Food and Trees in the Village –
Economic development strategies based on food production and forest resources: A social accounting analysis

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June 2004

Paper to be presented at the Conference "Input-Output and General Equilibrium Modeling: Data, Modeling and Policy Analysis", Brussels, September 2-4, 2004.

Abstract

This paper investigates the social and economic effects of different economic development strategies within a village economy in a rural setting using a social accounting framework. The analysis is based on a Social Accounting Matrix for a small village economy in Mozambique. The SAM approach is chosen to investigate, by means of a multiplier analysis, the scope and magnitude of direct and indirect impacts of policy-induced and/or exogenous changes on production activities, value added and income distribution. These aspects are examined under different assumptions regarding supply constraints.

Policy simulations are undertaken to assess the impacts of: i. exogenous demand changes for food (maize); ii. exogenous demand changes for forest-based products (charcoal); iii. stricter enforcement and regulation of village charcoal production. In contrast with other village SAM-based studies, we built our SAM from our own household survey, and therefore we can use the results of the SAM-based simulations to go back to the household-level dataset and assess the poverty and income distribution consequences of the different policy scenarios. The empirical results from the SAM multiplier analysis are discussed in the light of economic theory, and the limitations and strengths of this approach for local/regional policy planning and analysis are highlighted.

1. Introduction

Poverty reduction and sustainable use and management of natural resources are two common objectives of economic policy in most developing countries. These two objectives do not necessarily need to contradict each other. However, when economic growth is based on natural resource-intensive activities, the achievements of these two goals may be more tricky or elusive. Poor countries whose economic structure relies heavily on natural resources face this dilemma on a daily basis. In rural and peri-urban communities in those countries, where dependence on their natural resource base is straightforward the challenge is most demanding.

The challenge for Mozambique today - and the focus of the Government's new poverty reduction strategy - is to promote rapid, broad-based, sustainable and private sector-led economic growth, and to ensure that the benefits are broadly distributed and reach the poor[1]. Since economic growth in Mozambique depends heavily on natural resource-intensive sectors[2], the achievement of these growth prospects relies on the availability and sustainable use of the existing resources. The nature of the challenge of combining economic growth, food security and sustainable use of natural resources is confirmed by two of the most influent strategic policy documents currently in Mozambique: the Mozambican Action Plan for the Reduction of Absolute Poverty (PARPA)[3] and the national Report on the Millennium Development Goals (MDGs)[4] (GOM, 2002). They both identify, among the main challenges Mozambique will be facing in the near future, the following: i. poverty reduction; ii. food security; and iii. sustainable natural resource use and management.

[1] According to UNDP's 2002 Human Development Report, Mozambique's Human Development Index (HDI) ranks 170 out of 173 countries (UNDP, 2002).
[2] During most of the nineties, sectoral GDP contributions from natural resource-intensive sectors, i.e. Agriculture (incl. forestry), Fisheries, Agricultural processing and Mining, ranged between 40% and 45%.
[3] PARPA (Plano de Acção para a Redução da Pobreza Absoluta); (GOM, 2001).
[4] The MDGs is a set of inter-connected and mutually reinforcing development goals gathered in a global agenda. The MDG incorporate international development targets, synthesize broadly accepted goals and targets for monitoring human development.

There are different development options in a typical village economy with agriculture, livestock and the use of natural resources as their main economic activities. In such setting, households chose different economic activities as their livelihood strategies. These activities become their source of incomes and subsistence (or food). Their choices are usually based, among other aspects, on: i. household's endowments (land, labor, assets); ii. household's preferences (market participation) and; iii. on the demand they face for their products (food/cash crops, forest-based production). Our concern is that different livelihood strategies may have different social and environmental consequences, threatening the sustainability of the development process. For this reason, it is relevant to undertake an analysis of the expected consequences of different development strategies. This type of analysis can contribute to the discussion and eventually selection of the most appropriate strategies to face successfully the development challenges mentioned above. In this paper we will show how different livelihood strategy choices may affect households living conditions and general village welfare.

The general objective of this paper is to illustrate at a "micro-village level" the development challenges faced by the GoM and the Mozambican society at a "macro-nationwide level", as established in the PARPA and summarized above. The specific objectives for this investigation are: i. to identify structural features of the village economy – by illustrating the most relevant aspects of the circular flow of incomes; and ii. to simulate effects of policy-induced changes on village economy. We undertake these objectives within a social accounting framework based on a village Social Accounting Matrix (SAM).

For the first objective, we will focus on the interlinkages of food (maize) and other natural resource-intensive production activities (charcoal) with the rest of the local economy to characterize the structural features of the local economy. For the second objective, we will focus on the effects on poverty, village value added and the distribution of incomes of different policy-induced changes (or development strategies).

This paper is organized in 5 chapters. The next and second chapter presents a description of the basic characteristics of the village economy using the village SAM. The third chapter presents an analysis of the process of income distribution using SAM multipliers decomposition. The fourth chapter contains the results of three policy experiments and the poverty and income distribution effects. Finally, chapter 5 presents the conclusions.

2. Village economics: a Social Accounting Matrix for Bandula

To understand how livelihood strategy choices of households affect households living conditions and village general welfare, we need to identify the linkages between the economic activities taken place in the village economy, the generation of value added and the distribution of this value added across different household groups. We have chosen a social accounting framework to conduct our investigation since this framework provides a good picture of the circular flow of funds in the economy, allowing to track among others: economic activity's demand for inputs and factors, how factor remuneration is distributed across households, and households demands for goods and services.

To construct a social accounting matrix of a village economy we conducted fieldwork in the Bandula area in Manica province during the period May to August 2000. Fieldwork included a household survey of close to 130 households and focus groups meetings with relevant stakeholders in the area.

Structural features of village economy

The aggregated version of Bandula village SAM for year 2000, constructed with information from the household survey and community focus groups is given in Table 1. It is possible to identify broad features of the village economy by analyzing the aggregated SAM:

Open economy. The village economy is highly open, as 31% of the total marketed commodities are sold outside the village (to the Rest-of-the-World)[5].

Internal commodity market. There is a considerable share of commodity output that is marketed within the economy: 18% is being used as inputs by production activities and 38% is consumed by the household sector.

Factorial distribution of income. The total income from factors goes to the household sector. At this aggregation level, it is not possible to identify which factors incomes go to which household groups. This can be done with the more disaggregate version of the SAM used later on in this paper.

