AGRICULTURAL GROWTH LINKAGES IN MADAGASCAR

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with

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CFNPP is funded by several donors including the Agency for International Development, the World Bank, UNICEF, the Pew Memorial Trust, the Rockefeller and Ford Foundations, The Carnegie Corporation, The Thrasher Research Fund, and individual country governments.

Preparation of this document was financed by the U.S. Agency for International Development under USAID Cooperative Agreement AFR-000-A-0-8045-00 and by the World Bank.

 ISBN 1-56401-122-4

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This document was word processed by Diane Retson. The manuscript was edited by Elizabeth Mercado. The text was formatted by Gaudencio Dizon. The cover was produced by Jake Smith.

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CONTENTS

LIST OF TABLES

LIST OF APPENDIX TABLES

LIST OF FIGURES

ABBREVIATIONS

AIRD	Associates for International Resources and Development
BDE	Banque des Données de l'Etat
FMG	Franc Malagasy
IO	Input-output
SAM	Social Accounting Matrix
SIO	Semi-input-output

FOREWORD

Previous work on the impact of economic reform in Madagascar has established that policy has an important effect on agricultural performance, and agriculture plays a key role in generating employment and foreign exchange. However, the optimal investment strategy for agriculture is still not clear, specifically the relative merits of investing in export crops versus rice. The appropriateness and effects of export cropping versus cash cropping, and the effects of each on national and household food security and nutrition status have been debated in the literature. However, the macro and sectoral trade-offs in terms of national and sectoral income growth, and the impact on employment and income distribution of alternative strategies have not been sufficiently explored. This question is the focus of this research paper.

The approach used to address the strengths of alternative investment strategies in agriculture is based on a semi-input-output model, which is built around the social accounting matrix (SAM) constructed by Paul Dorosh and his colleagues at the *Banque des Donées de l'Etat* (BDE), reported in CFNPP Working Paper 6. The original purpose of the SAM was to form the basis for constructing a computable general equilibrium (CGE) model to examine the effects of economic reform on poverty and income distribution. This work will be reported in future CFNPP publications. The semi-input-output model that is particularly well-suited to examining the issue of growth linkages, however, serves as an excellent example of a spinoff from the time-intensive task of preparing the SAM. It illustrates well the cumulative nature of research, and how the investments in the empirical exercise of constructing the SAM can have large and meaningful externalities.

The results in this paper indicate strong linkages for both paddy and export crops, including coffee, vanilla, and cloves. Nonetheless, increases in rice production will cost less than increases in export crops. A rice-based agricultural growth strategy is therefore recommended. A further argument for the rice strategy is that it generates greater employment and results in a more equitable income distribution.

The sponsorship of the World Bank for constructing the semi-input-output model is acknowledged, as is the assistance of the U.S. Agency for International Development who underwrote the costs of preparing the SAM.

Washington, DC
January 1992

David E. Sahn
Deputy Director, CFNPP

1. ISSUES

What agricultural growth strategy will generate the greatest spinoffs in the Malagasy economy? Will continued investment in rice production yield highest income multipliers? Or will investment in coffee and other export crops stimulate greater domestic growth?

In the 1970s and 1980s, the Malagasy government invested sizable sums in large-scale irrigated rice perimeters, such as Lac Alaotra, as well as in increased production of export crops, particularly coffee. Many now argue that a heavier emphasis on export crops will yield the greatest prospects for long-run growth.

The food crop versus export crop debate attracts considerable attention in a primarily agricultural country such as Madagascar since agricultural investment priorities shape the scale and nature of opportunities available throughout the economy. Consequently, a firm understanding of the tradeoffs involved in alternative growth paths provides a fundamentally important input into public decisionmaking. The government's recent commitment to economic liberalization reinforces policymakers' need to predict the consequences of alternative growth strategies on public revenues, national income, employment, income distribution, and the sectoral composition of growth.

This linkage between agricultural performance and the overall health of Madagascar's economy has long been recognized by Malagasy policymakers. According to the National Agricultural Plan, written in 1984:

> Agriculture has generally stagnated in the course of the last decade, inducing a serious breakdown of the national economy. Because of the stagnation of production and its consequences – the decline in food availability – agricultural . . . surplus declined and commerce between farmers and other social groups diminished. The basic food needs of the population had to be met by imported goods. This disequilibria contributed to an aggravated balance of payments deficit, inducing the importation of production goods and limiting the resources earmarked for social and economic development (Plan National Agricole 1986, 1508).

Despite the awareness of the linkages between agriculture and the rest of the economy, agricultural policy analysis has remained focused on sectoral outcomes. In part, this is due to a lack of data and of an appropriate methodology with which to conduct quantitative analysis.

The recent construction of a social accounting matrix (SAM) for Madagascar (Dorosh et al. 1991), based on the detailed 1984 national accounts, provides a new and powerful analytical tool for addressing these and related issues. The SAM organizes the available data in a consistent framework and thus enables policy analysts to evaluate the relationships among economic sectors, households, government, and the rest of the world, making possible a wide range of analyses.

This paper develops a model for projecting the income and employment consequences of alternative agricultural growth strategies using the SAM as a framework for modeling the relationships among agriculture and the rest of the Malagasy economy. Given current options under review, the paper focuses on the tradeoffs between export crops and rice.

2. MODELING THE CONSEQUENCES OF AGRICULTURALLY INDUCED GROWTH

OVERVIEW OF THE MODEL

Agricultural growth stimulates demand for production inputs and for the consumer goods required by farm households. Because of these twin sources of demand, investment in agriculture generates not only direct income growth on the farm but also indirect increases in demand for nonagricultural goods and services. Where excess capacity exists, the increased demand translates into higher output and consequently higher nonfarm incomes. Thus the total income gain generated by agricultural growth includes the direct farm income plus the indirect earnings generated in other sectors.

The measurement of these indirect effects requires a model that relates sectoral output, household income, consumer demand, and interindustry input linkages. Since supply responsiveness across sectors determines how effectively growing demand will translate into increased domestic output and income, any model must make clear assumptions about supply elasticities in all sectors of the economy.

One option, the input-output model, embodies the classic approach to this question. It sets total supply in each sector (Z) equal to the two sources of demand, interindustry input demand (AZ) and final consumption demand (F). Final demand includes consumption by households (βY) and exogenous sources of demand such as exports (E). The value-added share (v) in gross commodity output (Z) determines income (Y):

$$\begin{aligned} Z &= AZ + F \\ &= AZ + \beta Y + E \\ &= AZ + \beta v Z + E. \end{aligned} \tag{1}$$

Presuming supply to be perfectly elastic in all sectors, total output and incomes become determined by the level of exogenous demand (E):

$$Z = (I - M)^{-1} E. \tag{2}$$

Because they assume perfectly elastic supply in all sectors, input-output models overestimate output responses following from any intervention. Yet in reality, in most developing countries some sectors face supply constraints. This is especially true for agriculture, where lack of land, labor, rainfall, and technology frequently limit output. By ignoring supply constraints altogether, input-output models typically overstate agricultural growth multipliers by a factor of two to ten (Haggblade, Hammer, and Hazell 1991).

A more realistic approach, and the one adopted here, is to use a semi-input-output (SIO) model. While retaining many of the basic assumptions of the IO approach, the SIO model differs in that it introduces supply rigidities in some sectors. The following two equations, contrasted with (1) and (2) above, capture the SIO model's essential distinction. By classifying all economic sectors as either supply constrained (Z_1) or perfectly elastic in supply (Z_2), the SIO model permits output responses only in some sectors (Z_2). In supply-constrained sectors (Z_1), increases in domestic demand merely reduce net exports (E_1), which then become endogenous to the system:

$$\begin{aligned} Z_1 &= A_1 Z + \beta_1 v_1 Z + E_1 \\ Z_2 &= A_2 Z + \beta_2 v_2 Z + E_2; \end{aligned} \tag{3}$$

$$\begin{bmatrix} E_1 \\ Z_2 \end{bmatrix} = (I - M*)^{-1} \begin{bmatrix} Z_1 \\ E_2 \end{bmatrix}. \tag{4}$$

For a formal exposition of the SIO model, see Appendix B.

The SIO model used here is built around a condensed SAM that includes 12 commodity accounts, 15 activities, 6 household groups, 1 other nongovernment institution, the government, the rest of the world, and 1 capital account (Table 1). Appendix A presents the SAM and describes how it was constructed from the larger SAM developed by the Cornell University and BDE team.

The SIO model is described graphically in Figure 1. For simplicity of exposition, it collapses the 12 SAM commodity accounts still further, into the following three categories: (Z_1) paddy; (Z_2) other supply-constrained commodities including tradables such as coffee, industrial crops, minerals, and formal manufacturing; and (Z_3) commodities highly elastic in supply including nontradables such as services, informal industries, perishable agriculture, plus the tradables such as vanilla and cloves.

Following along in Figure 1, consider the consequences of public investments in paddy production. The immediate impact of rehabilitating small irrigated perimeters or investing in large-scale irrigated rice schemes is to increase paddy supply. In Round 1, this directly raises farm income by FMG 0.49 for every FMG 1.00 of increased paddy supply. This direct injection triggers a series of responses that increase income even more.

In Round 2, the economy registers increased demand for the inputs used in paddy production plus increased farm household spending on consumer goods. These twin channels increase domestic demand for paddy, other supply-constrained tradables and the highly elastic supply of nontradable domestic services, informal manufactures, and perishable agricultural commodities. For paddy and

Table 1 — Madagascar: List of SAM Accounts

SAM Row Accounts	Supply Elasticity[a]
Activities	
1. Paddy, irrigated low-input	
2. Paddy, irrigated high-input	
3. Paddy, rain fed	
4. Coffee, low-input	
5. Coffee, high-input	
6. Vanilla and cloves	
7. Nontraditional export crops	
8. Industrial crops (cotton, groundnuts, sugarcane)	
9. Other agriculture (livestock, tubers, perishables)	
10. Mining, energy, and water	
11. Rice milling	
12. Formal manufacturing	
13. Informal industries	
14. Private services (commerce, construction, services)	
15. Public services	
Commodities	
16. Paddy	0
17. Coffee	0
18. Vanilla and cloves	*
19. Nontraditional export crops	0
20. Industrial crops	0
21. Other agriculture (livestock, tubers, perishables)	*
22. Mining, energy, and water	0
23. Rice	*
24. Formal manufacturing	0
25. Informal industries	*
26. Private services (commerce, construction, services)	*
27. Public services	*
Households	
28. Large urban areas	
29. Secondary urban centers	
30. Large farms	
31. Small farms	
32. Rural nonfarm poor	
33. Rural nonfarm rich	
34. Institutions (corporations, financial, nonprofits)	
35. Government	
36. Rest of the world	
37. Capital	

[a] 0 = inelastic; * = elastic.

Figure 1 — Graphic Representation of Multiplier Effects

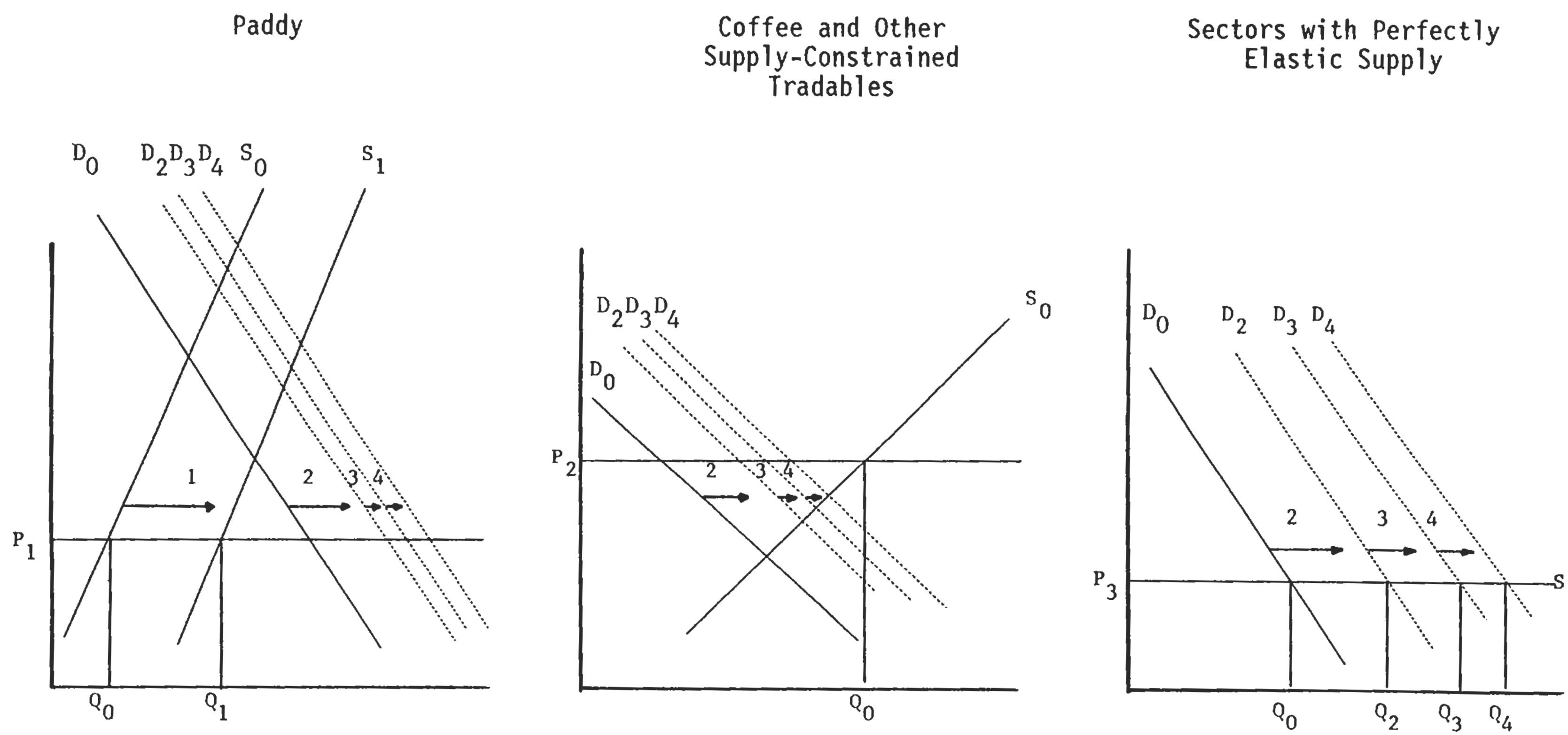

Figure 1 (continued)

Paddy	**Coffee**	**Vanilla and Cloves**
(Inelastic supply, imported good)	(Inelastic supply, exported good)	(Nontraded Goods, perfectly elastic supply)
Round 1		
Invest in paddy - increase in supply - increase in farmer income		
Round 2		
Increased demand (final and intermediate goods); supply fixed at Q_1 - exports decrease - domestic output and income unchanged	Increased demand (final and intermediate goods); supply fixed at Q_0 - exports decrease - domestic output and income unchanged	Increased demand (final and intermediate goods) - increased output - increased income
Rounds 3 and 4		
Increased demand (final and intermediate goods); supply fixed at Q_1 - exports decrease - domestic output and income unchanged	Increased demand (final and intermediate goods); supply fixed at Q_0 - exports decrease - domestic output and income unchanged	Increased demand (final and intermediate goods) - increased output - increased income

other supply-constrained tradables, this increase in demand does not stimulate further domestic production. It merely decreases net exports. In contrast, because of the elastic supply of nontradables, increased demand leads to higher output and higher domestic incomes in these other sectors, most of them outside of agriculture.

