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Microsimulation with SAM Multipliers

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Abstract

Applied general equilibrium models have long recognized that accounting for intra-household variations improves the measured impacts of exogenous shocks. Recent advances in computing power have made it possible to integrate the computation of intra-household effects to large scale empirical analyses. These analyses are now generically referred to as microsimulations, and most of them are based on *flexible-price* computable general equilibrium (CGE) models. In general, these models are inherently complicated, and the significant time investment required for using them, have restricted their use to a small group of initiated. There is, however, a class of *fixed-price* (zero-substitution) CGE models that can be directly estimated as SAM multipliers. Applied to a sufficiently disaggregated household data, the SAM multipliers matrix has the property of a microsimulation CGE model. Surprisingly to our knowledge, SAM multipliers have not been applied in the context of microsimulation analyses. This paper shows the use of SAM multipliers as a microsimulation CGE model. The model is applied to measure intra- and inter-group impacts of increasing agricultural exports in Niger. Three results are noteworthy: (i) ignoring intra-household variations would amount to more than 35% overestimation of value added and income multipliers; (ii) consequently, the rate of poverty reduction is also overestimated; and (iii) the extent of the mis-measurement is worse for the poorest households.

Keywords: SAM multipliers, microsimulation, poverty analysis, CGE model.

1. Introduction

Applied general equilibrium models have long recognized that accounting for intra-household variations improves the measured impacts of exogenous shocks on poverty (Decaluwé, Dumond and Savard, 1999). Recent advances in computing power have made it possible to integrate the computation of intra-household effects to large scale empirical analyses. These analyses are now generically referred to as microsimulations, and most of them are based on *flexible-price* computable general equilibrium (CGE) models. In general, inta-household effects are integrated into the CGE model in two ways. In the first approach, the within-group income distribution functions is described using distribution functions, including lognormal (de Janvry, Sadoulet and Fargeix, 1991) and beta (Decaluwé et al., 1999) densities. This approach assumes that except the mean, all other moments are fixed and therefore unaffected by the policy or technological shock analyzed (Cockburn, 2002). This restriction is relaxed in the second approach, which fully accounts for the within-group variations when measuring the impacts of shocks on households' income and poverty.

While the CGE literature has played a central role in microsimulation analyses, particularly in developing countries, applied CGE models still suffer from their perceived weakness regarding the sensitivity of the results to behavioral parameters and macroeconomic closures assumptions. In addition, these models are inherently complicated, and the significant time investment required for using them, have restricted their use to a small group of initiated. There is, however, a class of *fixed-price* (zero-substitution) CGE models that do not require behavioral parameter assumptions[1] and that can be directly estimated as SAM (social accounting matrix) multipliers. Applied to a sufficiently disaggregated household data, the SAM multipliers matrix has the property of a microsimulation CGE model. This model can then be used to capture the within-group variations in the impacts of exogenous shocks. The microsimulation SAM multipliers can also serve as a database for impact assessments, and they can be directly computed by the national statistical systems.

The use of a SAM multiplier framework is appealing because of its simplicity and the direct interpretation of results based on these multipliers. Despite its well-known limitations[2], the SAM multiplier model has the advantage of being transparent which makes it less a black-box than the commonly used general equilibrium models[3]. In addition, SAM multipliers can be computed without "borrowing" key behavioral parameters from alien sources, as is commonly done in CGE models. Surprisingly to our knowledge, SAM multipliers have not been applied in the context of microsimulation analyses. This paper shows the use of SAM multipliers as a microsimulation CGE model. The model is applied, first to estimate aggregate value added and household income multipliers in Niger, and second to examine the intra- and inter-group as well as the poverty impacts of increasing agricultural exports in Niger.

This paper is structured in 5 sections, including this introductory part. In the next section, we present the methodological framework qui includes the analytical model and its links to SAM multipliers and poverty analyses. Section 3 discusses the data and simulation procedures, with emphases on the reconciliation between the national accounts and household survey data. We present the result in Section 4, and the last section summarizes and draws a few conclusions from the studies.

2. Analytical Framework

2.1 Standard and Microsimulation SAM Multipliers Models

We start by defining the income (consumption) Y_g of the household group g, which is simply the sum of the incomes (consumption) of all the N_g households in the group g (Equation 1):

$$Y_g = \sum_{hg=1}^{N_g} Y_{hg} \tag{1}$$

[1] More accurately, the behavioral parameters—such as the unitary marginal propensities to consume and to save—are directly embodied in the fixed-price SAM multiplier model.
[2] Fixed price, no substitution, no supply constraint, etc…
[3] The black-box criticism of CGE model derives not from the methodological soundness of the model, but from the inability of many to understand the intricacies of the systems of equations upon which the model is based.

Equivalently, the total change in Y_g is the simple sum of the changes across all households in group g (Equation 2):

$$\Delta Y_g = \sum_{hg=1}^{N_g} \Delta Y_{hg} \tag{2}$$

We want to compute how Y_g changes with respect to any exogenous policy shock ΔP_i. As shown in Equation 3, this impact is computed by dividing the RHS and the LHS of (2) by ΔP_i

$$\frac{\Delta Y_g}{\Delta P_i} = \sum_{hg=1}^{N_g} \frac{\Delta Y_{hg}}{\Delta P_i} \tag{3}$$

Equation (3) measures the absolute change ΔY_g in Y_g in response to the policy shock ΔP_i. This is a single monetary measure, which does not allow for a comparison of the impacts of the policy shock across household groups. For comparison purposes, it is more practical to express the impacts as relative changes (Equation 4):

$$\frac{\Delta Y_g / \Delta P_i}{Y_g} = \sum_{hg=1}^{N_g} \omega_{hg} k_{hg} \tag{4}$$

with $\omega_{hg} = Y_{hg} / Y_g$ and $k_{hg} = \dfrac{\Delta Y_{hg} / \Delta P_i}{Y_{hg}}$; ω_{hg} are weights, each of which corresponding to the share of household h from group g in the total income of household group g.

