MICRO-SIMULATION IN COMPUTABLE GENERAL EQUILIBRIUM: PROCEDURE FOR ANALYZING AND RECONCILING DATA

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ABSTRACT

We describe a procedure for reconciling households survey data (incomes and expenditures), and their adjustment with a standard social accounting matrix (SAM). It is applied to the Nepalese data: the 1995/96 Nepal Living Standard Survey (NLSS) and the 1996/97 Nepal Social Accounting Matrix. The approach consists in increasing households' declared incomes, that we consider underestimated compared to their expenditure. First, we proceed with household incomes and expenditures vectors analysis, while adopting the structure of the MCS (top-down approach), then increase the households' capital and domestic transfers incomes to solve the problem of negative incomes from factors and negative saving. Incomes from households are adjusted by the inflation rate, and the net incomes generated from self-employment activities are imputed to the various factors used in these activities. The inter-household transfers expenditures being underestimated comprared to the income, we finance the difference by household savings to reconcile them. In order to insure the consistency of the survey data (incomes, consumptions and savings) compared to the SAM values, we proceed to their adjustment through the inflation rate, considering the lag in the NLSS and the SAM periods, and the implicit prices of self-employed ressources, as they might be overestimated.

Key Words: Nepal, Micro-simulation, Computable General Equilibrium, Data Analysis and reconciliation

Introduction

Computable general equilibrium (CGE) models typically include a small number of household categories (representative households), limiting their usefulness for analyzing poverty and the income distribution. Indeed, indictors used for the analysis of poverty and income distribution—the density function, Lorenz curves, dominance analysis, the Atkinson and Gini inequality coefficients, FGT poverty indices, etc.—generally use household- or individual-level data. Because of this, a large number of households are required for an adequate analysis of the impacts of macroeconomic policies on poverty and the income distribution. Thus, an increasing number of analysts are opting for micro-simulations within a computable general equilibrium framework in order to reconcile the use of CGE models with poverty and income distribution analysis, by integrating all categories of households from a national representative household surveys. This approach is equivalent to building a CGE model in which the number of household categories equals the number of participants in the household surveys, eliminating the assumption of representative agents.

Constructing a micro-simulation model in a computable general equilibrium framework requires the use of a social accounting matrix (SAM) and vectors of household incomes and expenditures. The SAM is a square matrix representing the flows between different sectors, agents and institutions within an economy during a given period.[1] Vectors of household incomes and expenditures are yielded by income-expenditure surveys conducted on households. The analysis of household incomes and expenditures requires the use of a data analysis computer program.

In the case of Nepal, we use the SAM for 1996/97, built by Prakash Sapkota of the Himalayan Institute of Development at Katmandu in collaboration with the CIRPÉE at Université Laval. Household incomes and expenditures are generated from the household survey (Nepal Living Standard Survey – NLSS) from 1995/96, based on a representative sample of 3388 Nepalese households.[2]

This paper addresses a procedure for reconciling households' incomes and expenditures, on the one hand, and their adjustment to the social accounting matrix, on the other. Section 1 presents the main features of household incomes and expenditures generated earlier. We discuss their reconciliation in Section 2. Inter-household transfers are the subject of Section 3. Adjusting

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[1] For details see Pyatt and Round (1985).

[2] We used the Stata package to analyze household incomes and expenditures.

households' average savings rates to those of representative households in the SAM is the subject of Section 4. Finally, comparative analysis of the adjusted data with respect to the SAM is in Section 5.

1   Household Incomes and Expenditures

After estimating incomes and expenditures from the survey, we proceed to a detailed analysis of these data, which must necessarily precede the reconciliation.

1.1   Items in Nepalese Households' Incomes and Expenditures

Table 1 presents the income and expenditure items for the seven socio-economic household categories in the Nepalese social accounting matrix and the 3388 households in the survey. The SAM includes seven variables for income and three variables for expenditure, and the household survey features seven income variables and three consumption variables as well[3].

Analysis of household income and expenditure variables in the SAM and the survey reveals several situations detailed in Table 2.