The increased production of commodities with elastic supply (Z_3) once again raises demand for production inputs and consumer goods. In Round 3, this increases demand in all three sectors. As before, production of paddy and other supply-constrained commodities does not increase. Instead, net exports decrease still more. For this reason, as Equation (4) indicates, exports in these supply-constrained sectors become endogenous to the model. Yet once again, output and incomes rise in the activities with highly elastic supply. This induces further rounds of successively dampening demand increases.

In total, the indirect effects of the irrigation investment, from Rounds 2 on, stimulate another FMG 1.31 in national income. Thus the total increase resulting from paddy investments equals 0.49 + 1.31 = 1.80.

Investments in coffee production will generate the same sequence of events. They differ only in that the shock, the initial supply increase, will occur in sector Z_2, in coffee production. Since coffee generates different input demands than paddy and a different distribution of income, the second round demand shifts will differ from the paddy results in both composition and magnitude. Ultimately, the total income gain will also be different.

The experiments in Section 3 aim to measure these differences under an array of possible scenarios.

UNDERLYING PREMISES

The SIO model falls into the general family of linear, fixed-price models. For the SIO model to generate sensible predictions, each of these characteristics must offer reasonable approximations of reality.

Linearity

As with many kinds of economic models, the SIO requires that all relationships be expressed as linear functions. For intermediate inputs, this standard assumption suggests that increases in output require additional inputs in fixed proportions. For household consumption, it requires that consumption expenditures rise along with income. Although marginal expenditures or input demands may differ from the average, the increments must be expressed as linear functions of output and income.

In general, this simplification does not pose great problems. Nonlinear systems can be approximated by linear functions in the short run. And they offer considerable conveniences in computing model solutions.

Fixed Prices

Fixed prices likewise vastly simplify computational requirements by sidestepping cumbersome issues of substitution in production and consumption. Input-output coefficients and marginal budget shares, which remain fixed in a fixed-price world, become endogenous variables in a world where relative prices vary. While computational convenience is not a strong rationale for imposing fixed prices, it does offer a strong incentive to investigate the plausibility of such an assumption.

For tradable goods, most analysts agree that the fixed-price assumption is appropriate in small countries. World markets will determine their price level. Madagascar, a small country, takes world prices as given in all markets except vanilla and cloves, which account for over half of its world trade. We will return to the price fixing of vanilla and cloves in a moment.

For nontraded goods, such as services, informal manufactured goods, and many perishable agricultural commodities, fixed prices depend on the ability of firms to increase output at constant cost. Formally, this requires a perfectly elastic output supply. Because of the considerable unemployment and excess capacity in Madagascar, especially in the 1984 base year for which the SAM was constructed, the constant cost assumption appears to be a reasonable approximation of reality.

Vanilla and cloves, too, even though they are tradable commodities, are highly elastic in supply. Essentially wild gathered crops that require primarily harvesting labor, their output can be increased at constant cost so long as wage rates do not rise. Given current underemployment, it appears that vanilla and clove supply can be considered highly elastic, at least in the short run.

At some point, as expansion and liberalization proceed, supply constraints may develop in some of Madagascar's nontradable sectors. When this day arrives, the SIO model will overstate income multipliers emanating from agricultural growth. Consequently, some sort of adjustment will be required to capture the income-dampening effects of the inflation that will follow. Recent experiments suggest that in the face of upward-sloping nontradable supply, SIO models overstate true income multipliers by 10 to 25 percent (Haggblade, Hammer, and Hazell 1991). So the simplest accommodation would involve rule-of-thumb discounting based on these results. At the other extreme, analysts may wish to apply a full-blown computable general equilibrium model, such as the one being developed by Cornell University in conjunction with the Ministry of Plan.

OTHER APPLICATIONS

The SIO model developed here is applied purely to examine the relative merits of alternative agricultural development strategies. It focuses on the income and employment consequences of rice versus export crop strategy. Yet it can serve many other needs as well.

Because it provides a consistent set of full SAM accounts, analysts can use the model, or some modification of it, to generate new balanced SAMs resulting from a wide variety of exogenous shocks to the economy: shifting investment demands, growing export markets, changing tax rates, shifting consumption preferences, investments in other sectors of the economy, or new technology in a given sector. Similarly, building the model around a full SAM permits a projection of the impact of these shocks on government revenues, income distribution, trade balance, and savings. Although more difficult, it is possible to trace the effects of exogenous price shocks, a change in coffee prices, for example, as they percolate through the economy. Easiest of all, the model can readily examine the consequences of investment in nontraditional export crops as opportunities and options arise.

3. RESULTS

INCOME AND EMPLOYMENT IN THE MOST LIKELY SCENARIO

As a point of departure, the base run models what observers consider the most likely sources of agricultural growth: those focused on improved small farmer technology. High-input technology, and in the case of rice, rehabilitation of small-scale irrigation perimeters rather than rain-fed cultivation, seem the most viable avenues for future public investment.

In addition, the base run assumes that consumers spend additional income in the same way they have in the past, that is, that average budget shares equal marginals, and that savings is not translated into investment expenditure in the short run. That is, it considers investment to be exogenous.

Under these assumptions, a FMG 1.000 increase in paddy output will generate a GDP increase of FMG 1.802, while a similar boost in coffee output will produce FMG 1.974 in national income (Table 2). Vanilla and cloves, demand constrained unlike the others, will generate FMG 2.041 in GDP following an exogenous FMG 1.000 increase in export demand. Employment will increase by 2.9, 2.6, and 2.6 jobs, respectively, for each FMG 1 million increase in output.

Although export crops achieve 10 to 15 percent greater income growth than does paddy, the downstream - or multiplier - effects are essentially the same. The initial FMG 1.000 increase in export crops simply represents a greater initial injection of value added. For that reason, the value-added multipliers rank the three crops in reverse order.

Compared to other African countries, the value-added multipliers computed for Madagascar are high, 2.0 to 2.7, compared to 1.3 and 1.5 found elsewhere (Haggblade, Hazell, and Brown 1989; Haggblade and Hazell 1990; Lewis and Thorbecke forthcoming). This may be because other studies have considered only rural regions rather than the full national economy. While expenditures outside the rural region represent leakages in a regional model, they represent income gains for the nation at large.

The greater employment generated by paddy is most pronounced among unskilled workers. Because paddy production is relatively more labor intensive, a FMG 1 million increase in paddy supply generates 2.757 jobs for unskilled workers, compared to only 2.392 jobs for unskilled workers resulting from a FMG 1 million increase in coffee supply (Table 3). This translates into a more equitable

Table 2 — Madagascar: Income and Employment Multipliers for Small Farm Agricultural Growth

	Result of a FMG 1.000 Increase in Each of the Following:		
	Paddy Supply[a]	**Coffee Supply**[b]	**Vanilla and Clove Export Demand**
National income	1.802	1.974	2.041
Employment	2.929	2.639	2.617

[a] Small irrigated perimeters using fertilizers and improved varieties.

[b] High-input small farm production.

Table 3 — Madagascar: Multiplier Decomposition Under Improved Small Farmer Technology

	Effect of a FMG 1.000 Increase		
	Paddy Supply	**Coffee Supply**	**Vanilla/Cloves Export Demand**
Change in national income			
Initial direct increase	0.492	0.632	0.682
Multiplier effects	1.310	1.343	1.359
Total income increase	**1.802**	**1.974**	**2.041**
Value-added multiplier	2.66	2.13	1.99
Change in employment (jobs per million FMG)			
Skilled workers	0.024	0.046	0.049
Semiskilled workers	0.148	0.202	0.211
Unskilled workers	2.757	2.392	2.358
Total	**2.929**	**2.639**	**2.617**

Note: High-input paddy and coffee production, investment exogenous, average budget shares, 1984 world prices. Equivalent to improved technology figures in Tables 2 and 3.

distribution of income as well (Table 4).[1] Urban households and government earn a large share of the income generated from export crops; rural farm households gain half of the income generated from paddy production (0.904 out of 1.802). This difference in income distribution arises largely because 45 percent of export crop value accrues to the government and traders as commodity taxes and commercial margins.

The sectoral impact of growth in alternative agricultural commodities is strikingly similar (Table 5). Private services attract by far the largest component of agricultural demand linkages. Industries other than formal manufacturing also grow rapidly in the wake of agricultural expansion. So does other agriculture, which consists mainly of perishable foods. The important development in production of milk, horticultural crops, and tubers in the Hauts-Plateaux since the recent liberalization underscores the importance of demand linkages in stimulating production of these nonfood items. It suggests that agricultural investment strategies focused on paddy or export crops will contribute, through demand linkages, to broader agricultural growth.

Only public service growth differs across the three crops. Because of the large share of tax revenue in export crop earnings, and because we assume that government spends new income as it has spent past revenue, this results in large increases in the civil service payroll as output of export crops increases.

The predominance of consumption linkages over demand for intermediates explains the striking similarity in sectoral growth across agricultural strategies. Of the two sources of demand linkages – demand for intermediates and final consumer goods – consumption linkages dominate, accounting for 80 percent of total multiplier effects induced by agricultural growth (Table 6). Because of the overwhelming importance of consumption linkages, any strategy that raises farmer income induces broadly similar subsequent consumption expenditure.

CONTRASTING EXPERIMENTS

Under a range of alternative assumptions, the income and employment responses are similar to those of the base run. In particular, low export prices[2] and a regime of export tax reduction alter the multipliers very little.

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[1] The low export tax rate scenario shown in Table 4 is discussed later.

[2] The base year for our SAM is 1984, a year of moderately high export crop prices. Since coffee and vanilla prices have fallen 40 percent since then, it becomes important to establish whether or not projections will differ under more current conditions. To do so, we require a balanced SAM under a regime of low export prices as our point of departure. To obtain one, we have assumed that government export taxes diminish to absorb any fall in export prices. This accords with stated policy and with the evidence in Figure 2. We reduce both government export tax revenues and export value by the 40 percent fall in price. To balance the government and rest of the world accounts, we assume the

(continued...)

Table 4 — Madagascar: Income Distribution Effects of Small Farmer-Led Agricultural Growth

	Effect of a FMG 1.000 Increase in Each of the Following:		
	Paddy Supply	**Coffee Supply**	**Vanilla/Cloves Export Demand**
HIGH EXPORT TAX RATE			
Household income			
Large cities	0.177	0.272	0.286
Secondary towns	0.036	0.051	0.053
Large farms	0.345	0.311	0.397
Small farms	0.904	0.611	0.562
Rural nonfarm, poor	0.068	0.052	0.036
Rural nonfarm, rich	0.063	0.078	0.080
Total households	**1.593**	**1.374**	**1.413**
Institutions' income	0.142	0.164	0.122
Government share of national income	0.067	0.436	0.504
Total national income	**1.802**	**1.974**	**2.041**
LOW EXPORT TAX RATE			
Household income			
Large cities	0.177	0.207	0.217
Secondary towns	0.036	0.042	0.043
Large farms	0.345	0.454	0.670
Small farms	0.904	1.025	0.987
Rural nonfarm, poor	0.068	0.071	0.048
Rural nonfarm, rich	0.063	0.075	0.077
Total households	**1.593**	**1.875**	**2.037**
Institutions' income	0.142	0.207	0.159
Government share of national income	0.067	0.078	0.084
Total national income	**1.802**	**2.160**	**2.280**

Source: Model simulations.

Note: The government's share of national income is the value added it receives from taxes on commodities and production activities. It does not include the revenue they receive from corporate and household income taxes.

Table 5 — Madagascar: Sectoral Composition of Small Farmer-Led Agricultural Growth

	Effect of a FMG 1.000 Increase		
Output Change in Each Sector	**Paddy Supply**	**Coffee Supply**	**Vanilla/Cloves Export Demand**
Paddy, low-input	0.000	0.000	0.000
Paddy, high-input	0.979	0.000	0.000
Paddy, rain fed	0.000	0.000	0.000
Coffee, low-input	0.000	0.000	0.000
Coffee, high-input	0.000	0.300	0.000
Vanilla, cloves	0.000	0.000	0.249
New export crops	0.000	0.000	0.000
Industrial crops	0.000	0.000	0.000
Other agriculture	0.497	0.382	0.388
Mining, energy, water	0.005	0.005	0.005
Rice milling	0.202	0.165	0.164
Formal manufacturing	0.003	0.003	0.003
Other industries	0.381	0.322	0.330
Private services	0.895	0.947	0.930
Public services	0.088	0.296	0.328

Source: Model simulations.

