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SOUTHMOD – simulating tax and benefit policies for development

Dealing with the oversimulation of taxes and benefits in SOUTHMOD microsimulation models

The case of Girinka in Rwanda

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Abstract: SOUTHMOD tax-benefit microsimulation models may in some cases oversimulate taxes or benefits, generating greater expenditure, a greater number of beneficiaries, or greater amounts of taxes or taxpayers than reported in administrative data. Drawing on an example of a social benefit policy in Rwanda, implemented in the RWAMOD model, this technical note shows why such issues can be important in the analysis of tax-benefit policy reforms. The note also shows how oversimulation can be addressed in SOUTHMOD models by downward adjustment of relevant taxes and benefits.

Key words: microsimulation, oversimulation, taxes, benefits, Rwanda

JEL classification: C18, C63, C81

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1 Background

1.1 Oversimulation in SOUTHMOD models

It is often the case that social benefits and taxes simulated by the SOUTHMOD country models generate greater expenditure on social benefits, a greater number of beneficiaries, or greater amounts of taxes or taxpayers than reported in administrative data. In other words, the models appear to oversimulate taxes or benefits.

There can be many reasons for this. In the case of social benefits, this may be due to issues of take-up—the benefits may in practice not be taken up by all those entitled to them. This is commonly the case with means-tested benefits and is referred to as exclusion error. The SOUTHMOD models allocate benefits to all those entitled according to the rules as they have been translated on the model, which should be the closest possible rendition of the 'de jure' implementation of the policy. Another reason for oversimulating benefits is that proxies might have been needed for some of the entitlement conditions as the precise conditions are not reflected in the underpinning dataset, and the proxies might capture too broad a group of people as eligible beneficiaries.

As regards taxes, oversimulation may be due to issues of compliance. The SOUTHMOD country models simulate a situation based on full compliance whereas this is not always the case in practice. There are other reasons for oversimulation, including errors in recording income information in the survey, or in the definition of formality when personal income tax is limited to the formal sector. Over and above this there are also issues relating to the comparability of administrative data about taxes as compared to the output of the model—for example, the SOUTHMOD country models simulate taxes on an 'accrual basis' but administrative data is typically recorded on a 'cash flow basis'.

1.2 Downward adjustment of simulation on the model

Whatever the reason for the oversimulation, it may in certain circumstances be desirable to downwardly adjust the simulation on the model to reflect the administrative data. An example might be in the case of a new child benefit being introduced to reduce child poverty. Oversimulation of another existing benefit may suggest that child poverty is lower than it is in practice. In such a situation one might want to restrict the existing benefit to the external validation figure. Otherwise, any estimates about how to achieve a certain goal in the reduction of child poverty using the new child benefit would underestimate the resources needed. Downward adjustment of the existing benefit could reveal that the new child benefit would need to be introduced at a higher level of payment than would be necessary if the existing benefit had not been constrained to the external validation data about current receipt.

2 The case of Girinka—the one-cow-per-poor-family programme in Rwanda

Introduced in 2006, the one-cow-per-poor-family programme known as Girinka was implemented to ensure that each household in poverty has a cow, with the goal of reducing child malnutrition and increasing the incomes of poor farmers. The eligibility conditions are that beneficiary households must not already own a cow, they must have constructed a cow shed, have at least 0.25–0.75 hectares of land (some of which must be planted with fodder), be considered poor, have

a household member who is considered a person of integrity by the community, and have no other sources of income. Beneficiaries who do not have enough land individually may join with others in the community to build a common cow shed. Priority is given to female-headed households (de Mahieu et al. 2023).

Girinka is simulated in RWAMOD, the tax-benefit microsimulation model for Rwanda, based on the Integrated Household Living Conditions Survey of Rwanda (EICV) of 2016/17. In order to simulate Girinka, questions from the survey are used which identify, first, whether a given household has ever received a cow under the programme and, second, whether the household still owns it. The data do not indicate whether the cow was received specifically during the survey year. Without adjustments, the simulations assume that a cow (namely, the monetary value of a cow per year) is received each year by households that fulfil both of the above-mentioned conditions.

When compared to the external estimates of annual recipient households provided by MINAGRI (2022), we find that the actual number of recipients is much fewer than estimated by the model. Depending on the year, only 18 to 25 per cent of households allocated a cow by the model actually receive one in the year in question (17.6 per cent in 2020, the year used in the example below).

In cases such as this, it may be desirable to downward adjust the estimates provided by the model. So, in this case, as a cash value is assigned to the cow, oversimulation would have the undesirable effect of underestimating poverty.

The way downward adjustment is achieved is by a process of using EUROMOD's random number generator to allocate the benefit to only a random subset of the households estimated to be in receipt by the model.

