Cooperation vs. non cooperation in the multilateral trading system: the impact on poverty and inequality in developing countries

Antoine Bouët*, Carmen Estrades† and David Laborde‡
IFPRI, Washington DC

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Abstract

The objective of this paper is to use the new version of MIRAGE, MIRAGE-HH (MIRAGE Households), to evaluate the potential impact of the Doha Development Agenda and a protectionist scenario on households' welfare, poverty and inequality in developing countries. MIRAGE-HH is a version of the MIRAGE model of the world economy which includes households heterogeneity in order to studying the impact of trade reforms on real income and welfare at the household level. In six developing countries (Brazil, Indonesia, Pakistan, Tanzania, Uruguay and Vietnam), the model disaggregates the representative household into up to 124 households by country. 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. Various public sector closures are available. Inter-households private transfers are endogenized according to a "pure altruism" assumption (Lucas and Stark, 1985). 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 study two contrasting scenarios, one cooperative scenario that is close to what could be the Doha Development Agenda, and one non-cooperative scenario which consists in the implementation of moderate protectionism worldwide. We calculate the impact of both trade reforms (cooperation vs non cooperation) on the real income of 87-124 households in Brazil, Indonesia, Pakistan, Tanzania, Uruguay and Vietnam, and also calculate the impact on poverty and inequality by computing the well-known FGT poverty indicators (poverty headcount, poverty gap and poverty severity) and the Gini and Theil indicators concerning income distribution.

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

*International Food Policy Research Institute (IFPRI) and LAREFI/University of Montesquieu Bordeaux IV ; Corresponding author : a.bouet@cgiar.org; (33) 5 56 84 29 75.
†International Food Policy Research Institute (IFPRI)
‡International Food Policy Research Institute (IFPRI)

1 Introduction

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...). The channels of transmission of external shocks to poverty are manifold: changes in price of goods and factors, impact on terms of trade, changes in public revenue and impact on transfers to the poor, short term risks, adjustment costs, etc. It is therefore important to develop a consistent and detailed modeling instrument that allows i) understanding these different channels of transmission, and ii) accounting for changes in poverty in developing countries when these shocks occur.

The objective of this paper is to use the new version of MIRAGE[1], MIRAGE-HH (MIRAGE Households), to evaluate the potential impact of the Doha Development Agenda on households' welfare, poverty and inequality in developing countries. We also evaluate the potential impact of a realistic protectionist scenario.

MIRAGE-HH is a version of the MIRAGE model of the world economy which includes households heterogeneity in order to studying the impact of trade reforms on real income and welfare at the household level. In six developing countries (Brazil, Indonesia, Pakistan, Tanzania, Uruguay and Vietnam), the model disaggregates the representative household into up to 80-120 households by country. 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. Various public sector closures are available. Inter-households private transfers are endogenized according to a "tempered altruism/ enlightened self interest" assumption (Lucas and Stark, 1985). 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 study the impact of a potential Doha Development Agenda, according to the most recent official guidelines. This multilateral trade reform is implemented at the tariff line level. In order to illustrate the benefits of multilateral cooperation, we also evaluate the potential impact of a protectionist shock applied to the world economy. In order to make this shock realistic we calculate the liberalization implemented worldwide during the last 15 years and we implement a return to this level of protectionism throughout the world taking into account current bound import duties. We calculate the impact of both trade reforms (cooperation vs non cooperation) on the real income of 80-100 households in Brazil, Indonesia, Pakistan, Tanzania, Uruguay and Vietnam, and also calculate the impact on poverty and inequality by computing the well-known FGT poverty indicators (poverty headcount, poverty gap and poverty severity) and the Gini and Theil indicators concerning income distribution.

In section 2 we present the methodological framework developed for this paper: first improvements introduced to MIRAGE to model the public agent and to include disaggregation of households, second the way statistical information coming from households' survey has been treated and reconciled to the GTAP database on which the MIRAGE model is

[1]The MIRAGE model is a dynamic multi-sector multi-country Computable General Equilibrium Model. See Bchir et al., 2002 and Decreux and Valin, 2007.

grounded, and third the micro-accounting procedure to extend the analysis at a micro-level. Section 3 presents the shock implemented, the data used for this exercise and the results obtained, using the new version with household disaggregation. We also discuss various rules of indexation of public transfers and closure to the public accounts. Finally, section 4 concludes.

2 Methodology

In this section we present metodological improvements introduced to the MIRAGE model. The first subsection presents the changes introduced to the modeling structure, then we present the data treatment and finally we present the method applied to analyze poverty and income distribution.