Table 6 — Madagascar: Share of Consumption Linkages in Total Multipliers

	Effect of a FMG 1.000 Increase		
	Paddy Supply	**Coffee Supply**	**Vanilla/Cloves Export Demand**
Current technology mix			
1. Consumption plus production linkages			
a. Total income gain	2.062	2.060	2.041
b. Direct	0.579	0.664	0.682
c. Indirect	1.483	1.396	1.359
2. Production linkages only			
a. Total income gain	0.804	0.933	0.932
b. Direct	0.579	0.664	0.682
c. Indirect	0.224	0.269	0.250
3. Consumption linkages			
a. Indirect income (1c-2c)	1.259	1.127	1.109
b. As share of total multiplier (3a/1c)	84.9%	80.7%	81.6%
High-input technologies			
1. Consumption plus production linkages			
a. Total income gain	1.802	1.974	
b. Direct	0.492	0.632	
c. Indirect	1.310	1.343	
2. Production linkages only			
a. Total income gain			
b. Direct	0.711	0.917	
c. Indirect	0.492	0.632	
	0.219	0.285	
3. Consumption linkages			
a. Indirect income (1c-2c)	1.091	1.058	
b. As share of total multiplier (3a/1c)	83.8%	78.8%	

Assumptions about investment behavior do, however, affect the multipliers. Since most linkage studies take investment expenditures as exogenous,[3] we adopt that as our default assumption. In other words, we assume that, in the short run, savings accumulates and is not spent on investment goods. In contrast, if investment is endogenous, then savings is immediately translated into purchases of investment goods. If that happens, it obviously increases the demand linkages and hence growth multipliers in the short run.[4] As Tables 7 and 8 indicate, endogenizing investment increases multipliers 20 percent to 30 percent.

The set of marginal budget shares estimated from household survey data lowers the multipliers by 15 to 20 percent. The big drop in the multipliers is due mainly to a high estimated marginal propensity to consume rice relative to the average budget share derived from the SAM. Since paddy supply is assumed to be inelastic, increased demand for rice translates into increased imports and hence greater leakages from the domestic economy. Given the uncertain quality of the survey data underlying the marginal propensities to consume, it is likely that the average budget shares in the SAM are a better approximation of reality.[5]

STIMULATING GROWTH THROUGH INVESTMENT

Ultimately, the tradeoff among agricultural growth strategies depends on the amount of investment required to initiate output growth in the first place. Once output grows by FMG 1, the consequences are broadly similar.

But the investment necessary to increase paddy output by FMG 1 differs substantially from investment requirements for boosting coffee output. Table 9 shows two investment scenarios, based on traditional cost-benefit analysis, for both paddy and coffee. The paddy scenarios show the costs and benefits for rehabilitation of small irrigated perimeters in the high plateaus using traditional and input intensive technologies (AIRD 1990). These yield pessimistic and optimistic projections, respectively. These coffee scenarios are based on FAO (1989) high and low world coffee price assumptions.

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[2](...continued)
government borrows the amount of the shortfall from abroad. See Appendix A for details.

[3] See Bell, Hazell, and Slade (1982) for example.

[4] In the long run, investment also increases production capacity by shifting supply curves.

[5] The estimated marginal expenditure shares were based largely on surveys by the Ministry of Agriculture designed especially to measure household consumption and rice purchases. Other expenditures appear to be under-reported, compared with the consumption estimates in the national accounts of the SAM. The estimated marginal budget shares and the methodology used are described in Appendix C.

Table 7 — Madagascar: GDP/Output Multipliers

	Paddy	Coffee	Vanilla/ Cloves
1984 world coffee price			
Improved small farmer technology[a]	1.802	1.974	2.041
Status quo[b]	2.062	2.060	2.041
Endogenous investment	2.151	2.637	2.710
Production linkages only	0.711	0.917	0.932
New consumption parameters	1.506	1.709	1.766
Reduced export taxes			
Exogenous investment	1.802	2.160	2.280
Endogenous investment	2.152	2.607	2.688
Low world prices for export crops[c]			
Improved small farmer technology	1.802	1.975	2.094
Status quo	2.062	2.112	2.094
Endogenous investment	2.150	2.447	2.517

Source: Model simulations.

[a] Improved small farmer technology mix in all sectors, investments exogenous, average budget shares.

[b] Status quo: current farm size and technology mix in all sectors.

[c] World coffee price reduced by 38 percent of 1984 level; world vanilla and clove prices reduced by 44 percent of 1984 level.

Table 8 — Madagascar: Employment/Output Multipliers

	Paddy	Coffee	Vanilla/ Cloves
	Jobs per Million FMG of Increased Supply		
1984 world coffee price			
Improved small farmer technology[a]	3.557	2.834	2.617
Status quo[b]	2.929	2.639	2.617
Endogenous investment	3.466	3.664	3.652
Production linkages only	1.281	1.137	1.056
New consumption parameters	2.489	2.261	2.225
Reduced export taxes			
Exogenous investment	2.929	3.046	3.130
Endogenous investment	3.467	3.739	3.763
Low world prices for export crops[c]			
Improved small farmer technology	3.577	3.829	3.757
Status quo	2.929	3.516	3.757
Endogenous investment	3.472	4.258	4.423

Source: Model simulations.

[a] Improved small farmer technology mix in all sectors, investments exogenous, average budget shares.

[b] Status quo: current farm size and technology mix in all sectors.

[c] World coffee price reduced by 38 percent of 1984 level; world vanilla and clove prices reduced by 44 percent of 1984 level.

Table 9 – Madagascar: Investment Multipliers

	Pessimistic Scenario	Optimistic Scenario
	GDP per FMG Invested	
	(Traditional Technology)	(High-Input Technology)
Paddy: Rehabilitation of small irrigated perimeters	3.68	4.65
	(Low World Price)	(High World Price)
Robusta coffee project: Mixed uplanting and pruning, high-input technology	1.69	3.22

Note: For details of calculation, see Appendix Table D.4.

Although investments vary considerably across settings and over time, even for the same crop, it appears that under best- and worst-case settings for each crop, policymakers can increase paddy output at significantly lower investment cost than coffee. Under optimistic assumptions (high-input technology), FMG 1.0 invested in paddy rehabilitation will generate FMG 4.7 in national income (GDP). Yet the same FMG 1.0 invested in coffee, even under the optimistic high world coffee price scenario, would only yield FMG 3.2 in national income.[6] On efficiency grounds, it appears that investments in paddy yield higher returns.[7]

STIMULATING GROWTH THROUGH EXPORT CROP TAXATION

Gains from Export Tax Reduction

In periods of high export prices, export taxes range between 40 and 60 percent of the value of the world market price (Figure 2). The government's current policy of export liberalization aims to raise farm-gate prices of export crops by lowering export tax rates and allowing competition among traders to reduce the marketing costs between farm-gate and port. Because this strategy was adopted as world prices slumped, producers have not yet seen an increase in the farm-gate price. But in the future, as prices revive, the government may be willing to pass on a greater share of the price increase to farmers. If they do, what will be the impact on national income?

In general, we might anticipate two consequences from a redistribution of export tax revenue to farmers. First, the redistribution of spending power will generate different domestic consumption patterns. If farmers spend more on locally produced nontradables than government does, a pure redistribution will increase GDP. Second, if the supply elasticity of coffee is positive in the short run, the higher price will induce a supply response, thereby raising output and income as well. As illustrated in Figure 3, a complete suppression of export taxes on coffee and vanilla would increase domestic production from Q_0 to Q_1.

Redistributing Purchasing Power

The experiments summarized in Table 10 suggest that the pure redistribution effect of transferring income from government to farmers' income will be very small. Depending on the situation, it will change GDP by -0.1 to +1.0 percent.

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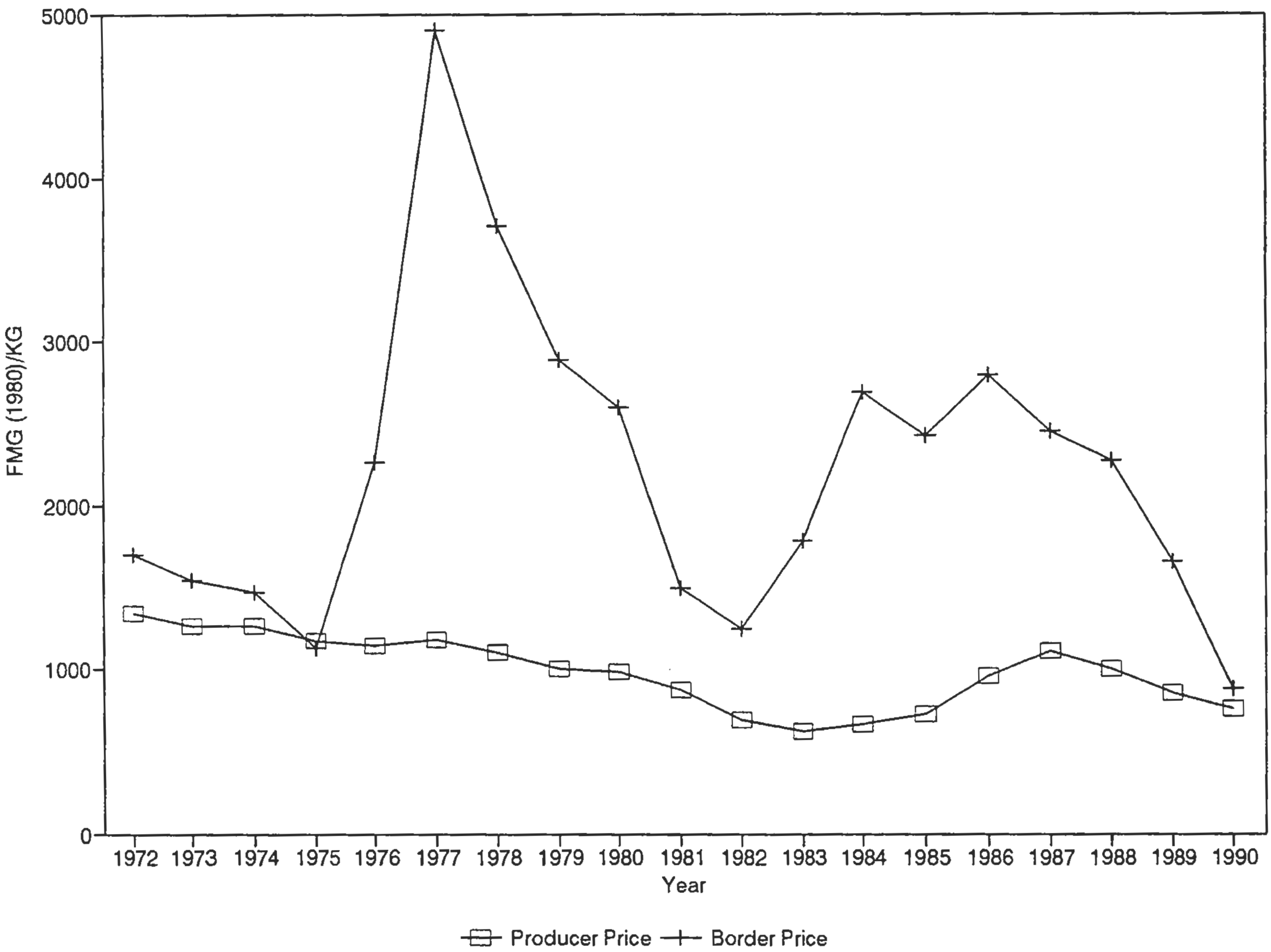
[6] Benefits and costs for the coffee project are amortized annual values calculated at a discount rate of 10 percent.

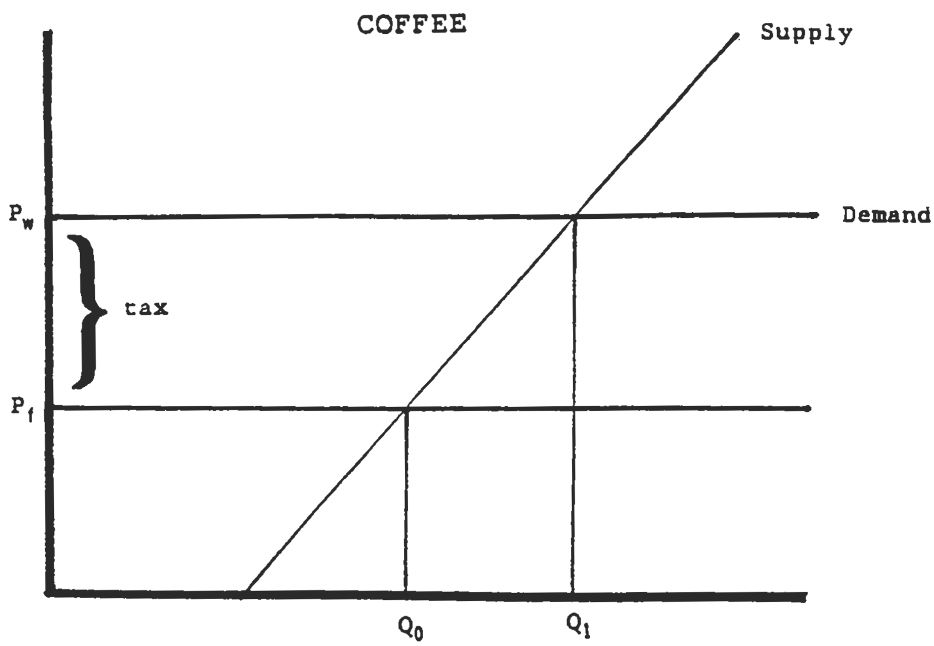
[7] An increase in vanilla export would require different sorts of investment. Instead of irrigation rehabilitation, new seedlings, and extension support, it would require market development or other interventions to boost demand. Since we have little feel for the costs of boosting exports by a given amount, we have ignored vanilla in computing the investment multipliers.

