Households heterogeneity in a global CGE model: an illustration with the MIRAGE poverty module

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Abstract

The objective of this paper is to develop a version of the MIRAGE model of the world economy which includes households heterogeneity in order to studying the impact of trade liberalization on real income and welfare at the household level. In five developing countries, the model disaggregates the representative household into up to 80 households by country, characterized by exogenous criteria like geographic place of residence, qualification and gender of the household's head, (private vs. public or agriculture vs. industry vs. services) sector of activity,... The sources of income and consumption structure reflect disaggregated statistical information coming from households' surveys. The new model better captures the behavior of the public agent in terms of revenues collected and in terms of expenditures. This new version of MIRAGE allows studying the impact of various policy shocks and identifying which households are expected to win, which households are expected to lose and why, while taking into account the reaction of households to these shocks in an integrated and consistent framework. We illustrate the development of this poverty module of the MIRAGE model by studying the impact of full trade liberalization on these households. This study tends to conclude that: (i) while the impact of full trade liberalization may be small at the macroeconomic level, the effect on households' real income may be quite substantial at the household level with a great heterogeneity in terms of results; (ii) the major channel of transmission of trade liberalization on households' real income is productive factors' remuneration while the impact through consumption prices of commodities is limited; (iii) various domestic policies simultaneously implemented to trade liberalization like modification of public transfers to households or changes in income taxation may drastically change the picture and offer compensation for negative effects of this shock or amplify direct impact of full trade liberalization.

Keywords: CGE modeling, poverty, trade liberalization, households survey
JEL classification: F11, F17, O19

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Poverty in developing countries can be directly impacted (either negatively or positively) by international shocks at the worldwide level, such as climate change, financial crises, volatility of world food prices, major trade agreements, domestic policies in rich countries (e.g. agricultural domestic support, biofuel mandates...). It is therefore important to develop a consistent and detailed modeling instrument that allows understanding how poverty in developing countries reacts to these different shocks. As already underlined by Winters et al. (2003) the channels of transmission of external shocks on poverty are (throughout this enumeration we will envisage the impact of full trade liberalization on a developing countries' households):

- *Price and availability of goods* . Full trade liberalization should lead in each country to an increase of domestic prices of exportables goods and a reduction in prices of imported goods. The impact on each household's real income depends on households' consumption structure at a detailed level.

- *Factor prices, income and employment.* The impact on each household's real income depends on households' source of income and how households' endowment in primary factors can be reallocated across different sectors of activity.

- *Government transfers.* Full trade liberalization implies a loss of public revenues which can be compensated or not by an increase of different taxes (lump-sum taxes, income taxes, indirect taxes...) and/or a decrease in public expenditures or public transfers to households and/or a reduction in the public budget surplus. Households are differently impacted depending on how they rely on public transfers and/or how the public agent reacts to this initial loss of public revenues.

- *Incentives for investment and innovation that affects long term growth.* National investment can either augment or contract as the impact of trade liberalization on remuneration of capital and on private and public savings are either positive or negative. Trade liberalization also affects land supply and may have a long term impact on the split of the population bewteen skilled vs. unskilled persons through the remuneration of these factors. This process should also favor product and cost innovation. Increased accumulation of capital, land and skilled labor effects can boost economic growth which usually leads to poverty reduction.

- *External shocks and in particular changes in terms of trade.* Variations in terms of trade are related to openness of foreign and domestic markets. The former can either be positive (more demand for national exportable commodities thanks to the elimination of protection previously taxing these exports) or negative (less demand for national exportable commodities thanks to an erosion of initial preferences). Opening domestic markets usually leads to increased national demand for foreign products that translates in augmented import prices and deterioration of terms of trade.

- *Short run risks and adjustements costs.* The impact of trade liberalization on households' real income may be negative in the short term, but positive in the long term when considering the capacity of reallocation of productive factors to sectors in expansion.This reallocation takes time and implies adjustment costs in the short term.

This enumeration clearly shows what is required from a methodology to evaluate the impact of external shocks on households' real income at a detailed level. In particular the evolution of factor prices, income and employment is of highest importance thanks to strong specialization of individuals in terms of source of revenue. By comparison utilization of revenue, across commodities and savings is much more similar. The importance of factor prices my come also from an amplification effect, theoretically proven, but not clearly confirmed from an empirical point of view. The methodology designed to study poverty has to be consistent in order to tackle all these economic mechanisms, based on detailed data featuring the economic characteristices of households in developing countries and flexible in order to study various accompanying policies and dynamic mechanisms.

Reviewing the various methodologies for estimating the poverty impact of trade liberalization, Reimer (2002) makes a distinction between four methodologies:

- Cross country regression analysis
- Partial equilibrium and /or cost of living approaches
- General equilibrium analysis
- Micro-macro synthesis which links a model with micro-level data.

Based on cross country regression analysis Dollar and Kray (2004) have shown that globalized countries have a higher rate of growth than non-globalized. Based on econometrics, results obtained through this method are more general than results obtained through a Computable General Equilibrium (CGE) analysis, but this methodology cannot offer a counterfactual analysis and cannot provide results on the impact of a policy shocks on numerous economic variables. Cost of living analysis approaches (see Levinsohn et al., 1999) are simple but they only focus on consumption effects and expenditure shares are constant. In particular they do not include the evolution of factor prices, income and employment which is of crucial importance as previously stated. CGE analysis are usually undertaken under a hypothesis of a unique or several representative agent(s): the average income and total income are endogenous while the moments of the distribution are exogenous. It is usually supposed that all the real incomes of a category of households vary identically. This assumption has been criticized by Dervis, de Melo and Robinson (1982), Huppie and Ravallion (1991) and Ravallion and Chen (1997). Moreover Single Country CGEs cannot tackle the impact of multilateral trade reform, in particular the complexity of international trade relations based on numerous trade agreements, either being multilateral or regional or non reciprocal. Under a microsimulation a large number of households categories are included in the model, sometimes a full household survey; therefore the behaviour of many agents is analyzed (Cockburn, 2001; Cogneau and Robillard, 2000). But this kind of approach is costly in terms of data and results are difficult to summarize. Moreover this methodology seems difficult to implement in a multi-country CGE and therefore it cannot properly account for evaluating the impact of multilateral trade reform. Top-down approaches (see for example Robillard, 2001) are based on CGE models of which results are implemented in a household survey. This is a very practical option but it is not completely satisfactory as it does not account for the reaction of agents to price variations.

