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May the pro-poor impacts of trade liberalization vanish because of imperfect information?

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Abstract :
In this paper, we try to evaluate the change in welfare gains and their distribution due to trade liberalization when imperfect information is considered. The results of two versions of a computable general equilibrium (CGE) model, using GTAP database and representing goods as well as capital flows, are compared. In the first one, a standard world CGE approach is followed. In the second version we include risk aversion, imperfect information and production lag in the agricultural sector. After a brief description of the two versions, changes in welfare, represented by the income of two types of household (middle-low and middle-high) in three regions (Europe, United States, Rest of the World) after agricultural trade liberalization are presented. Theoretical and political consequences of the results are discussed.

Key words: Agricultural trade liberalization, world CGE model, equity, imperfect information, price instability

1. Introduction

Following the multilateral trade liberalization negotiations, several studies evaluate the positive impacts on global welfare of trade liberalization, including the agricultural sector (Hertel and al. 1999, Hertel and Martin 2000, Anderson, 2002).

The development of generic general equilibrium model (Hertel and al. 1997) and the importance of expected side-effect between economic sectors have generated a large number of studies using this methodology. All of them underline the positive effect of trade liberalization due to efficiency gains. Recently there is a growing concern about the impacts of trade liberalization on developing countries, and especially on poverty. The consequences on equity within these countries of various schemes of liberalization are examined (Hertel and al. 2002).

The new round of negotiations has been called the development round and there is large hope that trade liberalization will help fighting poverty. A particular obstacle may arise however from price instability. Negative impacts of price instability on the poorest are well documented : as consumers, they often spend more than half their expenditures in food, which makes them very sensitive to any price increase. It was indeed the primary reason motivating trade restrictions by government

isolating their market from world food price fluctuations. Actually, stabilization is recommended to fight poverty (Timmer 2000). As producers, risk limits investment and prevents the poorest producers from using more efficient technology. Recently, some attempts have been done to include price instability and its impact on the poorest in trade liberalization analysis (Hertel and al 2001). However price instability is always considered as stemming exclusively from external shocks like climatic disturbances. In such a case, as demonstrated by Bale and Lutz (1978) and evaluated by Tyers and Anderson (1992), the removing of trade barriers stabilizes world price.

Indeed, if instability originates from normally distributed exogenous shocks, the larger the market, the smaller the impact of shocks on price deviation. Following this line of thinking, including price instability in the model should improve the pro-poor impacts of trade liberalization : price instability would decrease for the benefits of all and especially the poorest (Hertel and al. 2001).

But it is now established that at least a part of price instability on commodity markets is due to market behavior itself. Such a situation arises when imperfect information holds (Mandelbrot 1971 ; Kindelberger, 1996 ; Chavas and Holt, 1991). The importance of price expectations in the price formation process explains that markets may sometimes run to failure and may be the theater of huge fluctuations, panics and crashes. In the meantime the recurrent currency crisis in the nineties remind us that market economy are subject to large fluctuations and that public regulations are required (Stiglitz 2000).

Several authors, in the tradition of business cycle analysis, have shown that endogenous prices fluctuations may be generated by models including liquidity constraint, risk and relatively rigid demand curves (Boussard, 1996, Day 1999, Rosser 2000). In this paper imperfect information and expectations are introduced in a standard CGE model including a rich and a poor household in each region. The analysis focuses on the difference in results due to the imperfect information assumption.

2. Modifying the basic CGE

Let us define the sets I for factors, J for commodities, H for institution, t for time. Denote by: F_j (.) a production function., U_{ht} (.) the utility function of consumer h, and G(.) the investment function which transforms inputs into factors – mainly capital, but manpower as well.

Call $y_{jt,}$ the supply of commodity j ; z_{hjt} the final consumption of commodity j by consumer h ; x_{ij} the quantity of commodity or factor i used as input for commodity j ; v_{kjt} the demand of commodity j by consumer k for investment, e_{hi}, the quantity of factor I belonging to institution k ; $\phi_{jt,}$ the profit of industry j ; s_{ht} the savings by institution h, δ_{hi} a depreciation rate. Prices are denoted by p_{jt} for commodity, π_{it} for factors.