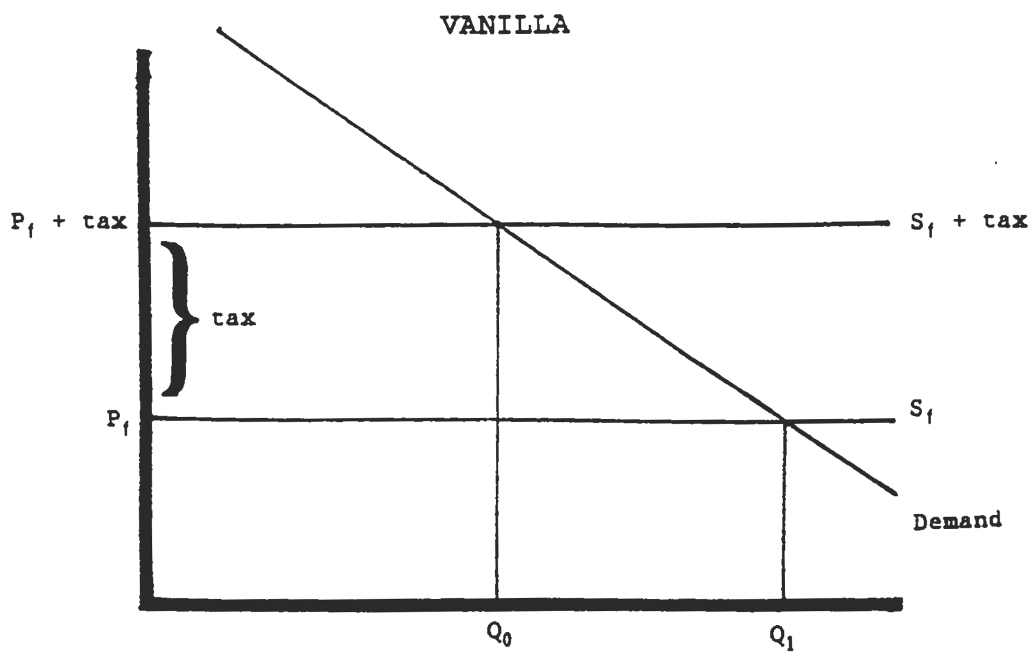
Figure 2 — Real Coffee Prices, 1972-1990



Source: Dorosh and Bernier (1991).

Figure 3 – The Effect of Export Crop Taxes on Coffee and Vanilla Production





Key:

P_w = World price
P_f = Farm-gate price

Table 10 — Madagascar: Effect of Redistributing Purchasing Power from Government to Farmers by Reducing Taxes on Export Crops

	Coffee	**Vanilla/Cloves**
	Percent Change in GDP	
Investment exogenous	+1.0	+0.8
Investment endogenous	-0.1	-0.05

Source: Model simulations.

Supply Response

Yet the second effect, the impact of a positive supply response, could be quite large in periods of high export crop taxation (Table 11). For example, in 1984 complete suppression of export taxes would increase the farm-gate price of coffee by 125 percent and of vanilla by 178 percent. The magnitude of the resulting supply response depends on the elasticities of supply and demand, respectively (see Figure 3).

Although everyone agrees that the supply elasticity for coffee is positive in the long run, the short-run opportunities for increasing output of tree crops is less certain. If output supply elasticity attains the modest level of 0.2, a complete suppression of the coffee export tax in 1984 would have increased GDP by 2.8 percent (Table 11).

For vanilla, estimated demand elasticities vary widely depending on assumptions about substitutability between Malagasy and Indonesian vanilla. If demand elasticity of vanilla lies near -0.2, vanilla tax level price reductions would induce an output response that will increase GDP by 1.2 percent. This output response occurs because, if Madagascar reduces its selling price on the world market, eliminating the export tax and keeping the producer price unchanged, world demand for Madagascar's vanilla would rise and Madagascar's vanilla production would increase to match it (Figure 3). If, as the World Bank (1991) study suggests, demand is even more highly elastic, and if supply elasticity is likewise highly elastic, suppression of export crop taxes could increase vanilla output sufficiently to raise GDP more than 2 percent (Table 11).

Dual Policy Levers

To promote export crops, policymakers have two powerful levers at their disposal: (a) public investment in production capacity; and (b) increasing farmer price incentives by lowering export taxes. In promoting paddy production, the investment lever offers substantially more leverage given the current low level of rice taxes.

Of the two, investment appears to be the more powerful lever for promoting both paddy and export crops. Comparing coffee tax rebates with investment of equal value, Table 12 suggests that funds invested in coffee production will generate twice as much national income as they would if paid to farmers in the form of higher farm-gate prices. In paddy production, that same investment would generate three times as much national income as would export tax rebates (Table 12).[8]

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[8] Because the model takes investment as exchanges, these results assume that any revenue needed for investment or tax rebates is borrowed from abroad in order to maintain constant investment.

Table 11 – Madagascar: Supply Response from Transferring All Export Crop Tax Revenue from Government to Farmers

	Increase in Farm-gate Price	Increase in Output	Increase in GDP
		Percentage	
Coffee			
Supply elasticity	+125		
0.0		0	0
0.2		25	2.8
0.4		50	5.6
Vanilla			
Demand elasticity	+178		
0.0		0	0
-0.2		36	1.3
-0.5		89	3.3

Note: See Appendix Table D.5 for calculation details.

Table 12 — Madagascar: Options for Stimulating Agricultural Growth

	Investment In			Price Policy (Stimulate Supply Via Lower Export Taxes on Coffee)	Combined Price Policy and Investment in Coffee
	Paddy	Coffee			
		High Taxes	Low Taxes		
	(a)	(b)	(c)	(d)	(e) = c + d
	Million FMG				
Intervention					
Investment in production	36,004	36,004	36,004	0	36,004
Increase in farm-gate price	0	0	0	+125%	+125%
Financial cost to government	36,004	36,004	36,004	36,004[a]	72,008[a]
Resulting change in					
Output	92,926	58,434	58,434	23,962	82,396
GDP	9.4%	6.5%	7.1%	2.8%	9.9%
Savings	20,630	25,441	17,297	7,164	24,461
Government finances					
Initial cost	-36,004	-36,004	-36,004	-36,004	-72,008
Increased revenue	+11,337	+28,697	+8,824	+3,618	+12,376
Increased expenses	-6,190	-15,688	-4,782	-1,976	-6,758
Net change	**-30,857**	**-22,975**	**-32,028**	**-34,362**	**-66,390**
Net change (percent GDP)	-1.7	-1.3	-1.8	-1.9	-3.7
Efficiency of public spending (ΔGDP/ Δgovernment spending)	5.4	5.0	3.9	1.4	2.6

Source: Model simulations.

[a] The reduction in government revenues due to the lower export taxes on coffee shown here, equal to FMG 36,004 million, is actually a transfer payment, not an economic cost.

IMPACT ON RICE DEMAND

In the future, if Madagascar becomes self-sufficient in rice production, additional investment in paddy may depress domestic prices. Given the uncertainties of exporting rice on a thin world market, there may be a limit to how far Madagascar can focus on rice. Table 13 shows the net effect of various agricultural growth strategies on rice imports. Under all scenarios, investment in paddy reduces rice imports, as the increase in production more than offsets the multiplier effects of increased final demand for rice. In contrast, increasing export crop supplies results in higher incomes, increased demand for rice, and larger rice imports.

A balanced growth strategy might consider increasing investments in export crops while increasing domestic paddy production enough to enable domestic supply of additional paddy demand generated by higher incomes in export crops. A large coffee project currently under consideration would generate an annual rice demand of 5,892 tons under low world coffee prices (and 11,112 tons of rice per year if coffee prices are high) (Table 14). This increased demand for rice would occur beginning in year seven of the coffee project, when the coffee trees came of bearing age. Meeting this demand would require rehabilitation of 2,843 to 4,533 hectares of small irrigated rice perimeters (4,533 hectares if world coffee prices are high).

SAVINGS AND DYNAMIC LINKAGES

Different investment strategies also generate different levels of savings (Table 15). Under high world prices, export crops generate enormous tax revenues, given the current high level of taxation. If, as the model assumes, government saves most of the increased revenues, the export crop strategy generates 80 percent more savings per unit of output than does paddy. Under low world prices, prospects for taxing export crops diminish, and in this setting, investments in paddy rehabilitation generate savings per unit of investment twice as large as those earned in coffee.

So the ranking of dynamic growth paths is ambiguous. The long-run, investment-led growth emanating from export crop investments may be higher or lower than that of paddy, depending on trends in world export crop prices.

AGRICULTURE AS AN ENGINE OF GROWTH

Although agriculture generates powerful linkages with other sectors of the economy, paddy and export crops alone cannot stimulate enough growth to keep pace with Madagascar's rapid population growth. Investments necessary to sustain growth in paddy, coffee, vanilla, and cloves at 5.0 percent per year will generate GDP growth of about 2.2 percent per year and employment growth of 2.3

Table 13 — Madagascar: Impact of Alternative Agricultural Growth Strategies on Rice Imports

	Impact on Net Rice[a] Imports of a FMG 1.000 Increase		
	Paddy Supply	**Coffee Supply**	**Vanilla/Cloves Export Demand**
High-input small farm technology	-0.981	0.208	0.206
Status quo	-0.969	0.223	0.206
Investment	-0.972	0.290	0.290
Production linkages only	-1.209	0.000	0.000
Marginal budget shares	-0.815	0.381	0.385
Reduce export taxes			
Investment exogenous	-1.006	0.296	0.308
Investment endogenous	-0.972	0.351	0.356

[a] Rice imports (FMG) are calculated as paddy value times 1.259 to account for milling and marketing margins.

Table 14 – Madagascar: Rice Balance Effects

	Low World Price	High World Price
Coffee project (years 7-30)		
Net present value of coffee (million FMG)	66,009	132,018
Annualized value of coffee (million FMG/year)	6,679	13,358
Change in rice imports per FMG increase in coffee supply	0.261	0.208
Change in rice imports (million FMG/year)	1,743	2,778
	Traditional Technology	**High-input Technology**
Rice project		
Investment cost per MT increase in production (FMG/MT)	161,043	96,853
Value of rice output per FMG invested (FMG)	1.552	2.581
Change in rice imports per FMG increase in paddy output	-0.917	-0.981
Change in rice imports per FMG invested	-1.423	-2.532
Coffee and rice projects combined[a]		
Rice investment required for no net change in rice imports		
Million FMG	1,225[b]	1,097[c]
Hectares	5,071[b]	4,533[c]

[a] Rice investment made in year 7 of coffee project.

[b] Low world coffee price, traditional rice technology.

[c] High world coffee price, high-input rice technology.

Table 15 – Madagascar: Accumulated Savings

	Effect of a FMG 1.000 Increase in Each of the Following		
	Paddy	**Coffee**	**Vanilla/ Cloves**
1984 World Coffee Price			
Improved small farmer technology	0.222	0.444	0.448
Status quo	0.254	0.427	0.448
Endogenous investment	0.285	0.560	0.565
Production linkages only	0.711	0.917	0.932
New consumption parameters	0.172	0.393	0.396
No coffee export tax			
Exogenous investment	0.222	0.299	0.273
Endogenous investment	0.283	0.376	0.343
Low World Coffee Price			
Improved small farmer technology	0.222	0.318	0.285
Status quo	0.254	0.290	0.285
Endogenous investment	0.283	0.399	0.358

Source: Authors' calculations.

percent per year, both slightly below the rate of population growth (Table 16).[9] While paddy and export crops can sustain a critical share of Madagascar's growth requirements, development efforts will need to expand beyond these two arenas – to industrial crops, and manufacturing and services – in order to successfully raise living standards for the country's growing population.

[9] Calculated from Table 16 as 1.04 + 0.72 + 0.47 = 2.23 and 1.15 + 0.70 + 0.45 = 2.30.

Table 16 — Madagascar: Potential Rates of Agriculture-Led Economic Growth

Results in the Following Annual Percentage Growth Rates In:	**A Sustained 5 Percent Growth in Each Crop Over 20 Years**				
		Export Crops, High Tax		**Export Crops, Low Tax**	
	Paddy	**Coffee**	**Vanilla and Cloves**	**Coffee**	**Vanilla and Cloves**
	Percentage				
GNP	1.04	0.66	0.43	0.72	0.47
Employment	1.15	0.61	0.38	0.70	0.45
Sectoral output					
Agriculture	1.63	0.89	0.56	1.00	0.65
Manufacturing	0.66	0.31	0.20	0.43	0.28
Services	0.87	0.63	0.39	0.62	0.39

Source: Income/output, employment/output, and output/output multipliers in Tables 3 and 4. Assumes only 80 percent of multipliers achieved due to reduced unemployment, and hence upward-sloping supply curves over time. See Haggblade, Hammer, and Hazell (1991) regarding the 80 percent rule of thumb for deflating SIO multipliers.

4. IMPLICATIONS FOR AGRICULTURAL GROWTH STRATEGIES

RICE VERSUS EXPORT CROPS

Both paddy and export crops have strong linkages with the domestic economy. A FMG 1 increase in the output of paddy, coffee, or vanilla and cloves generates about FMG 2 in total GDP. This striking similarity arises because of similar input demands in coffee and paddy and because consumption linkages account for 80 percent of total multipliers. Since either strategy increases small farmer income, agricultural growth, regardless of its origin, produces broadly similar ripples throughout the rest of the economy. This may change with the advent of new export crops with dramatically different input requirements and income distribution. But for the present, the options on the shelf generate very similar spinoffs throughout the economy.