This rapid review of literature allows to specify the properties required from an analytical instrument designed to study the impact of world shock on poverty. It has to be economically consistent in the sense it must capture interdependance and income effects and all economic mechanisms in a single integrated framework; it has to tackle the economic mechanisms that lead to international transmission of major shocks and it has to provide a detailed representation of the characteristics of poverty in developing countries.

The objective of this paper is to develop a poverty module of the MIRAGE model of the world economy in an integrated framework with a bottom-up approach. A new version of this model is developed and it will progressively enriched with disaggregation of households into 30-120 strata (depending on the economic characteristics of the developing country and the quality of household survey) in some developing countries. Herein we develop a model with households disaggregation starting within five developing countries[1]. In these countries, the model disaggregates the representative household into up to 70-80 households by country[2], characterized by exogenous criteria like geographic place of residence, qualification and gender of the household's head, sector of activity (private vs. public or agriculture vs. industry vs. services) ... The sources of income and consumption structure strictly reflect disaggregated statistical information coming from households' surveys. Moreover, the new model better captures the behavior of the public agent in terms of revenues collected and in terms of expenditures.

This new version of MIRAGE allows studying the impact of various policy shocks and identifying which households are expected to win, which households are expected to lose and why, while taking into account the reaction of households to these shocks. This version is dynamic and models the long term evolution of the various strata of households. A systematic procedure is developed to reconcile disaggregated statistical information coming from households' surveys and the GTAP database. This allows a large flexibility in order to add countries to the scope of study. This represents a considerable improvement of the MIRAGE model.

This is a long term project and this paper will provide a first step in this process. In this first step, we will simulate full trade liberalization. As various studies have already evaluated the potential impact of full trade liberalization on poverty, this exercise will allow comparing these first results to results from past studies.

In section 2 we present the improvements brought in MIRAGE to model the public agent and to include disaggregation of households. Section 3 presents the way statistical information coming from households' survey has been treated and reconciled to the GTAP database on which the MIRAGE model is grounded. Section 4 implements a shock and gives results at the national level. Section 5 provides results at the households' level. While pointing out the heterogeneity of individual situations we identify the main channels through which trade liberalization impacts individual situations. Finally we show how fiscal and/or public transfer policies can accomodate the shock of liberalization. Section 6 concludes.

[1] In this preliminary version we only disaggregate households in two countries, Pakistan and Uruguay.

[2] In this preliminary version we only disaggregate into uo to 30-40 households.

1 Including households' heterogeneity in the MIRAGE model

The objective of this section is to present the theoretical improvements included in the MIRAGE model of the world economy in order to include households' heterogeneity. It requests to model specifically a public agent, then to improve the modelling of the private agent (representative household), finally to include households' heterogeneity.

1.1 The public agent

As shown on Figure 1 until now, the MIRAGE model was based on a representative agent who received income from production activities and also tax receipts (taxes on consumption, taxes on imports, taxes on production and taxes on exports). He spent a constant share of its income (epa(r) ; r for country r) in savings which financed investment while the rest of income was spent on final consumption (BUDC(r)). This representative agent had CES - LES preferences on all goods and these preferences defined his demand for each good (C(i,r); demand for good i on country r). Therefore C(i,r) represented private and public final consumption. The budget closure implied that this representative agent can be in deficit or in surplus and thus can be financed by or finance the rest of the world but this deficit/surplus was constant as a share of world GDP (which allowed for some limited flexibility). Figure 1 illustrates these assumptions.

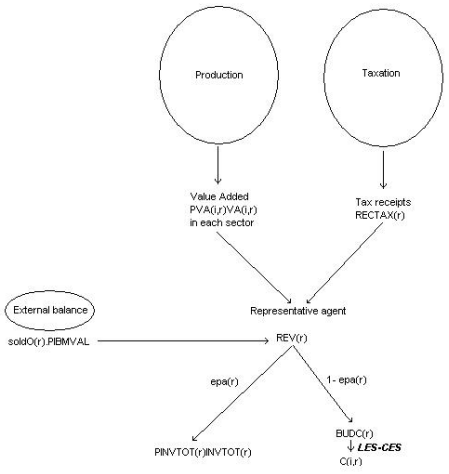

Figure 1: The representative agent in the traditional version of MIRAGE

In the new version of MIRAGE we first differentiate a public agent from a private agent. While the latter receives income from production activities, the former receive income from

taxation (RECTAX(r)). The private agent has still CES - LES preferences on all goods but now these preferences define private final demand for each good (CH(i,r); demand for good i on country r). The public agent has Cobb Douglass preferences which implies that the share of public consumption of sector i (CG(i,r)) in total public expenditures (BUDG(r)) is constant in value. Finally the consumption tax on public expenses is the same as for the private consumption (taxcc(i,r)). The public agent can spend more (public deficit) or less (public surplus) than tax receipts but this difference remains constant in proportion of country r's GDP. C(i,r) represents total final consumption with $C(i,r) = CG(i,r)+CH(i,r)$. Figure 2 illustrates these new assumptions.