Then, reduced to skeleton, a standard recursive[1] CGE can be described with the following equations:

(1) $$F_j (\ldots x_{ijt}..) = \sum_k z_{kjt} + \sum_{i \in I,J} x_{jit} + \sum_h v_{hjt}\,, \qquad j \in J$$ (supply equates demand)

(2) $$\phi_{jt} = p_{jt} F_j (\ldots x_{ij}..) - \sum_{i \in J} p_{it} x_{ijt} - \sum_{i \in I} \pi_{it} x_{ijt,} \qquad j \in J\,;$$ (producer's utility)

(3) $$\sum_j x_{ijt} = \sum_k e_{hit} \qquad \forall i \in I$$ (factors availability)

(4) $$u_{kt} = U(\ldots z_{hjt}.., s_{ht}), \qquad h \in H\,;$$ (consumer's utility)

(5) $$\sum_j p_{jt} z_{hjt} = \sum_{i \in I} s_k + e_{iht} \pi_{it} \qquad h \in H$$ (consumer's budget constraint)

(6) $$s_{ht} = \sum_h \sum_j p_{jt} v_{hjt} \qquad h \in H$$ (value for savings)

(7) $$e_{hit} = e_{hit-1}(1 - \delta_{hi}) + G(..v_{hjt}\ldots) \qquad h \in H,\ i \in I$$ (recurrence equation)

[1] "Recursive" here means that plans $x_{t\tau}$ made at time t for time τ depend on observed past values x_{t-1}. However, $x_{t\tau}$ may be eventually revised, in such a way that $x_{t+1,1}$ may be different from $x_{t,2}$. Thus, in this framework, a model may be both recursive and multiperiodic, although the planning horizon is only one in all applications below.

The model is closed by writing the first-order conditions for producer's and consumer's optima, viz. the derivatives with respect to x_{ijt} of equation (2) subject to (3), and the derivatives with respect to z_{hjt} and s_{ht} of equation (4) subject to (5). It is to be noticed that, here, the only intertemporal equation is (9), which, applied to capital, is the basic dynamical equation.

The question is then : How should such a model be modified to include imperfect information ?

2.1. A lag between production and consumption decisions

First, a lag is introduced between the production and the consumption decisions. Equation (1) must be rewritten as:

(1bis) $$F_j (\ldots x_{ijt-1}..) = \sum_k z_{kjt} + \sum_{i \in I,J} x_{jit-1} + \sum_h v_{hjt} , \qquad j \in J$$

Thus, the market equilibrium occurs by the confrontation of last year (given) production, and current consumption. But this means that production decisions must not be taken on the basis of equilibrium prices. Rather, expected prices $\hat{p}_{jt}$ must be used. Hence equation (2) is modified :

(2bis) $$\phi_{jt} = \hat{p}_{jt} \; F_j (\ldots x_{ij}..) - \sum_{i \in J} p_{it} x_{ijt} - \sum_{i \in I} \pi_{it} x_{ijt} \qquad j \forall \in J ;$$

In addition, an expectation function $E_m(.)$ must be defined to determine $\hat{p}_{jt}$.

Here, as in Boussard (1996), $\hat{p}_{jt} = \tilde{p}$, viz. expectations are constant. It is clear however that different expectation schemes can (and should) be envisaged[2]. Notice that actual equilibrium prices are used for inputs, so that expectations are important only for next year production. At the same time, since incomes are distributed immediately, incomes for year t depend heavily on expectations for year

[2] We tried also to make use of naïve, "Ezekiel" expectations. Results are surprising : in this case, the model becomes unstable, and cease to converge after a few periods, generally a few (a dozen(of "years". It is surprising, because naïve expectations, even subject to criticism, are more plausible than perfect indifference to recent past price levels. Also, in the case of the Boussard's theoretical one commodity model, other expectation schemes worked as well. Many hypothesis may explain this result. One is that never in history any economic policy has been pursued without change for more than ten years. Another is that the naïve expectation scheme is itself too naïve, and should be replaced by adaptative or more complicate functions of past prices.

t+1, which implies that firms may suffer losses or profit gains. They hence bear risks : this is the last and most important aspect of the model. In fact, risk plays a key role in two different ways: in the producer's utility function (2bis), and in the recurrence equation (7).