Yet it appears that paddy output can be increased at lowest cost. Consequently, investment in irrigated rice currently generates the greatest increase in national income per unit of investment: a FMG 1.0 investment in paddy generates a FMG 4.7 increase in GDP, whereas the same FMG 1.0 invested in coffee generates only FMG 3.2 in GDP, even under optimistic assumptions about world coffee prices. Paddy also generates more employment and a slightly more equitable income distribution. So at least in the short run, investment in paddy appears preferable on both efficiency and equity grounds.

This conclusion hinges on currently available data that suggest lower investment costs are necessary for increasing paddy output. In future investigations of charting opportunities for agricultural growth, these investment data warrant special scrutiny. Available data appear fragile, and costs clearly vary from one location to another. So future investigations should concentrate on locating output growth at the lowest possible investment cost. Increases in farmer incomes, whether derived from increased paddy or export crop production, will produce strong linkage effects throughout the economy as farmers spend their new earnings on locally produced goods and services.

SUSTAINING THE GROWTH LINKAGES

For the agricultural growth linkages to achieve their full potential, policymakers must bear in mind several key features of the spinoffs of agriculture-led growth. First, most of the spinoffs occur in rural areas and in rural towns. Hence the state of rural infrastructure — roads, electricity, water, and communications — will affect the ability of nonfarm sectors to respond to the increased demand of farm households. If spinoffs are to achieve their full potential, ongoing decisions about the placement, construction, maintenance, and finance of rural infrastructure will have to be made. In all these phases, local decisionmaking and the ability to mobilize local resources will be important. This makes local governments important actors in agriculture-led growth strategies. To play their role effectively, the local authorities must enjoy the necessary political and financial authority as well as the management skills necessary to mobilize local resources and coordinate decisionmaking.

Second, direct intervention on behalf of nonfarm and secondary farm activities can effectively accelerate their growth. To enjoy the full benefit of the agriculturally induced demand stimulus, evidence suggests that supporting supply-side interventions can be cost-effective (Haggblade, Hazell, and Brown 1989). While credit programs have proven most popular, technical assistance can also be viable if judiciously targeted.

APPENDIX A

THE SOCIAL ACCOUNTING MATRIX (SAM)

The social accounting matrix used in the multiplier analysis (Appendix Table A.1) is a modification of a more disaggregated SAM (hereafter called SAM1), described in detail in Dorosh et al. (1991). In this section the basic methodology used in constructing SAM1 is briefly outlined, and the modifications made in the new SAM (SAM2) are described.

SAM1 takes as its starting point the production and total income data from the national accounts. Incomes and expenditures by household were estimated using the results of several household surveys. Urban expenditure data were considered to be more reliable than rural survey results and were used with only small modifications (to account for items apparently under-reported in the surveys). Rural expenditures, apart from rice consumption data, are calculated largely as a residual of total national consumption less estimated urban consumption.

SAM2 differs from SAM1 in several major ways: in the specification of production activities and commodities, the absence of factor accounts, the disaggregation of households, and the methodology used for estimating the level of household expenditures and savings.

Both SAM1 and SAM2 disaggregate agriculture, a single subsector in the national accounts. Several agricultural activities are specified in SAM2 (smallholder low-input irrigated rice, largeholder high-input irrigated rice, upland rice, smallholder coffee, largeholder coffee, vanilla and cloves, and other agriculture). Production cost estimates for paddy and export crops are based on AIRD (1984) and World Bank (1984). The 30 nonagricultural activities in the national accounts are aggregated into 19 activities in SAM1 and 6 activities in SAM2 (mining and energy, rice milling, formal industry, informal industry and textiles, private services, and public services). In SAM2, manufactured goods produced by individual enterprises are grouped with textiles under the assumption that these goods are elastic in supply. No data separating consumption of manufactured goods according to origin (formal versus informal sector goods) are available. All intermediate consumption of domestic manufactured products (except textiles) by formal sector industries was assumed to originate from other formal sector industries. The share of informal sector manufactured goods out of total consumption of manufactured goods was assumed to be the same across household groups.

SAM1 contained factor accounts and thus did not show payments of value added from activities directly to households and other institutions. In SAM2, all

Appendix Table A.1 — Madagascar: Social Accounting Matrix

		ACTIVITES 1 PaddyA	2 PaddyB	3 PaddyC	4 CafeA	5 CafeB	6 Van	7 Nouv	8 CuInd	9 AuAg	10 Min/En	11 Riz	12 MfF	13 AuInd	14 S.Priv	15 S.Pub	COMMODITES 16 Paddy	17 Cafe	18 Van	19 NouvCXp	20 CuInd
ACTIVITES	1 PaddyA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59973	0	0	0	0
	2 PaddyB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	87315	0	0	0	0
	3 PaddyC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20918	0	0	0	0
	4 CafeA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21534	0	0	0
	5 CafeB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7201	0	0	0
	6 Van/GirExp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14569	0	0
	7 NouvCultExp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8 CultInd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14176
	9 AutreAg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10 Mines/Ener/Eau	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11 Rizerie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12 Mftr.Formelle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	13 Autre.Ind	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	14 Serv.Privees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15 Ad.Pub	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COMMODITES	16 Paddy	3539	3592	2443	0	0	0	0	0	0	0	162156	0	0	0	0	0	0	0	0	0
	17 Cafe	0	0	0	11	11	0	0	0	0	0	0	0	4078	0	0	0	0	0	0	0
	18 Van/Gir	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	19 NouvCultExp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	20 CultInd	0	0	0	0	0	0	0	372	0	0	0	0	12102	0	0	0	0	0	0	0
	21 AutreAg	18079	3020	1139	0	84	0	0	3161	34164	7	0	858	171528	18831	336	0	0	0	0	0
	22 Mines/Ener/Eau	0	2423	0	0	65	0	0	141	7919	33446	1510	6183	7663	52248	4856	0	0	0	0	0
	23 Riz	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	24 Mftr.Formelle	0	15566	17	0	347	566	0	891	7848	4838	0	30841	27744	68946	14241	0	0	0	0	0
	25 Autre.Ind	0	1777	1	0	86	0	0	102	10467	262	0	2026	53164	29438	15997	0	0	0	0	0
	26 Serv.Privees	0	17100	0	0	457	0	0	997	10927	14232	2516	7851	18898	113533	38042	3524	31109	17997	0	9549
	27 Ad.Pub	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MENAGES	28 UrbGrCen	0	0	0	0	0	0	0	0	3736	8288	1385	13008	26057	109098	98766	0	0	0	0	0
	29 UrbCenSec	0	0	0	0	0	0	0	0	754	1402	267	2283	5429	24291	15672	0	0	0	0	0
	30 AgCultGrand	0	34527	5375	0	3875	5088	0	880	177338	36	0	0	8782	174138	0	0	0	0	0	0
	31 AgCultPetit	36556	6113	11734	21219	899	8915	0	6486	209947	8	0	0	5181	257072	0	0	0	0	0	0
	32 NonagRurPauvre	1799	2619	209	304	386	0	0	233	14965	4	0	0	1084	25139	0	0	0	0	0	0
	33 NonagRurRiche	0	0	0	0	0	0	0	0	1761	1639	375	2796	9151	49079	15863	0	0	0	0	0
INSTITUTIONS	34 Institutions	0	578	0	0	991	0	0	913	10509	20592	1779	15696	39468	85413	0	0	0	0	0	0
GOUVERNEMENT	35 Gouv't.	0	0	0	0	0	0	0	0	-2850	544	0	3343	13500	-6138	26	0	36004	25835	0	0
RESTE DU MONDE	36 ROM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAPITAUX	37 Capitaux	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SOMME	**59973**	**87315**	**20918**	**21534**	**7201**	**14569**	**1**	**14176**	**487485**	**85298**	**169988**	**84885**	**403829**	**1001088**	**203799**	**171730**	**95848**	**58401**	**1**	**23725**

Appendix Table A.1 (continued)

		21 AutreAg	22 Min/En	23 Riz	24 MfF	25 AuInd	26 S.Priv	MENAGES 27 S.Pub	28 GCU	29 CUS	30 AgGr	31 AgPt	32 NRPauv	33 NRRich	34 Inst	35 Gov	36 RDM	37 Cap	SOMME
ACTIVITES	1 PaddyA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59973
	2 PaddyB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	87315
	3 PaddyC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20918
	4 CafeA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21534
	5 CafeB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7201
	6 Van/GirExp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14569
	7 NouvCultExp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8 CultInd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14176
	9 AutreAg	483896	46	0	0	1143	2400	0	0	0	0	0	0	0	0	0	0	0	487485
	10 Mines/Ener/Eau	0	79735	0	143	71	5349	0	0	0	0	0	0	0	0	0	0	0	85298
	11 Rizerie	0	0	169988	0	0	0	0	0	0	0	0	0	0	0	0	0	0	169988
	12 Mftr.Formelle	191	96	0	81374	66	3158	0	0	0	0	0	0	0	0	0	0	0	84885
	13 Autre.Ind	2461	0	0	1007	390737	9624	0	0	0	0	0	0	0	0	0	0	0	403829
	14 Serv.Privees	1167	363	0	16441	10004	973113	0	0	0	0	0	0	0	0	0	0	0	1001088
	15 Ad.Pub	272	0	0	5074	12172	5908	180373	0	0	0	0	0	0	0	0	0	0	203799
COMMODITES	16 Paddy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	171730
	17 Cafe	0	0	0	0	0	0	0	0	0	1366	7081	0	406	0	0	82895	0	95848
	18 Van/Gir	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54074	4327	58401
	19 NouvCultExp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	20 CultInd	0	0	0	0	0	0	0	0	0	1683	8720	0	495	0	0	0	353	23725
	21 AutreAg	0	0	0	0	0	0	0	29389	6274	123941	152566	13601	36587	0	0	14617	3188	631370
	22 Mines/Ener/Eau	0	0	0	0	0	0	0	17785	3767	2009	2578	208	594	0	0	7791	10333	161519
	23 Riz	0	0	0	0	0	0	0	35873	8206	44447	90255	8961	13120	0	0	0	0	200862
	24 Mftr.Formelle	0	0	0	0	0	0	0	16641	3343	25691	28118	2271	7585	0	0	2311	45677	303482
	25 Autre.Ind	0	0	0	0	0	0	0	43851	8913	147143	154968	10850	43440	0	0	24254	14027	560766
	26 Serv.Privees	139449	5952	12921	48702	92715	0	0	87204	17602	100576	129040	10425	29699	0	0	37225	80348	1078590
	27 Ad.Pub	0	0	0	0	0	0	0	1127	233	127	163	13	37	5354	173319	0	0	180373
MENAGES	28 UrbGrCen	0	0	0	0	0	0	0	0	0	0	0	167	298	58512	23291	13468	0	356074
	29 UrbCenSec	0	0	0	0	0	0	0	0	0	0	0	19	34	10296	4223	1513	0	66183
	30 AgCultGrand	0	0	0	0	0	0	0	0	0	0	16113	0	0	45972	0	0	0	472124
	31 AgCultPetit	0	0	0	0	0	0	0	0	0	0	0	0	0	644	0	0	0	564774
	32 NonagRurPauvre	0	0	0	0	0	0	0	0	0	0	0	0	0	58	2179	0	0	48979
	33 NonagRurRiche	0	0	0	0	0	0	0	0	0	0	0	0	0	55979	3885	0	0	140528
INSTITUTIONS	34 Institutions	0	0	0	0	0	0	0	15610	2826	25141	0	1456	2595	0	55211	3319	0	282097
GOUVERNEMENT	35 Gouv't.	1083	9076	0	40971	36952	28548	0	33806	6129	0	0	3163	5638	57039	0	24900	0	317569
RESTE DU MONDE	36 RDM	2851	66251	17953	109770	16906	50490	0	16935	1903	0	0	0	0	67140	29704	0	0	379903
CAPITAUX	37 Capitaux	0	0	0	0	0	0	0	57853	6987	0	-24828	-2155	0	-18897	25757	113536	0	158253
	SOMME	631370	161519	200862	303482	560766	1078590	180373	356074	66183	472124	564774	48979	140528	282097	317569	379903	158253	

labor and capital incomes in agriculture are paid directly to rural households according to their shares in landholdings by crop activity and according to their share in total rural labor force. All formal sector activity wages are paid to urban households according to their ownership of labor by skill type. Returns to informal capital from each activity were allocated to households in the same proportions used for the allocation of total returns to informal capital in SAM1.

DISAGGREGATION OF HOUSEHOLDS

There are six household groups in SAM2. The rural rich category of SAM1 was divided into two groups: large farmers (those owning more than 1.5 hectares) and nonfarm rural rich. All small farmers in SAM1 were aggregated to form one group in SAM2. Nonfarm rural poor remain a separate group as in SAM1. In the urban areas, SAM1 divides households according to the type of employment of the head of household (*categorie socio-professionel*); SAM2 splits urban households according to location (large and small urban centers).

Incomes and expenditures for households living in large urban centers in SAM2 were calculated using the shares of total urban expenditures by socioeconomic status (*categorie socio-professionel*). (Large urban center residents accounted for 89.9 percent of urban expenditures by high-income households (Urban I in SAM1), and 80.5 percent and 77.8 percent of urban expenditures by middle- and low-income households, respectively.) These shares were used to allocate incomes and expenditures by the three urban household groups in SAM1 to the two urban household groups in SAM2.

DETERMINATION OF HOUSEHOLD SAVINGS

In SAM1, consumption of households was first estimated and savings were calculated as a residual. Moreover, the level of per capita consumption was assumed to be the same for all three types of rural small farm households. This procedure gives widely varying savings rates across rural households. In SAM2, it is assumed that small farm households and rural nonfarm poor have zero savings and that the savings rate is the same for both rural nonfarm rich and large farm households. Total consumption by each rural household is calculated as income less savings less transfers.

