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MARKETING MARGINS AND AGRICULTURAL TECHNOLOGY IN MOZAMBIQUE

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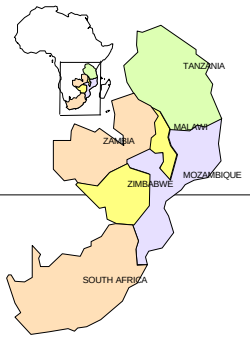

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ABSTRACT

Improvements in agricultural productivity and reductions in marketing costs in Mozambique are analysed using a computable general equilibrium (CGE) model. The model incorporates detailed marketing margins and separates household demand for marketed and home-produced goods. Simulations improving agricultural technology and lowering marketing margins yield gains across the economy, but with differential impacts on factor returns. A combined scenario reveals significant synergy effects, as welfare gains exceed the sum of gains from the individual scenarios. Factor returns increase in roughly equal proportions, an attractive feature when assessing the political feasibility of policy initiatives.

Keywords: Computable general equilibrium (CGE), home consumption, agricultural technology, marketing margins.

JEL codes: D58, O13, Q18

TABLE OF CONTENTS

1. Introduction

Widespread poverty is characteristic of rural areas in Mozambique where the vast majority of the population lives and where much of the economy's economic activity takes place. Mozambique has only recently recovered from the devastating effects inflicted by the war of the 1980s and early 1990s, and the economic infrastructure is extremely underdeveloped. In this environment, improving the marketing infrastructure and agricultural production technologies are critical challenges in promoting growth and poverty alleviation. Furthermore, agricultural technology and marketing improvements are likely to interact. The limited market access of poor, small-scale farmers makes it difficult for them to purchase intermediate inputs like improved seed and simple investment goods like tools for cultivation, which could increase the productivity of their farming methods.

This paper presents a quantitative assessment of the potential benefits from increases in the productivity of the agricultural sector and improvements to marketing networks. The analysis is based on a computable general equilibrium (CGE) model designed to capture important structural features of Mozambique. The model explicitly incorporates separate marketing costs for imports, exports, and domestic sales. Agriculture is disaggregated into eight sub-sectors. Household demand is split between marketed goods and home-consumption of own production, valued at production cost rather than market prices.

The model is based on a recent Social Accounting Matrix (SAM) for Mozambique, an aggregate version of which is presented in the Appendix A (Arndt, Cruz, Jensen, Robinson, and Tarp, 1998). Appendix B outlines all model equations. Some of the CGE model elasticity parameters were estimated using a new maximum entropy estimation approach that uses scarce information efficiently in a data-poor environment (Arndt, Robinson, and Tarp, 1999).

The SAM data show that marketing margins for some sectors are as high as three times the producer price in 1995, and they are especially large for primary agricultural production. These marketing costs represent wedges between producer and purchaser prices, and partly explain why more than half of agricultural production remains non-marketed. Since the vast majority of the Mozambican population relies on agricultural production for their livelihood, there is potential for very large income gains through improved market integration in rural areas. One would expect synergy between a poverty-reducing strategy of increasing agricultural productivity combined with parallel improvements in the marketing infrastructure.

The country background of Mozambique is set out in Section 2. The SAM data base and the CGE model are described in Section 3, followed by a presentation of the simulation results in Section 4. Section 5 concludes.

2. Country of Origin

Mozambique has recently emerged from war, regional conflict, and dramatic changes in the dominating political ideology. Much of the rural economic and social infrastructure was destroyed by war. Large parts of the rural agricultural areas were effectively cut off from the rest of the economy, and many rural people were driven away from their homes to seek refuge in safer urban areas and neighbouring countries. Following the peace agreement in 1992 and the first free general elections in 1994, there was a massive return of displaced people to rural agricultural areas. This has played an important role in the recovery of aggregate agricultural production during recent years. Nevertheless, production technologies employed by most farmers remain rudimentary. Intermediate inputs account for less than 13 percent of total costs in agriculture, while value added accounts for more than 87 percent. In addition, almost 90 percent of total value added in agriculture is generated by labour inputs (not tabulated). Accordingly, there are significant possibilities for improving production technologies in the agricultural sector (Bay, 1998).

In addition, the change from colonial to socialist rule in 1975 and the gradual change to liberal rule during the late 1980s and early 1990s have been instrumental in shaping the current society, both economically and socially. Substantial economic decentralisation has occurred. In particular, all domestic and external prices have been freed up and the centralised marketing system for agricultural crops has been effectively dismantled. It is, however, debatable whether this strategy has, as yet, significantly transformed agricultural production. Recent high agricultural growth rates may be mainly attributable to good rains and war recovery.

A major problem limiting the impact of market reforms is that many farmers do not have market access since the domestic marketing infrastructure is poorly developed. The east-west, international-trade-oriented, transport corridors have been reestablished and investment programmes for the further development of port facilities as well as roads running alongside the rail lines have been outlined. In contrast, the major task of reestablishing the road networks connecting the different regions of Mozambique on a north-south axis has been coming along slowly. Some progress has been made regarding the extension of primary and secondary road networks and this has been accompanied by some integration of trading activities between different parts of the country. Despite these efforts, bringing the different regions into one integrated domestic economy, linking rural production areas with urban

consumption centres through the establishment of country-wide transport, storage, and communication facilities, remains, for the time being, an elusive goal.

The limited degree of integration of rural areas into the rest of the economy can be seen from the high level of home consumption of agricultural production. Home consumption accounts for 65 percent of total agricultural production valued at producer prices (i.e., excluding marketing margins and consumption taxes) and represents about 23% of total household consumption of commodities. It is clear that a large part of home-consumed production is grown out of safety-first considerations, since Mozambique is normally hit by at least one major natural disaster every seven years (Rojas and Amade, 1997). The food-security motive is likely to be particularly important for the production of the drought-resistant staple crop cassava, which has, as shown in Table 1, the largest production value among all agricultural activities as well as a home consumption share of more than 90 percent of total production (not tabulated). Nevertheless, for a number of other crops, such as maize, vegetables (included in basic food crops), and raw cashew, the poor marketing system is a key determinant for the high shares of home consumed production.

