor, J. E., A. Yunez-Naude, and G. Dyer (1999). *Agricultural Price Policy, Employment, and Migration in a Diversified Rural Economy: A Village-Town CGE Analysis from Mexico.* American Journal of Agricultural Economics, 81, 653-662.

Thorbecke, E. (1998). *Social Accounting Matrices and Social Accounting Analysis* (Chapter 7, in *Methods of Interregional and Regional Analysis*, by Isard, W., I. Azis, M. Drennan, R. Miller, S. Salzman, and E. Thorbecke. Ashgate Publishing Company, Brookfield, VT.

Tschirley, D., A. Ofiço, and D. Boughton (2005). *Mozambique Country Study*. Collaborative Research Project on Competition and Coordination in Cotton Market Systems in Southern and Eastern Africa.

Tschirley, D., C. Poulton and D. Boughton (2006). *The Many Paths of Cotton Sector Reform in Eastern and Southern Africa: Lessons from a Decade of Experience*. MSU International Development Working Paper No. 88. East Lansing. http://www.aec.msu.edu/agecon/fs2/papers/idwp88.pdf.

World Bank (2005). Study on Contract Farming and Supply Chain Financing in Mozambique