For each household hg (i.e. household h from group g), the standard SAM multiplier model implicitly imposes the assumption in Equation 5:

$$k_{hg} = k_g \tag{5}$$

where k_g is a constant measuring the impact of a policy shock ΔP_i on the household group g. Because k_g is constant across the group, the relative change in income (consumption) in each household h in group g is the same.

By substituting (5) in (4), it is straightforward to see that the relative impact of ΔP_i on ΔY_g is simply k_g. This follows from the knowledge that the sum over the N_g households of all weights ω_{hg} must equal 1 (Equation 6):

$$\sum_{hg=1}^{N_g} \omega_{hg} = 1 \qquad \textbf{(6)}$$

In microsimulation models, k_{hg} is no longer assumed to be constant across the N_g households in group g. These models explicitly recognize that Equation 7 below holds:

$$\frac{\Delta Y_{hg} / \Delta P_i}{Y_{hg}} = k_{hg} \qquad \textbf{(7)}$$

Equation 7 says that each individual household h of group g presents a unique response (k_{hg}) to the policy shock ΔP_i. Depending on household-specific income and consumption linkages in the general economy, the differences in the k_{hg} can be substantial. In turn, these differences are accounted for in measuring the aggregate impact k_g^* of the shock ΔP_i on household group g. This impact, shown in Equation 8, is computed by substituting (7) in (4):

$$\frac{\Delta Y_g / \Delta P_i}{Y_g} = \sum_{hg=1}^{N_g} \omega_{hg} k_{hg} = k_g^* \qquad \textbf{(8)}$$

where the star (*) is added to differentiate standard SAM multiplier impact (with G household groups) from the microsimulation results (N real households, with $N = \sum_g N_g$, N_g being the number of households in group g; g = 1, 2, …G; G <<N_g[4]).

To determine the methodological gains from developing a SAM suitable for microsimulation analyses (i.e. a SAM that include real households instead of representative households), it is important to compare standard SAM multiplier impact (k_g) with the "microsimulated" impact (k_g^*). This comparison is an empirical question, because k_g^* may be less, equal or greater than k_g, depending on the shares ω_{hg} of the household hg in total income (consumption) of the group and on the household-specific impact of the exogenous shock (k_{hg}). Thus, we can postulate that Equation 9 trivially holds:

$$k_g^* \le k_g \text{ or } k_g^* > k_g \tag{9}$$

For a sector or household group and for any exogenous shock, only one of the three possibilities in (9) will hold. In general, if we consider the microsimulation results to be the most accurate, the standard SAM multiplier model will tend to overestimate the "true" results if households with relatively larger weights also show relatively smaller impacts (k_{hg} relatively small for relatively large ω_{hg}) or if the relatively smaller households in terms of weights present relatively larger responses to exogenous shocks (k_{hg} relatively large for relatively small ω_{hg}). In both cases, the product $k_{hg}*\omega_{hg}$ will be relatively small for individual households. Thus, the sum of this product over the N_g households of group g (i.e. k_g^*) will also tend to be smaller relative to the standard SAM multiplier effect (i.e k_g). The converse will hold in the case that the standard SAM multiplier results underestimate the "true" microsimulation results. It is, however, important to stress once again that there is no unique way to determine *a priori* which of the impacts will dominate, hence the need for an empirical evaluation.

2.2 Empirical Implementation of the Model

With the G household groups in the standard SAM multiplier model, it is straightforward to compute the k_g (Equation 10):

$$k_g = [M_g] * \Delta P_i / Y_g \tag{10}$$

where M_g is the row of the standard SAM multiplier matrix M_G that corresponds to the household group $g, \Delta P_i$ is a conformable vector of exogenous shocks as defined earlier, and Y_g is the row or column total of the SAM account g.

[4] In Niger, G = 7 whereas N =6690.

When, instead of G household groups of the standard SAM multiplier matrix M_G, we consider the N households in the microsimulation model, the impact k_{hg} of a given shock on household hg in group g is given by Equation 11:

$$k_g = [M_g] * \Delta P_i / Y_g \qquad \textbf{(11)}$$

Here also, M_{hg} is the row of the microsimulation SAM multiplier matrix M_N that corresponds to the individual household hg, ΔP_i is a conformable vector of exogenous shocks, and Y_{hg} is the row or column total of the microsam account hg.

Substituting (11) in (8) yields Equation 12, which measures the aggregate impact on the group g as the ω_{hg}-weighed sum over h of k_{hg}:

$$k_g^* = \sum_{h=1}^{N_g} \omega_{hg} [M_{hg}] * \Delta P_i / Y_{hg} \qquad \textbf{(12)}$$

The weights ω_{hg} are computed coefficients from the detailed microsimulation SAM. The comparison between k_g and k_g^* is equivalent to comparing the results of equations 10 and 12.

To compute the standard and microsimulation SAM multipliers, M_G and M_N respectively (G and N referring to the number of households in the SAM), we use the standard approach from the literature (for details, see seminal work such as Pyatt and Round (1979) and Defourny and Thorbecke (1984)). According to this approach, M_G and M_N are computed as followed:

$$\boldsymbol{M_G = (I_G - A_G)^{-1}\ ;\ M_N = (I_N - A_N)^{-1}} \qquad \textbf{(13)}$$

Where G and N denotes the number of households in the standard and microsimulation SAMs, respectively; I and A (with indices G and N) are identity and technical coefficient matrices for endogenous accounts. The technical coefficients are obtained by dividing each entry of the SAM by the total of the corresponding column. The endogenous accounts are those assumed to be affected by exogenous policy shocks. They include production accounts (activities and commodities), production factors, and households. The difference between the standard and the microsimulation SAMs lies in the number of households. All the other elements of the two SAMs are identical (further details in Section 3).