3. Data and Modelling Framework

The SAM employed for this analysis was constructed on the basis of a new set of national accounts compiled by the National Institute of Statistics (NIS) in accordance with the United Nations standards for national accounting.[1] The NIS national account figures diverge from the official data compiled by the National Department of Planning (NDP). The collection of data by the NDP is based on questionable estimation and cross-checking procedures (Johnson, 1995). More specifically, the NDP accounts rely heavily on data from technical ministries and public enterprises and do not, for example, capture activities in the services sector very well. In contrast, the NIS data are based on a variety of surveys and adjustment is made for items which go unnoticed in the NDP approach.

The SAM was developed with the specific purpose of establishing a comprehensive data base with a detailed picture of the agricultural sector. The data set includes 40 production activities, among which there are 12 primary agricultural sectors and two agricultural processing sectors.[2] A special activity is included to take account of the costs of commercial

[1] A thorough description of the features of the SAM can be found in Arndt, Jensen, and Tarp (1999*b*) from which several of the data in what follows have been taken.

[2] The 40 SAM activities were aggregated into 27 CGE activities, including eight primary agricultural and two agricultural processing sectors. The complete GAMS code for estimating SAM coefficients and the modelling exercise is available from the authors.

services related to the marketing of imports, exports, and domestically marketed production. Since commercial services are used to market output, the cost of these services represents a wedge between producer and purchaser prices. These margins, together with consumption taxes, represent the differences in the value of non-marketed goods at the activity level and marketed goods at the commodity level.

Factors of production include agricultural labour, non-agricultural labour, and capital. Land is considered abundant in most circumstances, and, since no data on returns to land are available, returns to land were lumped into returns to capital. Except for some minor factor and enterprise tax payments, the main shares of factor incomes are passed on to households. There are two household sub-categories, urban and rural. Agricultural labour income is allocated between rural and urban households, with approximately 82 percent to the former and 18 percent to the latter, while non-agricultural labour income is allocated with 44 percent to the former and 56 percent to the latter. Poverty-alleviation initiatives directed at poor rural households can have a major effect if they increase labour income in general and target agricultural labour income in particular. In contrast, around 80 percent of capital income goes to urban households, while only 20 percent goes to rural households.

As the macroeconomic SAM in Table A2 shows, the expenditure patterns of the two household types are different, especially regarding home consumption, which makes up 44 percent of rural household consumption but only 5 percent of urban household consumption.[3] The individual savings rates of the two household categories differ greatly; the urban rate is slightly more than 12 percent while the rural savings rate is less than four percent. Aggregate household savings are small, and, combined with a comparably low level of enterprise savings, the SAM indicates very small overall domestic savings. Government and private investment rely to a large extent on funding from foreign capital inflows with the sum of these two amounting to about one third of GDP.[4]

Marketing margins are based on the distinction between factory/farm gate prices on the one hand and purchaser prices on the other, reflecting storage, and marketing costs.[5] The

[3] Since home consumption is valued at farm gate prices while marketed consumption is valued at consumer prices, it follows that the home consumption share of physical rural consumption is even higher than the 44 percent in value terms.

[4] The investment share derived from the SAM in Table A2 is slightly higher due to the inclusion of non-governmental organization (NGO) expenditures in the capital rows and columns.

[5] The price gap may reflect some degree of imperfect competition. In the SAM and the model, they are assumed to reflect real costs.

marketing margins were introduced into the CGE model through commercial service coefficients. This treatment amounts to assuming that each production good from a given production sector requires a fixed amount of marketing services in order to reach the market. In essence, they are input-output coefficients relating the demand for commerce services required to move goods from producer to market. A single production activity provides the marketing services associated with imported, exported, and domestically marketed commodities.

The model formulation incorporates home consumption and marketed consumption through a linear expenditure system (LES). In this formulation, the marginal budget shares of marketed and non-marketed goods are fixed and each commodity has an associated minimum consumption level below which physical consumption cannot fall. Home consumed goods are, as already noted, valued at producer prices while marketed goods are valued at purchaser prices, including consumption taxes and marketing margins.

Labour supplies are fixed in the agricultural and non-agricultural sectors.[4] As a result, wage rates are allowed to diverge between agricultural and non-agricultural labour. The model assumes full employment of available resources in the sense that overall factor supplies are kept fixed, while average factor returns vary to clear the separate factor markets. In the macro closure, government recurrent and investment expenditure are constant shares of aggregate absorption. Foreign capital inflows and savings rates of the different agents and institutions are kept fixed, so private investment is set by available savings. A freely varying real exchange rate equilibrates the external account. The value of imports exceeded the value of exports by a factor of 2.6 in 1995 (see Table A2). The excess of imports over exports was largely financed by aid inflows. Finally, the consumer price index, including both marketed and home consumption, defines the numeraire in the model.

The model employs behavioural parameters available in Arndt, Robinson, and Tarp (1999). They produced estimates of minimum consumption levels for the LES specification of home and marketed consumption, and provided import substitution (CES) and export transformation (CET) elasticities for some aggregate commodity categories. For the purposes of the current simulations, the parameter estimates for the aggregate sectors were allocated among the more disaggregate sectors according to the particular aggregation chosen for the estimation exercise.

[4] Simulations with a sluggish labour specification between agricultural and non-agricultural labour lead to the same conclusions.

Table 1 provides additional information on the structure of the economy with emphasis on the production side. Grains have a high import share at 42.4 percent. Other export crops have a high export share but a low share of value added. Overall, trade shares in primary agriculture are low with a bias towards imports. Agricultural value added amounts to 25.9 percent of total value added (fisheries excluded). Domestic margins vary greatly but tend to be higher in primary agriculture and are also quite high in food processing and textiles and leather. Finally, the commerce sector, which provides commercial services, represents 21.9 percent of value added.