Households receive most of their incomes (95%) from factor (labor) sales, and only a small share of their total income from (local) government transfers. They expend 82% of their incomes in final (commodity) consumption, 5% in taxes and save the resting 13%.

Government revenues come mainly from commodity taxes (63%) and the rest (37%) from income taxes from the household. Government expends some in transfers to the household sector, but since the SAM only shows a positive net flow of funds from households to the government, it is not possible (in the aggregated SAM) to identify which household groups are net payers (of taxes) and which ones are net receivers (of governmental transfers).

Although the aggregated SAM –as shown in the previous analysis– provides a description of the village economy features, it is very much like a "black box", where most of the transactions (within and across major SAM accounts) are not identified. In order to take advantages of the SAM approach to analyze the local economy one has to go beyond the aggregated SAM and look into a more disaggregated version.

[5] In our case, the Rest-of-the-World account is actually a Rest-of-the-Country account, since we did not track any direct transaction between the village and a neighbor country.

We have constructed a disaggregated village SAM with 53 accounts[6]. These accounts are grouped into the following major categories:

- 18 production activities
- 22 commodities
- 5 factor of production (incl. three land types, in addition to labor and capital)
- 1 savings-investments account
- 4 institutions (household groups)
- 3 exogenous accounts

Village value added

The total village value added (7 792 thousand Mts.) that appeared in the aggregated SAM as the total payment to factors in one single cell (factors row and activity column) is disaggregated by main production activities in Table 3. It shows that village value added comes mainly from natural resource based activities: agriculture/maize (18%); charcoal production (11%) and environmental services (15%).

Using the SAM is also possible to disaggregate further the value added, by breaking it down by each factor of production. This is shown in Table 4. It shows that agricultural activities make more intensive use of labor and land (fields and cleared forests). It also shows the difference between the two maize production activities: one based on production on agricultural fields and the other on cleared forest. Each of these activities makes use of its own combination of factors of production. Charcoal production is also a natural resource-intensive activity which demands much labor (57%); while Food processing is a more capital intensive (51%) activity.

Demographic and socio-economic characterization

One of the most interesting features of the SAM-based analysis is the possibility to track the circular flow of funds of the local economy. The SAM-based analysis of social and economic effects of exogenous shocks in the local economy benefits from a disaggregated household sector. The disaggregation of the household sector allows to

[6] A detailed list of the accounts is shown in Table 2.

conduct a more relevant and accurate analysis. In our case, we have considered four household categories, based on key demographic and socio-economic characteristics (shown in Table 5).

The four household types considered relevant for our analysis can be identified by the particular characteristics summarized in the following table:

Table 5. Summary characteristics of household types

Household type 1 "Food surplus"	These households are characterized by the production of food surpluses. It can be observed that these households have considerable higher literate rates and years of schooling than the rest of the population. They also have the largest farm sizes, and achieve the largest levels of value added, both at the household and per capita level.
Household type 2 "Charcoal producer"	The main characteristic of these households is the production of charcoal. Some particular characteristics of these households are: none is female-headed, have the lowest availability of labor, and use the lowest amount of hired-labor.
Household type 3 "Food Self-sufficient"	These households are characterized by the fact that produce their own food, and do not participate in food markets. These households are characterized by the largest household sizes, labor availability and use of hired-labor. They also have the largest number of cattle.
Household type 4 "Food deficitary"	These households are characterized by chronic deficits in food production. These households have the largest share of female-heads and the largest amounts of off-farm labor. At the same time, these households have low levels of food production and the lowest levels of value added, both at the household and per capita level.

Factorial distribution of income

Households receive remunerations from factors according to their contribution to the different production activities. We observe in Table 6 that labor payments make the largest share of most household groups' income. The only exceptions are the charcoal producer households (household type 2) which receive 52% of incomes from the use of forested land as a factor of production. However, there are differences among the household groups regarding the second largest factor income. For instance, for households with food surpluses (household type 1) and for food self-sufficient households (household type 3) the second largest factor income comes from capital; whereas for food deficitary households (household type 4) incomes come from land (forested).

Village trade pattern

From the SAM accounts it is also possible to map the village trade pattern at the commodity level. Table 7 shows imports and export shares by commodity. It shows – among other aspects- (first column) that the village is self sufficient in food crops (0% maize imports); while it is dependent on externally produced commodities such as kerosene, and fertilizers among others. In the second column of the same Table, we can observe that charcoal, environmental services and skilled labor together with maize and livestock are the main exports. The third column shows how the total village exports are shared among commodities.

Consumption pattern

One of the particular features of SAMs is that they allow to map the circular flow of funds of the total economy; in contrast, for example, with an input-output framework, where final household demand is an exogenous account. Table 8 shows the commodity consumption shares by each household group, based on the information from the disaggregated (53x53) village SAM. One can observe that households with food surpluses (household type 1) are characterized by a substantially lower share of maize (3,3%) and other agricultural commodities (4,2%) consumption, but higher consumption (17,3 %) of livestock products. On the contrary, Food deficitary households (household type 4) consume a larger share (22,2%) of their budget in food crops (maize) and much less (1,8%) on livestock products. Food surplus households (household type 1) have also the largest share of consumption of education and leisure. Charcoal producer households (household type 2) have the largest share of expenditures in maize and in processed food. Food deficitary households (household type 4) “expends” the largest share of household time into household chores.

3. Income distribution by multiplier decomposition analysis

As presented earlier, one of the development challenges of Mozambique is to secure that the benefits of economic growth also reaches the poor. For this reason the focus of the poverty reduction efforts is not only in promoting economic growth, but also on finding mechanisms to ensure that growth is inclusive, so that the poor will benefit integrally. To meet this challenge, it is important to have a clear picture and understanding of how income distribution takes place across the economy.

In order to characterize the process of income distribution in the village economy we undertake a special multiplier decomposition technique (Roland-Holst and Sancho, 1992). This decomposition may shed some light on the process of income distribution and hence may contribute to find effective means to promote a more progressive process of income distribution. This type of multiplier decomposition has earlier been used to study income distributions of a regional economy (Llop and Manresa, 2003).