APPENDIX B

THE FORMAL SIO MODEL

OBJECTIVES

This model aims to predict how all SAM accounts will change in response to a series of exogenous shocks. To do this requires several steps. First, all SAM row accounts must be written as linear functions of one another. Second, the modeler must make some decisions about what variables are endogenous to the system.

Figure 4 describes the organization of the SAM and the variable labels adopted in this formulation.

Linearity Assumptions

Production Accounts (X_j). All production activities (X_j) produce a series of commodities (D_{ji}) as outputs:

$$X_j = \sum_i D_{ji}. \tag{5}$$

Initially, assume that each activity produces a fixed share of each commodity's output. This assumption can be relaxed later:

$$D_{ji} = d_{ji} Z_i. \tag{6}$$

This leads to the following linear relationship between activity (X_j) and commodity (Z_i) accounts:

$$X_j = \sum_i D_{ji} = \sum_i d_{ji} Z_i. \tag{7}$$

Commodity Accounts (Z_i). Commodities supply their wares as inputs in production activities (A_{ij}); add commercial margins to other commodity accounts (C_{ii}); supply households (C_{ih}), institutions (C_{in}), and government (C_{ig}) with final consumption goods; and sell exports (E_i) to the rest of the world and investment goods (I_i) to capital accounts:

Figure 4 – Madagascar: SAM Structure

<table>
<tr><th></th><th>Activities
j</th><th>Commodities
i</th><th>Households
h</th><th>Institutions
n</th><th>Government</th><th>Rest of
World</th><th>Capital</th><th>Row
Sums</th></tr>
<tr><td>Activities
j</td><td></td><td>Dji</td><td></td><td></td><td></td><td></td><td></td><td>xj</td></tr>
<tr><td rowspan="2">Commodities
i</td><td colspan="2">INTERMEDIATES</td><td colspan="3">FINAL CONSUMPTION</td><td>Exports</td><td>Invest.</td><td rowspan="2">Zi</td></tr>
<tr><td>Aij</td><td>Cij</td><td>Cih</td><td>Cin</td><td>Cig</td><td>Ei</td><td>Ii</td></tr>
<tr><td rowspan="2">Households
h</td><td rowspan="2">Vhj</td><td rowspan="2"></td><td colspan="3">TRANSFERS TO HOUSEHOLDS</td><td rowspan="2">Rh</td><td rowspan="2"></td><td rowspan="2">Yh</td></tr>
<tr><td>Bhh</td><td>Bhn</td><td>Bhg</td></tr>
<tr><td rowspan="2">Institutions
n</td><td rowspan="2">Vnj</td><td rowspan="2"></td><td colspan="3">TRANSFERS TO INSTITUTIONS</td><td rowspan="2">Rn</td><td rowspan="2"></td><td rowspan="2">Nn</td></tr>
<tr><td>Bnh</td><td>Bnn</td><td>Bng</td></tr>
<tr><td>Government</td><td>Tj</td><td>Ti</td><td>Th</td><td>Tn</td><td></td><td>Rg</td><td></td><td>G</td></tr>
<tr><td rowspan="2">Rest of World</td><td rowspan="2"></td><td rowspan="2">Mi</td><td colspan="3">TRANSFERS TO R.O.W.</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">R</td></tr>
<tr><td>Brh</td><td>Brn</td><td>Brg</td></tr>
<tr><td rowspan="2">Capital</td><td rowspan="2"></td><td rowspan="2"></td><td colspan="3">SAVINGS</td><td rowspan="2">Rk</td><td rowspan="2"></td><td rowspan="2">S</td></tr>
<tr><td>Sh</td><td>Sn</td><td>Sg</td></tr>
<tr><td>Column Sums</td><td>Xj</td><td>Zi</td><td>Yh</td><td>Nn</td><td>G</td><td>R</td><td>S</td><td></td></tr>
</table>

$$Z_i = \sum_j A_{ij} + \sum_i C_{ii} + \sum_h C_{ih} + \sum_n C_{in} + C_{ig} + E_i + I_i. \tag{8}$$

Assume that intermediates (A_{ij}) remain a fixed share of gross output in each sector (Z_i), the classic Leontief assumption:

$$A_{ij} = a_{ij} X_j, \tag{9}$$

and that commercial margins (C_{ii}) likewise remain a fixed share of final commodity value (Z_i).

$$C_{ii} = c_{ii} Z_i. \tag{10}$$

Assume also that household consumption (C_{ih}) is a linear function of household expenditure (household income [Y_h] less transfers paid [B_{*h}] less direct taxes paid by the household [T_h] less household savings [S_h]):[10]

$$C_{ih} = \alpha_{ih} + \beta_{ih} (Y_h - B_{*h} - T_h - S_h), \tag{11}$$

where

$$\bar{B}_{*h} = \sum_h \bar{B}_{h^*h} + \sum_n \bar{B}_{nh} + \bar{B}_{rh};$$

that institutional (C_{in}) and government (C_{ig}) consumption of final goods and services remain a fixed proportion of final output,

$$\begin{aligned} C_{in} &= c_{in} N_n \\ C_{ig} &= c_{ig} G; \end{aligned} \tag{12}$$

and, initially, that investment remains fixed exogenously:

$$I_i = \bar{I}_i. \tag{13}$$

Substituting and combining like terms yields the following summation of the commodity accounts:

---

[10] The notation $\bar{B}_{*h}$ indicates transfers paid by households (h) to all sources (*), including other households ($\bar{B}_{h*h}$), nongovernment institutions ($\bar{B}_{nh}$), and the rest of world ($\bar{B}_{rh}$).

$$(1-\sum_i c_{ii})Z_i = \sum_j a_{ij}X_j + \sum_h \beta_{ih}(Y_h - T_h - S_h) + \sum_h \alpha_{ih} + C_{in}N + C_{ig}G + E_i + \bar{I}_i. \tag{14}$$

Household Accounts (Y_h). Households (Y_h) earn income from value-added payments by activities (V_{hj}) and from transfers they receive from other households (B_{hh*}), from institutions (B_{hn}), from government (B_{hg}) and from the rest of the world (B_{hr}):

$$Y_h = \sum_i V_{hj} + \sum_{h^*} B_{hh^*} + \sum_n B_{hn} + B_{hg} + B_{hr}. \tag{15}$$

As with intermediates, value-added payments to households (V_{hj}) remain a fixed proportion of activity output (X_j), while all transfers are taken as fixed:

$$V_{hj} = \lambda_{hj} X_j, \tag{16}$$

$$\begin{aligned} B_{hh^*} &= \bar{B}_{hh^*} \\ B_{hn} &= \bar{B}_{hn} \\ B_{hg} &= \bar{B}_{hg} \\ B_{hr} &= \bar{B}_{hr}. \end{aligned} \tag{17}$$

Substituting Equations 16 and 17 into Equation 15 leads to the following relationship between household income (Y_h) and activity output (X_j):

$$Y_h = \sum_j \lambda_{hj} X_j + \bar{B}_{h^*}. \tag{18}$$

where

$$\bar{B}_{h^*} = \sum_{h^*} \bar{B}_{hh^*} + \sum_n \bar{B}_{hn} + \bar{B}_{hg} + \bar{B}_{hr}.$$

Institutions (N). Institutions (N), like households, earn income from value-added payments by activities (V_{nj}) and from transfers they receive from households (B_{nh}), from institutions (B_{nn*}), from government (B_{ng}), and from the rest of the world (B_{nr}):

$$N = \sum_j V_{nj} + \sum_h B_{nh} + \sum_{n*} B_{nn^*} + B_{ng} + B_{nr}. \tag{19}$$

As with intermediates, value-added payments to households (V_{nj}) remain a fixed proportion of activity output (X_j), while all transfers are taken as fixed:

$$V_{nj} = \lambda_{nj} X_j, \tag{20}$$

$$\begin{aligned} B_{nh} &= \bar{B}_{nh} \\ B_{nn^*} &= \bar{B}_{nn^*} \\ B_{ng} &= \bar{B}_{ng} \\ B_{nr} &= \bar{B}_{nr}. \end{aligned} \tag{21}$$

Substituting Equations 20 and 21 into Equation 19 leads to the following relationship between institutions' income (N) and activity output (X_j):

$$N = \sum_j \lambda_{nj} X_j + \sum_h \bar{B}_{nh} + \bar{B}_{nn^*} + \bar{B}_{ng}. \tag{22}$$

Government G. Government receives indirect taxes from activities (T_j) and commodities (T_i) as well as income taxes from households (T_h) and institutions (T_n) and transfers from rest of the world (R_g):

$$G = \sum_j T_j + \sum_i T_i + \sum_h T_h + \sum_n T_n + R_g. \tag{23}$$

Assume that indirect taxes remain a fixed proportion of activity and commodity output,

$$T_j = t_j X_j, \tag{24}$$

$$T_i = t_i Z_i; \tag{25}$$

that income and profits taxes increase linearly with household and institutions' earnings,

$$T_h = t_h^{\circ} + t_h Y_h, \tag{26}$$

$$T_n = t_n^{\circ} + t_n N; \tag{27}$$

and that transfers from the rest of the world remained fixed:

$$R_g = \overline{R}_g. \tag{28}$$

Substitution among these relationships into (23) yields the following relationship between government revenues and the remaining SAM accounts:

$$\begin{aligned} G &= \sum_j t_j X_j + \sum_i t_i Z_i + \sum_h (t_h^\circ + t_h Y_h) + t_n^\circ + t_n N + \overline{R}_g \\ &= \sum_j t_j X_j + \sum_i t_i Z_i + \sum_h t_h Y_h + t_n N + \sum_h t_h^\circ + t_n^\circ + \overline{R}_g. \end{aligned} \tag{29}$$

Rest of the World (R). The rest of the world account receives payments for commodity imports (M_i) and receives transfers from households (B_{rh}), institutions (B_{rn}), and government (B_{rg}):

$$R = \sum_i M_i + \sum_h B_{rh} + \sum_n B_{rn} + B_{rg}. \tag{30}$$

Assume that imports (M_j) remain a fixed proportion of commodity output (Z_i) and, as before, that transfers remain fixed:

$$M_i = m_i Z_i, \tag{31}$$

$$\begin{aligned} B_{rh} &= \overline{B}_{rh} \\ B_{rn} &= \overline{B}_{rn} \\ B_{rg} &= \overline{B}_{rg}. \end{aligned} \tag{32}$$

Total rest of the world earnings (R) then become

$$R = \sum_i m_i Z_i + \sum_h \overline{B}_{rh} + \overline{B}_{rn} + \overline{B}_{rg}. \tag{33}$$

Capital (S). Total savings (S) equals the sum of savings by households (S_h), institutions (S_n), government (S_g), and capital transfers from the rest of the world (R_k):

$$S = S_h + S_n + S_g + R_k. \tag{34}$$

Assume that transfers remain fixed but that all domestic sources savings goes up linearly with their earnings:

$$S_h = \sigma_h Y_h + \bar{s}_h^\circ, \tag{35}$$

$$S_n = \sigma_n N + \bar{s}_n^\circ, \tag{36}$$

$$S_g = \sigma_g G + \bar{s}_g^\circ, \tag{37}$$

$$R_k = \bar{R}_k. \tag{38}$$

Total savings can then be expressed as a function of household income (Y_h), institutional earnings (N), and government revenue (G):

$$S = \sum_h \sigma_h Y_h + \sigma_n N + \sigma_g G + \sum_h \bar{s}_h^\circ + \bar{s}_n^\circ + \bar{s}_g^\circ + \bar{R}_k. \tag{39}$$

Parameter Restrictions. For the SAM to remain balanced, increased revenue must generate an equivalent increase in expenditure. For expenditures to equal revenue, the sum of all column coefficients in the M matrix must equal 1.

In particular,

$$\sum_i a_{ij} + \sum_h \lambda_{hj} + \lambda_{nj} + t_j = 1, \quad \textit{for all } j, \tag{40}$$

$$\sum_j d_{ji} + \sum_i c_{ii} + t_i + m_i = 1, \textit{ for all } i, \tag{41}$$

$$\sum_i \beta_{ih} = 1, \textit{ for all } h, \tag{42}$$

$$\sum_i c_{in} + t_n + \sigma_n = 1; \quad \therefore \sigma_n = 1 - \sum_i c_{in} - t_n, \tag{43}$$

$$\sum_j c_{ig} + \sigma_g = 1; \quad \therefore \sigma_g = 1 - \sum_i c_{ig}. \tag{44}$$

System Summary. Appendix Table B.1 summarizes this 37 equation system in matrix form. In doing so, it divides the 12 commodity accounts into two groups, (Z_1)

Appendix Table B.1 – Madagascar: Model Equations

$$\begin{bmatrix} 1 & -D_1 & -D_2 & 0 & 0 & 0 & 0 & 0 \\ -A_1 & 1-C_{11} & -C_{12} & -B_1[1-t_h-\sigma_h] & -C_{1n} & -C_{1g} & 0 & 0 \\ -A_2 & -C_{21} & 1-C_{22} & -B_2[1-t_h-\sigma_h] & -C_{2n} & -C_{2g} & 0 & 0 \\ -\lambda_h & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ -\lambda_n & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ -t'_j & -t'_1 & -t'_2 & -t'_h & -t'_n & 1 & 0 & 0 \\ 0 & -m'_1 & -m'_2 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -\sigma'_h & -\sigma_n & -\sigma_g & 0 & 1 \end{bmatrix} \times \begin{bmatrix} X \\ Z_1 \\ Z_2 \\ Y \\ N \\ G \\ R \\ S \end{bmatrix} = \begin{bmatrix} 0 \\ E_1 + I_1 + [\alpha_1 - B_1 K]\, i \\ E_2 + I_2 + [\alpha_2 - B_2 K]\, i \\ \overline{B_{h*}} + \overline{R_h} \\ \overline{B_{n*}} + \overline{R_n} \\ \overline{T_{hi}} + \overline{T_n} + \overline{R_g} \\ \overline{B_{rh}} + \overline{B_{rn}} + \overline{B_{rg}} \\ \overline{S_{hi}} + \overline{S_n} + \overline{S_g} + R_k \end{bmatrix}$$

Where K is a diagonal matrix with $T_h^o + S_h^o + \overline{B_{h*}}$ as each diagonal element,

i is a column vector of 1's,

1 is an identity matrix.

and (Z_2), depending on their supply elasticity. The first group, (Z_1), represents all sectors with upward-sloping supply curves. In the Madagascar SAM, these include paddy, coffee, nontraditional exports, industrial crops, mining, and formal manufacturing. For the remaining six commodities (Z_2), producers can increase output at constant unit cost. Hence, their supply is perfectly elastic.