2.2. The producer's utility function

In the producer's utility function, following the remarks above, it seems relevant to introduce some sort of risk premium. Although there is a variety of possibilities, we opt for the simpler Markowitz utility function. Thus, instead of (2bis), we make use of (2ter):

$$\text{(2ter)} \qquad \phi_{jt} = \hat{p}_{jt}\ F_j(\ldots x_{ij}..) - \sum_{i \in J} p_{it}\, x_{ijt} - \sum_{i \in I} \pi_{it}\, x_{ijt} - 2A_{jt}\ \hat{\sigma}^2_{jt}\, F^2_{jt}(\ldots x_{ij}..)$$

where $\hat{\sigma}^2_{jt}$ is the expected variance of p_{jt}, and A_{jt} some risk aversion coefficient. Of course, this implies to define an expectation function $E_v(.)$ for the variance. With naïve expectations, E_m,, it would be logical to take $\hat{\sigma}^2_{jt} = (\hat{p}_{jt} - p_{jt})^2$. However, in the present state of the model, we take $\hat{\sigma}^2_{jt}$ constant, although more complicated expectation schemes could be envisaged. The order of magnitude of A_{jt} is important. It is an absolute risk aversion coefficient, the magnitude of which should therefore be commensurable with 1/w, where w is the wealth of the decision-maker. Of course, the data used in our model in this respect have been the subject of rough guesses. Finally, the last term of equation (2ter), $2A_{jt}\ \hat{\sigma}^2_{jt}\, F^2_{jt}(\ldots x_{ij}..)$, is an expected profit. It should be distributed one way or another. We decided to distribute it just as the income from capital.

2.3. The recurrence equation

(2ter) is not the only equation for which risk matters. As far as growth and accumulation are concerned, equation (7) and the function $G(..v_{hjt}\ldots)$ are of the utmost importance. In the first CGE

version, function G was straightforward: changes in total labor force were driven by demography, while capital was easily shifted from one sector to another, so that it was "naturally" invested in the most productive places. Yet, such assumptions imply that a nuclear power plant can be used to harvest grain, or that a bus driver can be employed immediately as a teacher in mathematics. It not very realistic. Many models have been set up with sector-specific labor force and capital. The difficulty, in that case, is that neither capital nor labor are obviously stuck with any sector for ever. Some flexibility must be added.

In the present model, no special care has been taken for labor : it shifts freely within groups of sectors (agriculture, manufactures, etc..). In addition, the total labor force is driven by simple demographic considerations. By contrast, an original submodel has been developed for capital. The old capital is fixed by sector, just decaying at a constant rate. But the "new" capital owned by each institution is allocated between sectors according to a Markowitz(1970) mean/variance portfolio selection model.

Let,

k_{jt} : capital of branch j, time t

S_t : total saving period t

$\hat{\pi}_{jt}$: expected profitability of capital in branch j

$\hat{V}(\pi_{jt})$: expected variance of π_{jt}

A_k : risk aversion parameter

P_{kjt} : price of the capital good for branch j

$\hat{P}_{kjt}$: expected value of P_{kjt}

I_{jt} : capital good bought for branch j, time t

Then, I_{jt} is chosen by investors through the maximization of :

(8) $\sum_j \hat{\pi}_{jt} P_{kjt} I_{jt} - A_k \hat{V}(\pi_{jt}) \mathrm{I}_{jt}^2$

subject to :

(9) $\sum_j P_{kjt} I_{jt} \leq S_t$

with a naïve expectation scheme :

(10) $\hat{\pi}_{jt} = \pi_{jt}$

(11) $\hat{P}_{kjt} = \mathrm{P}_{kjt-1}$

(12) $\hat{V}(\pi_{jt}) = (\hat{\pi}_{jt-1} - \hat{\pi}_{jt-2})^2$

In addition, since $\hat{P}_{kjt} \neq \mathrm{P}_{kjt}$, some saving may last or be created on time t. It is then credited to or subtracted from saving year t+1.

The capital available for each branch j is updated in the recursive loop over time:

(13) $\mathrm{kj}_{t+1} = \mathrm{kj}_t (1-*) + \mathrm{I}_{jt}$

Although exchange rate variability has not been taken into account, such a model could be easily extended to cope with this important source of volatility.