In this section we assess how production activities affect income distribution among household groups in the village by means of income distribution multiplier decomposition. This is important as this will inform us about which activities are more likely to generate incomes that accrue to the poor. First, we look at the nominal multipliers which show how much do household incomes are affected by an unitary change in exogenous demand for each corresponding production activity. Table 9 shows these multipliers. One can observe that the lowest multiplicators correspond to livestock, food processing and unskilled employment (between 1.13 and 1.60). On the contrary, agricultural and forest-based production activities (Maize, Other agricultural and Charcoal) have relatively higher multipliers (between 1.75 and 1.88) meaning that the promotion of these production activities are more likely to increase household incomes. It is also interesting to note the fact that environmental services have an even higher multiplier (2.02). The interpretation of each single multiplier is as follows; take for instance the multiplier corresponding to Maize production on cleared land and Household group 3 (Food self-sufficient) (0.74). For each unitary increase in the demand/output from maize produced on cleared land, food self-sufficient households (household type 3) will increase their incomes by 0.74 units. In the latter case, it means that an unitary increase in the demand for environmental services will increase total households incomes by 2.02 units, with the largest share accruing to the charcoal producer households (household type 2). This fact highlights the key role of natural resources on the income chain of households in the village, as well as the dependence on natural resources of households for their subsistence.

But to understand income distribution we need to investigate further. The next step then, is to look at how these exogenous changes in the demand for production activities affect the relative distribution of incomes[7]. Understanding how production activities affect the relative position of households is interesting information for economic policy. This information is reflected by the coefficients of the so-called *multiplier effect matrix D(M-I)* presented in Table 10. These coefficients show how increased demand for different activities can affect the relative incomes of household groups as the result of their interdependence relationships. Each coefficient in this Table shows the additive contribution of the net multiplier to the distribution process. We note that the highest contributions to relative distribution of incomes take place in the agriculture and other natural resource-based activities, e.g. charcoal and environmental services (between 0.41 and 0.62). Other activities such as livestock and food processing showing slightly lower values (between 0.12 and 0.35) contribute only moderately to changes in the relative distribution of incomes. Increased demand for environmental services has positive and relative large effects on the relative income distribution for the four household groups. There are some negative numbers in this table –meaning a negative effect on the relative income distribution- and they affect primarily charcoal producer households (household type 2). For example, as shown in the first four columns, increases in demand for maize on fields, maize on cleared land, other agricultural, and livestock have all negative impacts on relative income distribution to charcoal producer households (household type

[7] Appendix B shows the multiplier decomposition for the income distribution analysis used in this section.

2). The final column, with the total row sums, shows that households with food surpluses (household type 1) and food self-sufficient households (household type 3) receive most of the gains from the multiplier contribution to relative income distribution.

How incomes are redistributed after an exogenous shock is an interesting piece of information for policy design. Therefore our final step is to look at how incomes are redistributed among the different household groups due to exogenous changes in demand/output from production activities. Table 11 shows the elements of matrix *(e'Mx)R* corresponding to household groups (rows) and production activities (columns). These coefficients show the direction and amount of redistributed income to each household group due to exogenous shocks when total income in the endogenous accounts is held constant at the initial level[8]. Negative signs indicate income loses for a particular household group due to the redistribution of incomes following an exogenous change in a production activity. The total effect at the bottom of each column in Table 10 shows the income redistributed to households by an exogenous change in the demand for and output of the different production activities. Looking at the figures we observe that the highest income redistribution among households take place in activities commerce and environmental services (0.45 and 0.44 respectively). We can observe that there are some negative signs, again primarily along the row corresponding to charcoal producer households (household type 2). Food surplus producing households (household type 1) also show some negative signs –meaning negative redistribution of income- for exogenous increases in the demand for unskilled employment and environmental services. Food processing also shows negative redistribution of incomes among household groups. Looking at total row sums by household group, we can notice that charcoal producing households (household type 2) is a "loser" (or at least not a "winner") in the redistribution of incomes. On the aggregate, the other three household groups benefit from redistribution of income due to exogenous increases in demand for production activities. Nonetheless, the major gains accrue to food surplus producing households (household type 1) and to food self-sufficient households (household type 3), whereas food deficitary households (household type 4) benefit only marginally.

[8] It can be shown that the total columns of the matrix *(e'Mx)R* sum up to zero.

4. Development strategies for the village economy: poverty and income distribution effects

Small rural villages in Mozambique, as is common in the majority of Sub-Saharan Africa, rely on agricultural-based and forestry-based production for their subsistence. Under these circumstances, as mentioned in the introduction, an important challenge for the economic agents –mainly represented by small household farms– consists on the sustainability of their economic strategies. Since maize production can take place on either existing agricultural fields or on new opened forested land, the technology choice will have implications for further economic growth. Similarly, because charcoal production is based on a renewable (but exhaustible) natural resource, an economic growth strategy based on the utilization of forests for this aim should take into consideration the exhaustibility of their inputs in their production plans.

In this section, we analyze the effects of different policies or development strategies on the village economy by means of SAM multiplier-based experiments. We design the experiments aiming to compare the effects of different exogenous shocks on the village economy, according to different conditions of supply constraints.

We conduct three main experiments: a. an exogenous increase in the external demand for food (maize); b. an exogenous increase in the external demand for forest-based products (charcoal); and c. the expected effects of stricter enforcement and/or regulations of the use/extraction of natural resources on the village economy. For comparison reasons, in the first two experiments, we use exogenous "injections" of similar dimension (equivalent to 20% of total demand for maize - about 250 millions Meticais[9]). With the first two experiments we aim to illustrate the consequences/effects on village living conditions of two different livelihood strategies: one based on food-crop (maize) production and the other on forest resource-based (charcoal) production. The third

[9] This is close to 5% of total village exports.

experiment illustrates the effects of a dramatic reduction in the external demand/output of village charcoal due to stricter regulations. This is exemplified by an exogenous decrease –by 50%– in the demand for charcoal.

For the first two experiments, we run four alternative scenarios. Each scenario illustrates a different assumption on the supply-constraints in the village economy. First, we run an unconstrained multiplier analysis for each experiment, i.e. assuming no capacity constraints in the village economy, as in the standard "perfect elasticity" and "supply-driven" input-output framework. One could say that the results of this run provides an indication of the maximum possible response of the village economy to an external shock. In reality, we know, especially in the agricultural sector, that these assumptions are unrealistic. For that reason, we run additional scenarios for each experiment, corresponding to different supply-constraints assumptions. The additional three supply-condition scenarios used in this paper are: a. labor constraints; b. agricultural land constraints; and c. forested land constraints. For the third experiment (reduction in charcoal demand) supply constraints are not binding, and therefore, we only report the results of the unconstrained case.