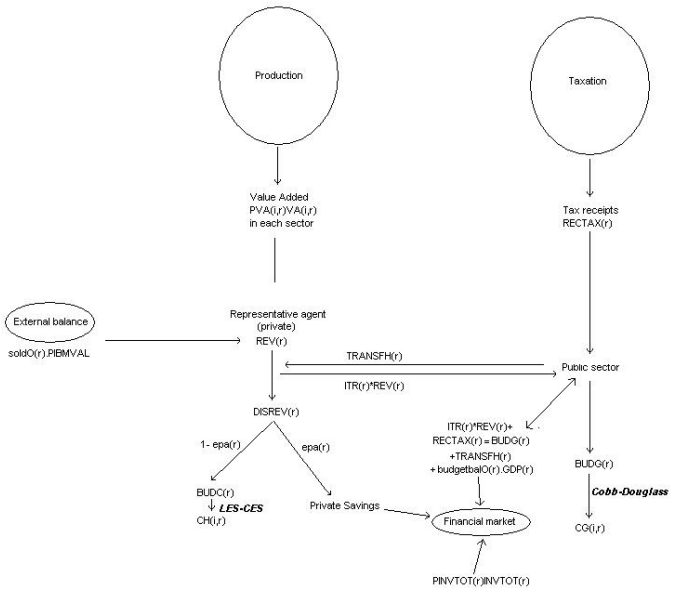

Figure 2: The representative public and private agents in the new version of MIRAGE

Therefore the following equations (with traditional MRAGE annotations - see Decreux and Valin, 2007) hold in this new version of MIRAGE:

$$PC\left(i,r\right) \times CG\left(i,r\right) = \alpha_g\left(i,r\right) \times BUDG\left(r\right) \tag{1}$$

$$C\left(i,r\right) = CH\left(i,r\right) + CG\left(i,r\right) \tag{2}$$

$$CH\left(i,r\right) - cmin\left(i,r\right) = a_C\left(i,r\right) \times AUX(r) \times \left[\frac{P\left(r\right)}{PC\left(i,r\right)}\right]^{\sigma_C} \tag{3}$$

$$P\left(r\right) \times AUX\left(r\right) = \sum_i PC\left(i,r\right) \times CH\left(i,r\right) - cmin\left(i,r\right) \tag{4}$$

$$BUDC\left(r\right) = \sum_i PC\left(i,r\right) \times CH\left(i,r\right) \tag{5}$$

$$RECTAX\,(r) = BUDG\,(r) + budgbalO\,(r) \times \sum_i \left[PVA\,(i,r) \times VA\,(i,r)\right] \tag{6}$$

$$REV\,(r) + BUDG\,(r) + soldO\,(r)\; PIBMVAL = RECTAX\,(r) + \sum_i \left[PVA\,(i,r) \times VA\,(i,r)\right] \tag{7}$$

Equation (1) describes the Cobb-Douglass allocation of public expenses with $\sum_i \alpha_g\,(i,r) = 1$. Equation (2) computes total final consumption. Equation (3) describes the LES-CES allocation of private final consumption. Equation (4) calculates the price associated to private utility. Equation (5) describes the private consumer's budget. Equation (6) is the budget closure of public agent. Finally equation (7) describes the macroeconomic closure for country r.

1.2 Households' behavior

Instead of having a single household by country, we define a subset $rh(r)$ of countries r where households are disaggregated into $nh(rh)$ categories; for example we define 95 categories of households in Uruguay[3] distinguished by geographical location of residence, main source of income of the household, education of main income earner of the household and gender of main income earner of the household. Let us call $CHh\,(hh,i,r)$ the final consumption of commodity i per household in category hh in country r, $cminhh\,(hh,i,r)$ the parameter measuring minimal consumption of commodity i per household in category hh in country r, $AUXh\,(hh,r)$ the utility of the representative household of category hh in country r, $PUh\,(hh,r)$ is the shadow price of utility of the representative household of category hh in country r. As the functional form of all households' utility function from different categories is still CES-LES, we have :

$$CHh\,(hh,i,r) - cminh\,(hh,i,r) = ah_C\,(hh,i,r) \times AUXh\,(hh,r) \times \left[\frac{PUh\,(hh,r)}{PC\,(i,r)}\right]^{\sigma_C(hh,r)} \tag{8}$$

$$PUh\,(hh,r) \times AUXh\,(hh,r) = \sum_i PC\,(i,r) \times CHh\,(hh,i,r) - cminh\,(hh,i,r) \tag{9}$$

$$BUDCh\,(hh,r) = \sum_i PC\,(i,r) \times CHh\,(hh,i,r) \tag{10}$$

Elasticities of substitution in consumption $\sigma_C\,(hh,r)$ are now defined at the households' level. Annex 1 presents the econometric method implemented to estimate these elasticities. In a country rh with households disaggregation, total final demand for commodity i is now:

$$\sum_{hh} Pop_{hh}\,(hh,r) \times CHh\,(hh,i,r) + CG\,(i,r) = C\,(i,r) \tag{11}$$

with $Pop_{hh}\,(hh,r,t)$ the category hh's population. In country r household hh receives transfers $TRANSFh\,(hh,r,t)$ from governments. We implement different modes of indexation of these transfers. Either we hold them constant relatively to national revenue $REV\,(r)$

[3] See next section.

or in real terms or relatively to households' income. For example the first mode of indexation implies:

$$\frac{TRANSFh\left(hh,r,t\right)}{TRANSFhO\left(hh,r\right)}=\frac{REV\left(r,t\right)}{REVO\left(r\right)} \tag{12}$$

where $TRANSFhO\left(hh,r,t\right)$ is initial government's tranfer to representative household of stratum hh. When the indexation of transfers is on prices we get:

$$\frac{TRANSFh\left(hh,r,t\right)}{TRANSFhO\left(hh,r\right)}=\frac{PI\left(r,t\right)}{PIO\left(r\right)} \tag{13}$$

where $PI\left(r,t\right)$ is a price index ($PIO\left(r\right)$ is initial price index in country r). If transfers are a constant share of households' income we have:

$$\frac{TRANSFh\left(hh,r,t\right)}{TRANSFhO\left(hh,r\right)}=\frac{REVh\left(hh,r,t\right)}{REVhO\left(hh,r\right)} \tag{14}$$