Since the Z_1 commodities are tradable, the world price imposes the fixed-price requirement of the SIO model. The (Z_2) commodities achieve fixed prices by virtue of their perfectly elastic supply.

SOLVING THE BASIC MODEL

The relationships defined above translate the 37 SAM row accounts into 37 equations, one for each of the 15 activities, 12 commodities, and 6 households, plus one each for institutions, government, rest of the world, and capital account. A system of 37 equations can predict 37 endogenous variables, with the rest remaining exogenous.

The simplest selection of endogenous variables takes each SAM account total as endogenous and makes exports, investments, and all transfers as exogenous. The input-output model partitions the system variables in exactly this way. In the initial formulation, where transfers and investments are taken as exogenous, commodity export demand becomes the prime determinant of system change. Appendix Table B.2 displays the resulting input-output (IO) model after differentiation.

The semi-input-output (SIO) model differs only in its choice of exogenous variables. Since (Z_1) commodities are supply constrained, their output is fixed in a fixed-price world. So supply, not exports, become exogenous in these six equations. With output fixed and domestic demand determined by changes in incomes, exports (E_1), rather than supply (Z_1), become endogenous in the six equations. Appendix Table B.3 rewrites the SAM model in SIO form.

EXTENSIONS

The basic SIO model in Appendix Table B.3 can be extended in many directions. The discussion below considers three: (1) rendering investment endogenous; (2) allowing changes in export taxes; and (3) allowing the price of export crops to change.

Endogenous Investment

To make investment endogenous requires adding a 38th equation to explain this additional variable. In fact, since investment is spread over 12 commodities, we require equations that determine not only aggregate investment but also its distribution across the 12 commodities.

Appendix Table B.2 – Madagascar: Input-Output Model

$$\begin{bmatrix} 1 & -D_1 & -D_2 & 0 & 0 & 0 & 0 & 0 \\ -A_1 & 1-C_{11} & -C_{12} & -B_1[1-t_h-\sigma_h] & -C_{1n} & -C_{1g} & 0 & 0 \\ -A_2 & -C_{21} & 1-C_{22} & -B_2[1-t_h-\sigma_h] & -C_{2n} & -C_{2g} & 0 & 0 \\ -\lambda_h & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ -\lambda_n & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ -t'_j & -t'_1 & -t'_2 & -t'_h & -t'_n & 1 & 0 & 0 \\ 0 & -m'_1 & -m'_2 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -\sigma'_h & -\sigma_n & -\sigma_g & 0 & 1 \end{bmatrix} \times \begin{bmatrix} dX \\ dZ_1 \\ dZ_2 \\ dY \\ dN \\ dG \\ dR \\ dS \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} dE_1 + \begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} dE_2$$

Appendix Table B.3 — Madagascar: Semi-Input-Output Model

$$\begin{bmatrix} 1 & 0 & -D_2 & 0 & 0 & 0 & 0 & 0 \\ -A_1 & -1 & -C_{12} & -\beta_1[1-t_h-\sigma_h] & -C_{1n} & -C_{1g} & 0 & 0^* \\ -A_2 & 0 & 1-C_{22} & \beta_2[1-t_h-\sigma_h] & -C_{2n} & -C_{2g} & 0 & 0^* \\ -\lambda_{hj} & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ -\lambda_{nj} & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ -t_j' & 0 & -t_2' & -t_h' & -t_n & 1 & 0 & 0 \\ 0 & 0 & -m_2' & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -\sigma_h' & -\sigma_n & -\sigma_g & 0 & 1 \end{bmatrix} \times \begin{bmatrix} dX \\ dE_1 \\ dZ_2 \\ dY \\ dN \\ dG \\ dR \\ dS \end{bmatrix} = \begin{bmatrix} D_1 \\ -(1-C_{11}) \\ C_{21} \\ 0 \\ 0 \\ t_1' \\ m_1' \\ 0 \end{bmatrix} dZ_1 + \begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} dE_2$$

* To make investment endogenous, replace "0" with $c_1 k + c_2 k$.

Typically, economists assume that aggregate investment (I) equals aggregate savings. This is equivalent to saying that changes in investment (dI) equal changes in savings (dS):

$$\sum_i dI_i = dI = dS. \tag{45}$$

To explain how investors allocate their purchases across commodity groups, assume proportionality constant according to past investment shares (C_{ik}):

$$dI_i = c_{ik} dI = c_{ik} dS. \tag{46}$$

Since $dI = dS$, these relationships can be substituted directly into the commodity equations as described in Appendix Table B.3.

Redistributing Export Taxes to Households. Normally, modelers take the M-matrix parameters as constant. But in Madagascar, high rates of export taxation have led policymakers to wonder about prospects for increasing spending power and output supply by lowering taxes and redistributing the earnings to farm families. If commodity tax rates (t_i) change, then so must the other parameters (d_{ji}, c_{ii}, r_{hi}, r_{ni}, and m_i) in the commodity expenditure columns.[11] Decreased tax rates must lead to increased payments to other accounts.

To model this, we need to make these other i-column parameters endogenous and functions of t_i. Formally, this requires differentiating the original system in Table 11 with respect to t_i, d_{ji}, c_{ii}, r_{hi}, r_{ni}, and m_i. We then require additional equations relating d_{ji}, c_{ii}, r_{hi}, r_{ni}, and m_i to t_i. Let μ_* equal the proportion of redistributed tax revenue (dt_i) accruing to each of the i-column accounts. In this setting, Appendix Table B.4 describes how to estimate changes in SAM accounts resulting from policy-induced exogenous changes in the commodity tax rate (dt_i).

Changing Export Crop Prices

Prices for Madagascar's principal export crops are extremely volatile, as Figure 2 indicates. In response, the government has varied export tax rates to maintain roughly constant domestic producer prices. In this way, they have insulated farmers from world price swings. If the government continues to act as a shock absorber, insulating the domestic economy from gyrating world prices, the domestic repercussions of world price swings may be minimal. Given this behavior, a new, low-price SAM more appropriate to the 1990s can be estimated very simply from the 1984 SAM simply by deducting world price drops from tax

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[11] Here for simplicity, export taxes are redistributed directly to households and institutions (using the parameters r_{hi} and r_{ni}), rather than increasing d_{ji}, payments to activities.

revenues, reducing export values by the same amount, and financing the temporary government shortfall by external borrowing. This is the method used to make the low-price projections in Table 2.

But in the future, government may be unable or unwilling to insulate the economy from further export crop price swings. If so, it will be of interest to estimate the contractionary effects of the price changes on the domestic economy. These will, in effect, be reverse multipliers, since lower export earnings will lower incomes, lower expenditure, and lead to contraction in nonagricultural sectors of the economy.

To estimate the effects of world price changes in export crops, return to Appendix Table B.1 and differentiate the system of SAM equations with respect to export crop prices (P_1). Since export crops do not serve as inputs in domestic industry and are not consumed domestically in any appreciable quantity, we can ignore the possible inflationary effects of these price shifts in other sectors. Doing so allows us to predict changes in the SAM accounts resulting from exogenous shifts in world coffee and vanilla prices. Appendix Table B.4 presents the necessary right-hand-side shifter matrix.

In principle, it is possible to extend the SIO model in many more similar directions. We leave it to the interested policymaker to modify the model as new issues emerge.

Appendix Table B.4 — Madagascar: Semi-Input-Output Model with Extensions

$$\begin{bmatrix} 1 & 0 & -D_2 & 0 & 0 & 0 & 0 & 0 \\ -A_1 & -1 & -C_{12} & -B_1[1-t_h-\sigma_h] & -C_{1n} & -C_{1g} & 0 & 0^* \\ -A_2 & 0 & 1-C_{22} & -B_2[1-t_h-\sigma_h] & -C_{2n} & -C_{2g} & 0 & 0^* \\ -\lambda_h & 0 & \lambda_{h2} & 1 & 0 & 0 & 0 & 0 \\ -\lambda_{nj} & 0 & \lambda_{h2} & 0 & 1 & 0 & 0 & 0 \\ -t'_j & 0 & -t'_2 & -t'_h & -t'_n & 1 & 0 & 0 \\ 0 & 0 & -m'_2 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -\sigma'_h & -\sigma_n & -\sigma_g & 0 & 1 \end{bmatrix} \times \begin{bmatrix} dX \\ dE_1 \\ dZ_2 \\ dY \\ dN \\ dG \\ dR \\ dS \end{bmatrix} = \begin{bmatrix} D_1 \\ -(1-C_{11}) \\ C_{21} \\ \lambda_{h1} \\ \lambda_{n1} \\ t'_1 \\ m'_1 \\ 0 \end{bmatrix} dZ_1 + \begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} dE_2 + \begin{bmatrix} -\mu_1 Z_1 \\ -\mu_2 Z_1 \\ -\mu_3 Z_1 \\ -\mu_4 Z_1 \\ -\mu_5 Z_1 \\ 0 \\ -\mu_7 Z_1 \\ 0 \end{bmatrix} dt_1 + \begin{bmatrix} D_1 Z_1 \\ -Z_1 + C_{11} Z_1 + E_1 + I_1 \\ C_{21} Z_1 \\ \lambda_{h1} Z_1 \\ \lambda_{n1} Z_1 \\ t_1 Z_1 \\ m_1 Z_1 \\ 0 \end{bmatrix} dP_1$$

* To make investment endogenous, replace "0" with $C_{k1} + C_2 K_1$.

APPENDIX C

ESTIMATES OF MARGINAL BUDGET SHARES

Marginal budget shares for the household categories in the social accounting matrix (SAM) were estimated using data from Ministry of Agriculture surveys of urban and rural areas in Madagascar (see AIRD 1984 for a description of the survey and summary tables). The urban second round survey took place during the December 1983/January 1984 period. The rural second round survey was in October and November 1984.

For urban households, marginal budget shares were estimated econometrically using a semilog specification:

$$S_i = a + b * \ln(y) + e_i. \tag{47}$$

where S_i is the budget share of commodity i in total expenditures, a is the unit constant, and y is expenditure per consumer unit (with adults equal to 1 consumer unit, children between the ages of 11 and 15 years equal to .75 consumer units, children between the ages of 6 and 10 years equal to .50 consumer units, and children under 6 equal to .25 consumer units). The regressions were run for 15 sectors. The results were later aggregated into the 12 SAM sectors.

For urban households, regressions were run separately for households headed by highly skilled workers (*cadres supérieurs et moyens*), skilled workers (*autres cadres en fonction publique, employés des entreprises* and *ouvriers et manoeuvres*), and unskilled workers (*gens de petits services*). A regression was also run for all nonagricultural urban households (Appendix Table C.1). While budget shares did vary across household types, the regression results for all nonagricultural urban household types were used to estimate marginal budget shares for all urban households. For rural households, regressions using the above equation were run for rich and poor households (defined as having per consumption unit monthly expenditures of greater than, or less than or equal to FMG 10,250, respectively) in each of three regions of the country (Plateau, East Coast, and West/South) (Appendix Table C.2).