2.1 Including households' heterogeneity in the MIRAGE model

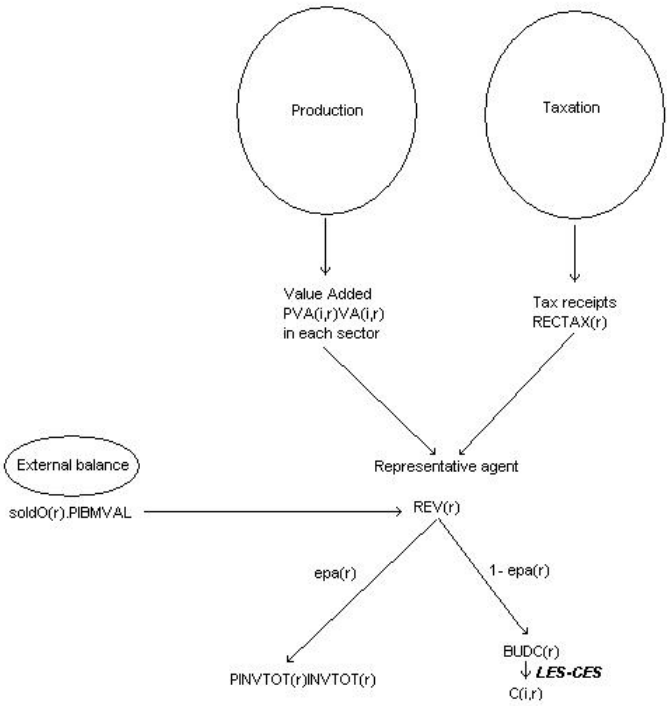
The objective of this section is to present the theoretical improvements included in the MIRAGE model of the world economy in order to include households' heterogeneity. It requests to model specifically a public agent, then to improve the modelling of the private agent (representative household), and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

2.1.1 The public agent

Until now, the MIRAGE model was based on a representative agent who received income from production activities ($PVA(i,r)VA(i,r)$, where $VA(i,r)$ is value added in volume in sector i in country r and $PVA(i,r)$ is price of value added) and also tax receipts $RECTAX(r)$ (taxes on consumption, taxes on imports, taxes on production and taxes on exports). S/he spent a constant share of its income in savings (epa(r); for country r) 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 her/his demand for each good (C(i,r); demand for good i on country r). Therefore C(i,r) represented both private and public final consumption. The budget closure implies 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 is constant as a share of world GDP, which allowed for some limited flexibility: $sold0(r).PIBMVAL$ where $sold0(r)$ is the constant share of country r's external balance in world Gross Domestic Product called $PIBMVAL$. Figure 1 illustrates these assumptions.

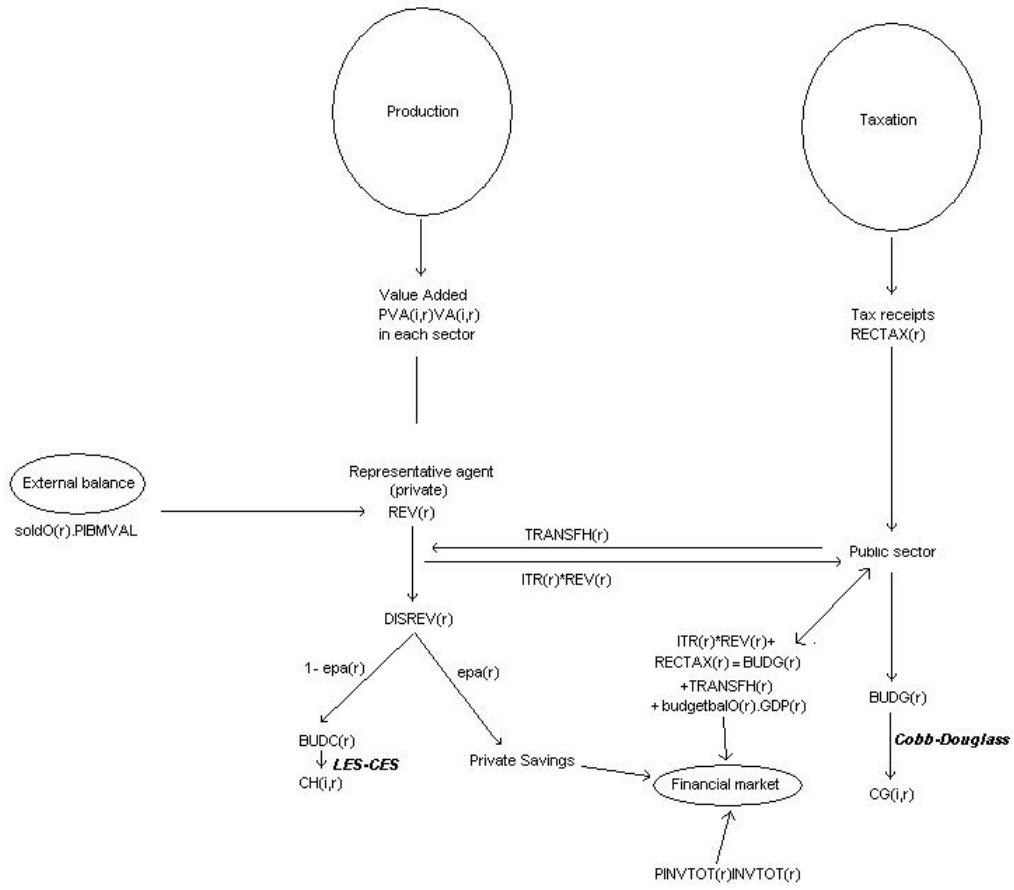
In the version of MIRAGE developed here, we first differentiate a public agent from a private agent. While the latter receives income from production activities, the former receives income from taxation (RECTAX(r)). The private agent has still CES - LES preferences on all goods but now these preferences define private final demand for each good (CH(i,r); demand for good i on country r). Her/his disposable income is $DISREV(r)$ differs from revenue from productive factors since he pays income taxes at a rate $ITR(r)$ and receives public transfers ($TRANSFH(r)$). The public agent has Cobb-Douglas preferences, which implies that the share of public consumption of good i (CG(i,r)) in total public expenditures (BUDG(r)) is constant in value. Finally the consumption tax on public expenses is the same