Table 1: *Production Structure of the Economy*

	Value Added	Exports	Imports	E/X	M/Q	Domestic Margin
Grain	5.7	0.2	4	0.8	42.4	27.4
Cassava	6.1	0	0	0	0	302.5
Raw Cashew	0.7	0.2	0	5.7	0	44.2
Raw Cotton	0.3	0	0	0	0	0
Other Export Crops	0.6	2.4	0.1	54.8	8.2	52.3
Basic Food Crops	6.8	0.3	1.6	0.9	10.9	111.2
Livestock	2.4	0.1	0.2	0.4	7.4	13.6
Forestry	3.3	1.7	0	9.3	0.2	14.9
Fishery	4.3	21.3	0	71.5	0	44.3
Mining	0.5	2.6	0.3	77.6	41.1	8.9
Food Processing	2.8	8.6	18.8	13.7	26.9	58.7
Textiles and Leather	1	6.8	2.8	67.8	39.5	36.2
Wood	0.5	1.2	0.6	21.7	19.9	26
Paper and Packaging	0.1	0	1.4	1.2	40.7	37.4
Fuels and Chemicals	0.5	1.1	18.5	15.4	54.2	46.7
Non-Metals	0.3	0	3.1	0.7	39.9	31.6
Metals	0.2	0.7	1.4	41.3	56.2	23.4
Machinery and Equipment	0.2	0.6	28.7	17.5	76.2	14
Electricity and Water	0.6	0	1.4	0	21	0
Construction	12.6	0	0	0	0	0
Transport and Communication	6.8	23.9	4.8	21.7	12.3	0
Banking and Insurance	7.2	0.9	0.2	2.2	1.2	0
Dwellings	1.1	0	0	0	0	0
Public Administration	3.7	0	0	0	0	0
Education	1.7	0	0	0	0	0
Health	0.6	0	0	0	0	0
Other Services	7.5	27.3	12	39.5	40	0
Commerce	21.9	0	0	0	NA	NA
Total/Average	100	100	100	12.5	26.9	11.9

4. Simulation Results

In the model, implementation of agricultural technology improvements, through Hicks neutral productivity increases, is straightforward. Similarly, reductions in marketing margins are modelled through scaling down commercial service coefficients. In the analysis, investment expenditures associated with improved technology and marketing infrastructure are ignored. This treatment amounts to assuming that these investments are undertaken prior to the current simulations, and the analysis makes no attempt to quantify the costs of realising the policy initiatives studied here — the focus is on benefits.

Table 2: *Scenarios*

Scenario	Description
Base run	Base SAM data set for 1995
Scen. 1	Increase in productivity by 30 percent for all agricultural products
Scen. 2	Reduction of marketing margins for all goods by 15 percent
Scen. 3	Scen. 1 & Scen. 2 combined

The simulations include a uniform 30 percent improvement in productivity across agricultural sectors and a 15 percent reduction in the commercial service coefficients for imported, exported, and domestically produced and marketed commodities. The simulations are summarised in Table 2. Achieving agricultural productivity growth of the order of 30 percent in Mozambique is probably feasible over a reasonably short time span due to the rudimentary nature of current agricultural production practices. Reductions in marketing margins of the order of 15 percent are also feasible, given the scope for improving the marketing system after the devastation caused by the war. While a 15 percent gain may come relatively cheaply, large investments in marketing infrastructure will likely be needed to achieve significant further declines in marketing costs.

Table 3: *Macroeconomic Indicators and Prices*

		Percent deviation from base values		
	Base Run	Scen. 1	Scen. 2	Scen. 3
Real GDP (10^{11} Meticais)	172.1	6.8	5.0	12.2
Absorption (10^{11} Meticais)	223.3	6.8	4.9	12.9
Value added price index	100	1.4	5.3	7.3
Export producer price index	100	4.8	5.3	10.3
Import purchaser price index	100	6.2	0.2	6.4
Cost of living index for rurals	100	-5.9	2.8	-3.1
Cost of living index for urbans	100	3.7	-0.8	3.0
Real exchange rate index	100	3.3	-0.1	2.8
Ag. terms of trade: Producer	100	-24.9	7.4	-17.8
Ag. terms of trade: Value added	100	-29.4	7.1	-22.4
Ag. terms of trade: Export	100	-1.8	6.7	5.1
Ag. terms of trade: Import	100	0.2	-0.6	-0.5
Price of commerce	1	9.8	2.2	12.7

Macroeconomic indicators and price measures for the different scenarios are given in Table 3. The productivity increase of 30 percent for all agricultural products (scenario 1) yields an aggregate welfare improvement of 6.8 percent (the change in absorption deflated by the aggregate consumer price index). The productivity increase raises output and lowers relative prices significantly in the agricultural sector. The price decline moderates the increase in aggregate rural income and transmits much of the gain to the urban sector. Since agriculture has very high trade margins (Table 1), the greater output generates a significant increase in demand for commerce services, driving up their price. The result is that the gap between supplier and market prices for exports and imports rises. Exports decrease more than imports in real terms, and a mild depreciation of the real exchange rate (3.3 percent) restores equilibrium in the trade balance.

The 15 percent reduction in marketing margins (scenario 2) leads to a 4.9 percent increase in welfare. The decrease in marketing margins narrows the spread between producer and purchaser prices, raising the former and lowering the latter. Both producers and consumers gain and the gains are spread evenly across the economy, as further discussed below. The impact on trade is the converse of scenario 1: exports gain slightly more than imports and there is a slight appreciation of the real exchange rate (0.1 percent) to restore equilibrium.