In the same vein we authorize several modes of determination of public expenditures evolution. First public expenditures may be constant in proportion of national revenue:

$$\frac{BUDG\left(r,t\right)}{BUDGO\left(r\right)}=\frac{REV\left(r,t\right)}{REVO\left(r\right)} \tag{15}$$

where $BUDGO\left(r,t\right)$ is initial public expenditures. When public expendituresis are constant in real terms we get:

$$\frac{BUDG\left(r,t\right)}{BUDGO\left(r\right)}=\frac{PI\left(r,t\right)}{PIO\left(r\right)} \tag{16}$$

In a country with households disaggregated, the government's budget becomes:

$$\begin{aligned} RECTAX\left(r,t\right)+\sum_{hh}ITO\left(hh,r\right)\times Pop_{hh}\left(hh,r,t\right)\times REVh\left(hh,r,t\right)+\\ lst\left(r,t\right)\times\sum_{hh}Pop_{hh}\left(hh,r,t\right)=PUBSOLD\left(r,t\right)\times\sum_{i}PVA\left(i,r,t\right)\times VA\left(i,r,t\right)\\ +BUDG\left(r,t\right)+\sum_{hh}Pop_{hh}\left(hh,r,t\right)\times TRANSFh\left(hh,r,t\right) \end{aligned} \tag{17}$$

$ITO\left(hh,r\right)$ is the (constant) income tax applied on category hh's households. lst is a lump-sum tax potentially levied on each household to compensate for eventual loss of tariff revenues.

In a country with disaggregation of households the disposable revenue of household hh is :

$$\begin{aligned} DISREVh\left(hh,r,t\right)=\left(1-ITRO\left(hh,r\right)\right)\times REVh\left(hh,r,t\right)\\ +TRANSFh\left(hh,r,t\right)+NETTRANSFh\left(hh,r,t\right)-lst\left(r,t\right) \end{aligned} \tag{18}$$

$NETTRANSFh\left(hh,r,t\right)$ is a (exogenous) net intra-transfer received (paid if negative) by households hh in country r at time t.

In a country with disaggregation of households, if $epah\left(hh,r\right)$ is the saving rate of household hh, his final consumption budget is:

$$BUDCh\left(hh,r,t\right)=\left(1-epah\left(hh,r\right)\right)\times DISREVh\left(hh,r,t\right) \tag{19}$$

The investment-savings equilibrium is now:

$$\begin{aligned}\sum_{hh} epah\left(hh,r\right)\times DISREVh\left(hh,r,t\right)\times Pop_{hh}\left(hh,r,t\right)\\ +PUBSOLD\left(r,t\right)\times\sum_{i}PVA\left(i,r,t\right)\times VA\left(i,r,t\right)\\ =\sum_{i,s}PINVTOT\left(s,t\right)\times INV\left(i,r,s,t\right)\end{aligned} \tag{20}$$

with $INV\left(i,r,s,t\right)$ being the investment by country r in sector i of country s and $PINVTOT_{r,t}$ being a composite price of this investment. Figure 3 illustrates these new assumptions.

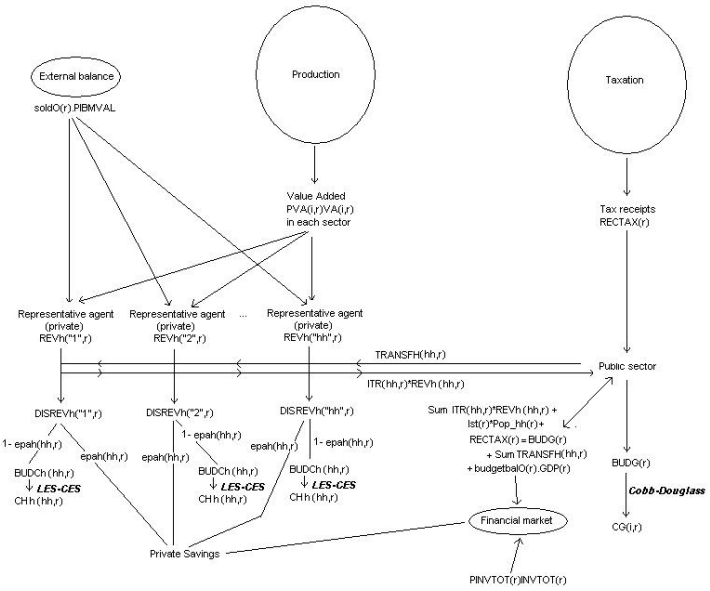

Figure 3: The new version of MIRAGE with households' heterogeneity

1.3 The advantages of this new modelling

Clearly these new assumptions constitute major improvements in the MIRAGE model of the world economy. First the distinction between private and public agent implies a much better modelling of final demand while the representation of public demand by a Cobb-Douglass is simple but realistic. Making a distinction between up to 80 households allows to better understand the impact of the variation of factor prices on households' income and final demand. A modification in the distribution of income, under constant national income,

may imply a variation in final demand but also of private savings as categories of households differ not only in terms of consumption structure but also in terms of saving rate.This is an important new economic mechanism that exists now in this model.

The detailed repesentation of the behavior of a public agent is also an important contribution to this model. in particular we introduce an income taxation, proportional to income in this version but that we will be able to modify in next versions, in particular in order to make it progressive. Public transfers to households are an important innovation as it allows studying various accompanying policies to trade liberalization.

Comments to be added...

2 The data

This section is aimed at presenting how disaggregation of households has been carried out in this poverty module of the MIRAGE model.

Building a bottom up CGE model at the global level requires to having a rich dataset. Even if the goal of our approach is not to have households disaggregated for all the model regions, we need to develop a collection of national level dataset that provide us the opportunity to implement our model for a large set of countries. In addition, the process should grant enough flexibility to change the country coverage and the level of household disaggregation. Figure 4 displays the different steps in the data processing generation that is detailed in the following sections.