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



Source: Authors' elaboration

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



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as for the private consumption (taxcc(i,r)). The public agent can spend more (public deficit) or less (public surplus) than tax receipts ($RECTAX(r) + ITR(r).REV(r)$) but this difference remains constant in proportion ($budgbal0(r)$) of country r's Gross Domestic Product ($GDP(r)$)[2]. C(i,r) represents total final consumption with $C(i,r) = CG(i,r) + CH(i,r)$. Figure 2 illustrates these new assumptions.

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

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

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

[2]This assumption can be changed: we can also define the public deficit as constant in real or nominal terms. We do not adopt this alternative closure since changes in public deficit/surpluses may impact private investment.

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

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

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

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

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

Equation (1) describes the Cobb-Douglass allocation of public expenses with $\sum_{i}\alpha_{g}\left(i,r\right)=1$, $CG(i,r)beinggovernmentconsumptioninsectori$. Equation (2) computes total final consumption. Equation (3) describes the LES-CES allocation of private final consumption, where $cmin(i,r)$ is the minimal private consumption of good i in final demand of region r, $AUX(r)$ is the utility of the representative private agent in region r, $P(r)$ is the price of utility, $PC(i,r)$ is the price of good i in region r and $a_{c}(i,r)$ and σ_{C} are share and elasticity parameters. Equation (4) calculates the price associated to private utility ($P(r)$) and Equation (5) describes the private consumer's budget ($BUDC(r)$). Equation (6) is the budget closure of public agent, with $budgbalO(r)$ being the government's budget balance in proportion as domestic GDP, and $VA(i,r)$ and $PVA(i,r)$ being the value added and the price of value added respectively. Finally equation (7) describes the macroeconomic closure for country r, with $REV(r)$ being the regional revenue, $soldO(r)$ the current account balance in region r and $PIBMVAL$ world's GDP in value.

2.1.2 Households' behavior

We extend the above model by incorporating household disaggregation for some countries. 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. Let us call $CHh\left(hh,i,r\right)$ the final consumption of commodity i per household in category hh in country r, $cminhh\left(hh,i,r\right)$ the parameter measuring minimal consumption of commodity i per household in category hh in country r, $AUXh\left(hh,r\right)$ the utility of the representative household of category hh in country r, and $PUh\left(hh,r\right)$ 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:

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

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

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

Elasticities of substitution in consumption $\sigma_C\left(hh,r\right)$ are now defined at the households' level. However we did not yet estimate these behavioral parameters at the household level. We apply for all households within a country the demand elasticities traditionally used in MIRAGE.

In a country rh with households disaggregation, total final demand for commodity i is now:

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

with $Pop_{hh}\left(hh,r,t\right)$ the number of households in category hh. In country r household hh also receives transfers $TRANSFh\left(hh,r,t\right)$ from government. We implement different modes of indexation of these transfers. Either we hold them constant relatively to national revenue $REV\left(r\right)$ or in real terms or relatively to households' income. 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 the initial government's tranfer to representative household of category 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).

Finally, 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 expenditures are constant in real terms we get:

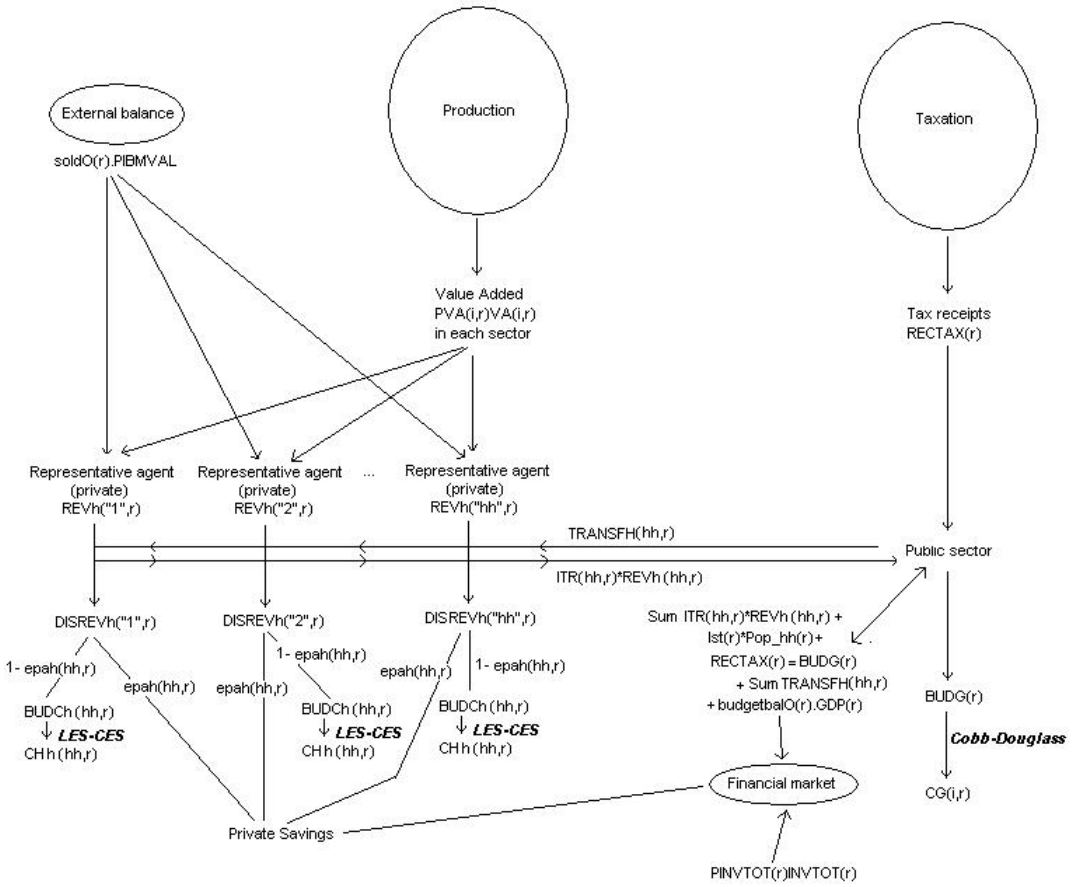
$$\frac{BUDG\left(r,t\right)}{BUDGO\left(r\right)}=\frac{PI\left(r,t\right)}{PIO\left(r\right)} \tag{16}$$

Finally, public expenditures can be defined as constant in nominal terms:

$$BUDG(r,t)=BUDGO(r) \tag{17}$$

Of course changes in public expenditures may lead to changes in the level of provision of public goods. In that respect it is difficult to interpret this assumption: for example when public expenditures are constant in nominal terms this may imply a reduction in the provision of public good while the need for fiscal receipts decreases which may affect positively household's real income. This kind of results is difficult to interpret. Therefore

Figure 3: The new version of MIRAGE with household heterogeneity



Source: Authors' elaboration

throughout this paper we suppose that public expenditures are constant in percentage of national revenue. However we conduct sensitivity analysis on the rule of indexation of public transfers and the tax (either consumption tax or income tax) used to compensate for the loss of custom receipts.

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

$$\begin{aligned} RECTAX(r,t) + \sum_{hh} ITRO(hh,r) \times Pop_{hh}(hh,r,t) \times REVh(hh,r,t) \\ = PUBSOLD(r,t) \times \sum_{i} PVA(i,r,t) \times VA(i,r,t) \\ + BUDG(r,t) + \sum_{hh} Pop_{hh}(hh,r,t) \times TRANSFh(hh,r,t) \end{aligned} \tag{18}$$

where $ITRO(hh,r)$ is the (constant) income tax applied on category hh's households.
In a country with disaggregation of households the disposable revenue of household hh is :

$$\begin{aligned} DISREVh(hh,r,t) = (1 - ITRO(hh,r)) \times REVh(hh,r,t) \\ + TRANSFh(hh,r,t) + NT(hh,r,t) \end{aligned} \tag{19}$$

with $NT(hh,r,t)$ being the net transfers between households, explained in the next subsection.

Being $epah(hh,r)$the saving rate of household hh, its final consumption budget is:

$$BUDCh(hh,r,t) = (1 - epah(hh,r)) \times DISREVh(hh,r,t) \tag{20}$$

The investment-savings equilibrium is now:

$$\begin{aligned} \sum_{hh} [epah(hh,r) \times DISREVh(hh,r,t) \times Pop_{hh}(hh,r,t)] \\ + PUBSOLD(r,t) \times \sum_{i} PVA(i,r,t) \times VA(i,r,t) \\ = \sum_{i,s} PINVTOT(s,t) \times INV(i,r,s,t) \end{aligned} \tag{21}$$

with $INV(i,r,s,t)$ 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.