Combining the first two scenarios (scenario 3), there is evidence supporting the hypothesis that improvements in marketing infrastructure allow the economy to reap greater benefits from improvements in agricultural productivity. The increase in welfare in scenario 3 is about 10 percent greater than the sum of the effects of scenarios 1 and 2 run separately. The reduction in marketing margins diminishes the decrease in agricultural producer prices that would otherwise follow from the significant expansion of supply as agricultural productivity rises. Improvements to the marketing network ensure that increased production following agricultural productivity improvements benefits both farmers and consumers more, as the gap between producer and purchaser prices is narrowed.

The relative changes in the cost of living indices for rural and urban households differ across the scenarios. A gain in agricultural productivity (scenario 1) lowers agricultural prices significantly, and since rural households allocate a larger share of their budget to agricultural goods (Table A2), their cost of living index falls relative to that of urban households. In contrast, lower marketing margins (scenario 2) increase producer prices in agriculture and increase the relative cost of living for rural households with significant home consumption. The cost of living effects of the combined scenario are very close to the sum of the two separate scenarios.

Table 3 also shows that increased agricultural productivity, which increases output, worsens the agricultural terms of trade. Decreased marketing costs improve the agricultural terms of trade by increasing the producer price of agriculture more than that of non-agriculture. In the combined scenario (scenario 3), however, the agricultural productivity effect is stronger and the terms of trade move significantly against agriculture. From a policy perspective, the combined scenario is attractive because the adverse terms of trade effect of increasing agricultural productivity is significantly ameliorated.

Table 4: *Equivalent Variation on Consumption (percent of base consumption)*

	Base Run	Scen. 1	Scen. 2	Scen. 3
Urban	0	5.2	4.7	10.5
Rural	0	12.3	4.6	18.2
Total	0	8.5	4.6	14.1

Table 4 presents the welfare impact of the scenarios in terms of changes in household consumption, measured by equivalent variation from the base.[5] Given that average household savings rates are assumed fixed in the model, these measures provide a good indicator of the

[5] Equivalent variation measures the lump sum transfer that would make the household indifferent between the scenario and the base case plus the transfer.

distributional impact of the scenarios between rural and urban households. Rural households are the main gainers from increased agricultural productivity. The significant increases in agricultural production are accompanied by substantial decreases in producer prices, so rural household income increases only slightly. Yet, rural households benefit significantly on the consumption side since they allocate a relatively large share of their budgets to agricultural goods.

Urban and rural households gain roughly the same percent increase from lowering trade margins (scenario 2). As noted above, narrowing the gap between producer and purchaser prices spreads the gains across the economy. Again, the results for scenario 3 indicate a synergy between the two effects — the gain in welfare for both urban and rural households from scenario 3 is greater than the sum of the gains from the two separate scenarios.

Table 5: *Components of Real GDP*

	10^{11} Meticais	Percent deviation from base values		
	Base Run	Scen. 1	Scen. 2	Scen. 3
Exports	32.7	-2.2	9.4	8.0
Imports	83.9	-0.8	3.7	3.1
Home Consumption	32.6	24.3	-0.8	22.5
Marketed Consumption	106.8	4.4	6.4	11.8
Recurrent Govt.	16.8	-0.7	2.7	2.4
Non-Govt. Organizations	5.5	-2.5	1.5	-1.5
Investment	61.5	-1.1	2.4	1.2
Real GDP	172.1	6.8	5.0	12.2

Table 5 presents data on the effect of the scenarios on components of real GDP. There is significant interaction between agricultural productivity increases and marketing margin reductions for most of the final demand components of real GDP — the results from scenario 3 generally do not equal the sum of the other two scenarios. For example, increased agricultural productivity (scenario 1) leads to significant import substitution in grains, which has a high import share (Table 1),[6] and hence aggregate exports decline because less export earnings are required to achieve the fixed trade balance. Lowering trade margins, on the other hand, narrows the gap between border prices and domestic market prices for both imports and exports, and leads to increases in both. The trade-creating effect dominates in the combined scenario, which indicates a significant interaction between increasing the supply

[6] This effect is likely to diminish as Mozambique becomes more self sufficient in food following economic recovery.

of traded goods and lowering the costs of moving these goods to and from international markets.

Agricultural productivity increases have a major effect on the level of home-consumed production. Increased agricultural production decreases prices, which makes home consumption of agricultural goods attractive. Moreover, the increase in the price of marketing services amplifies the gap between producer and purchaser prices, which further favours home consumption. Lowering marketing margins ameliorates the effect of the widening price gap —scenario 2 lowers home consumption— and provides incentives for a further switch towards marketed consumption in the combined scenario. However, the agricultural production effect on the consumption patters still dominates in this case.

Table 6: *Factor Prices*

	Index	Percent deviation from base values		
	Base Run	Scen. 1	Scen. 2	Scen. 3
Labour	1	0.1	11.4	15.0
Non-Agricultural Labour	1	8.9	4.9	14.4
Capital	1	10.6	2.0	13.4

Table 6 shows the effect of the scenarios on returns to labour and capital. The increase in agricultural productivity leads to almost no change in the agricultural wage (it rises by 0.1 percent). The decline in producer prices almost exactly offsets the effect of increased productivity as far as agricultural labour is concerned. In this scenario, some of the gains are transmitted through lower prices to the non-agricultural sectors. The wage of non-agricultural labour and the capital rental rate both rise significantly, but the significant increase in demand for capital intensive commercial services increases capital returns relative to wages.

Lower trade margins (scenario 2) increase all factor returns, but favour agricultural labour since the agricultural sectors have the highest trade margins (Tables A2 and 1). The combined scenario is notable in that it spreads the gains more evenly across the three factors, with all factors gaining more than the sum of the effects of the two separate scenarios. The synergy between increasing agricultural productivity and lowering trade margins in parallel yields returns to all factors that exceed the sum of the separate scenarios, with little change to the overall functional distribution of income. From a policy perspective, the results of these interactions are very desirable, since much political conflict is rooted in changes in the distribution of income among factors of production.