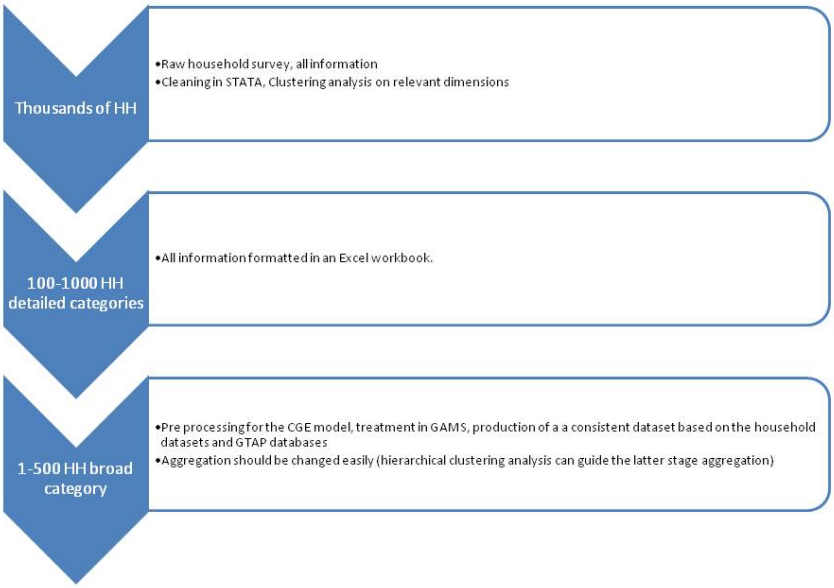

Figure 4: Framework to build a systematic and flexible treatment for a global model

2.1 Preparing input data

For each country, the ideal would be to have a national household survey with information on income by sources and detailed consumption of different goods. The survey should also include relevant information on households in order to make the appropriate characterization (depending on the country), such as geographical location, size, main income source, education/gender/race/language of members, assets ownership, etc. Attention should be paid to taxes (income taxes may or may not be declared with incomes, depending on each countrys tax system). Apart from the data, we should also gather information on the country that allows to make an appropriate characterization of the households (for example, decide if race is a relevant feature or not).

2.2 Mapping the data

In order to make the information consistent with the model structure, we have to map the income sources declared at the survey with income sources included in the model (skilled and unskilled labor according to ILO classification - capital, land and natural resources/ public and private transfers). Then, a similar operation is done for the tax typology and the categories of goods included in the survey with GTAP sectors. For the latter, we allow n-to-n mapping.

2.3 Building household typology

The idea is to group households from the household survey according to some characteristics that may be relevant within a CGE model, such as their income structure and consumption structure. Indeed, many characteristics that differentiate households in reality are not relevant for a bottom up CGE. For instance, geographical location in itself is not a dimension useful for the household disaggregation in the model if we do not have different subregional markets for goods and/or factors.

2.4 Defining household groups using clustering procedure

This activity involves working with as many national household surveys as countries for which we disaggregate the representative private agent in the model. In order to systematize the activity, we apply a cluster methodology. The clustering procedure selected is a hierarchical analysis, which allows choosing different levels of aggregation of the clusters. There are different methods that can be applied when carrying out hierarchical analysis. We apply the weighted average linkage method, which is the method that reports higher optimum number of clusters and provides better distribution of households within the clusters. This operation is performed in STATA. In order to carry out the hierarchical analysis, we take into account three variables: income per capita of the household (in logarithm), consumption structure (share of each GTAP product in total consumption) and income structure (share of capital, labor, self-employed labor and transfers in total income of the household). Thus, we select 10 to 12 level of cluster classifications, and we build a hierarchical map among the different cluster classifications, from less disperse (households classified in 10 clusters approximately) to more disperse (households classified in 500 clusters approx).

Category	HH det	HH ag	HH det	Nb HH	Nb pers	ExpCoeff
Montevideo labor income unskilled male headed no child	1	HH1	1	85	196	202
Montevideo labor income unskilled male headed with child	2	HH1	2	121	548	233
Montevideo labor income unskilled female headed no child	3	HH1	3	83	176	202

Table 1: Household groups definition

This allows disaggregating households in more or less groups within the MIRAGE model, according to the needs.

2.5 Trade margins

Most household surveys provide information on expenditures at consumer prices. Trade margins are included in the commodity prices. Since the GTAP database separates trade margins (a service) and underlying value of goods in the consumption structure, we need to collect sectoral information on trade margins in order to be able to recompute expenditures structure using the same nomenclature.

2.6 Quality control

An important stage is to assess the overall level of discrepancies between the information from the household survey and the equivalent data from the GTAP database. It will allow us to spot potential problems (mismatching in definition) and assess the magnitude of the fitting process to perform. Once the classification of households has been made, the following shares should be computed:

- Share of each income source in total income of the household (differentiating among factor income and other income).
- Share of each household in income by source.
- Share of each household in consumption of each good.
- Savings rate for each household (savings/total income).
- Share of each household in income taxes. A first step is to compare some of these parameters to their equivalent from the National SAM extracted from the GTAP dataset.
- Share of each income source in total income.
- Share of each good in total consumption
- Savings rate.

HH det	Transf pension	Transf GOV	Transf HH	Transf ROW	Transf DWE
1	6,325	465	345	147	7,965
2	2,908	2,496	1,054	0	9,324
3	5,015	62	494	161	6,305

Table 2: Households resources

HH det	Transf GOV	Transf HH	Transf ROW	Savings	IncomeTaxLabour	IncomeTaxOther	SocialCon
1	482	2,376	18	4,763	1,560	0	5,2
2	167	344	70	17,524	1,472	0	5,9
3	170	816	208	869	885	0	3,9

Table 3: Households uses

In addition to comparing information with GTAP , we check consistency with GDP, GDP per capita, structure of population (weight of each household type in total population), and poverty rates from other sources (national accounts, etc.). Input format for MIRAGE The information provided by the household surveys is fed into an excel file that works as a link between the household data and the model. In this file, specific for each country of analysis, we define the set of household groups as presented in Table 1, which includes information on the weight and size of each group. Other sets are also defined in this instance, such as a mapping between the consumption products included in the household survey and the products included in the model. Then, the file distinguishes between resources of the households and uses of the households. Among the former, we include all types of factor remuneration (as disaggregated as the information in the household survey allows), and income from transfers (also with the highest possible level of detail). Table 2 shows and example of the households resources. Then, in the uses of the household resources, we include expenditures in goods and services (in the product codes defined by each household survey), transfers to other agents, payment of taxes, and savings (Table 3). Each households resources and uses must balance. Finally, the file also includes information on trade margins by product, at the product level that the available information allows.