1.   The variable appears in both data sources (the SAM and NLSS); in this case, it is simply a matter of reconciling the data (e.g. skilled wage labor, unskilled wage labor, direct tax, consumption expenditures, etc.)
2.   The variable appears in one of the data sources, but not the other;
     a.   When the variable is absent from the SAM, its aggregate value is estimated from NLSS by simple addition (e.g. transfers between domestic households).
     b.   When the variable is not featured in the survey, it is approximated by the SAM ratio (e.g. public transfers and dividends).
     c.   Imputation is used to allocate net income from self-employment activities to the factors of production involved.
3.   Owing to the unreliability of declared savings, we estimate this variable from residuals, i.e. the difference between total household income and consumption.

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[3] The SAM and the household survey might have different number of variable for income and expenditure.

1.2 Principal Characteristics

According to Paxson (1992) and Deaton (1997), it is usually more difficult to collect data on income than on consumption. Data on consumption are usually more recent, and by extension more reliable, because the reference period for most consumer goods (non-durables) is generally shorter, on the order of one week or one month. Owing to its seasonal nature, the reference period for income is generally one year, and consequently declaration and measurement errors linked to this variable are greater. Also, to adequately measure households' incomes we require a thorough knowledge of their assets and wages, which are very often underestimated. Most households in developing countries receive the bulk of their income from informal production activities, in which family income and business revenues are very often combined. The absence of formal accounting in these activities makes it impossible to constitute an accurate picture of the income of producer households, as they tend to underestimate incomes (or overestimate expenditures) generated by these activities.

Analysis of the survey reveals that incomes declared by households are underestimated relative to consumption, which explains the computed low savings rates compared to those in the SAM (Table 3). Forty-five per cent of Nepalese households declared a total income that was below their total consumption. A few households (0.4 per cent) showed a negative total income. Table 4 presents details on incomes and dissavings of households by region.

The low incomes, and by extension the low savings rates, can be attributed to several factors, including:

1. The mismatch between the income and consumption reference periods causes an overestimation of consumption owing to inflation and, consequently, an underestimation of savings (Paxson, 1992).
2. Underestimation of incomes generated by household self-employment activities is the principal reason for low income declarations. [4] Over 91 per cent of Nepalese households engage in self-employment activities, and over 46 per cent of them declared total income that was lower than their total consumption. From another perspective, among households that dissave, 93 per cent receive their income primarily from self-employment activities. Consequently, it is of some interest to take a closer look at this source of income.

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[4] For more details, see Deaton (1997).

3. Low incomes could also be attributable to transitory financial difficulties experienced by households[5] (job loss, unusual climatic conditions, etc.), in keeping with Milton Friedman's (1957) permanent income theory. Thus, to maintain the same level of consumption as during previous periods, these households either cash in part of their previously accumulated assets (dissave), or borrow, or are supported by other family members. With limited access to the formal credit system, households generally borrow from other households in informal arrangements that do not incur financing charges (interest). This leads us to the conclusion that domestic inter-household transfers are underestimated in the Nepalese survey. Transfers-in and transfers-out, represent four (4) and one (1) per cent of total income, respectively. It should also be noted that the former are considerably greater than the latter.

2 Reconciling Household Income and Expenditure

The use of household income and expenditure vectors in a micro-simulation program within a computable general equilibrium framework requires preliminary adjustments. There is no recipe for handling adjustments to survey data. Any procedure for reconciling survey data for purposes of analysing policy must first be based on a detailed and rigorous analysis of these data. The adjustment procedure in this section is based on the points previously described. Thus, it primarily consists of augmenting the underestimated household incomes from the survey.

STEP 1: Inflating Income by the Consumer Price Index

Paxson (1992) argues that inflation tends to cause consumption to be overestimated relative to income, owing to the mismatch of the reference (or data collection) periods. In order to solve the problem of negative savings, he deflates household consumption by the inflation rate over the period of the survey. In a similar vein, we adjust household income upward by half of the inflation rate for the period. We assume that recent income, which is largely generated by the sale of goods and services from household productive activities, is also affected by inflation. Given the impossibility of distinguishing between income from the beginning and the end of the period, we use half of the applicable inflation rate as a proxy for adjusting incomes. Thus, for 1995/96, the household consumer price index grew by 8.1 per cent (Sakpoka, 2001). The low levels of aggregate household incomes and savings in the survey relative to the corresponding values in the SAM led us to inflate households' incomes rather than deflate their consumption.