2.3 Special Case: Direct Comparison of Standard and Microsimulation SAM Multipliers

In general, the definition of a SAM multiplier M_{ji} is the change in the row-account j that would result from a unit change in the column-account i. In this case, the policy shock ΔP_i is normalized to unit, so is the total of each column i. It follows that Equation (14) below is satisfied:

$$\frac{\Delta Y_{hg} / \Delta P_i}{Y_{hg}} = M_{hg,i} \quad \textbf{(14)}$$

where $M_{hg,i}$ is the entry in the hg-th row and the i-th column of the microsimulation multiplier matrix M_N. Thus for each policy shock ΔP_i, $k^*_{g,i}$ can be computed as follows:

$$k^*_{g,i} = \sum_{hg=1}^{N_g} \frac{\Delta Y_{hg} / \Delta P_i}{Y_{hg}} = \sum_{hg=1}^{N_g} M_{hg,i} \quad \textbf{(15)}$$

Equation (15) states that for each household group g and any given policy shock i, the aggregate multiplier is the sum of the multipliers of individual households hg belonging to the group g.

2.4. Poverty Analysis

Each policy shock brings about a change in household income or consumption aggregate. This change may be translated in terms of poverty indices, such as the widely used FGT indices[5] (Foster, Greer et Thorbecke, 1984). The basic idea is that the policy

[5] In general, FGT indices for the entire population are written as follows $P_\alpha(y,z) = \frac{1}{N}\sum_{hg=1}^{q}\left(\frac{z - Y^s_{hg}}{z}\right)^\alpha$

where Y^s_{hg} is a vector of households' consumption (income) after the shock, z is the poverty line, N is the total population, q is the population living below poverty line, and α is the power of the FGT indices. If $\alpha = 0$, we obtain the P_0 index, which measures poverty rate. The P_1 index measures poverty gap ($\alpha = 1$), and the P_2 index measures the severity of poverty ($\alpha = 2$). Datt and Ravallion (1992) show that the change in shock changes households' income/consumption aggregate from Y_{hg} (Y_g for the standard SAM multiplier model) to Y_{hg}^s (Y_g^s for the standard model), which is defined as follows (Equation 16):

$$Y_{hg}^s = (1 + k_{hg})Y_{hg} \tag{16}$$

where k_{hg} is the impact of the policy shock on individual household *hg*, as defined in Equation (11) as Y_{hg} is a defined earlier.

3. Data and Simulation Procedures

The standard SAM used in this analysis has been constructed by Nganou, Tsimpo and Wodon (2006) and Nouve, Nganou and Wodon (2006) provides a description of the matrix. The Niger's standard SAM is disaggregated into 71 accounts, including 23 production activities (sectors), 24 commodities (goods and services), 8 production factors, 7 household groups. The nine remaining accounts include the other domestic institutions, such as the current Government account, four tax accounts (activity tax, import tariffs, export taxes, other indirect taxes), and three capital accounts (public savings-investments, public savings-investments and changes in stocks). There is finally one external institution account, which is represented by the rest of the world (ROW).

This analysis is based on a microsimulation SAM, which is specifically built for the purposes. Several accounts are common to the standard and microsimulation social accounting matrices. These include the production sectors, commodities, production factors, and all domestic and foreign institutional accounts excluding households. The key distinction between the two SAMs is that, while the standard matrix has only 7 household groups (or representative households), the microsimulation matrix has 6690 individual households that have been surveyed in the 2004 household income and expenditure survey.

an index between two states can be decomposed into three effects: the growth effect, the inequality effect and the residual. This decomposition is used in the text to further explain the differences between the SSM and the MSM models.

It is a well-known fact that household survey and national accounts data do no match (for discussion and examples, see Ravallion, 2003; and Deaton, 2005). Thus, the single most important challenge in building a microsimulation SAM is reconciling data from the household survey and the standard SAM (based on national accounts). The reasons of this discrepancy are numerous, and Dumont (2000) provides a useful summary of the key issues. According to him, household surveys tend to suffer from sampling errors due to measurement errors and problems in survey design. On the other hand, while the interindustrial production and income information from national accounts tend to be of a higher quality in the formal sector, it is less so in the informal sector, which concentrates a large share of the economic activity in developing countries.

According to the Niger's 2004 household survey, the total income declared by households represents less than 54% of the declared total consumption. Echoing Paxson (1992) and Deaton (1997), Fofana and Cockburn explore several reasons why household surveys tend to under-measure incomes, relative to consumption. They argue, first, that consumption data tend to be more recent, and they are collected over shorter reference period (week or month) than income data (year). This implies that relative to income, consumption will tend to be overestimated owing to inflation, and that the longer reference period for income data implies greater measurement errors. In Niger, income and consumption data are collected in the same year, so the inflation problem is less a concern here. Second, they also argue that the informal nature of family businesses in developing countries makes it difficult to separate household account from the business account, and the ultimate consequence is the overestimation of expenditures and the underestimation of incomes. Niger is no exception in this regard. They finally identify self-employment as another factor explaining underestimation of household incomes. The 2004 Niger data show than four household's heads in five are self-employed in the informal sector, which compounds the likelihood that income is under-measured in the country.