Estimates of marginal budget shares according to the SAM household groups were then constructed from the marginal budget shares for the survey household

Appendix Table C.1 —Madagascar: Urban Budget Shares, Regression Results

Sector	Household Type 1			Household Type 2			Household Type 3			All Urban		
	Coeffi-cient	Elasti-city	Marginal Budget Share	Coeffi-cient	Elasti-city	Marginal Budget Share	Coeffi-cient	Elasti-city	Marginal Budget Share	Coeffi-cient	Elasti-city	Marginal Budget Share
1	-	-	-	-	-	-	-	-	-	-	-	-
2	0.011	1.170	0.0666	-0.037	0.449	0.0646	-0.049	0.425	0.0817	-0.037	0.466	0.0682
	(0.707)			(-4.334)			(-2.005)			(-6.761)		
3	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-
5	0.009	1.120	0.0765	-0.026	0.699	0.0866	0.016	1.135	0.1191	-0.025	0.733	0.0935
	(0.662)			(-3.770)			(0.908)			(-4.963)		
6	0.012	1.204	0.0572	-0.003	0.925	0.0376	-0.020	0.504	0.0383	-0.002	0.955	0.0416
	(0.710)			(-0.854)			(-1.947)			(-6.957)		
7	-0.066	0.635	0.1772	-0.074	0.691	0.2359	-0.080	0.744	0.3088	-0.079	0.683	0.2447
	(-1.139)			(-4.221)			(-1.947)			(-6.957)		
8	-0.001	0.994	0.2435	0.070	1.263	0.2686	0.077	1.373	0.2104	0.073	1.285	0.2596
	(-0.033)			(4.368)			(2.626)			(7.043)		
9	0.065	1.730	0.0908	0.046	1.597	0.0801	0.084	2.520	0.0615	0.055	1.761	0.0749
	(1.466)			(3.939)			(3.942)			(7.289)		
10	0.004	1.049	0.0752	-0.014	0.789	0.0636	0.014	1.208	0.0672	-0.010	0.856	0.0659
	(0.077)			(-2.084)			(0.935)			(-2.226)		
11	(-0.015)	-1.184	0.0064	0.002	1.337	0.0072	0.000	0.818	0.0005	0.004	1.502	0.0072
	(-0.639)			(0.605)			(-0.099)			(1.377)		
12	0.034	1.599	0.0583	0.034	1.973	0.0368	0.002	1.423	0.0044	0.025	1.839	0.0315
	(2.232)			(4.945)			(0.524)			(6.248)		
13	-	-	-	-	-	-	-	-	-	-	-	-
14	0.001	1.043	0.0147	0.009	1.782	0.0117	0.002	1.504	0.0047	0.005	1.635	0.0087
	(1.072)			(2.155)			(1.088)			(0.128)		
15	-0.051	0.441	0.0884	-0.015	0.784	0.0704	-0.035	0.422	0.0581	-0.015	0.777	0.0671
	(-1.718)			(-1.881)			(-1.782)			(-2.828)		

Appendix Table C.2 — Madagascar: Rural Budget Shares

	Poor Households								
	Zone A			Zone B			Zone C		
Sector	Coef-ficient	Elas-ticity	Marginal Budget Share	Coef-ficient	Elas-ticity	Marginal Budget Share	Coef-ficient	Elas-ticity	Marginal Budget Share
1	-	-	-	-	-	-	-	-	-
2	-0.065	-0.0973	0.0526	-0.074	0.5003	0.1386	-0.031	-0.2621	0.0210
	(-6.533)			(-3.27)			(-2.246)		
3	-0.004	0.1606	0.0044	-0.025	-0.3326	0.0154	-0.001	0.9672	0.0307
	(-2.205)			(-7.895)			(-0.101)		
4	-	-	-	-	-	-	-	-	-
5	-0.001	0.9721	0.0337	-0.011	0.3519	0.0148	0.021	1.3324	0.0659
	(-0.090)			(-1.773)			(0.985)		
6	-0.009	0.4223	0.0155	-0.014	-0.0585	0.0112	-0.008	0.5894	0.0193
	(-3.538)			(-6.757)			(-1.726)		
7	0.049	1.0696	0.7084	0.244	1.4430	0.5838	-0.294	0.4973	0.5529
	(1.524)			(8.335)			(-4.932)		
8	0.023	1.2995	0.0777	-0.111	0.2323	0.1300	0.124	1.8489	0.1594
	(1.606)			(-5.989)			(2.629)		
9	0.038	1.7733	0.0524	0.010	1.3557	0.0305	0.173	3.1780	0.0984
	(2.102)			(1.207)			(3.544)		
10	-0.003	0.8438	0.0193	-0.037	-0.0674	0.0300	-0.020	0.4519	0.0342
	(-1.169)			(-7.828)			(-2.222)		
11	-	-	-	-	-	-	-	-	-
12	0.002	1.5224	0.0037	0.017	2.0085	0.0187	-	-	-
	(0.443)			(1.961)					
13	-	-	-	-	-	-	-	-	-
14	0.000	1.1366	0.0008	0.000	1.3452	0.0004	0.000	5.2258	0.0001
	(0.081)			(0.129)			(0.000)		
15	-0.029	0.1571	0.0316	0.000	1.0158	0.0268	0.035	3.4804	0.0182
	(-2.403)			(0.056)			(2.472)		

Note: t-statistics are given in parentheses.

Appendix Table C.2 (continued)

Sector	Rich Households								
	Zone A			Zone B			Zone C		
	Coef-ficient	Elas-ticity	Marginal Budget Share	Coef-ficient	Elas-ticity	Marginal Budget Share	Coef-ficient	Elas-ticity	Marginal Budget Share
1	-	-	-	-	-	-	-	-	-
2	0.010	1.2988	0.0336	0.106	1.7146	0.1560	0.008	1.3042	0.0257
	(0.777)			(1.471)			(0.523)		
3	-0.002	0.3323	0.0027	-0.005	0.7261	0.0176	-0.009	0.4570	0.0159
	(-0.488)			(-0.632)			(-8.906)		
4	-	-	-	-	-	-	-	-	-
5	-0.032	0.2354	0.0402	0.006	1.2379	0.0249	-0.013	0.7280	0.0454
	(-1.316)			(0.291)			(-0.513)		
6	-0.009	0.2186	0.0144	-0.002	0.8331	0.0091	0.002	1.1174	0.0173
	(-1.600)			(-0.425)			(0.226)		
7	-0.326	0.5017	0.6390	-0.278	0.4107	0.4535	-0.173	0.5805	0.4036
	(-3.737)			(-4.072)			(-2.242)		
8	0.113	2.3154	0.0912	0.036	1.2442	0.1511	0.058	1.2265	0.2607
	(2.271)			(0.801)			(0.765)		
9	0.114	2.2065	0.0999	0.039	1.7709	0.0528	-0.057	0.4935	0.1101
	(1.923)			(0.921)			(-0.736)		
10	0.011	0.5380	0.0224	-0.017	0.4676	0.0301	-0.017	0.5313	0.0355
	(0.945)			(-1.680)			(-1.348)		
11	-	-	-	-	-	-	-	-	-
12	0.112	6.3952	0.0263	0.095	3.0375	0.0531	0.132	6.1074	0.0330
	(2.405)			(2.055)			(3.837)		
13	-	-	-	-	-	-	-	-	-
14	0.021	8.6778	0.0037	0.000	0.7218	0.0004	0.006	3.4460	0.0027
	(2.624)			(-0.203)			(1.075)		
15	0.011	1.3716	0.0294	0.019	1.3769	0.0516	0.063	2.3579	0.0501
	(0.562)			(0.540)			(1.130)		

Note: t-statistics are given in parentheses.

groups (Appendix Table C.3).[12] It was necessary to adjust the marginal budget shares derived from the survey data to account for consumption expenditures under-reported in the survey.[13] Marginal budget shares for other food crops, formal manufacturing, other industry, private services, and public administration were set equal to the average budget shares for each rural household group in the SAM. The econometrically estimated marginal budget shares for the remaining commodities were then multiplied by a scaling factor so that the sum of the marginal budget shares equals one.

In spite of these adjustments, it appears that the derived marginal budget shares for rice are perhaps still too high for rural households. For most of the multiplier experiments presented in this paper, average budget shares are used.

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[12] Marginal budget shares are calculated as the sum of the average budget share, s_i from the regression sample plus m_i, where m_i equals the ratio of the Beta coefficient for each sector and the average total expenditure. The sum of the marginal budget shares for each household group equals one minus the average savings rate.

[13] These single-visit surveys were designed to investigate household rice consumption, purchases, and sales. A lesser effort was made to collect data on consumption of other items.

Appendix Table C.3 — Madagascar: Marginal Budget Shares by SAM Sector

	SAM Sector	Large Cities	Small Cities	Aggregate Small Farms	Aggregate Large Farms	Rural Nonfarm Poor	Rural Nonfarm Rich
1	Paddy	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	Coffee	0.0000	0.0000	0.0090	0.0070	0.0080	0.0070
3	Vanilla	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4	New export crops	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	Industrial cultures	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6	Other agriculture	0.1078	0.1241	0.2468	0.2084	0.2486	0.2067
7	Mines/energy	0.0161	0.0186	0.0087	0.0073	0.0078	0.0073
8	Rice milling	0.0950	0.1096	0.3641	0.3028	0.3251	0.3003
9	Formal manufactures	0.0465	0.0502	0.0498	0.0544	0.0464	0.0540
10	Other industries	0.1355	0.1559	0.1083	0.1535	0.0969	0.1523
11	Services	0.2435	0.2645	0.2285	0.2130	0.2128	0.2113
12	Public administration	0.0031	0.0035	0.0003	0.0003	0.0003	0.0003
Total consumption		**231,870**	**48,341**	**573,490**	**446,982**	**46,329**	**131,964**
Total expenditure		**358,065**	**66,544**	**564,774**	**472,124**	**48,979**	**140,528**

APPENDIX D

FURTHER MODEL SIMULATIONS AND RESULTS

Appendix Table D.1 – Madagascar: Multiplier Decomposition Under No Export Tax Scenario

	Effect of a FMG 1.000 Increase		
	Paddy Supply	**Coffee Supply**	**Vanilla/Cloves Export Demand**
Change in national income			
Initial direct increase	0.492	0.632	0.682
Multiplier effects	1.310	1.528	1.599
Total income increase	**1.802**	**2.160**	**2.280**
Value-added multiplier			
(Multiplier effects/ initial direct increase)	2.66	2.42	2.34
Change in employment (Jobs per million FMG)			
Skilled workers	0.024	0.030	0.030
Semiskilled workers	0.148	0.177	0.185
Unskilled workers	2.757	2.839	2.916
Total	**2.929**	**3.046**	**3.130**

Note: High-input paddy and coffee production, investment exogenous, average budget shares, 1984 world prices.

Appendix Table D.2 — Madagascar: Income Distribution Effects of Agricultural Growth (No Export Taxes Scenario)

	Effect of a FMG 1.000 Increase		
	Paddy Supply	**Coffee Supply**	**Vanilla/Cloves Export Demand**
Household income			
Large cities	0.177	0.207	0.212
Secondary town	0.036	0.042	0.043
Large farms	0.345	0.454	0.670
Small farms	0.904	1.025	0.987
Rural nonfarm, poor	0.068	0.071	0.048
Rural nonfarm, rich	0.063	0.075	0.077
Total households	**1.593**	**1.875**	**2.038**
Institutions' income	0.142	0.207	0.159
Government share of national income[a]	0.067	0.078	0.084
Total national income	**1.802**	**2.160**	**2.280**

[a] The government's share of national income is the value added it receives from taxes on commodities and production activities. It does not include the revenue received from corporate and household income taxes.

Appendix Table D.3 – Madagascar: Sectoral Composition of Agriculturally Induced Growth (No Export Taxes Scenario)

	Effect of a FMG 1.000 Increase		
	Paddy Supply	**Coffee Supply**	**Vanilla/Cloves Export Demand**
Output change in each sector			
Paddy, low-input	0.000	0.000	0.000
Paddy, high-input	0.979	0.000	0.000
Paddy, rain fed	0.000	0.000	0.000
Coffee, low-input	0.000	0.000	0.000
Coffee, high-input	0.000	0.300	0.000
Vanilla, cloves	0.000	0.000	0.249
New export crops	0.000	0.000	0.000
Industrial crops	0.000	0.000	0.000
Other agriculture	0.497	0.544	0.588
Mining, energy, water	0.005	0.006	0.006
Rice milling	0.202	0.235	0.245
Formal manufacturing	0.003	0.004	0.004
Other industries	0.381	0.437	0.476
Private services	0.895	1.115	1.140
Public services	0.088	0.108	0.106

Appendix Table D.4 — Madagascar: Worksheet for Calculating Investment Multipliers

Paddy: Rehabilitation of Small Irrigated Perimeters	Pessimistic (Traditional Technology)	Optimistic (High-Input Technology)
Investment cost (FMG/ha)	241,564	242,133
Marginal increase in output (mt/ha)	1.5	2.5
Investment cost per mt increase in production (FMG/mt)	161,043	96,853
Price of paddy (FMG/mt)	250,000	250,000
Value of output per FMG invested (FMG)	1.552	2.581
GDP/output multiplier	2.369	1.802
GDP/FMG invested (FMG)	3.677	4.651
Jobs/FMG million increase in output	4.129	2.929
Jobs/FMG million invested	6.408	7.560

Robusta Coffee Project: Mixed Replanting and Pruning, High-Input Technology	Pesimistic (Low World Price)	Optimistic (High World Price)
Investment cost (FMG million)	4,896	4,896
Additional output of coffee (FMG million)	3,820	7,639
Additional output of rice (FMG million)	307	307
FMG value of coffee output per FMG invested	0.780	1.560
FMG value of rice output per FMG invested	0.063	0.063
GDP/output multiplier coffee	1.975	1.974
GDP/output multiplier paddy	2.292	2.292
GDP/FMG invested (coffee)	1.541	3.079
GDP/FMG invested (paddy)	0.144	0.144
GDP/FMG invested (total)	1.685	3.223
Jobs/FMG million increase in output (coffee)	3.516	2.639
Jobs/FMG million increase in output (paddy)	4.734	4.734
Jobs/FMG million invested	3.041	4.415

Notes: Benefits and costs for the coffee project are amortized annual values calculated at a discount rate of 10 percent. The GDP/output multipliers for the scenarios are as follows: scenario A: traditional, low-input technology for irrigated paddy; scenario B: improved technology for irrigated paddy; scenario C: upland technology for paddy, improved technology for coffee (low world price); and scenario D: upland technology for paddy, improved technology for coffee (high world price).

Appendix Table D.5 — Madagascar: Effects of Reducing Taxes on Export Crops

	Effects of Transferring Export Crop Tax Revenue from Government to Households	
	Coffee	**Vanilla/Cloves**
Redistributed purchasing power		
Investment exogenous[a]		
Change in GDP	17,105.00	13,520.00
Percentage change	1.00	0.80
Investment endogenous[b]		
Change in GDP	-2,373.00	-778.00
Percentage change	-0.10	-0.05
Induced supply response		
Change in farmer price		
Tax as percentage output value	37.6	44.2
Farm price as percent output	30.0	24.9
Assumed tax decrease	100%	100%
Resulting increase in farmer price[a]	125.0	178.0
If zero supply or demand elasticity	0	0
positive elasticities		
Supply elasticity	0.2	n/a
Demand elasticity	n/a	-0.2
Supply increase percent	25.0	35.6
Supply increase, FMG	23,962.0	10,811.0
Income multiplier	2.060	2.041
Total increase in GDP	49,362	22,066
Percentage increase in GDP	2.8%	1.2%

[a] Requires increased borrowing to maintain government spending and investment at current levels.

[b] All savings spent on investment goods; investment adjusts to changing income and savings levels.

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