When commenting on the results of these experiments, we focus our attention on the global effects of each strategy on total village value added and on the distribution of incomes to the household sector. Hence, Tables with the experiment results only report the outcomes of total value added and on the distribution of value added to the four household groups.

Finally, we also assess the poverty and income distribution effects of the proposed experiments using different poverty, income distribution and welfare indicators. For poverty assessment, we use the P_o (headcount-ratio) and P_1 (poverty gap) (Foster, Greer and Thorbecke; 1984); for income distribution, we use several General Entropy measures GE (a), i.e. the mean log deviation (GE(0)), the Theil Index (GE(1)), and the transformed coefficient of variation (GE(2))[10]. In addition, we also estimate Atkinson measures[11] A(e) and the Gini coefficient. Finally, to assess overall effects we use a welfare index suggested by Sen (1992)[12].

Experiment 1: Increased demand for food

The first experiment consists in an exogenous increase in demand for maize in 20% or close to 250 million Meticais. The effects on value added, household incomes and village GDP of such exogenous increase in demand for food (Maize) from the village are shown in Table 12. We notice (under the column corresponding to the unconstrained case) that incomes to food surplus producing households (household type 1) experience the largest increases (8.5%); while incomes to charcoal producer households (household type 2) remain almost unchanged (increased by only 0.1%). The overall impact of this exogenous demand shock is summarized by a 4.3% increase in total village gross domestic product (value added).

When we impose labor-constraints we see (in the next column) that all income growth rates are reduced; with, household groups 2, 3 and 4 affected the most. The overall impact of this exogenous shock on maize demand is reflected by the limited increase of 1.2% in village gross domestic product (value added). This is a dramatic change when comparing to the 4.3% of the unconstrained case.

[10] The parameter a in the GE class represents the weight given to distances between incomes at different parts of the income distribution, and can take any real value. For lower values of a GE is more sensitive to changes in the lower tail of the distribution, and for higher values GE is more sensitive to changes that affect the upper tail. Common values used are 0,1 and 2; hence a value of a =0 gives more weight to distances between incomes in the lower tail, a =1 applies equal weights across the distribution, while a value of a=2 gives proportionately more weight to gaps in the upper tail. The GE measures with parameters 0 and 1 become two of Theil's measures of inequality the mean log deviation and the Theil index respectively.

[11] The sensitivity of the Atkinson measure depends upon the choice of the value of e: the larger the e, the greater is the weight assigned to the lower part of distribution.

[12] Sen proposed a welfare measure that is a combination of the headcount, poverty-gap, and Gini coefficient. The Sen index, S, is shown to be the average of the headcount and the poverty-gap measures weighted by the Gini coefficient of the poor.

Constraints in the availability of agricultural land have less dramatic impacts on village total value added (3.3% increase compared to the 4.3% of the unconstrained case). This may appear surprising at the first glance, since agricultural land is such an important input for agricultural production. The limited negative effect of land availability on maize production means that for maize, constraints on the availability of other inputs are binding; e.g. labor as seen in the previous scenario before agricultural land becomes scarce.

Finally, constraints in forested land affects even less the overall gross domestic product of the village economy (3.7% increase compared to the 4.3% of the unconstrained case). This is not surprising since this experiment consist on agriculture-led growth which is not highly dependent on forest resources availability. One can observe, by looking at the last row of Table12, that supply-constraints in land and forest result, in a 23% and 13% reduction respectively, in village GDP when compared to the unconstrained case.

Experiment 2: Increased demand for charcoal

Increased demand for charcoal, in the unconstrained case (first column in Table 13) generates increased incomes for all household groups, with charcoal producers household benefiting the most with a 8,3% increase in incomes. Increase in total village GDP in the case of forest products-led growth is lower (3,6) than in the previous agriculture-led growth case (4.3%); i.e.under shocks of similar dimension (about 250 million Meticais) total village GDP grows larger under the agriculture-led strategy than under the forest products-led growth case. The results of the labor and forest supply-constraint alternatives show, as expected, that under such conditions, increases in village GDP are more modest; only 34% and 48% of the increase expected in the unconstrained case, respectively.

In addition to the previous analysis which comments on the results of each separate experiment, there is also interesting to compare the results across the experiments, in particular the "extreme" cases in each of them. These correspond to the land-constrained scenario in experiment 1 and the forest-constrained scenario for experiment 2. Since agricultural land is a key factor for agricultural production, increased demand for agricultural output will be most affected under this scenario. In the case of charcoal, forests constitute a key factor of production and therefore economic growth due to increased demand for charcoal will be restricted under the forest constrained scenario. With increased demand for maize (experiment 1), food self-sufficient households (household type 3) and food deficitary households (household type 4) increase their incomes under the land-constrained scenario in a much larger amount than in experiment 2 under the forest-constrained scenario. It means that agricultural growth, even under agricultural land constraints, offers a larger "income multiplicator" effect, than the one reached by forest products-led growth (experiment 2) under forest constraints.

Experiment 3: Reduced demand for charcoal

The effects on household incomes and village (value added) GDP of an exogenous reduction in the external demand for charcoal are shown in Table 14. Such a reduction in charcoal demand may be the outcome of increased enforcement or additional environmental regulations on the utilization of biomass. We notice that total village value added is reduced by 13.6%; and incomes of charcoal producer households (household type 2) are reduced by 31%. It is worth to notice that incomes of the other household types are also reduced, but by a lower percentage than total village value added. Charcoal producers households (household type 2) whose main source of income is charcoal sales, not unexpectedly, are the most affected under this experiment.

Poverty and income distribution effects

Finally, we conclude this paper by comparing poverty and income distribution implications of village economic growth based on the two different growth strategies exemplified by experiments 1 and 2. These are: i. food-crop based economic growth (e.g. by means of maize production) and ii. forest-based based economic growth (e.g. by means of charcoal production).

Poverty implications

In experiment 1, increased demand for maize reduces both the incidence and the intensity (depth) of poverty in Bandula, as expressed by the headcount and the poverty gap indexes respectively, when there are no supply-constraints in the economy (from 0.580 to 0.565 and from 0.272 to 0.268, respectively), as shown in Table 15. In most of the supply-constrained cases poverty is also reduced, with the exception of only one case: under labor constraints, where the poverty gap increases, in spite that the headcount index is also reduced. The headcount index is very robust as it remains almost unchanged under the different supply-constraint scenarios. The poverty gap, as said before, increases under labor constraints, but remains unchanged (0.565) under the land and forest constraints.