In reconciling the consumption and income data in Niger, we follow three simple steps. First, for each household *hg* receiving an income from a production factor *f*, we scale-up the declared incomes $Y_{hg,f}$ by a factor k_f so that the scaled-up income

$Y'_{hg,f}$ is the sum over hg of $k_f * Y_{hg,f}$. The ratio k_f is computed by dividing the total income from factor f that is distributed to the group g in the standard SAM (say $SAM_{g,f}$) by the total income of all hg households as measured in the survey.

$$Y'_{hg,f} = \sum_{hg=1}^{N_g} k_f * Y_{hg,f} \text{, with:} \qquad \textbf{(17)}$$

$$k_f = \frac{SAM_{g,f}}{\sum_{hg=1}^{N_g} Y_{hg,f}}$$

Second, a similar procedure is used to ensure a consistency between the standard and the microsimulation SAM data, as regards the other sources and uses of the household incomes. Additional resources include transfers received from the Government and the rest of the world, and uses refer to the savings and direct taxes that households pay to the Government. Here, the adjustment of transfers, savings and direct taxes is assumed to be proportional to the within-group household aggregate consumption shares. Regarding savings for example, we note that not all households declared having some savings, and we assume that households with savings are those who declare having some. Household savings is thus calculated by distributing total savings of the group to each group member (with nonzero savings) in proportion of within-group consumption shares. Similarly, with regards to the direct taxes received by the Government, we assume that households paying these taxes are those headed by individuals employed in the formal sector by the Government, other non-government institutions or by a private firm. According to this criterion, about each other household can be considered as paying a direct tax to the Government.[6] Finally, we also use within-group household consumption shares to distribute the transfers from the

[6] We consider an alternative assumption to distribute the direct taxes to households. In addition to above criterion, two other household groups are assumed to pay direct taxes. If a household does not satisfy the employer condition, it can still be considered as paying direct taxes if the head is identified as either an employer, a salaried worker, or self-employed. This latter category excludes a household head who is a house worker or a non-paid apprentice. If none of the above condition is satisfied, a household will acquire a direct tax payer status if its main activity is not agriculture. Thus, household not satisfying the above three criteria and who work in agriculture are assumed not to pay direct taxes. According to this assumption, almost all households (99.6%) can be viewed as paying direct taxes, which is unrealistic in an agrarian economy such as Niger.

Government and the rest of the world to households. Household beneficiaries of these transfers are identified as such from relevant indicators from the survey. [7]

In the third and final step, we balance the matrix once all the adjusted data are introduced into the disaggregated SAM. Several SAM balancing techniques are available, including the RAS and the cross-entropy procedures (for a detailed review of SAM balancing techniques, see Round, 2003). In this exploratory study, however, we rely on a balancing by residual. This is done by adding a residual account, which directly absorbs the differences between resources and employments of each household account. We note that the non-households accounts are already balanced, because they are directly linked to balanced standard matrix. The balancing by residual has the advantage of not altering the base technical coefficients of the adjusted matrix which directly reflect the household survey data. The disadvantage is that some residuals are relatively large, and they may be sources of leakage in the microsimulated economy.

Once the microsimulation SAM is created and balanced, it can be transformed from a database to a multiplier model. As explained in Section 2, this is done by partitioning the SAM into endogenous and exogenous accounts. In this example, we treat the Government current and taxes accounts, the capital accounts, and the rest of the world's account as exogenous. The production, factor, and household accounts are endogenous. We then compute technical coefficients for the endogenous accounts, which allow the computation of microsimulation SAM multiplier matrix M_N, as discussed in Equation 13.

4. Results

Results are analyzed from three perspectives. First, we compare the value added and household income multipliers in the two models. Next, we discuss the results of a policy experiment under the two alternative specification of the SAM multiplier model. In particular, we examine and compare the poverty effects of a 10% increase in agricultural exports in the country. These exports include irrigated and non irrigated

[7] Transfers received from the Government include social security and scholarships. There is no specific data on remittances and other transfers from the rest of the world. We use the "other transfers" as a proxy of the rest of the world transfers to households.

export crops and livestock. Finally, we use the growth incidence curve approach to analyze the distributional impacts of the policy shocks.

4.1 Aggregate production and household income impacts

If we consider the microsimulation SAM multiplier (MSM) to be the most representative of the “true” yet unknown model, the results show that the standard SAM (SSM) overestimates the true effects. The magnitude of this overestimation varies across sectors. For value added multipliers, for example, the rate of overestimation varies from 67% in chemical production to more than 7% for health and social service. The rate for household income multipliers is also the highest in the chemical production sector (59%), whereas textile production appears to be the sector where the deviation between the standard and microsimulation SAM multipliers are the smallest (nearly 5%). On average, the SSM yields value added multipliers that are 39% to 49% larger than the microsimulation SAM multipliers. As regards household income multipliers, the SSM impact is on average 35% to 39% larger than the MSM impact (Table 1).

Table 1

These differences can be attributed to differences in the consumption and income generation processes of the two models, even though the production sub-matrices from the microsimulation and standard SAM are identical. As mentioned earlier, incomes and consumption in the standard SAM model are aggregated by household groups. Thus, any nonzero SAM transaction on the consumption or income sources of a household group is also representative of all individual households belonging to the given group. In the microsimulation SAM model, the group-level relationship becomes irrelevant, since each household now has its specific consumption and income linkages in the matrix.

In the standard SAM for example, food crop households (i.e. households deriving most of their incomes from food crops) receive factor incomes from 7 sources, including the agricultural labor factor. The maximum number of income sources is 4 in all household groups and only 1.5% of food crop households derive income from 4 sources. The majority (39.2%) derive incomes from two sources, whereas the rest receive their income from a single source (29.8%) or three sources (29.6%). In any case the majority of households belonging to the food crop household group have a much fewer income linkage than the average income linkage identified in the standard SAM. This holds true for the six remaining household groups, with perhaps two additional particularities. First, households from the informal sector, for example, receive incomes from all 8 factors in the standard SAM but one household in two in this group has only a single source of income. Second, more than 70% of mixed income households receive the totality of their income from nonfactor sources in the microsimulation SAM. Yet, in aggregate this household group receives income from all 8 production factors in the standard SAM. Additional details appear in Appendices 1 and 2.