3. A world of perfect foresight versus uncertainty : models presentation

The Gtap data base (version 4) has been used to represent the world through three[3] regions (Europe, United States, Rest of the world), five production factors[4] and ten sectors, including five for agricultural production and one for agri-business[5].

[3] An other version of the same model splits the world into 12 regions using the same data base, allowing for a more detailed analysis of gains and losses across the world. The authors are currently working on updated versions of the model using GTAP version 5 and a new sectoral and spatial desegregation

Two types of households are considered, splitting the population around the income median, and defining middle-low income and middle-high income group, in order account for equity issues.

Agricultural policy is represented by producers support estimates (PSE), as calculated by OECD. Armington assumption of imperfect substitutes of products from different countries holds. Parameters as well as transport costs are taken from the GTAP data base.

Whenever a factor is labeled "commodity specific", as for capital, the amount of capital available is fixed on a yearly basis in the recursive, according to past equipment existing in the sector and new one determined by investment, based on expected return and risk by sector.

The production module represents physical flows of products, production and consumption behavior. It has been largely taken from Burniaux and Van der Mensbrugge (1991). Production is described by embedded CES production functions. At the first level, aggregate added value and aggregate variable inputs are considered. These are disaggregated at the second level, where two other CES are used, one for the five production factor and another for inputs. Parameters are taken from the GTAP data base[6]. Demand is a linear expenditure system, estimated by using GTAP income elasticities as well as consumption and price levels. Exchange rates are exogenous. Investment is determined by savings and foreign capital flows, calculated to balance the external trade. Government budget is balanced through public consumption adjustment. The two versions of the model are dynamic, using temporary equilibria. Because of uncertainty on agricultural prices, the expected profitability of agricultural activity, which determines resources allocation to the various agricultural activities, may differ from the real ones, calculated one year later. Therefore, at least one production factor has returns distributed with the same lag, so as to allow the adjustment

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[4] Land, Natural resources, Highly and low qualified workers , Capital. Land is used only by agricultural sectors, it has a perfect mobility among these sectors and flexible prices. Natural resources is used only by forestry and energy-resources sectors and show the same characteristics. Workers mobility is free inside 4 aggregated sectors (agriculture, manufacture, services,energy), wages are flexible. Capital is sector specific, flexible prices

[5] Rice,Other Grains (wheat,others cereal grains),Other crops(Vegetables-fruits-nuts, oil seeds, sugar cane, sugar beet, plant-based fibers, others crops) , Livestock (Bovine cattle-sheep-goats-horses, other animal products, raw milk, wool, silk worm cocoons, fishing), Forestry, Agri-business (9 GTAP sectors),Wood products,Other industries (15 GTAP sectors),Services (4 GTAP sectors),Energy, resources (7 GTAP sectors)

[6] Detailed equations of the model can be found in Boussard et al. (2002)

between expected and real results. Capital returns are calculated ex-post, in order to allow this adjustment.

4. Results : welfare gains for the poor vanish with imperfect information

Preliminary results are presented in figures 1 to 4, displaying GDP variations due to trade liberalization over the simulation period (45 years) in the two versions of the model.

In figure 1, usual results of welfare gains associated to world trade liberalization in a world of perfect information are presented. Welfare gains increase over time according to the depreciation and investment rates as well as to labor migration across sectors, allowing productions factors to be allocated in a more efficient way. As expected, agricultural trade liberalization is highly beneficial to most participants. It is particularly beneficial to the rest of the world, confirming the positive impact, at least at the aggregated level, of trade liberalization on poverty alleviation. As underlined by Anderson (2002) "fortuitously, that too is in the economic interests of rural poor countries". This result is confirmed by income analysis (figure 3) : the poor from the Rest of the World are the winner of the game. The only (slight) looser is EC.

Figures 2 and 4 show results obtained from the model modified and including short term rigidity of agricultural supply, risk averse behavior and imperfect information. Results are much more unstable, at the aggregate level (GDP) as well as at the household incomes level. Periods of gains and losses succeed years after years[7]. Overall, aggregate results on the whole simulation period are negative for all players. The poor from the Rest of the World are the principal looser. These results are still preliminary[8]. Would they be confirmed by further research, they may change economist prescriptions on trade liberalization when uncertainty holds.