5. Conclusion

Mozambique is a wide-spread country with a large agricultural sector and significant potential for agricultural development, especially in the northern provinces. The integration of rural areas with the rest of the economy has been limited, which is reflected in the high share of home consumption out of rural household own production. In this environment, there are enormous potential gains from improving agricultural productivity and lowering costs of moving goods from producers to purchasers.

The results presented in this paper indicate that increasing agricultural productivity is an important priority for Mozambique, with large potential gains. However, increasing agricultural output in an environment of very high marketing costs leads to a significant fall in prices. These price declines transmit most of the gains in factor income to the non-agricultural sectors and factors of production. Rural households do, however, gain from greater availability of food and lower producer prices which lower the cost of home-consumed goods.

Lowering marketing costs decreases the gap between producer and purchaser prices in all markets. The gains are spread across the economy, but agriculture gains relatively more because its marketing margins are higher. The scenario is trade creating, both aggregate exports and imports grow, because the lower marketing margins increase the returns to producers supplying to export markets and lower the domestic market price to purchasers of imports. The consumption of marketed goods rises significantly, while home-consumption declines slightly.

The combined scenario reveals significant synergy between increasing agricultural productivity and lowering marketing costs in parallel. The welfare gains from the combined scenario are larger than the sum of the gains from the two separate scenarios. Lowering marketing costs somewhat ameliorates the worsening in the agricultural terms of trade caused by the increase in supply due to the increase in agricultural productivity. Both rural and urban households gain significantly as returns to all factors increase —rural wages, urban wages, and capital rentals. Compared to the separate scenarios, the combined scenario yields little change in the distribution of income across factors of production —the functional distribution. This result makes the combined scenario appealing from a policy perspective. It should cause a relatively low level of political strain, while providing relatively larger increases in the welfare of poor rural households.

Appendix A: A Macroeconomic Social Accounting Matrix for Mozambique

A social accounting matrix (SAM) provides a snapshot of an economy at a point in time. A SAM can be very detailed, tracking information across an array of activities, commodities, factors, and institutions, or very aggregate with a simple depiction of the macroeconomic aggregates. Regardless of dimensions, it is important that a SAM be in balance; that is, that row sums equal column sums. A balanced SAM ensures that all of the basic macroeconomic identities are satisfied. Table A1 provides the labels and Table A2 provides the figures for a basic macroeconomic SAM for Mozambique for 1995 (Arndt, Cruz, Jensen, Robinson, and Tarp 1998). From this basic macroeconomic SAM, one can read directly, or derive very simply, GDP, gross savings rates, the trade balance, the government deficit, net capital inflows, and the structure of demand. For example, to obtain GDP in market prices ($172.1*10^{11}$ Meticais), one simply sums the figures in the cells labelled "value added", "output taxes", and "consumption taxes". Row and column balance assures that GDP derived from the demand side will equal the sum of factor returns and indirect taxes.

The macroeconomic SAM presented in Table A2, and the microeconomic SAM upon which it is based, are in many ways quite standard. They generally follow the structure presented by Pyatt and Round (1985). They differ from most existing SAMs in that home consumption is accounted for and marketing margins are carefully tracked. Also, relative to many SAMs for Africa, the microeconomic SAM contains substantial agricultural sector detail.

Table A1: *Labels of the Macroeconomic Social Accounting Matrix*

		-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12
-1	Ag Activity				marketed sales including exports			home consumption					
-2	Non-Ag Activity												
-3	Commerce				marketing margins								
-4	Ag Commodity	intermediate consumption						marketed consumption		govt. commodity purchases	investment	exports	
-5	Non-Ag Commodity												
-6	Value Added	value added											
-7	Urban Household						factor payments			govt. transfers		net remittances	
-8	Rural Household												
-9	Recurrent Govt.	output taxes			consumption taxes		factor taxes	income taxes					
-10	Capital						retained earnings	savings		budget surplus		net capital inflow (aid)	
-11	Rest of World				imports								
-12	Total												

Table A2: *Macroeconomic Social Accounting Matrix* (10^{11} Meticais)

		-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12
-1	Ag Activity				16.08			2.89	26.9				45.87
-2	Non-Ag Activity					178.4		0.75	2.09				181.2
-3	Commerce				11.54	37.89							49.43
-4	Ag Commodity	1.5	12.07					11.55	6.92	0	0.09	1.6	33.74
-5	Non-Ag Commodity	4.24	87.89	15.39				58.64	29.74	16.78	66.97	31.11	310.7
-6	Value Added	40.32	81.35	34.08									155.8
-7	Urban Household									1.06		1.83	86.6
-8	Rural Household						66.89			0.27		1.63	68.78
-9	Recurrent Govt.	-0.19	-0.1	0	1.11	15.59	3.68	2	0.49				22.53
-10	Capital						1.49	10.78	2.65	4.43		47.73	67.06
-11	Rest of World				5.01	78.89							83.9
-12	Total	45.87	181.2	49.43	33.74	310.7	155.8	86.6	68.78	22.53	67.06	83.9	

Appendix B: CGE Model Equations

Definition of Model Indices, Parameters, and Variables indices

j Activities

Aliases of j: activ, activ1

Subsets of j:

iaga	Agricultural activities
iagr	Risk contrained agricultural activities
pactiv	Productive activities
imr	Marketing activities
iagn	Non-agricultural activities

i Commodities

Aliases of i: comm, comm1

Subsets of i:

im	Imported commodities
imn	Non-imported commodities
ie	Exported commodities
ien	Non-exported commodities

f Factors of Production

Subsets of f:

aglabo	Agricultural labour
naglabo	Non-agricultural labour

h Households

Parameters

GAMS Name	Symbol	Description
a(comm,activ)		Input-output coefficients
ac(comm)	a^C_i	Armington function shift parameter
ad(activ)	a^D_j	Production function shift parameter
af	a^f	CET labor function shift parameter
alpha(f,activ)	α_i	Factor share parameter - production function
at(comm)	a^T_i	CET export function shift parameter
betah(comm,hh)		LES marginal consumption level of home produced goods
betam(comm,hh)		LES marginal consumption level of marketed commodities
cpiwtsh(comm)		Price index weights for home consumed goods in consumer price index
cpiwtsm(comm)		Price index weights for marketed goods in consumer price index
delta(comm)		Armington function share parameter
esr0		Enterprise savings rate
eta(comm)		Export demand price elasticitity
etr0		Enterprise tax rate
exrb		Base exchange rate
gamma(comm)	γ_i	CET export function share parameter
gammah(comm,hh)		LES minimum consumption level of home produced goods
gammam(comm,hh)		LES minimum consumption level of marketed commodities
qd(activ)		Dummy variable for computing AD(activ)
gles(comm)		Government consumption share
imake(activ,comm)		Make row coefficients

makef(activ,comm)		Make FLOWS Matrices
mrd(comm)		Domestic margin coefficient
mrdf(comm)		Value of margins on domestics
mre(comm)		Export margin
mref(comm)		Value of margins on imports
mrm(comm)		Import margin coefficient
mrmf(comm)		Value of margins on imports
pcb(comm)		Base final consumption commodity price
pdab(activ)		Base domestic price
pdcb(comm)		Base domestic marketed supply price
pdchb(comm)		Base domestic home consumed supply price
ppiwts(activ)		Price index weights for producer price index
pqab(activ)		Base composite activity price
pqqb(comm)		Base composite consumption price
pqxb(comm)		Base composite commodity price
pweb(comm)		Base export price
pwmb(comm)		Base import price
pvb(activ)		Base value added price
rhoc(comm)	ρ^{C}_{i}	Armington function exponent
rhof	ρ^{f}	CET labor function exponent
rhot(comm)	ρ^{T}_{i}	CET export function exponent
risklow(activ)		Lower bound on production for risk
rmd(comm)		Ratio of imports to domestic sales
sdistr(hh)		Distributed profit shares
sremit(hh)		Remittance shares
strans(hh)		Government transfer shares
SUPERNUM(hh)		Household supernumerary income

tau	τ	CET labor function share parameter
tcb(comm)		Base consumption tax rate
tc0(comm)		Consumption tax(+) or subsidy(-) rates
te(comm)		Export tax(+) or subsidy(-) rates
teb(comm)		Base export tax
tf(f)		Factor tax rates
th(hh)		Household tax rate
thmul0		Uniform household tax rate multiplier
tm(comm)		Tariff rates on imports
tmb(comm)		Base tariff rate
txb(activ)		Base indirect tax
tx0(activ)		Output tax rates
ymap(instp,f)		Factors to private institutions map

Variables

Price variables	
EXR	Exchange rate (MT per world $)
PC(comm)	Consumption price of composite goods
PDC(comm)	Domestic marketed commodity goods price
PDCH(comm)	Domestic home commodity goods price
PE(comm)	Price of exports
PINDEX	Producer prices or GDP index
PM(comm)	Price of imports
PQA(activ)	Average production composite activity price
PQQ(comm)	Price of composite consumption good
PQX(comm)	Average production composite commodity price

PV(activ	Value added price
RISK(activ)	Risk premium complementarity

Production variables	
DC(comm)	Domestic commodity marketed consumption
DCH(comm)	Domestic commodity home consumption
E(comm)	Exports
M(comm)	Imports
QQ(comm)	Composite goods demand
QX(comm)	Domestic composite commodities output
QA(activ)	Domestic composite activities output

Factor variables	
FDSC(f,activ)	Factor demand by sector
FS(f)	Factor supply
FSLAB	Aggregate labor supply
WF(f)	Average factor price
WFDIST(f,activ)	Factor price sectoral proportionality ratios
WFLAB	Aggregate average labor force
YFCTR(f)	Factor income

Income and expenditure variables	
CAPINV	Real private investment
CAPINV	Total private investment
CDH(comm,hh)	Final demand for home produced commodities

CDM(comm,hh)	Final demand for marketed commodities
CI(comm)	Final demand for private productive investment
CONTAX	Consumption tax revenue
DISTR	Distributed profits
ENTSAV	Enterprise
ENTTAX	Enterprise tax
ESR	Enterprise savings rate
ETR	Enterprise tax rate
EXPTAX	Export subsidy payments
FACTAX	Factor tax revenue
FAIDGIN	Aid in government organization budget
FAIDNGO	Aid in non government organization budget
FSAV	Net foreign savings
GD(comm)	Final demand for government consumption
GDTOT	Total volume of government recurrent consumption
GI(comm)	Final demand for government productive investment
GININV	Total government investment
GINREV	Government investment account revenue
GINSAV	Government investment account savings
GOVTH	Government transfers to households
GOVTE	Government transfers to enterprises
GRESAV	Recurrent government account savings
GREREV	Government recurrent account revenue
HHSAV	Total household savings
HHTAX	Household tax revenue
ID(comm)	Final demand for productive investment
INDTAX	Indirect tax revenue

INT(comm	Intermediates uses
INVEST	Nominal private investment
MPS(hh)	Marginal propensity to save by household type
NGOD(comm)	Final demand for non government organization consumption
NGOREV	Non government organization account revenue
REMIT	Remittances
SAVING	Total nominal private savings
SAVING	Total savings
TARIFF	Tariff revenue
THMUL	Uniform household tax rate multiplier
WALRAS1	Slack variable for savings investment
YE	Enterprise income
YH(hh)	Household income
Yinstp(instp)	Private institutional income

GDP and other derived variables	
ABSORB	Absorption in market prices
GDPVA	Value added in market prices GDP
GOVRABS	Government recurrent to absorption ratio
GOVIABS	Government investment to absorption ratio
INVGDP	Investment to GDP ratio
RGDP	Real GDP