2.1.3 Endogenous inter-household private transfers

So far, we have only considered transfers from the public agent to the private agent. However, if we consider household disaggregation, we should also consider intra-households transfers as they may represent an important share of total income for some households, especially poor households. How are these remittances, or inter-households transfers, determined?

This is a controversial issue when considering the economic literature. Becker (1974) for example (see also Stark, 1984) develops a model based on *altruistic motive* and concludes that inter-household transfers are increasing with the gap of incomes of the donor and the

recipient. In the case of altruistic transfers the relationship between the recipient's pre-transfer income and the transfer amount is always negative.

Cox (1987), but also Cox, Eser et Jimenez (1998) develop a *mutual exchange strategy* where transfer is the price of a service rendered by the receiver. The latter model is especially relevant in the case of intergenerational transfers (Laferrère and Wolff, 2006). In the case of altruistic transfers the relationship between the recipient's pre-transfer income and the transfer amount is always negative while a transfer under a *mutual exchange strategy* may admit a positive relationship.

Other common models rely on *strategic game* analysis (Stark and Wang, 2002), *insurance strategy*, *moral hazard* (Stark and Levhari, 1982; Rozenzweig and Stark, 1989) and *mixed motives* (Lucas and Stark, 1985; and Cox, Eser and Jimenez,1998). Amongst the models relying on *mixed motives*, *tempered altruism/enlightened self-interest* developed by Lucas and Stark (1985) involve both altruistic considerations and mutual exchange strategies.

We develop here a model of *pure altruism*. Following the formulation in Lucas and Stark (1985) without consideration for the number of persons in the recipient famlity [3], if we define u_m as the donor's utility, y_m her/his income, c_m her/his consumption and r the amount of the transfer, and we call u_h the utility of the recipient and c_h her/his consumption, then we have:

$$u_m = u\left[c_m\left(y_m - r\right); u_h\left(c_h\right)\right] \tag{22}$$

The remittance augments the recipient's income and therefore her/his consumpion:

$$c_h = c\left[y_h + r\right] \tag{23}$$

Therefore we obtain:

$$r = r\left[y_m; y_h\right] \tag{24}$$

with $\frac{\partial r}{\partial y_m} > 0$ and $\frac{\partial r}{\partial y_h} < 0$. Therefore the private inter-households transfer is increasing with the donor's income and decreasing with the recipient's income. We adopt this theoretical microeconomic foundation first because of its simplicity and second since other theoretical frameworks like *mutual exchange strategy* or *tempered altruism/enlightened self-interest* require an intergenerational approach which looks difficult to implement herein.

We adopt the following functional form:

$$-NT(hh,r) = M(r).\frac{ARh(hh,r)}{\frac{\sum_{hh\in Re} ARh(hh,r)}{\sum_{hh\in Re} ARhO(hh,r)}}\left[1 + e^{\alpha(aNT(hh,r) - ARh(hh,r))}\right] \tag{25}$$

Equation 25 holds for $NT(hh,r) > 0$. As already explained NT(hh,r) is the private inter-household transfer and since in equation 25, $-NT(hh,r) < 0$, household hh is a donor. We call Re the set of recipient households. $M(r)$ is a positive parameter, characterizing inter-household transfers in country r. $aNT(hh,r)$ is a positive parameter reflectling household hh's idiosyncrasy. α is a parameter measuring the sensitivity of remittances to the

[3] This is without loss of generality since Lucas and Stark (1985) conclude on an un-restricted relationship between the level of remittance and this number.

donor's after-tax pre-remittance income $ARh(hh,r)$. We choose $\alpha = 0.05$ which implies that transfers are relatively rigid to the after-tax pre-remittance income of the donor. We will have to estimate econometrically this parameter in a next stage of this work.

Therefore equation 25 implies that an inter-households private transfer varies positively with the donor's after-tax pre-remittance income $ARh(hh,r)$ and negatively with an increase of the recipient's after-tax pre-remittance income as compared to the initial situation $\sum_{hh\in Re} ARh(hh,r)/\sum_{hh\in Re} ARhO(hh,r)$. Therefore we suppose that remittances decrease when the after-tax pre-remittance income of all households receiving transfers increases. It means that the donor adjusts remittances to the economic situation of all recipients. Of course this assumption may diminish the role of transfers in the transmission of shocks, but we cannot bilateralize transfers since we do not get data on bilateral remittances. Moreover the functional form described in equation 25 implies that the share of a transfer in the donor's after-tax pre-remittance income $-NT(hh,r)/ARh(hh,r)$ is a sigmoid function of the donor's after-tax pre-remittance income, other things being equal: therefore this share is a convex then a concave function of this income, with a maximum share $M(r)$ reflecting a societal characteristic existing for all households and $aNT(hh,r)$ the curvature of the function specific to household hh. We should note that we are only considering intra household transfers within one country, not between households located in different countries.