3 Implementing the random downward adjustment of the simulation of Girinka

There are two stages to implement the random downward adjustment of the simulation of Girinka. First, a random number generator needs to be established. Second, an additional function needs to be added to the policy to randomly allocate the benefit to a proportion of those determined as eligible in the model.

In many cases it is appropriate to add a third stage. This would be in the form of an extension (sometimes called a switch) which would allow the downward adjustment to be either implemented or not depending on user choice at runtime. Please see the SOUTHMOD user manual for instructions on using extensions with SOUTHMOD models (UNU-WIDER 2023).

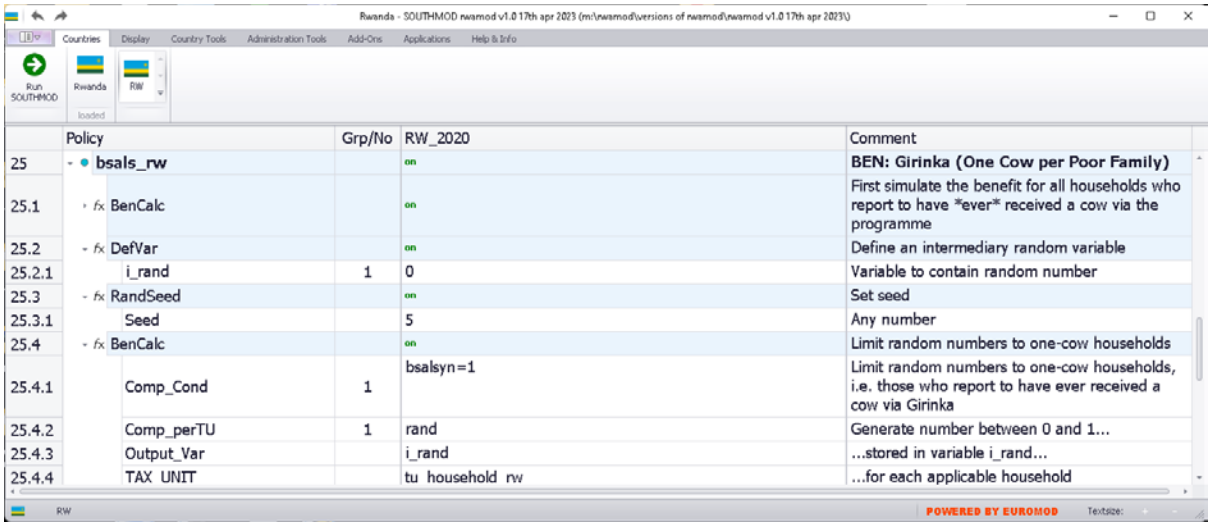
The random number generator can be implemented as a separate policy or, as is the case in Girinka, as a function within the policy in question. Both approaches have their advantages. If downward adjustment is necessary in a number of policies, then implementing the random number generator as a distinct policy has the advantage that it only needs to be implemented once. However, the disadvantage of this approach is that each individual (or household) in the entire dataset is allocated a random number, including those individuals or households who are not eligible to the downwardly adjusted policy. This means that more trial and error is required to obtain the correct formula for the random allocation. Positioning the random number generator within the policy in question and limiting the allocation of the random number to potentially eligible cases makes it much easier to select the correct formula.

3.1 Stage 1: The random number generator policy

Random numbers generated by computers are, in fact, not random numbers in the true sense of the word but rather a series of pseudo-random numbers generated by algorithms. To ensure that the same 'random number' is assigned to a case on each occasion that the random number generator is used, the random number generator is allocated a 'seed'. This marks the starting point for the generation of the series of random numbers and ensures that each case is allocated the same random number every time the function is run. Most random number generators adhere to this principle, and this is also the case with the random number generator implemented in EUROMOD.

The random number generator policy in EUROMOD is usually comprised of three functions. The first is an initial *DefVar* function, the second is a special function called *RandSeed*, and the third is, in the case of Girinka, a simple *BenCalc* function.

Figure 1: The random number generator functions within the Girinka policy



Source: RWAMOD, the tax-benefit microsimulation model for Rwanda.

First, the *DefVar* function is used to initialize the temporary variable *i_rand*. It is so named because it will contain the random number generated by the random number generator functions. It is initially set to zero.

Second, the special *RandSeed* function is there to ensure that the random number generator allocates the same numbers each time the policy is run. The seed can be any number. The only criterion is that it must be the same number across systems; otherwise, there will not be consistency in the generation of the random numbers. More information on this special function can be found in the EUROMOD help menu under the 'Help & Info' tab.