2.7 Ensuring consistency between the GTAP database and household dataset inputs

The last processing stage is to aggregate the data in the same sectoral nomenclature as the model (any subset of the GTAP nomenclature) and ensure that national Social Accounting Matrices (SAM) are consistent with the household datasets. The following paragraphs details this procedure. An important element to keep in mind is that we do not limit ourselves to fit the household surveys but we all for changing some aspects of the GTAP SAMs, in particular on some aspects of the database that are largely reprocessed during the building of the GTAP database (e.g. VA share in the agricultural sectors). Disaggregating national SAMs This information preprocessed in the Excel workbook (clustered household dataset and mappings) are imported into a fitting procedure run in GAMS. This process implies making some assumptions and treating some inconsistencies of data between the

information provided in the household survey and GTAP data. The different steps of the procedure are detailed in Figure 5 and Figure 6. We use sequentially different cross entropy procedures to fit the different constaints listed in this figure.

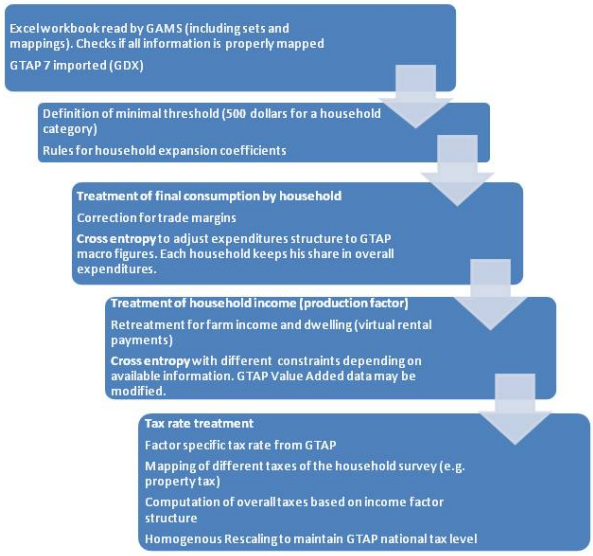

Figure 5: Dataset fitting - first steps

2.8 The Income and Expenditure Survey from Uruguay

In order to disaggregate Uruguayan household we used the Income and Expenditure Survey (IES) 2005-2006 carried out by the Statistics National Institute (INE). This survey is representative of the entire population of Uruguay and includes information of income (all member of the household), personal characteristics and income of all members of the household and detailed information about expenditures of the household. We performed 4 levels of disaggregation:

1. First, we divided the sample according to the geographic location of the household. Half the population in Uruguay lives in the capital city, Montevideo. One of the most relevant features of a household's geographical location is whether it lives in Montevideo or the rest of the country (which is called "Interior"). For example, poverty lines are different for Montevideo and Interior. Another important characteristic, from population living in urban areas in the rest of the country, is if they live in cities with more or less than 5,000 inhabitants. Finally, the rural/urban division is important, especially for the rest of the country. Thus, we divided the sample in five groups: i) Montevideo urban; ii) Montevideo rural; iii) Rest of the country urban cities with more than 5,000 inhabitants; iv) Rest of the Country urban cities with less than 5,000 inhabitants; v) Rest of the Country rural.

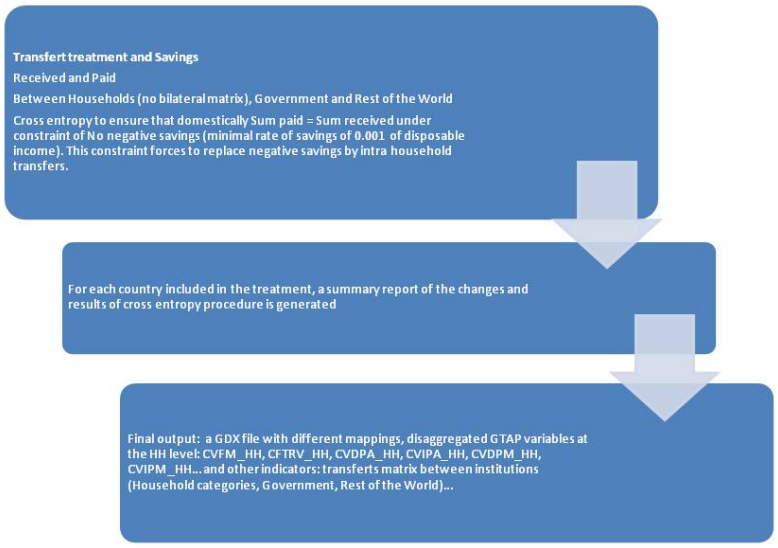

Figure 6: Dataset fitting - last steps

2. Then, we divided each of those groups in four groups according to main source of household income: dependant labor (employed workers), autonomous labor (self-employed), capital (rents, including rents from land) and transfers (pensions, social security, etc).

3. Third, we consider the education of main income earner of the household. We considered three skill levels according to years of schooling: unskilled (8 or less years of schooling); medium-skilled (between 9 and 11 years of schooling) and skilled (12 or more years of schooling).

4. Finally, we considered the sex of the main income earner of the household. Labor market in Uruguay is segmented by gender, and there is evidence of gender discrimination (e.g. lower wages, glass ceiling).

Applying these four levels, we came up with 109 household groups. Some groups weight more in total population (see Table 1). As expected, households with highest mean monthly income are located in Montevideo urban, are skilled male headed and their main source of income is capital. On the other extreme, household with lowest income are in Montevideo in rural areas, are unskilled female headed households and their main source of income is self-employed income.