4.2 The k_g / k_g^* ratios

In addition to the aggregate production and household income impacts, it is also possible to obtain impacts at a more disaggregated household level. For each household group and a demand shock originating from each of the 23 goods and services, we compare the standard SAM multipliers with the microsimulation SAM multipliers using the ratio k_g / k_g^*. If this ratio is greater than one, we can say that the standard SAM analysis overestimates the microsimulation effect. The converse is true if the former underestimates the later. It is clear from Table 2 that overall, the standard SAM multipliers are on average larger than the microsimulation multipliers with up to a fivefold average difference between the two. The largest differences are observed in households who derive a major share of their incomes from export crops. For these households, the estimated effects using the SSM multipliers may be 12 to 13 times larger than estimates from the MSM model for shocks originating in agricultural sectors, such as irrigated and non-irrigated food and export crops. Estimated impacts are slightly smaller for households receiving a large share of their incomes from food crops (3-4% on average, with a range between 0.8% and 9%. However, the impacts are much lower for the “other agriculture” households as well as non agricultural households.

While it is clear from Table 2 that there is a consistent overestimation of multipliers for export crop households, effects are only overestimated in four sectors for the skilled formal sector households. These include health and social services (9 times), public administration (7.5 times), utilities (4.2 times), and education services (3.4 times). For a demand shock in all the other sectors, the SSM multipliers are smaller than the MSM multipliers in the skilled formal sector households. For example, the k_g / k_g^* ratio equals 0.4 for transport/communication and the livestock/fishing sectors; it is 0.5 for sectors such as forestry, irrigated/non-irrigated food agriculture, non-irrigated export agriculture, and textiles/clothing. For each of these sectors, the SMS estimate is half or less of the corresponding MSS estimate. A similar analysis can be done for the remaining household groups. A common message from all analyses is that, accounting for microsimulation linkages would dramatically change the measuring impacts of policy.

Table 2

4.3 Poverty impact

The differences between the SSM and the MSM models can also translate into differences in poverty impacts. In the initial situation with no shock, the 2004 Niger's household survey data indicates a national poverty incidence of 63.8%. This poverty rate corresponds to the initial households' consumption (income) vector Y_{hg}, as defined earlier. With the policy shock, the vector Y_{hg} becomes Y_{hg}^s, and this variation is associated with changes in poverty indices. Thus, a 10% increase in agricultural exports reduces national poverty in Niger from 63.8% to 63% with the SSM model, and to 63.4% in MSM model. Thus, the estimated reduction in poverty is 0.8 percentage point in the SSM, and only 0.4 percentage point in the MSM. Which model is used, therefore, has direct implication on the measured impact of agricultural export expansion on poverty reduction in Niger. The difference in the rate of poverty reduction is 0.4 percentage point. Similar tendencies are observed with higher-power FGT indices, in particular the poverty gap (0.4 percentage point lower in the MSM model than in the SSM model) and the severity of poverty, which is 0.2 percentage point lower in the MSM model (Table 3).

Table 3

Differences are even more striking if we examine the effects at the level of household groups. Noteworthy is the fact a 10% increase in agricultural exports appears to have no effect on households receiving a large share of their incomes from export crops and other agricultural activities, such as livestock production. In contrast, households with no direct link to the production of agricultural exports appear to enjoy the largest gains in poverty reduction if agricultural exports were to increase by 10%. For example, poverty incidence would be 0.9% lower in mixed income households and 0.6% lower for households in the unskilled formal sector. While the general tendency is preserved for five household groups, it is reversed in the skilled formal and the informal sector households. For these household groups, the MSM model estimates a larger rate of poverty reduction than the SSM model. Specifically, the reduction in the poverty headcount ratio (P0) is 0.3 and 0.1 percentage point larger in the MSM for the skilled formal and informal sector households, respectively. Considering once again the microsimulation SAM model as the reference, it can be said that the standard SAM models underestimates the impact of poverty reduction in the latter two household group (skilled formal and informal sector households) while overestimating in the first five household groups (households receiving a large share of their incomes from food crops, export crops, other agriculture, unskilled formal and mixed income). Here again, the difference in the estimated impacts from the two models may be linked to differences in the consumption and income linkages in the standard and microsimulation SAM models.

4.4 Growth incidence curve

Following Datt and Ravaillon (2002), a change in a poverty index (e.g. from the SSM to the MSM models) may be decomposed into three effects: growth, redistribution and residual effects. The growth effect measures the difference between the poverty indices, keeping income distribution constant between the two models. The redistribution effect measures the difference in poverty indices while keeping average income constant over the two models. The residual effect measures the variation that is attributable to the interaction between the growth and redistribution effects. As shown in Table 4, moving from the SSM to the MSM would amount to a 0.4 percentage point increase in poverty incidence. More than 92% of this difference is explained by the growth factor, implying that keeping the distribution unchanged, the average income growth is slightly higher in the SSM model. The remaining 8% is explained by a change in income distribution between the two models. In order words, income distribution slightly worsened when one moves from the SSM to the MSM model. Put differently, using the SSM model in lieu of the MSM model will not only overestimate the rate of poverty reduction, but it will also underestimate the change (increase) in inequality.

Table 4

We can also measure the difference between the two models using growth incidence curves (GIC). A GIC represents the percentage change in aggregate household consumption/income for each income or consumption percentile. The curve measures the distributional impact of a given shock. We will say that a given shock has a pro-poor impact if the associated GIC is downward sloping with naturally ordered axes. As can be seen in Figure 1, the growth incidence curves are upward-sloping for the large part of the distribution of household consumption expenditure.