Although increased demand for maize reduces the headcount index (the percentage of poor); the situation of those remaining poor is not improved, as shown by the mean income amongst the poor (which is reduced) and the mean of the poverty gap (which increases).

In experiment 2, an increase in the external demand for charcoal, poverty incidence and depth are only reduced in the case of the unconstrained scenario; whereas in the constrained cases, the headcount index increases (in the case of labor and forest constraints) or remains constant (in the case of agricultural land constraints). The poverty gap index increases in all three constrained cases. Again, similar as in the previous case, the situation of the poor deteriorates, but at a more moderate degree with slight reductions in the mean incomes amongst the poor and increased mean of the poverty gap.

Income distribution implications

The General Entropy measures in Table 17 show that inequality tends to increase (although only moderately) in experiment 1; but, remain almost unchanged in experiment 2. The largest increases in inequality are expressed by the GE(0), which by definition tends to give more weight to the lower incomes. This means that under increased external demand for maize (experiment 1), inequality tends to increase more among the poorest ("the lower tail"). This is also confirmed by the Atkinson inequality measures shown in

Table 18; where the largest deviation from the base case takes place under the experiment 1 at the lower part of the distribution (A(2)). Atkinson measures also confirm that income distribution remains unaffected under experiment 2.

Welfare effects

The Sen welfare index tries to achieve an almost impossible task: to summarize in one single number the effects of policy or exogenous shocks on peoples welfare. However, although imperfect, this measure allows us to wrap up with this section the consequences of alternative growth scenarios. According to the figures in Table 19, under the unconstrained scenarios both growth alternatives (agriculture-led and forest resources-led) improve welfare of the population (reduction in the Sen index) relative to the base case. However, only in the agriculture-led alternative (experiment 1) the indexes under the constrained scenarios show improvements in people's welfare. On the contrary, in the forest-based growth alternative welfare is slightly deteriorated (increased Sen index) under the three different constrained-supply scenarios.

5. Conclusions

SAM framework

The SAM framework possesses well known limitations for policy analysis. One of these limitations is that it implies unitary expenditure elasticities when assessing the multiplier effects of exogenous shocks. Some researchers have suggested the introduction of a matrix of marginal expenditure propensities to accommodate this limitation by (Lewis and Thorbecke, 1992). In our paper we have not included this extension of the basic SAM model, since we believe these aspects will not affect considerably our comparative analysis. Both cases studied here for comparison purposes, e.g. experiments 1 and 2, will face the same limitation and therefore the comparative analysis may not suffer from it.

Another limitation is the assumption of the existence of excess capacity and unemployed or underemployed factors of production. Under these assumptions the SAM framework can be used to estimate the effects of exogenous changes and injections, such as an increase in the demand for a given production activity, government expenditures or exports on the whole system. As long as excess capacity and factors slack prevail; i.e. no factor "constraints", any exogenous change in demand can be satisfied through a corresponding increase in output without having any effect on prices (Thorbecke, 2000). In our case, we have estimated the SAM multipliers both the unconstrained case, but also for cases of different factor constraints. By conducting "sensitivity" analysis or scenario simulations for different types of supply-constraints, the SAM framework can actually be used for policy analysis, illustrating on the role of the different factors of production in overall village economy and the different household groups incomes.

Income distribution decomposition

Using multiplier decomposition we showed how the income distribution process –from production activities to household groups- takes place in the village economy. The multiplier decomposition showed that agricultural-led and forest resource-led economic growth have different effects on the income distribution of the four household groups. Economic growth based on agriculture has stronger repercussions on income distribution for household groups 1 and 3; while, as expected, forest resource-led growth has stronger effects on the income distribution of household group 2 (Charcoal producers), and also positive, but more moderate on income distribution for household group 4 (Food deficitary). These different effects were also reflected in the outcome of the policy experiments shown above and commented below.

More interesting perhaps from the multiplier decomposition was the evidence on the important contribution to income distribution of activities such as environmental services, and commerce; and the moderate contributions of activities such as unskilled labor and food processing.

Poverty and income distribution assessments

The analysis of the consequences on poverty and income distribution of policies or development strategies cannot rely on the results of single indicators. The assessment of these matters usually requires looking and interpreting a variety of indicators. In this paper we have used the FGT-family of measures to assess poverty; the General Entropy and Atkinson measures to assess income's inequality, and the Sen index for a welfare measure. In our policy experiments, poverty measures P_o and P_1 not always changed in the same direction. Especially in such cases, it is important to count with additional information or indicators in order to interpret the changes.

Similarly, assessing income inequalities demands the use of several measures. Care should be taken when interpreting changes in inequality indexes because there are value judgments embedded in the definition of each inequality indicator. Each indicator gives different weights to income inequalities at different levels of the distribution curve, reflecting different dimensions of inequality of incomes across the population.

Growth strategies

The two growth strategies analyzed in this paper, i.e. agricultural-led and forest resources-led growth, appear to produce different outcomes for the village economy as a whole and for the different household groups. For instance, the village total gross domestic product tends to be higher for the agriculture-led growth based strategy even in the case of agricultural land constraints. On the contrary, under forest constraints the forest resources-led growth based strategy generates only moderate increase in village total gross domestic product.

The welfare of the population is also affected differently under the two alternative growth strategies. Agricultural-led growth reduces poverty incidence under all the different supply constraint scenarios, but fails to reduce the poverty gap in the case of labor constraints. A drawback is that agricultural-led growth tends to increase income inequalities among the poor (lower part of the distribution), as expressed by the GE and Atkinson indexes. In the unconstrained case, the comparison was difficult as both strategies behave very similar. However, as soon as one introduces the existence of supply-constraints, the agricultural-led growth strategy is clearly superior to the forest resources-based strategy.

Finally, by looking at the overall or summary indicator (the Sen index), agricultural-led growth also ended up as a better choice from the point of view of the social welfare. On the contrary, in the forest resources-based economic growth strategy, poverty incidence and poverty gaps were not reduced when increased demand faces supply constraints. Only in the unconstrained case, the forest resources-led growth reduced poverty incidence and poverty gaps compared to the base case.