2.9 The 2005 households' survey from Pakistan

We used the 2005-2006 Pakistan Social and Living Standards Measurement Survey, carried out by the Federal Bureau of Statistics of the government of Pakistan. The survey was carried out between July 2005 and June 2006, presents detailed information on Education,

Health, Population Welfare, Water and Sanitation and Income and Expenditure, and is representative of the entire population of Pakistan. We disaggregated households applying 5 different criteria:

1. Geographic location of the household, differentiating between urban and rural households, and also between provinces: Punjab (the most populated province), Sindh and other provinces.

2. Then, we differentiated between sex and level of education of household head. In this last case, we differentiated four groups: no education, primary education unfinished, secondary education unfinished, and higher education (secondary education finished and/or university studies).

3. Finally, households groups were further split according to employment status (self employed - paid employee in agriculture and manufacture sectors - paid employee in service sectors- other status) in male headed urban households. Male headed rural households were split according to owned land size in the case of farmers and sector of activity (agriculture and manufacture - services) in the case of non farmers. Female headed households, both in the urban and rural sector, are scarcer and further disaggregation was not relevant.

Applying these criteria, we disaggregated Pakistani households in 142 groups. A table containing some descriptive measures of the households is presented in the annex (Table 2).

2.10 The 2001 households' survey from Tanzania

We used the 2000/2001 Household Budget Survey carried out by the National Bureau of Statistics of Tanzania between May 2000 and June 2001. It is a nationally representative survey that collects detailed information on household members' education, economic activities and health status; household expenditure, consumption and income; ownership of consumer goods and assets; housing structure and building materials; and household access to services and facilities.

We disaggregated households using the following criteria:

1. Urban/ rural distinction. Urban households were also disaggregated among Dar es Salaam and other urban areas, while rural households were split using a land ownership criterion (ownership of land smaller than 2 acres or no land and land larger than 2 acres).

2. Sex of head of household. Female headed households are more scarce (23 percent of total households), and mainly concentrated in urban areas.

3. Education level of household head. Distinction was made between household heads with no education or primary education, secondary education unfinished and secondary education finished.

4. Employment status of household head. We differentiated between paid employees, self-employed workers in non-farm activities, farmers and employees in primary activities, and heads unemployed or with no economic activity (retired seniors, students, etc.).

Applying this criteria, there are 96 households groups in Tanzania, whose main characteristics are presented in Table 3. As expected, households with higher per capita income are located in urban areas, especially in Dar es Salaam.

Comments to be added on other households' surveys...

3 The impact of full trade liberalization at the households' level

We implement a full trade liberalization scenario by reducing all import duties across the world linearly in ten years. Three results are of particular interest:

1. First including households' heterogeneity allows for calculating impact of the policy shock inplemented on each household's real income; results show the large variety of individual situations concerning the effect of liberalization.
2. Second the main channel of transmission of trade liberalization on real income is the channel of factor prices while consumption prices of goods have a marginal effect.
3. Third the way public transfers are indexed clearly matters and may drastically change the consequences of full trade liberalization at the household level.

3.1 The impact of full trade liberalization at the national level

Comments to be added...

The same model used with only one household in Pakistan and Uruguay would conclude on a reduction of welfare of the representative household by 0.73 percent in Pakistan and an increase by 2.48 percent in Uruguay.

3.2 The heterogeneity of impact at the households' level

The heterogeneity of impact at the households' level is clearly shown by Figure 7 concerning Uruguay and Figure 8 concerning Pakistan. On Figure 7 for example, the impact on Uruguayan households is depicted with the Neperian logarithm of disposable income in 2025 in the baseline on the x-axis (there is too much inequality to take disposable income in value) and the impact of full trade liberalization in percentage on each household's real income on the y-axis. Each bubble represents a category of households and the size of the bubble is proportional to the population of this category. Variations in households' real income are from -12.3 percent (HH24: Rural Female high education No activity) to +10.1 percent (HH26: Urban Male Basic education Paid employee).

Globally people living in rural areas see their welfare augmented by 2.9 percent thanks to full trade liberalization while those living in urban areas get a mere 1.7 percent. People with high education gain more than people with basic education but the difference is small (2.6 percent vs. 2.4 percent). Female-headed households benefit more than male-headed households (3.8 percent vs. 2.2 percent). Also households whose the head is farming logically benefit more from full trade liberalization than those who does not: 2.8 percent vs. 2.3 percent.

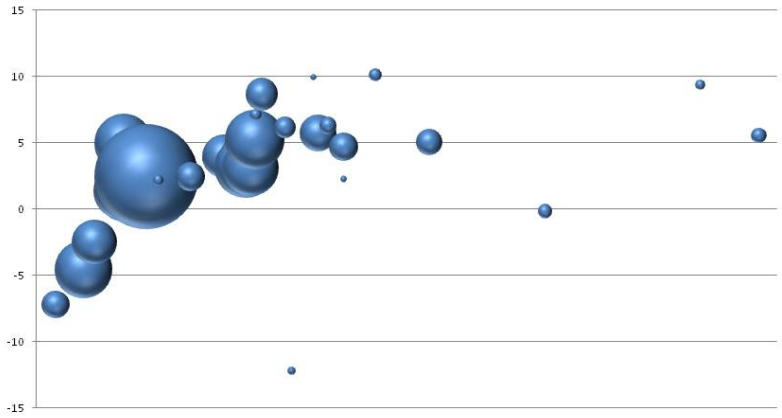

Figure 7: The impact of full trade liberalization at the households level in Uruguay - 2025

Education level	Share in total Male population	Average gain in welfare
No education	46.1 percent	-2.5 percent
Basic Education	6.8 percent	-0.2 percent
Medium Education	23.1 percent	0.5 percent
High Education	24.0 percent	2.9 percent

Table 4: Pakistan - Impact of FTL by education - 2025

In Pakistan results are much more contrasted. Globally people living in rural areas see their welfare decreased by 1.7 percent due to full trade liberalization while those living in urban areas benefit from an increase in their real income by 1.23 pecent. Female-headed households are significantly hurt by this trade reform (minus 5.6 percent); male-headed households are also hurt on average but by only 0.4 percent. Also households whose the head is a farmer logically see their welfare decreasing by 2.5 percent than those who is not benefit: plus 2.3 percent of welfare.