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[5] This reason was also mentioned by Deaton (1997), and by Robillard and Robinson (1999).

STEP 2: Imputing and Adjusting Self-Employment Incomes

Lie et al. (1998) and Wobst (1998) use distribution shares to impute net incomes from households' market production to the various factors that serve as inputs. According to the former, the allocation of agricultural value added between land, labor, and capital should be on the order of 15:65:25 for the countries of sub-Saharan Africa (in particular, South Africa and Zimbabwe). However, in this approach households' endowments in various factors of production are underestimated, when they understate their income, and in particular the value added generated by their productive activities.

Round (2001) uses market equivalent prices to transform volumes of non-marketed goods and services into values. He recognizes that imputing implicit prices still remains an important issue to explore. According to this author, the disadvantage of this approach lies in the excess value imputed to producer-household factor endowments, relative to other households[6].

In the case of Nepal, we estimate the prices of non-marketed goods and services as their *opportunity cost*. The assumption underlying this is that rational economic agents will not use their resources in self-employment production unless this yields at least as much as renting them out. The imputation procedure then involves estimating the market equivalent prices in term of opportunity cost of factors (labor, land, and capital) used in households' self-employment activities.

- **Labor:** Individuals will engage in self-employment either because they cannot find paid work in their profession (unemployment, underemployment) or because the expected implicit wage from this activity exceeds that offered in the market. Thus, we estimate the implicit wage from the wage of socio-professional categories (individuals having different reservation wages) adjusted by the employment rate for the category.

In the case of Nepal, the implicit price of an hour work in self-employment is approximated by the mean market wage of workers by socio-professional category, adjusted by the level of employment in each profession. Indeed, when the level of employment is high for a profession, the wage agents forgo when undertaking a self-employment productive activity is higher, and consequently they receive a larger implicit wage, and *vice versa*

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[6] Later, we closely look on this aspect by adjusting survey households' aggregate saving rate to the representative households' saving rate in the SAM.

Total labor income (by profession) = hours of work (by profession) x (1– ß) x mean market wage (by profession)

where $ß$ = unemployment rate by socio-professional category.

- **Land:** The mean rental price of land for the region would be a good indicator for this factor, assuming that landowners have no difficulty leasing their land for a rent. In the Nepalese case, we use the mean regional market price to valuate land used in self-employment agricultural activities.

Value of land in self-employment activities = number of units of land in self-employment activities x mean market price by region.

- **Capital:** The value of capital used in self-employment activities is estimated as a residual from net revenue and the estimated values of the other factors.

Value of capital in self-employment activities = net revenue from self-employment activities – implicit labor income in self-employment activities– implicit land value in self-employment activities.

Though households are endowed with nonnegative values of labor and land, a number of them present a negative capital income (41 per cent of households). Consequently, the adjustment process consists of increasing the business revenues of households showing a negative capital income, so as to bring the latter to nil. This adjustment justified in 2 and 3 section (1.2), brings the number of households that are dissaving from 40 per cent prior to adjustment, to 26 per cent after adjustment. To mitigate the undesirable effects of the imputation method (overestimation) previously described, we ensure in Section 4 that the aggregate income and saving rates correspond to their actual SAM equivalents. Table 6 summarizes the situation before and after adjustments.