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Appendix A

Tables

Table 1. Aggregated Village SAM-Bandula 2000

	Activities	Commodities	Factors	S - I	Households	GOV	TRANS row	ROW	Total
Activities	0	11 149	0	0	0	0	0	0	11 149
Commodities	3 157	0	0	1 688	6 576	0	513	5 323	17 257
Factors	7 992	0	0	0	0	0	0	0	7 992
S - I	0	0	0	0	1 017	1 071	0	-400	1 688
Households	0	0	7 992	0	0	0	0	0	7 992
GOV	0	672	0	0	399	0	0	0	1 071
TRANS row	0	513	0	0	0	0	0	0	513
ROW	0	4 923	0	0	0	0	0	0	4 923
Total	11 149	17 257	7 992	1 688	7 992	1 071	513	4 923	

Table 2

	Activities
1	Maize on fields
2	Maize on cleared land
3	Other agricultural
4	Livestock
5	Charcoal
6	Fishing
7	Food Processing
8	Commerce
9	Unskilled Employment
10	Skilled Employment
11	Oxen Rental Out
12	Oxen Rental In
13	Environmental Services
14	Land Clearing
15	Field Planting
16	House Chores Wood
17	House Chores Water
18	Time

	Commodities
19	Maize
20	Other agricultural
21	Livestock
22	Charcoal
23	Fishing
24	Food Processing
25	Kerosene
26	Commerce
27	Health services
28	Education
29	Traditional Cerem.
30	Unskilled Labor
31	Skilled Labor
32	Oxen
33	Manure
34	Fertilizer
35	Fodder
36	Environ. Services
37	Cleared Land
38	Planted Field
39	House Chores
40	Leisure

	Factors
41	Labor
42	Capital
43	Land Fields
44	Land Cleared
45	Land Forested

46	Investment/Savings

	Institutions
47	“Food surplus” Household type 1
48	“Charcoal producer” Household type 2
49	“Food self-sufficient” Household type 3
50	“Food deficitary” Household type 4

	Exogenous
51	Government
52	Transaction costs row
53	Rest-of-the-World

Table 3. Value added by production activity

Activity	Value added	Percentage
Maize on fields	1 475.4	18.5
Maize on cleared land	490.0	6.1
Other agricultural	260.8	3.3
Livestock	685.7	8.6
Charcoal	853.8	10.7
Fishing	81.4	1.0
Food Processing	103.8	1.3
Commerce	215.7	2.7
Environmental Services	1 181.7	14.8
Land Clearing	223.0	2.8
Field Planting	147.0	1.8
House Chores Wood	485.0	6.1
House Chores Water	568.6	7.1
Time	1 219.9	15.3
Total	7 991.8	100.0

Table 4. Factor shares by production activity

	41	42	43	44	45	
	Labor	Capital	Land Fields	Land Cleared	Land Forested	
Maize on fields	41.2	25.6	33.2	0.0	0.0	100,0
Maize on cleared land	30.5	11.4	0.0	58.2	0.0	100,0
Other agricultural	44.0	24.4	31.6	0.0	0.0	100,0
Livestock	41.6	48.8	0.0	0.0	9.6	100,0
Charcoal	56.8	11.4	0.0	0.0	31.8	100,0
Fishing	23.2	43.7	0.0	0.0	33.1	100,0
Food Processing	49.1	50.9	0.0	0.0	0.0	100,0
Commerce	72.0	28.0	0.0	0.0	0.0	100,0
Unskilled Employment	100.0	0.0	0.0	0.0	0.0	100,0
Skilled Employment	100.0	0.0	0.0	0.0	0.0	100,0
Oxen Rental Out	100.0	0.0	0.0	0.0	0.0	100,0
Oxen Rental In	100.0	0.0	0.0	0.0	0.0	100,0
Environmental Services	0.0	0.0	0.0	0.0	100.0	100,0
Land Clearing	59.1	12.8	0.0	0.0	28.1	100,0
Field Planting	63.8	14.0	22.2	0.0	0.0	100,0
House Chores Wood	85.6	0.0	0.0	0.0	14.4	100,0
House Chores Water	81.2	0.0	0.0	0.0	18.8	100,0
Time	100.0	0.0	0.0	0.0	0.0	100,0

Table 5. Factorial distribution of income

	TOTAL	Household type 1 Food surplus	Household type 2 Charcoal producer	Household type 3 Food Self-sufficient	Household type 4 Food deficitary
Age household head[a]	42.1	39.8	39.5	43.6	44.7
Female household head[b]	8.8%	0.5%*	0.0%*	11.1%	24.3%*
Literacy rate[b]	64.9%	85.2%*	44.1%	70.4%	48.7%
School years[a]	3.31	4.46*	2.06	3.32	3.12
Household size[a]	4.54	4.21	3.71	5.09*	4.69
Dependency ratio (cw-ratio)[b]	2.06	2.03	2.30	1.95	2.06
Labor Force (units adult eq.)[a]	2.29	2.16	1.62*	2.63*	2.44
Off-farm labor[b]	0.16	0.32	0.00*	0.09	0.26*
Farm size[a]	2.72	3.75*	1.33*	2.93	2.38*
Maize production[a]	1 104	1 464	372*	1 369	846
Use of seeds[b]	0.20	0.25	0.00*	0.20	0.33
Use of manure[b]	0.02	0.09	0.00	0.01	0.00
Hired labor (hrs.) [a]	109.05	70.33	35.07*	170.05*	108.34
Animal draft (days/yr) [a]	3.16	3.85	0.00*	4.65	2.42
Cattle (units) [a]	1.20	1.70	0.00*	2.04*	0.04*
Poultry (units) [a]	6.28	8.29	7.60	5.60	3.69
Number of fruit trees[a]	16.01	12.38	0.15*	20.23	28.62
Value added per household (Mts.)	11 237 136	16 364 298*	13 998 656	9 055 782*	6 227 148*
Value added per capita (Mts.)	2 714 791	4 005 170*	4 174 608	1 700 407*	1 633 803*
Weighted shares (%)	100	23.8	19.3	38.7	18.2

Notes:
Population weighted statistics and standard errors adjusted for clustering.
(*) indicates statistically significant difference in the means (between the corresponding category and the rest).
[a] sample corrected means.
[b] sample corrected ratios.