Concerning education it is possible to give more precise results as categories of households in Pakistan differ by four different levels of education in our data. Table 4 presents these results and see to what extent full trade liberalization has a differentiated impact on households depending on the level of education of the household's head: for example when the head is highly educated the variation in welfare is on average plus 2.9 percent while it is minus 2.5 percent when he did not get any education.

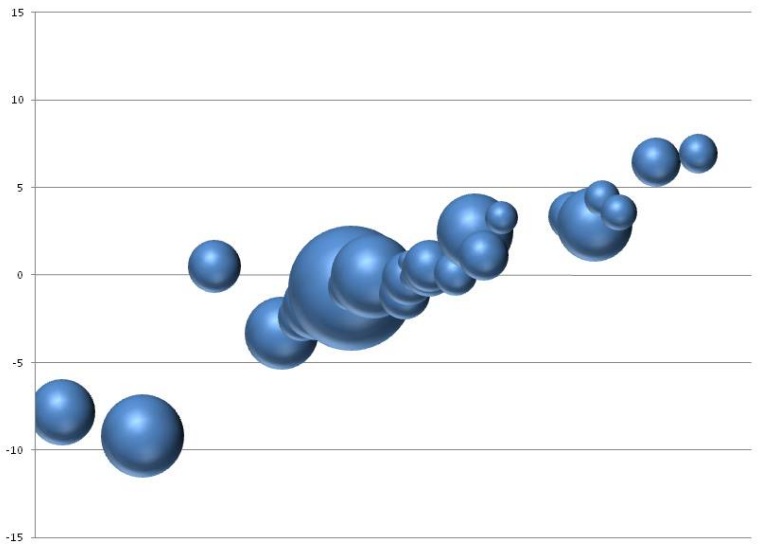

Figure 8: The impact of full trade liberalization at the households level in Pakistan - 2025

3.3 Channels of transmission

In this subsection we demonstrate that the major channel of transmission of the impact of trade liberalization on households' welfare is by far the remuneration of productive factors while variations of consumer prices of commodities impact only modestly households' welfare.

Comments and Tables to be added...

3.4 The importance of the rule of indexation of public transfers

As we have seen in previous subsections full trade liberalization may have a substantial impact, negative or positive, on households' welfare. However this impact also depends on the way domestic governement accompany this reform.

There are several channels by which simultaneously to a trade reform a government may also affect the real income of their constituencies: public transfers to households, public expenditures, income taxation, consumption taxes, implementation of a lumpsum tax to offset the loss of public revenue to the border reform.

In this subsection we show how the mode of indexation of public transfers and public expenditures affects welfare at the household level by undertaking a sensitivity analysis. While in the central scenario public transfers to households and public expenditures are constant in percentage of national Gross Domestic Product (GDP) we re-run the simulation supposing that they are now constant in real terms. Figure 9 (respectively figure 10) shows how the rate of variation of households's welfare implied by full trade liberalization in 2025 is affected by these different modes of indexation.

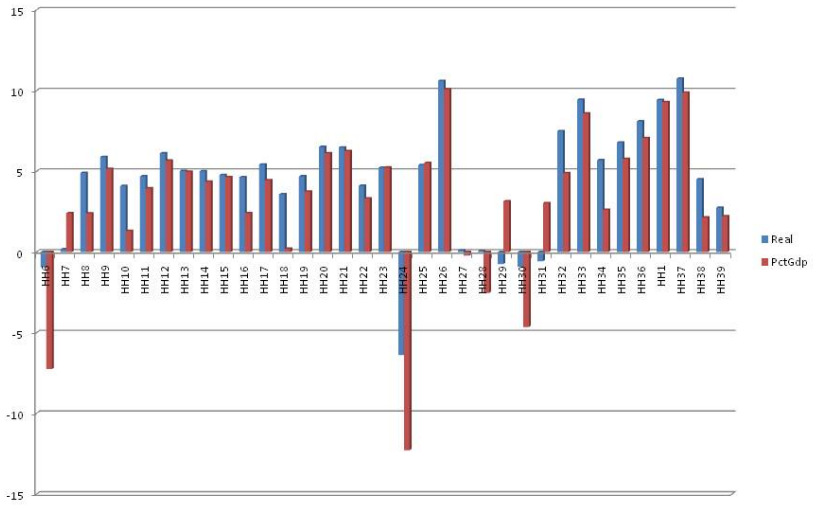

Figure 9: Uruguay - The differentiated impact of various modes of indexation of public transfers and expenses

Comments to be added....

4 Conclusion

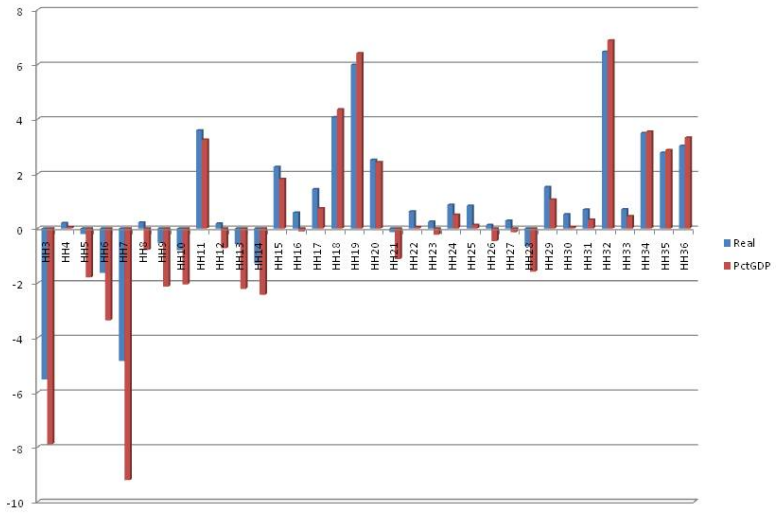

Figure 10: Pakistan - The differentiated impact of various modes of indexation of public transfers and expenses

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