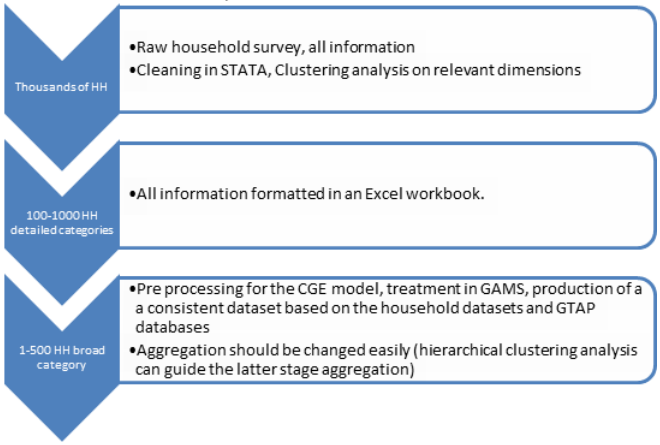
2.2 The data

This section is aimed at presenting how households were disaggregated in the new version of MIRAGE model. If the Social Accounting Matrix (SAM) is used to explore issues related to income distribution then the household account is to be broken down into a number of relatively homogeneous household groups reflecting the socioeconomic characteristics of the country or region under consideration (Decaluwe et al, 1999). Even if the goal of our approach is not to have households disaggregated for all the regions in the model, we need to develop a collection of national level datasets 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. Thus, we consider three different steps in the data processing generation, as displayed in Figure 4. The different stepts are detailed in the following subsections.

2.2.1 Microdata

We start the analysis with a detailed household survey for each country for which we include household disaggregation in the model. We include household surveys as long as they contain detailed information on income by sources and consumption by type of good, and preferably contain also information about households characteristics, such as geographical location, size, main income source, education/gender/race/language of members, assets ownership, etc. Special attention is paid to taxes (income taxes may or may not be declared with incomes, depending on each country's tax system), and to the difference between purchased goods for consumption and good produced for self-consumption. In order to make the information included in the household survey consistent with the model structure, we map the income sources declared at the survey with income sources included in the model (skilled

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



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. The information from the household surveys is also checked with information from other sources: GDP, GDP per capita, structure of population (weight of each household type in total population), and poverty rates.

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.

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 allows 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, we compute the following shares: a) Share of each income source in total income of the household (differentiating among factor income and other income); b) Share of each household in income by source; c) Share of each household in consumption of each good; d) Savings rate for each household (savings/total income); e) 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. In addition to comparing information with GTAP database, 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.).

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, 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). 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. Each household's 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.

2.2.2 Clustering analysis

Once the microdata is obtained, cleaned and made compatible with the model structure, we apply a cluster methodology that allow us to group households that share similar characteristics in terms of consumption and income structure. 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 levels 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). This allows disaggregating households in more or less groups within the MIRAGE model, according to the needs. As a result of applying this procedure, the intra-household variance of income is minimized.[4]

2.2.3 Incorporation into the model

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). The information preprocessed in the Excel workbook (clustered household dataset and mappings) is 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.

We use sequentially different cross entropy procedures to fit different constraints. In a first step, we adjust the expenditure structure obtained from the household survey to fit GTAP macro figures. In spite of this, each household keeps its share in the overall

[4] See Table 3 for an example.

expenditures of the economy. Second, we treat farm income and dwellings (virtual rental payments). In this step, data on value added from GTAP database may be modified. For the tax rate treatment, we take the factor specific tax rates from GTAP database. We map these rates with the taxes from the household survey (e.g. property tax), we compute the overall taxes based on income factor structure, and finally we rescale homogenously the model in order to maintain GTAP national tax level.

Specific attention is paid to the transfer matrix and savings rates of the households. In this sense, we apply a cross entropy method to ensure that domestically sum of transfers paid by households equals the sum of transfers received by households, and also to ensure that no household has negative savings rates (we set a minimum savings rate of 0.001 of disposable income). This constraint forces to replace negative savings rates from the household survey with intra household transfers.

2.3 Poverty analysis

To introduce poverty analysis within MIRAGE model, we apply a micro-accounting approach as described in Agenor et al (2003b, pp. 7), with some modifications. This approach assumes that each representative household (RH) in the model is representative of all households in its group, and the household survey can be fed with both data on income by RH and commodity prices in order to compute the changes in real income for all households of the survey, and to also adjust the value of the poverty line. This approach assumes that within-group distributions are unaffected by the shocks under consideration. This could be a problem, but the clustering procedure applied to create household groups guarantees very homogenous groups of households in terms of income distribution.

As we use a household survey to disaggregate households in the model in the first step, we can identify exactly each household in the survey with the correspondent household group in the model after computing changes in income and prices from the shocks. This is an advantage of our methodology: most macro-micro models work with a CGE model totally disassociated from the household survey. After computing the shock in the CGE model, we feed again the household survey with the results. We need two types of results. In the first place, changes in prices in order to update poverty lines. In this case, we take the changes in Consumer Price Index for poverty and Consumer Food Price Index for extreme poverty. In the second place, we modify income received by households by different sources. This approach shocks average income of households within a group differently, hence changing the income distribution within groups. Once income of households and poverty lines are updated with information from MIRAGE, we compute the well-known Foster Greer Thorbecke (FGT) poverty indicators: poverty headcount, poverty gap and squared poverty gap (poverty severity). For income distribution, we compute the Gini and Theil indicators. As we are creating a new income distribution at the microdata level, our approach allows us to also compute poverty indicators for different groups (according to location, sex of household head, and other relevant characteristics).