Table 6. Factorial distribution of income

		Labor	Capital	Land Fields	Land Cleared	Land Forested	Total
		41	42	43	44	45	
1	HH1	63.9	18.3	9.6	2.0	6.2	100,0
2	HH2	39.7	6.6	1.5	0.5	51.7	100,0
3	HH3	49.1	15.1	10.1	8.8	16.8	100,0
4	HH4	58.9	9.3	6.9	0.0	24.9	100,0

Table 7. Trade flows in village economy

	Mi/Yi	Ei/Yi	Ei/E
Maize	0.0	38.0	23.5
Livestock	33.7	34.4	9.2
Charcoal	0.0	100.0	35.2
Fishing	84.7	3.2	0.4
Kerosene	100.0	0.0	0.0
Commerce	93.3	0.0	0.0
Health services	100.0	0.0	0.0
Education	100.0	0.0	0.0
Traditional Cerem.	100.0	0.0	0.0
Unskilled Labor	30.7	0.0	0.0
Skilled Labor	0.0	58.6	8.6
Fertilizer	100.0	0.0	0.0
Fodder	0.0	0.0	0.0
Environ. Services	22.8	80.4	23.1

Table 8. Consumption shares by household group

	Household type 1 Food surplus	Household type 2 Charcoal producer	Household type 3 Food Self-sufficient	Household type 4 Food deficitary
Maize	3.3	34.8	19.5	22.2
Other agricultural	4.2	2.9	3.5	2.2
Livestock	17.3	4.3	8.8	1.8
Fishing	4.6	0.3	6.3	1.2
Food Processing	8.8	16.7	0.0	12.7
Kerosene	5.5	2.1	7.8	3.6
Health services	11.3	7.6	12.7	10.6
Education	10.4	7.2	6.9	6.6
Traditional Cerem.	6.1	8.2	9.3	9.7
House Chores	13.1	10.7	19.5	24.9
Leisure	15.3	5.3	5.8	4.6
	100,0	100,0	100,0	100,0

Table 9. Multipliers Households-Activities

		Maize on fields	Maize on cleared land	Other agricultural	Livestock	Charcoal	Fishing	Food Processing	Commerce	Unskilled Employment	Skilled Employment	Oxen Rental Out	Oxen Rental In	Environmental Services	Land Clearing	Field Planting	Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
47	HH1	0.73	0.67	0.78	0.64	0.61	0.63	0.61	0.82	0.46	0.72	0.73	0.72	0.50	0.73	0.82	12.50
48	HH2	0.27	0.31	0.29	0.28	0.48	0.39	0.24	0.34	0.20	0.32	0.32	0.32	0.73	0.45	0.32	6.46
49	HH3	0.58	0.74	0.62	0.52	0.54	0.54	0.51	0.62	0.35	0.54	0.57	0.56	0.57	0.60	0.64	10.32
50	HH4	0.17	0.15	0.18	0.15	0.19	0.17	0.14	0.20	0.12	0.19	0.18	0.18	0.21	0.20	0.20	3.27
	Total	1.75	1.87	1.88	1.60	1.81	1.72	1.50	1.98	1.13	1.76	1.80	1.78	2.02	1.99	1.98	

Table 10. Multiplier Contribution to Income Distribution

		Maize on fields	Maize on cleared land	Other agricultural	Livestock	Charcoal	Fishing	Food Processing	Commerce	Unskilled Employment	Skilled Employment	Oxen Rental Out	Oxen Rental In	Environmental Services	Land Clearing	Field Planting	Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
47	HH1	0.26	0.16	0.30	0.21	0.14	0.21	0.13	0.35	0.05	0.14	0.16	0.14	0.01	0.25	0.35	3.77
48	HH2	-0.05	-0.04	-0.04	-0.02	0.15	0.10	-0.09	0.01	-0.08	-0.09	-0.07	-0.08	0.40	0.12	-0.01	0.42
49	HH3	0.16	0.29	0.19	0.13	0.12	0.16	0.08	0.20	-0.02	0.02	0.05	0.04	0.13	0.17	0.22	2.47
50	HH4	0.04	0.01	0.04	0.03	0.05	0.04	0.00	0.06	0.00	0.02	0.02	0.01	0.07	0.07	0.06	0.74
	Total	0.41	0.43	0.49	0.35	0.47	0.51	0.12	0.62	-0.06	0.08	0.16	0.11	0.61	0.62	0.62	

Table 11. Redistributed Income

		Maize on fields	Maize on cleared land	Other agricultural	Livestock	Charcoal	Fishing	Food Processing	Commerce	Unskilled Employment	Skilled Employment	Oxen Rental Out	Oxen Rental In	Environmental Services	Land Clearing	Field Planting	Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
47	HH1	0.20	0.10	0.24	0.15	0.08	0.15	0.07	0.29	-0.01	0.08	0.10	0.08	-0.05	0.19	0.29	2.68
48	HH2	-0.09	-0.08	-0.08	-0.06	0.11	0.06	-0.13	-0.03	-0.12	-0.13	-0.12	-0.13	0.35	0.08	-0.05	-0.33
49	HH3	0.11	0.24	0.14	0.07	0.07	0.10	0.03	0.14	-0.08	-0.04	0.00	-0.02	0.08	0.12	0.16	1.49
50	HH4	0.02	-0.01	0.03	0.01	0.04	0.03	-0.02	0.04	-0.02	0.00	0.00	-0.01	0.05	0.05	0.04	0.42
	Total	0.24	0.25	0.32	0.17	0.30	0.33	-0.05	0.45	-0.23	-0.09	-0.02	-0.06	0.44	0.44	0.45	

Table 12. Experiment 1: increased demand for maize

	Un-constrained	Labor constrained	Land constrained	Forest constrained
“Food surplus” Household type 1	8.47	3.21	6.68	7.82
“Charcoal producer” Household type 2	0.12	0.02	0.08	0.08
“Food self-sufficient” Household type 3	3.18	0.28	2.31	2.31
“Food deficitary” Household type 4	3.21	0.18	2.45	2.57
%-age change in village GDP	4.28	1.23	3.30	3.71
Un-const. /Const. ratio	1.00	0.29	0.77	0.87

Table 13. Experiment 2: increased demand for charcoal

	Un-constrained	Labor constrained	Land constrained	Forest constrained
“Food surplus” Household type 1	1.92	0.41	1.56	0.91
“Charcoal producer” Household type 2	8.29	3.63	8.17	4.77
“Food self-sufficient” Household type 3	2.36	0.56	1.80	0.70
“Food deficitary” Household type 4	2.37	0.58	1.88	0.75
%-age change in village GDP	3.63	1.25	3.25	1.75
Un-const. /Const. ratio	1.00	0.34	0.90	0.48