STEP 3: Inter-Household Transfers

Transfers between domestic households are underestimated in the survey (2 and 3, Section 1.2), whence the relevance of this stage in which these values are augmented so as to bring dissaving to nil. The procedure of increasing income from inter-households transfers is formulated in the following way:

a) **Minimum income:** estimates the level of income required for consumption expenditures and indirect taxes.

$$MININC_h = TOTCONSO_h + INCTAXO_h$$

where *MININC* represents the minimum income; *TOTCONSO* the consumption, *INCTAXO* the income tax; and *h* a subscript for households.

b) **Income adjustment**: Households whose minimum income is greater than the initial level see their incomes increased by the difference.

$$ADJ_{ha} = MININC_{ha} - TOTINCO_{ha}$$

$$TOTINC_h = TOTINCO_h + ADJ_h$$

ADJ is the adjustment factor for household incomes; *TOTINC*, final income; *TOTINCO,* initial income[7]; and *ha* represents households for which the minimum income exceeds the initial income. It should be noted that these include households that are dissaving.

c) **Final saving** (SAV_h) is residual, i.e. the difference between final income and expenditures.

$$SAV_h = TOTINC_h - TOTCONSO_h - INCTAXO_h$$

The increase in incomes to households that are dissaving occurs over received transfers. After adjustment, inter-household transfer income represents 10 per cent of total income, compared with 4 per cent initially declared.

$$XFERIN_h = XFERINO_h + ADJ_h$$

XFERIN and *XFERINO* respectively represent adjusted and initial transfers received by households. The value of *ADJ* is positive for households *ha* and nil for the others.

In the following sections (3 and 4) we seek to reconcile households' transfers and savings. The excess of transfers received is financed by households' saving, and then regional saving rate in the survey is adjusted to the SAM.

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[7] Note that initial income includes income from items that are not mentioned in the survey. They are estimated using the SAM ratios. In the case of Nepal, ratios of public transfers are estimated as proportions of household total consumption, and dividends as a proportion of urban households' endowments in capital.

3 Reconciling Inter-Households' Transfers

In this stage, we reconcile domestic private transfers received and distributed by the households. Consequently, we proceed by augmenting the transfers-out, which are initially underestimated relative to the transfers-in of households. This increase is financed by a reduction (at a uniform rate ?) of households' saving. Then it is a matter of increasing the transfers-out from households that save:

$$XFEROUT_{hps} = XFEROUTO_{hps} + \boldsymbol{h} \times SAV_{hps}$$

such that

$$\sum XFERIN_h = \sum XFEROUTO_h$$

where *hps* represents households that save, *XFEROUT* and *XFEROUTO* respectively represent adjusted and initial transfers disbursed by households.

4 Adjusting Savings

After adjustment households incomes and expenditures from the 1996's household survey are underestimated compare to the 1997's SAM (about 40 per cent). The gap may be imputed to, the household sampling weights as thousands of households (15 categories) were omitted when computing their incomes and expenditures[8], as well as Nepalese population grew by 2.4 per cent between the two periods, and the inflation, as prices rose by 7.8 per cent between 1996 and 1997 (Sapkota, 2001). Consequently, we increase uniformly incomes and expenditures generated from the survey to match them to the SAM values.

In contrast, the survey regional saving rates remain above the SAM values (Table 7), which we attribute to overvaluation of the factors used in self-employment activities. Consequently, we reduce these values so as to reconcile the survey and the SAM regional saving rates (Table 8).

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[8] Lack of information on their incomes, expenditures, and/or other socio-economical variables.

Adjusted incomes and expenditures are then reconciled with the other variables in the social accounting matrix, using a SAM balancing program based on minimizing additional information (cross-entropy approach).[9]

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ANNEXES

Table 1: Sources of household incomes and consumption

Income	Expenditure
Social Accounting Matrix (SAM 1996/97)	
1- unskilled labor	1- consumption
2- skilled labor	2- direct taxes
3- land	3- savings
4- other capital	
5- dividends from firms	
6- transfers from government	
7- transfers from abroad	
Living Standard Survey (NLSS 1995/96)	
1- unskilled labor	1- consumption
2- skilled labor	2- savings
3- net income from households' productive activities	3- direct taxes
4- net domestic transfers	
5- net transfers from abroad	

6- other capital	
7- rent	

Table 2: Reconciliation of income and consumption sources

SAM 1996/97	Household survey NLSS 1995/96
Household income variables	
1) unskilled labor	1) unskilled labor + (3) share of net income from self-employment activities imputable to unskilled labor
2) skilled labor	2) skilled labor + (3) share of net income from self-employment activities imputable to skilled labor
3) land	7) rent + (3) share of net income from self-employment activities imputable to land
4) other capital	6) other capital + (3) share of net income from self-employment activities imputable to non-agricultural capital
6) transfers from abroad	5) transfers from abroad
5) transfers from government	*SAM ratio*
7) dividends	*SAM ratio*
NLSS Sum	4) domestic transfers
Household consumption variables	