This methodology is applied to study the impact of two scenarios on households' real income, on poverty and inequality in six countries: results are described in the next section.

3 An application of the new MIRAGE-HH model: impact of two scenarios on household's welfare and poverty

In order to make a first application of the MIRAGE-HH model described in the previous section, we analyze the impact of two scenarios on poverty and inequality in six countries. First, we describe the database on which this simulation is based and the shock implemented. In a second subsection we describe how both scenarios affects the economic situation of 87 representative households in Brazil, 99 in Pakistan, 100 in Indnoesia, 102 in Tanzania, 107 in Uruguay and 124 in Vietnam with a special focus on 2025. In a fourth subsection, we modify the rules of fiscal compensation (taxes implemented to compensate the loss of public revenues) and those of indexation of public transfers and analyze how this affects the results at the households level. Finally, in a last subsection we present macroeconomic results in terms of poverty and inequality.

3.1 Database, disaggregation of households and simulation scenarios

We calibrate our model with the GTAP7 database, which is a consistent representation of the world economy in 2007, including information on 113 regions and 57 commodities[5]. We aggregate GTAP7 into a reduced database of 23 regions and 19 sectors, which are depicted on Tables 1 and 2.

Among the regions included in the model, we include five developing countries for which we apply household disaggregation as presented in the previous section: Uruguay, Brazil, Indonesia, Vietnam, Pakistan and Tanzania. The number of representative households varies in each country as a result of the clustering procedure, that provides different optimum number of clusters in each case. In any case, we are working with between 87-124 household groups in each country. Table 3 presents the intra and inter household income variance as a consequence of the clustering method. As we can see, the variance of income within groups is minimized, while the variance across groups is maximized. Specific information on the household surveys used in each case is presented in Table 4.

We use a (recursive) dynamic version of MIRAGE where economic growth is represented through the accumulation of primary factors (exogenously concerning labor, endogenously concerning land and capital) and adjustment of total factor productivity to capture technical progress.

As the model is calibrated in 2007 and as full trade liberalization is implemented starting on 2011, we develop a pre-experiment between 2007 and 2011 under which all trade agreements agreed in 2007 but not yet (fully) in exercise are implemented.[6]

We implement a removal of all import duties in all countries throughout the world linearly from 2011 to 2020. In order to capture full implementation of all effects we usually focus on year 2025, for which we compare the scenario (with full trade liberalization) with the baseline (without full trade liberalization).

[5] Narayanan and Walmsley (2008)

[6] Details may be requested from the authors.

Table 1: Sectoral Disaggregation

	Abbrev.	Sector	GTAP correspondance
1	cmt	Cattle meat	cmt, omt
2	crp	Chemicals rubber plastic	crp
3	ff	Forestry and fishing	frs, fsh
4	lea	Leather products	lea
5	mil	Dairy	mil
6	mmet	Metals and minearls	nmm, i-s, nfm, fmp
7	oagr	Other Agricultural Products	pdr, wht, gro, v-f c-b, pfb, ocr, wol
8	oap	Other animal products	ctl, oap, rmk
9	ofd	Other food	vol, sgr, ofd, b-t
10	ome	Machinery and equipment	ome
11	omf	Other manufacture	mvh, otn, ele, omf
12	omn	Coal	coa, oil, gas, omn
13	osd	Oilseeds	osd
14	p-c	Petroleum and coal	p-c
15	pcr	Processed rice	pcr
16	serv	Services	ely, gdt, wtr, cns, trd, otp, wtp atp, cmn, ofi, isr, obs, ros, osg, dwe
17	tex	Textiles	tex
18	wap	Wearing apparel	wap
19	wpp	Wood and paper	lum, ppp