Table 14. Experiment 3: reduced demand for charcoal

	Un-constrained
“Food surplus” Household type 1	-7.20
“Charcoal producer” Household type 2	-31.10
“Food self-sufficient” Household type 3	-8.84
“Food deficitary” Household type 4	-8.88
%-age change in village GDP	-13.63

Table 15. Poverty indicators from increased demand for maize

	Base case	Un-constrained	Labor constrained	Land constrained	Forest constrained
P_o – Headcount index	0.580	0.565	0.565	0.565	0.565
P_1 – Poverty gap	0.272	0.268	0.278	0.271	0.271
Mean of income amongst the poor Base case = 1	1.00	0.990	0.959	0.980	0.982
Mean of poverty gaps Base case = 1	1.00	1.012	1.047	1.022	1.020

P_o : headcount ratio (proportion poor)

P_1 : average normalised poverty gap

Table 16. Poverty indicators increased demand for charcoal

	Base case	Un-constrained	Labor constrained	Land constrained	Forest constrained
P_o – Headcount index	0.580	0.565	0.584	0.580	0.584
P_1 – Poverty gap	0.272	0.268	0.278	0.275	0.278
Mean of income amongst the poor Base case = 1	1.000	0.990	0.988	0.993	0.989
Mean of poverty gaps Base case = 1	1.000	1.012	1.013	1.008	1.012

P_o : headcount ratio (proportion poor)

P_1 : average normalised poverty gap

:

Table 17. Generalized Entropy indices

	GE(-1)	GE(0)	GE(1)	GE(2)	Gini
Base case	0.536	0.373	0.351	0.428	0.468
Experiment 1	0.545	0.376	0.353	0.429	0.469
Experiment 2	0.536	0.372	0.350	0.425	0.467

GE(a), where a = income difference sensitivity parameter.

Table 18. Atkinson indices

	A(0.5)	A(1)	A(2)
Base case	0.167	0.311	0.517
Experiment 1	0.168	0.313	0.521
Experiment 2	0.167	0.311	0.518

A(e), where e > 0 is the inequality aversion parameter.

Table 19. Sen's Welfare index, by experiment and supply constraints

	Base case	Un-constrained	Labor constrained	Land constrained	Forest constrained
Experiment 1	0.371	0.365	0.371	0.366	0.366
Experiment 2	0.371	0.363	0.376	0.372	0.375

Appendix B

Multiplier decomposition for income distribution analysis

The multiplier analysis starts by dividing the total accounts of a SAM into two separate categories: endogenous accounts and exogenous accounts. If we consider a social accounting matrix with **m** endogenous institutions and **z** exogenous institutions, the total accounts **n** are the sum of the two types: **n = m + z**.

The SAM can then be written in the following way:

Equation 1

$$\begin{bmatrix} Y_m \\ Y_z \end{bmatrix} = \begin{bmatrix} A_{mm} & A_{mz} \\ A_{zm} & A_{zz} \end{bmatrix} \begin{bmatrix} Y_m \\ Y_z \end{bmatrix}$$

where $\boldsymbol{A_{ij}}$ are submatrices that contain the expenditure share coefficients, calculated by dividing the transactions in the SAM by the corresponding column.

Income from endogenous accounts $\boldsymbol{(Y_m)}$ can be obtained as follows:

Equation 2

$$Y_m = A_{mm}Y_m + A_{mz}Y_z = (I - A_{mm})^{-1} A_{mz}Y_z = Mx$$

where $\boldsymbol{I}$ is the identity matrix, $\boldsymbol{M = (I - A_{mm})^{-1}}$ is a matrix of multipliers and $\boldsymbol{x = A_{mz}Y_z}$ is a vector of exogenous injections. The multiplier matrix $\boldsymbol{M}$ shows the overall effect of a unitary increase in the exogenous components on the endogenous accounts.

The element $\boldsymbol{m_{ij}}$ of $\boldsymbol{M}$ quantifies the changes in the income of the institution $\boldsymbol{i}$ as a consequence of a unitary and exogenous injection received by the institution $\boldsymbol{j}$.

From expression (2), the analysis of multipliers corresponding to endogenous institutions illustrates the changes in the absolute levels of income. To study the changes associated with relative income, we should define measurements of distributional effects.

Roland-Holst and Sancho (1992) presented an overall context for distributive incidence. By using their approach, we can calculate how is affected the relative position of the endogenous accounts when a change in the exogenous injections is produced.

To examine the distributional effects, expression (2) can be normalised such that:

Equation 3

$$y_m = \frac{Y_m}{e'Y_m} = (e'Mx)^{-1} Mx$$

where ***e'*** is a unitary row vector.

Equation 4

$$dy_m = (e'Mx)^{-1} \lfloor I - (e'Mx)^{-1} (Mx) e' \rfloor Mdx$$
$$= \frac{1}{e'Y_m} \left[I - \frac{Y_m}{e'Y_m} e' \right] Mdx \ = Rdx$$

In this expression, ***R*** is the redistribution matrix and shows the change (positive or negative) in the relative income of the endogenous accounts caused by unitary modifications in the exogenous injections received. An individual element of this matrix, $\boldsymbol{r_{ij}}$, determines the magnitude and direction of the change in the relative income of the institution ***i*** as a result of a unitary inflow in the institution ***j***.

Equation 5

$$R = (e'Mx)^{-1} \lfloor I - (e'Mx)^{-1} (Mx) e' \rfloor M =$$
$$= bDM$$

Equation 6

$$R = bDM =$$
$$= b[I - (I - D) + D(M - I)]$$

This representation of ***R*** uncovers the underlying components of the income distribution process and displays the sequential terms involved.

In equation (6) ***D(M-I)*** is the multiplier effect and represents the additive contribution of the net multiplier to the distribution process. The multiplier contribution to income distribution is therefore equal to its multiplier (net) minus the redistribution generated by the sector ***j*** to the other endogenous institutions. This multiplier effect evaluates the effects caused by the net multipliers, as a result of the interdependence relationships between the endogenous institutions of the model.

The additive division of the matrix of redistribution clarifies the direction and magnitude of the changes in the relative position of the accounts.