Tax variables	
TC(comm)	Consumption tax rate
TX(activ)	Output tax rate

Other variables	
FOODAID(comm)	Food aid in form of composite commodity
TRADM(activ)	Demand for import commerce service by trade

Price Equations

#	**Equation**	Description
D1	$PM_{im} = pwm_{im} \cdot (1+tm_{im}) \cdot EXR + MRM_{im} \cdot \sum_{imr} PQA_{imr}$	Import prices
D2	$PE_{ie} = pwe_{ie} \cdot (1 - te_{ie}) \cdot EXR - MRE_{ie} \cdot \sum_{imr} PQA_{imr}$	Export prices
D3	$PDC_i = PDCH_i + MRD_i \cdot \sum_{imr} PQA_{imr}$	Marketed commodity prices
D4	$PQQ_i = \frac{PDC_i \cdot DC_i + PM_i \cdot M_i}{QQ_i}$	Composite commodity prices
D5	$PQX_i = \frac{PDCH_i \cdot (DC_i + DCH_i) + PE_i \cdot E_i}{QX_i}$	Producer commodity prices
D6	$PC_i = PQQ_i \cdot (1+tc_i)$	Consumer prices
D7	$PQA_{pactiv} = \sum_i imake_{pactiv,i} \cdot PQX_i$	Producer activity prices
D8	$PV_j = PQA_j \cdot (1-tx_j) - \sum_i PC_i \cdot a_{ij}$	Value-added prices net of output taxes
D9	$WFLAB \cdot FSLAB = \sum_{lab} FS_{lab} \cdot WF_{lab}$	Composite wage
D10	$PINDEX = \sum_i cpiwts_i \cdot \left(\frac{PC_i}{pindex0} \right)$	Consumer price index

Quantity Equations

#	**Equation**	**Description**
D11	$QA_j = a_j^D \cdot \prod_f FDSC_{j,f}^{\alpha_{j,f}}$	Cobb-Douglas production function
D12	$FDSC_{jf} = \frac{RISK_j \cdot QA_j \cdot PV_j \cdot \alpha_{jf}}{WF_f \cdot WFDIST_{jf}}$	Demand function for primary factors (profit maximization)
D13	$INT_i = \sum_j a_{ji} \cdot QA_j$	Total intermediate use

#	Equation	Description
D14	$QA_{imr} = \sum_{im} M_{im} \cdot MRM_{im} + \sum_{ie} E_{ie} \cdot MRE_{ie} + \sum_{i} D$	Commodity/marketing services relationship
D15	$QX_i = \sum_{pactiv} imake_{pactiv,i} \cdot QA_{pactiv}$	Commodity/activity relationship
D16	$FSLAB = a^f \cdot \left[\tau \, FS_{aglabo}^{\rho^f} + (1-\tau) \, FS_{naglabo}^{\rho^f} \right]^{\frac{1}{\rho^f}}$	Composite labor
D17	$FS_{aglab} = FS_{naglab} \cdot \left(\frac{WF_{naglab}}{WF_{aglab}} \right) \cdot \left(\frac{\tau}{1-\tau} \right)^{\left(\frac{1}{1-\rho^f} \right)}$	Agricultural labor supply
D18	$QX_{ie} = a_{ie}^T \cdot \left[\gamma_{ie} E_{ie}^{\rho_{ie}^T} + (1 - \gamma_{ie}) (DC_{ie} + DCH_{ie})^{\rho_{ie}^T} \right]^{\frac{1}{\rho}}$	Gross domestic output as a composite good for ie $\in$ i
D19	$QX_{ien} = DC_{ien} + DCH_{ien}$	Gross domestic output for ien $\in$ i
D20	$E_{ie} = (DC_{ie} + DCH_{ie}) \cdot \left(\frac{PDCH_{ie} \cdot \gamma_{ie}}{PE_{ie} \cdot (1-\gamma_{ie})} \right)^{\left(\frac{1}{1 - \rho_i^T} \right)}$	Export supply
D21	$QQ_{im} = a_{im}^C \left[\delta_{im} M_{im}^{-\rho_{im}^C} + (1-\delta_{im}) DC_{im}^{-\rho_{im}^C} \right]^{-\frac{1}{\rho_{im}^C}}$	Total supply of composite good - Armington function for im $\in$ i
D22	$QQ_{imn} = DC_{imn}$	Total supply for imn $\in$ i
D23	$M_{im} = DC_{im} \left(\frac{PDC_{im} \cdot \delta_{im}}{PM_{im} (1-\delta_{im})} \right)^{\frac{1}{1 + \rho_{im}^C}}$	F.O.C for cost minimization for composite good for im $\in$ i

Income Equations

#	Equation	Description
D24	$YFCTR_f = \sum_i WF_f \cdot FDSC_{jf} \cdot \left(\frac{WFDIST_{jf}}{RISK_j} \right)$	Factor income
D25	$Yinstp_{instp} = \sum_f ymap_{instp,f} \cdot YFCTR_f$	Private institutional income
D26	$YE = Yinstp_{enterp} + GOVTE$	Enterprise income
D27	$YE = DISTR + ENTTAX + ENTSAV$	Enterprise expenditure
D28	$YH_{hh} = Yinstp_{hh} + sdistr_{hh} \cdot DISTR + sremit_{hh} \cdot REMIT \cdot EXR + strans_{hh} \cdot GOVTH$	Household income
D29	$INDTAX = \sum_{activ} tx_{activ} \cdot PQA_{activ} \cdot QA_{activ}$	Indirect taxes on domestic production
D30	$EXPTAX = \sum_{ie} te_{ie} \cdot E_{ie} \cdot pwe_{ie} \cdot EXR$	Export subsidy payments
D31	$TARIFF = \sum_{im} tm_{im} \cdot M_{im} \cdot pwm_{im} \cdot EXR$	Tariff revenue
D32	$CONTAX = \sum_{comm} tc_{comm} \cdot PQQ_{comm} \cdot QQ_{comm}$	Consumption taxes
D33	$FACTAX = \sum_f tf_f \cdot YFCTR_f$	Factor tax
D34	$ENTTAX = ETR \cdot YE$	Enterprise tax
D35	$HHTAX = \sum_{hh} th_{hh} \cdot YH_{hh} \cdot THMUL$	Total Household tax collected by govt.
D36	$ENTSAV = ESR \cdot (YE - ENTTAX)$	Enterprise savings
D37	$HHSAV = \sum_{hh} MPS_{hh} \cdot YH_{hh} \cdot (1 - th_{hh} \cdot THMUL)$	Household savings
D38	$GREREV = INDTAX + EXPTAX + TARIFF + CONTAX + FACTAX + ENTTAX + HHTAX$	Government recurrent account revenue
D39	$GINREV = FAIDGIN \cdot EXR$	Government investment account revenue
D40	$NGOREV = FAIDNGO \cdot EXR$	Non government organization account revenue
D41	$SAVING = HHSAV + ENTSAV + GRESAV + GINSAV + FSAV \cdot EXR$	Total savings