Figure 1

With a few exceptions, the national trend is preserved at the disaggregated household group level as well. This indicates that relatively poorer households would suffer the greatest loss if one passes from SSM model to the MSM model. In order words, the SSM attributes much larger gains to the relatively poorer households than would the MSM model. Exceptions cover almost the entire distribution of the mixed income and other agricultural households, and the lowest percentiles of skilled formal and informal household. For these household groups, it can be said that applying the MSM model in lieu of the SSM model would result in a larger gain for the poorest percentiles.

5. Summary and Conclusion

Microsimulation models are increasingly used in economy-wide impact assessments, mainly because of their superior advantage in capturing intra-group heterogeneity in the impacts. Most microsimulation analyses are based on computable general equilibrium (CGE) models, but it is easy to challenge results from these models on the ground of the assumed parameter values or macroeconomic equilibrium mechanisms. Although subject to its own limitations, the SAM multipliers model represents a simple and transparent framework for measuring general equilibrium effects. Applied to a sufficiently disaggregated matrix, SAM multipliers may be viewed as a microsimulation general equilibrium model. Using SAM multipliers for microsimulation is an exercise that is lacking is the literature, and this study is an attempt to fill the gap. Specifically, the study compared the gains from extending the standard SAM multiplier analysis to the microsimulation framework. The comparison focuses on aggregate value added and household income multipliers, and on the poverty and distributional impacts of increasing agricultural exports in Niger.

A common message from all analyses is that, accounting for microsimulation linkages would dramatically change the measured impacts of policy. The key results can be summarized in three points. *First*, the standard SAM multipliers (SSM) model yields value added multipliers that are on average 39% to 49% larger than the microsimulation SAM multipliers (MSM). Similarly, the impacts on household income are on average 35% to 39% larger in the SSM model. In general, these differences are due to differences in the consumption and income generation processes of the two models. *Second*, the results clearly indicate that which model is used has direct implication for the measured impact of agricultural export expansion on poverty reduction in Niger. The difference in the rate of poverty reduction is 0.4 percentage point (0.8 percentage point in the SSM against only 0.4 percentage point in the MSM). *Third*, if agricultural exports were to increase by 10% in Niger, using the SSM model in lieu of the MSM model will not only overestimate the rate of poverty reduction, but it will also underestimate the change (increase) in inequality. In addition, the extent of the overestimates would tend to be much larger for relatively poorer households.

Some practical comments are also in order. First, the implementation of the microsimulation SAM multiplier model is straightforward if a standard SAM and a household consumption and income survey data is available. The two databases can be reconciled using standard techniques. This step is common the both the microsimulation that is based on the CGE model, and the one that is based on SAM multipliers. Thus, any assumption made in reconciling the data would carry the same weight irrespective to the final use of the database. Second, the microsimulation SAM database is easily transformed into a microsimulation SAM multipliers model. The inverse (multiplier) matrix may easily be computed with a reasonably sized database (6745 endogenous accounts in the case of Niger) on an average performing personal computer. Once the inverse matrix is computed, it can be stored as “policy impact” database that describes how households respond to unitary policy shocks. This activity may be easily executed by national statistical services, and the availability of such a database would greatly improve the impact assessment of economy-wide shocks.

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The papers carry the names of the authors and should be cited accordingly. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the view of the World Bank, its Executive Directors, or the countries they represent.

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Tables:

Table 1 Effects of a One-Unit Sectoral Injection on Aggregate Value Added and Household Income in the Standard and Microsam Multipliers Models, Niger 2004

	Value Added Multiplier			Household Income Multiplier		
Sectors	**Microsim SAM**	**Standard SAM**	**Difference in percent**	**Microsim SAM**	**Standard SAM**	**Difference in percent**
Chemical production	0.11	0.19	66.8%	0.12	0.19	58.8%
Metals production	0.68	1.08	58.7%	0.71	1.08	52.5%
Construction	1.43	2.17	52.0%	1.51	2.17	43.4%
Other services	2.02	3.06	51.3%	2.08	3.06	47.0%
Other manufacturing	0.27	0.40	49.5%	0.28	0.40	42.5%
Hotels and restaurants	1.53	2.27	48.0%	1.60	2.26	41.5%
Non-irrigated Food Agriculture	1.40	2.05	46.7%	1.44	2.05	42.6%
Non-irrigated Export Ag.	1.15	1.68	46.1%	1.19	1.68	41.6%
Irrigated Food Agriculture	1.89	2.75	46.0%	1.95	2.75	41.4%
Irrigated Export Agriculture	1.75	2.55	45.9%	1.81	2.55	41.0%
Real estate & business services	2.05	2.99	45.5%	2.11	2.98	41.5%
Food products and beverages	1.33	1.94	45.5%	1.40	1.93	38.6%
Social and pers. Services	2.06	2.98	44.7%	2.11	2.97	40.8%
Financial intermediation	1.81	2.60	44.0%	1.94	2.60	33.9%
Mining and quarrying	1.83	2.62	43.4%	1.92	2.61	36.4%
Livestock & Fishing	2.10	2.92	38.7%	2.16	2.91	34.6%
Forestry	2.06	2.84	38.3%	2.12	2.84	34.2%
Transport, and communication	1.81	2.21	22.6%	1.85	2.21	19.3%
Education services	1.60	1.96	22.1%	1.62	1.95	20.0%
Utilities	0.71	0.86	19.7%	0.73	0.85	17.0%
Public Administration	1.82	2.11	16.1%	1.67	2.10	25.7%
Textiles, clothing & footwear	0.77	0.84	9.5%	0.80	0.84	4.9%
Health and social services	2.04	2.20	7.4%	1.86	2.19	17.9%
Mean effect (unweighted)	1.43	1.97	39.5%	1.46	1.97	35.5%
Mean effect (weighted*)	1.74	2.46	40.9%	1.49	2.07	38.6%

* Value added weights are sectoral shares of the total value added; household income weights are national commodity consumption shares.