Third, the *BenCalc* function allocates the random number. Because the Girinka policy is a household-level policy, the random number needs to be allocated to each household. However, if the policy had been at the individual level, then the allocation of a random number would be at the individual level. The level is determined by the *TAX_UNIT* parameter of the *BenCalc* function (in this case, because the *TAX_UNIT* is 'household', the allocation is to the head of household).

The *Comp_Cond* parameter of the *BenCalc* restricts the allocation of a random number to those cases that have been determined to be eligible for a cow by virtue of the *BenCalc* positioned on the spine at position 25.1. The *Comp_perTU* parameter contains the special keyword *rand*. This

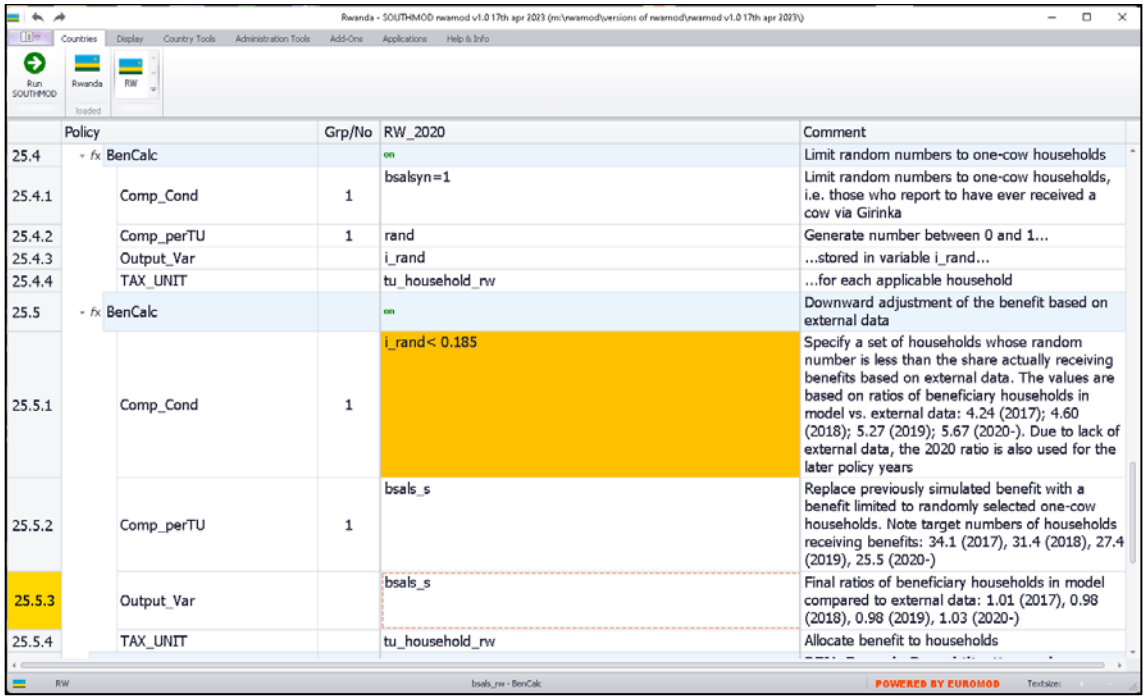
generates a random number between 0 and 1 for each household that has been determined as eligible for a cow by the *Comp_Cond* parameter. The random number so generated is placed in the temporary variable *i_rand* (the *Output_Var* parameter).

This variable is then used to randomly allocate the benefit.

3.2 Stage 2: Randomly restricting the allocation of the benefit

The final output variable of the Girinka policy is *bsals_s*. The function allocating this benefit is a *BenCalc* shown below (Figure 2) at spine position 25.5.

Figure 2: Downward adjustment of the benefit based on external data



Source: RWAMOD, the tax-benefit microsimulation model for Rwanda.

The *Comp_Cond* parameter of the *BenCalc* function requires a household to have been allocated a random number less than 0.185 in order to be allocated the benefit. Given the fact that in 2020 there were 5.67 times too many households allocated a cow, a random 17.6 per cent of the households should be, in fact, allocated a cow. One might therefore expect that the *Comp_Cond* ought to be i_rand < 0.176. However, because we are dealing with sample data with different households weighted differently, in practice to achieve the actual number of cows allocated, we need to select 18.5 per cent of all the eligible households to achieve the desired result. This share has been determined by manual testing, i.e. iteratively running the model with different shares (close to 0.176) and comparing the simulated number of Girinka recipient households to the external data.

The benefit is allocated by virtue of the *Comp_perTU* parameter, which will replace the previously allocated amount but only if the *Comp_Cond* is fulfilled. As an end result, the number of cow-recipient households simulated by the model matches those reported in administrative data (MINAGRI 2022) in 2020 (and in all years during which these external data are available and the downward adjustment is performed).

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