1) consumption	1) consumption
2) direct taxes	2) direct taxes
3) savings	*residual*

Table 3: Analysis of household income and consumption, from NLSS

	Number	Income			Totcons			Income/	Saving			
	households	volume	max	min	volume	max	min	Consum.	volume	max	min	rate
URBAN	0	17642.3	647.7	-664.3	17576.4	953.0	0.7	1.0	65.9	606.5	-942.6	0.0
TERAI	1112	52099.0	758.0	-47.9	44691.2	697.0	0.7	1.2	7407.8	512.3	-258.2	0.1
HILL & MOUNTAIN	1545	61427.0	3613.4	0.4	60828.9	739.6	1.7	1.0	598.1	3454.3	-582.0	0.0
ALL	2657	131168.3	3613.4	-664.3	123096.5	953.0	0.7	1.1	8071.8	3454.3	-942.6	0.1

Table 4: Analysis of negative income and consumption

	slfeinc		othinc		rent		xferdnet		xferwnet		uskwage		skwage		totinc		totcons		saving	
	nber	%	nber	%	nber	%	nber	%	nber	%	nber	%	nber	%	nber	%	nber	%	nber	%
URBAN	13	1.8	0	0.0	0	0.0	68	9.5	14	2.0	0	0.0	0	0.0	8	1.1	0	0.0	285	39.8
TERAI	13	1.2	0	0.0	0	0.0	109	9.8	16	1.4	0	0.0	0	0.0	5	0.4	0	0.0	390	35.1
HILL & MOUNTAIN	2	0.1	0	0.0	0	0.0	81	5.2	3	0.2	0	0.0	0	0.0	0	0.0	0	0.0	841	54.4
ALL	28	0.8	0	0.0	0	0.0	258	7.6	33	1.0	0	0.0	0	0.0	13	0.4	0	0.0	1516	44.9

Table 5: Adjustment of incomes for inflation

	Negative net income from self-employment activities of households	Negative income	Negative savings
Before adjustment			
Total nber		28.00	13.00	1519.00
Percent		0.83	0.39	45.03
After adjustment			
Total nber		28.00	13.00	1360.00
Percent		0.83	0.39	40.32

Table 6: Adjustment to revenue generated by household self-employment activities

	Negative capital	Negative revenues	Negative savings
Before adjustment			
Total nber	1373.00	13.00	1360.00
Per cent	40.71	0.39	40.32
After adjustment			
Total nber	0.00	4.00	865.00
Per cent	0.00	0.12	25.64

Table 7: Aggregate Household Savings Rates

	Urban households	Terai households	Hills/Mount households
Survey aggregate savings rate (1)	0.27	0.34	0.19
Official aggregate savings rate (2)	0.16	0.11	0.08
Ratio (1)/(2)	1.72	3.22	2.39

Table 8: Results of the adjustment

	ALL			URBAN			TERAI			HILLS/MOUNT.		
	Before	After	*Var**	Before	After	*Var**	Before	After	*Var**	Before	After	*Var**
No. households	3373	3373	*0.0*	716	716	*0.0*	1112	1112	*0.0*	1545	1545	*0.0*
Total household income												
Mean	38.9	74.3	*91.0*	24.6	124.1	*404.5*	46.9	73.2	*56.1*	39.8	52.1	*30.9*
Standard deviation	79.3	120.5	*52.0*	54.0	223.8	*314.4*	48.9	62.9	*28.6*	102.5	63.6	*-38.0*
Minimum	-664.3	2.1	*100.3*	-664.3	4.5	*100.7*	-47.9	6.1	*112.7*	0.4	2.1	*420.0*
Maximum	3613.4	4051.1	*12.1*	647.7	4051.1	*525.5*	758.0	1151.4	*51.9*	3613.4	1277.7	*-64.6*