Expenditure Equations

#	Equation	Description
D42	$PC_{comm} \cdot CDM_{comm,hh} = PC_{comm} \cdot gammam_{comm,hh} + betam_{comm,hh} \cdot ((1 - MPS_{hh} \cdot YH_{hh}) \cdot (1 - th_{hh} \cdot THMUL) - \sum_{comm1} PC_{comm1} \cdot gammam_{comm1,hh} - \sum_{comm1} PDCH_{comm1} \cdot gammah_{comm1,hh})$	Private consumption for marketed commodities
D43	$PDCH_{comm} \cdot CDH_{comm,hh} = PDCH_{comm} \cdot gammah_{comm,hh} + betah_{comm,hh} \cdot ((1 - MPS_{hh}) \cdot YH_{hh} \cdot (1 - th_{hh} \cdot THMUL) - \sum_{comm1} PC_{comm1} \cdot gammam_{comm1,hh} - \sum_{comm1} PDCH_{comm1} \cdot gammah_{comm1,hh})$	Private consumption behavior for home consumption
D44	$GD_{comm} \cdot PC_{comm} = gles_{comm} \cdot (GDTOT + (\frac{gdtot_0}{gininv_0 + gdtot_0}) \cdot \sum_{comm1} PC_{comm1} \cdot FOODAID_{comm1})$	Government consumption
D45	$GREREV = GDTOT + GOVTE + GOVTH + GRESA$	Government recurrent budget constraint
D46	$GI_{comm} \cdot PC_{comm} = gishr_{comm} \cdot (GININV + (\frac{gininv_0}{gininv_0 + gdtot_0}) \cdot \sum_{comm1} (PC_{comm1} \cdot FOODAID_{comm1}))$	Real government investment
D47	$GINREV = GININV + GINSAV$	Government investment budget constraint
D48	$NGOD_{comm} \cdot PC_{comm} = ngoshr_{comm} \cdot NGOREV$	Non government organization consumption
D49	$CI_{comm} \cdot PC_{comm} = cishr_{comm} \cdot CAPINV$	Real private investment
D50	$ID_{comm} = CI_{comm} + GI_{comm}$	Investment by sector of origin
D51	$INVEST = \sum_{comm} PC_{comm} \cdot CI_{comm}$	Total private investment at market prices

Market clearing

#	Equation	Description
D52	$QQ_{comm} + FOODAID_{comm} = INT_{comm} + \sum_{hh} CDM_{comm,hh} + GD_{comm} + NGOD_{comm} + ID_{comm}$	Commodities market equilibrium
D53	$DCH_{comm} = \sum_{hh} CDH_{comm,hh}$	Home consumption equilibrium
D54	$\sum_{activ} FDSC_{f,activ} = FS_f$	Factor market equilibrium
D55	$\sum_{im} pwm_{im} \cdot M_{im} = \sum_{ie} pwe_{ie} \cdot E_{ie} + FSAV + FAIDGIN + FAIDNGO + REMIT$	Current account balance
D56	$SAVING = INVEST + WALRAS1$	Savings-investment equilibrium
D57	$QA_{imr} \geq risklow_{imr}$	Risk Related Minimum Production

References

Arndt, C., Cruz, A., Jensen, H. T., Robinson, S., and Tarp, F. (1998). 'Social Accounting Matrices for Mozambique 1994 and 1995,' Trade and Macroeconomics Division Discussion Paper no. 28, International Food Policy Research Institute.

Arndt, C., Jensen, H. T., and Tarp, F. (1999*a*). 'Stabilisation and Structural Adjustment in Mozambique: An Appraisal,' *Journal of International Development*, forthcoming.

Arndt, C., Jensen, H. T., Tarp, F. (1999*b*). 'Structural Characteristics of the Economy of Mozambique: A SAM Based Analysis,' *Review of Development Economics*, forthcoming.

Arndt, C., Robinson, S., and Tarp, F. (1999). 'Parameter Estimation for a CGE Model: A Maximum Entropy Method,' Trade and Macroeconomics Division, Discussion Paper no. 40, International Food Policy Research Institute.

Bay, A. (1998). 'Mozambique Country Study, Agricultural Technology Component,' Trade and Macroeconomics Division, International Food Policy Research Institute, mimeo.

Dervis, K., de Melo, J., Robinson, S. (1982). *General Equilibrium Models for Development Policy*. New York: Cambridge University Press.

Johnson, J. (1995). 'A Development Plan for the National Accounts,' Statistics Sweden, Special Report Mozambique 1995:3.

Pyatt, G., and Round, J. (1985). 'Social Accounting Matrices: A Basis for Planning,' World Bank.

Rojas, O., and Amade, J. (1997). 'O Impacto de El Nino-Oscilação e sua Aplicação na Seguarança Alimentar.' DINA/MAP, Maputo, Mozambique, mimeo.