Source: authors' elaboration

Table 2: Geographical disaggregation

	Code	Region	GTAP correspondance
1	ANDC	Andean countries	BOL, COL, ECU, PER
2	ANZCERTA	ANZCERTA	AUS, NZL
3	ARG	Argentina	ARG
4	BRA	Brazil	BRA
5	CHL	Chile	CHL
6	CHN	China	CHN
7	CIS	Community of Independent States	BLR, RUS, UKR, XEE, XER KAZ, KGZ, XSU, ARM, AZE, GEO
8	Dvp AS	Developed Asia	HKG, JPN, KOR, TWN
9	EFTAp	EFTA	CHE, NOR, XEF, HRV
10	EU27	European Union	AUT, BEL, CYP, CZE, DNK, EST, FIN, FRA, DEU GRC, HUN, IRL, ITA, LVA, LTU, LUX, MLT, NLD POL, PRT, SVK, SVN, ESP, SWE, GBR, BGR, ROU
11	MENA	MENA	IRN, TUR, XWS, EGY, MAR, TUN, XNF
12	MEX	Mexico	MEX
13	PAK	Pakistan	PAK
14	PRY	Paraguay	PRY
15	XAS	Rest of Asia	XEA, KHM, IDN, LAO, MYS, PHL SGP, THA, XSE, BGD, IND, LKA, XSA
16	XLAC	Rest of Latin America	XSM, CRI, GTM, NIC, PAN, XCA, XCB
17	ROW	Rest of the world	XOC, CAN, XNA, ALB
18	SSA	Subsaharan Africa	NGA, SEN, XWF, XCF, XAC, ETH, MDG, MWI, MUS MOZ, UGA, ZMB, ZWE, XEC, BWA, ZAF, ZSC
19	TZA	Tanzania	TZA
20	USA	United States	USA
21	URY	Uruguay	URY
22	VEN	Venezuela	VEN
23	VNM	Vietnam	VNM

Source: authors' elaboration

Table 3: Analysis of intra and inter household income variance. Per capita income. Theil index and Atkinson(1) index

	Intra-group variance (Theil index)	Inter-group variance (Theil index)	Intra-group variance (Atkinson(1))	Inter-group variance (Atkinson (1))
Brazil	0.110	0.552	0.102	0.382
Pakistan	0.108	1.085	0.108	0.483
Tanzania	0.068	0.889	0.080	0.462
Uruguay	0.001	0.311	0.001	0.311
Vietnam	0.077	0.256	0.079	0.205

Source: authors' calculation

Table 4: Household surveys used

Country	Household survey	Year	Source
Brazil	Pesquisa da Orcamentos Familiares	2008-2009	Instituto Brasileiro de Geografia e Estatistica (IBGE)
Pakistan	Social and Living Standards Measurement Survey	2005-2006	Federal Bureau of Statistics
Tanzania	Household Budget Survey	2000-2001	National Bureau of Statistics
Uruguay	Encuesta Nacional de Gastos e Ingresos	2006	National Statistic Institute (INE)
Vietnam	Household Living Standards	2006	General Statistics Office (GSO)

Source: authors' elaboration

3.2 Impact of two scenarios

Our objective is to draw a contrasting picture of the impact of cooperation vs. non cooperation in the world trade arena on poverty and inequality in developing countries by studying two very different scenarios with MIRAGE-HH .

We study the impact of a potential Doha Development Agenda, according to the most recent official guidelines. This multilateral trade reform is implemented at the tariff line level.

In order to illustrate the benefits of multilateral cooperation, we also evaluate the potential impact of a protectionist shock applied to the world economy. In order to make this shock realistic we calculate the liberalization implemented worldwide during the last 15 years and we implement a return to this level of protectionism throughout the world taking into account current bound import duties.

3.3 Impact of trade liberalization with MIRAGE-HH household disaggregation in five countries

We simulate both scenarios with to the new version of MIRAGE presented in previous sections that includes household disaggregation for Brazil (87 representative households), Indonesia (100 households), Pakistan (99 households), Tanzania (102 households), Uruguay (107 households) and Vietnam (124 households). .

Comments to be drafted

3.4 Adjustement through a consumption tax vs. through an income tax

The previous results are obtained under the assumption that governments implement increases in the consumption tax in order to compensate for the loss of public revenues coming from trade liberalization (removal of import duties). In this section we consider that fiscal compensation is implemented through increased income tax instead of increased consumption tax. In MIRAGE-HH income tax $ITR0(hh, r)$ is defined in percentage terms applied to

households' income coming from productive factors and public transfers ($REVh(hh,r,t) + TRANSFh(hh,r,t)$). Thus, the tax rate is specific to each household and remains constant over time. As an alternative closure to keep fiscal revenue constant when custom revenue falls, we introduce a new component to income tax, not household specific: $ITR0(hh,r) + itr(r,t)$, being still applied on households' income coming from productive factors plus public transfers.

Comments to be drafted

We also conducted a sensitivity analysis on the rules of indexation of public transfers. In our central setting, public transfers are constant in percentage of each country's Gross Domestic Product. We consider two alternative rules, either they are constant in real terms of constnt in percentage of each household's pre-transfer and pre-income revenue.

Comments to be drafted

3.5 Impact on poverty and inequality

The analysis in the previous subsections was made taking into account results obtained through the application of the new version of MIRAGE with household disaggregation. In this subsection, we combine the results obtained in the CGE model with microdata in the micro-accounting procedure as depicted in section 3.3, in order to compute the impact on poverty and income distribution indicators. Results are presented in Table **??**, as percentage change of indicators value in each country in 2025 at the baseline and as a consequence of trade liberalization.

Comments to be drafted

4 Conclusion

Comments to be drafted

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