Table 2 Ratios k_g / k_g^* for 23 Goods and Services in 7 Household Groups, Niger 2004

	Household Groups Defined by the Major Employment Sector						
Sectors	**Food Crops**	**Export Crops**	**Other agricul-ture**	**Skilled formal**	**Unskil-led formal**	**Infor-mal**	**Mixed income**
Public Administration	0.9	3.4	1.1	7.5	0.6	1.2	0.9
Chemical production	2.9	4.1	1.2	0.6	1.3	2.7	1.1
Construction	3.6	4.0	1.0	0.8	1.0	2.3	1.4
Education services	1.1	2.7	0.7	3.4	0.6	1.7	1.1
Food products and beverages	4.3	5.1	1.5	0.7	1.1	1.6	0.9
Financial intermediation	2.1	2.9	0.6	0.7	1.1	2.5	1.6
Forestry	4.3	5.0	3.8	0.5	1.8	1.4	0.3
Health and social services	0.8	3.4	1.1	9.0	0.6	0.9	0.8
Hotels and restaurants	3.8	5.0	1.2	0.7	1.3	1.7	1.0
Irrigated Export Agriculture	8.7	12.7	2.2	0.6	3.3	0.5	1.9
Irrigated Food Agriculture	9.0	13.1	2.2	0.5	3.4	0.5	1.9
Livestock & Fishing	4.4	5.0	3.9	0.4	1.7	1.4	0.4
Metals production	3.2	4.2	0.8	0.8	1.2	2.8	1.6
Mining and quarrying	3.8	4.2	0.9	0.8	1.0	2.2	1.3
Non-irrigated Export Ag.	9.0	13.1	2.2	0.5	3.4	0.5	1.9
Non-irrigated Food Ag.	8.7	12.9	2.0	0.5	3.3	0.5	2.0
Other manufacturing	2.5	3.6	0.8	0.7	1.2	2.6	1.1
Other services	2.3	3.7	0.5	0.6	1.5	3.0	1.5
Social and pers. Services	2.9	4.1	0.6	0.6	1.3	2.6	1.7
Real estate & business serv.	2.7	4.0	0.6	0.6	1.3	2.7	1.6
Textile, clothing & footwear	3.1	3.3	0.7	0.5	1.0	1.4	1.0
Transport & communication	2.3	3.4	0.5	0.4	1.1	2.3	1.5
Utilities	0.9	2.0	0.9	4.2	0.6	1.4	1.0
Mean impact (unweighted)	3.8	5.4	1.3	1.6	1.5	1.8	1.3
Mean impact (weighted)	3.1	4.6	1.3	2.2	1.3	2.0	1.2

* Household weights are household consumption budget shares.

Table 3 Poverty Effects of a 10% Increase in Agricultural Exports

Household groups	Base (no shock)	Shock (SAM model)	Shock (Microsam model)	Gains (SAM model)	Gains (Microsam model)	Difference SAM et Microsam
			Poverty head count index (P0)			
Food Crops	66.9	65.8	66.5	-1.0	-0.4	-0.6
Export Crops	74.1	73.2	74.1	-0.9	0.0	-0.9
Other agriculture	77.2	76.3	77.2	-0.9	0.0	-0.9
Skilled formal	11.2	11.2	10.8	0.0	-0.3	0.3
Unskilled formal	65.5	64.6	64.9	-0.9	-0.6	-0.3
Informal	62.7	62.5	62.3	-0.2	-0.3	0.1
Mixed income	53.9	52.5	52.9	-1.4	-0.9	-0.5
Total	63.8	63.0	63.4	-0.8	-0.4	-0.4
			Poverty gap (P1)			
Food Crops	30.6	30.0	30.5	-0.6	-0.1	-0.5
Export Crops	35.7	35.0	35.7	-0.7	-0.1	-0.6
Other agriculture	36.7	35.8	36.5	-0.9	-0.2	-0.7
Skilled formal	2.9	2.9	2.9	0.0	0.0	0.0
Unskilled formal	29.0	28.6	28.9	-0.4	-0.1	-0.3
Informal	28.0	27.6	27.6	-0.4	-0.3	-0.1
Mixed income	22.2	21.7	21.8	-0.5	-0.4	-0.1
Total	28.8	28.3	28.7	-0.5	-0.2	-0.4
			Poverty Severity (P2)			
Food Crops	17.3	16.9	17.3	-0.4	0.0	-0.4
Export Crops	20.8	20.2	20.7	-0.5	0.0	-0.5
Other agriculture	21.0	20.2	20.8	-0.7	-0.2	-0.6
Skilled formal	1.2	1.2	1.2	0.0	0.0	0.0
Unskilled formal	16.0	15.7	15.9	-0.3	-0.1	-0.2
Informal	15.4	15.1	15.2	-0.3	-0.2	0.0
Mixed income	12.2	11.9	11.9	-0.3	-0.3	-0.1
Total	16.1	15.7	16.0	-0.4	-0.2	-0.2

Table 4 Decomposition of the Change in Poverty Incidence

Poverty rates and decomposition	**Values (in percent point)**
Poverty rate in the standard SAM model	63.05
Poverty rate in the microsimulation SAM model	63.44
Change in poverty	0.39
Growth component	0.36
Redistribution component	0.03
Residual	0.00

Figures:

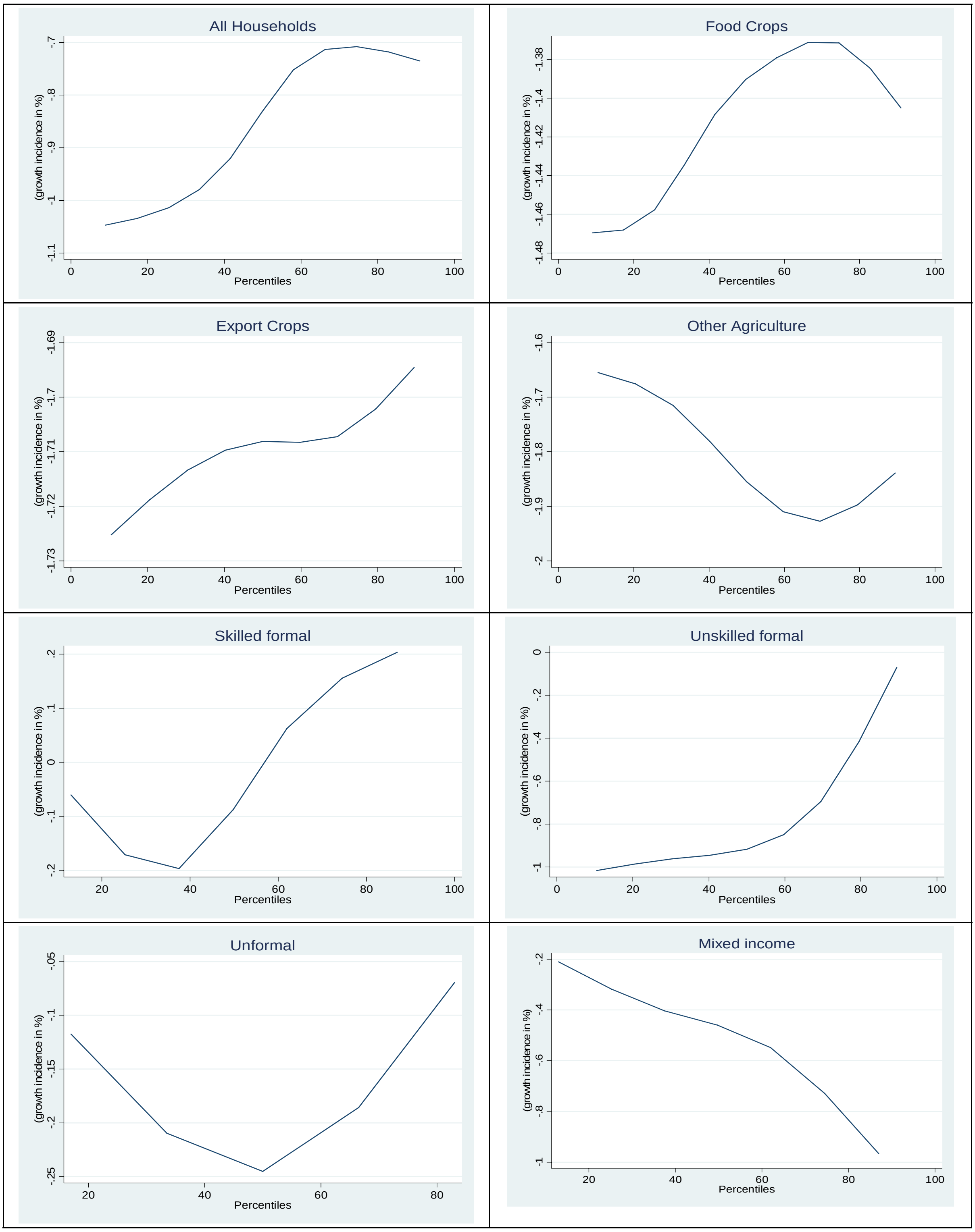

Figure 1 From Standard to Micro SAM Model: Growth Incidence Curves

Appendices:

Appendix 1 Distribution of the Number of Income Sources per Household Group in the Microsimulation SAM

Household groups in the microsimulation SAM	Number of income sources					Total
	0	1	2	3	4	
Food Crops	0	142	187	141	7	477
Export Crops	0	283	211	64	1	559
Other agriculture	0	615	478	343	8	1,444
Skilled formal	0	200	74	18	3	295
Unskilled formal	0	202	433	356	12	1,003
Informal	0	925	628	278	12	1,843
Mixed income	750	125	131	58	5	1,069
Total	750	2,492	2,142	1,258	48	6,690
	Distribution within household groups (%)					
Food Crops	0.0	29.8	39.2	29.6	1.5	100.0
Export Crops	0.0	50.6	37.8	11.5	0.2	100.0
Other agriculture	0.0	42.6	33.1	23.8	0.6	100.0
Skilled formal	0.0	67.8	25.1	6.1	1.0	100.0
Unskilled formal	0.0	20.1	43.2	35.5	1.2	100.0
Informal	0.0	50.2	34.1	15.1	0.7	100.0
Mixed income	70.2	11.7	12.3	5.4	0.5	100.0
Total	11.2	37.3	32.0	18.8	0.7	100.0
	Distribution between household groups (%)					
Food Crops	0.0	5.7	8.7	11.2	14.6	7.1
Export Crops	0.0	11.4	9.9	5.1	2.1	8.4
Other agriculture	0.0	24.7	22.3	27.3	16.7	21.6
Skilled formal	0.0	8.0	3.5	1.4	6.3	4.4
Unskilled formal	0.0	8.1	20.2	28.3	25.0	15.0
Informal	0.0	37.1	29.3	22.1	25.0	27.6
Mixed income	100.0	5.0	6.1	4.6	10.4	16.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Appendix 2 Number of Income Sources per Household Group in the Standard SAM

Household group	**Number of income source**
Food Crops	7
Export Crops	6
Other agriculture	8
Skilled formal	6
Unskilled formal	6
Informal	8
Mixed income	8