[7] It is because this instability of results that the simulation is performed on 50 years, to get a general picture of the impact of trade liberalization on the long term. This kind of simulation model help exploring possible futures, it is not design for forecasting purpose.

[8] Especially, the sensitivity of the results to changes in key parameters value has not been yet performed.

5. Conclusion

In this paper, two different versions of a world CGE model, one with classical perfect foresight, the other with imperfect information, are used to evaluate the impact of trade liberalization on growth and poverty. For each version, the results of a "free-trade" simulation are compared with the base-run. The main finding is that the global gains associated with trade liberalization are removed by the imperfect information assumptions as included in the model. As underlined by Stiglitz (1998), imperfect information appears as a constraint preventing the economy to reach the optimum. Recent crises have forced both academic economists and policymakers to question some of their most basic assumptions about the appropriate design of capital liberalization (Bagwati, 1998; Stiglitz,2000). As underlined by Duncan (1997, page 442), "Research, is needed on the question of the social value of reducing price uncertainty (…)". Some of them should include risks and its impacts on producers behavior.

Price instability in particular remains a major issue: will price instability on agricultural markets be removed by trade liberalization or not? If price instability is coming from exogenous, normally distributed shocks, it will be largely smoothed by globalization and may then be neglected. It is this line of reasoning which has been followed by global trade analyst up to now. By contrast, if it is generated by market functioning itself, due to imperfect information, risk averse behavior and liquidity constraint, then price instability would remain after trade liberalization and may seriously affect trade liberalization gains as shown in this paper. The results presented here are in the line of thought of Timmer(2000): some social benefit may be associated to price uncertainty reduction, for specific commodities in specific context.

Figure 1 : Change in GDP after trade liberalization in the perfect information model % of base-run

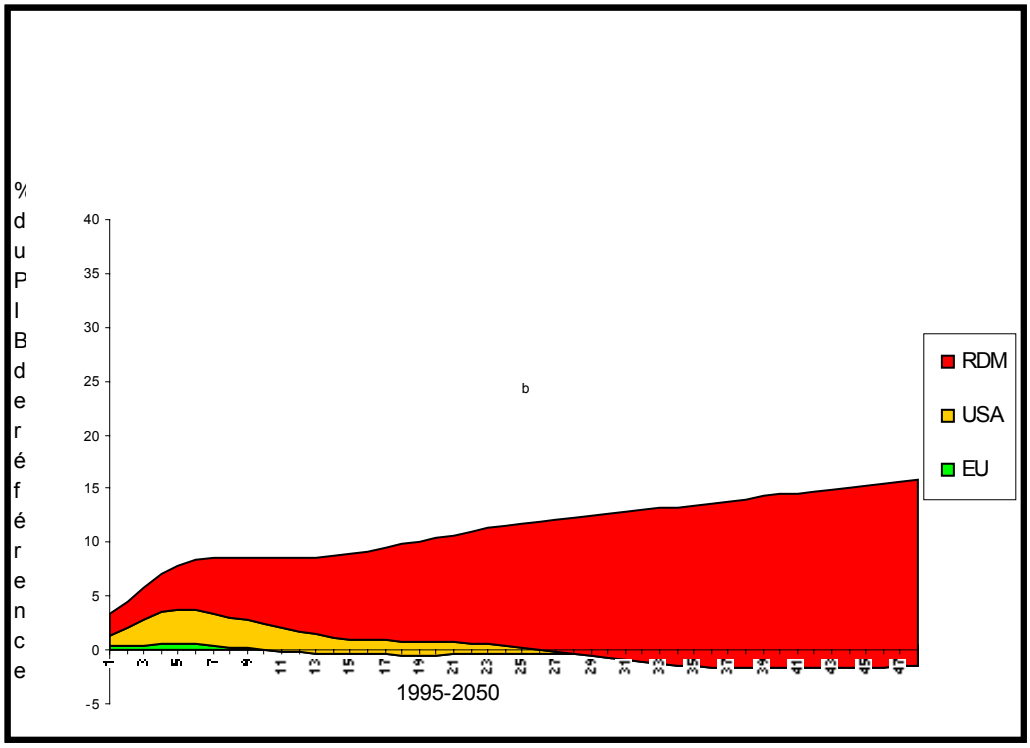


Figure 2 : Change in real income after trade liberalization in the imperfect information model % of base-run

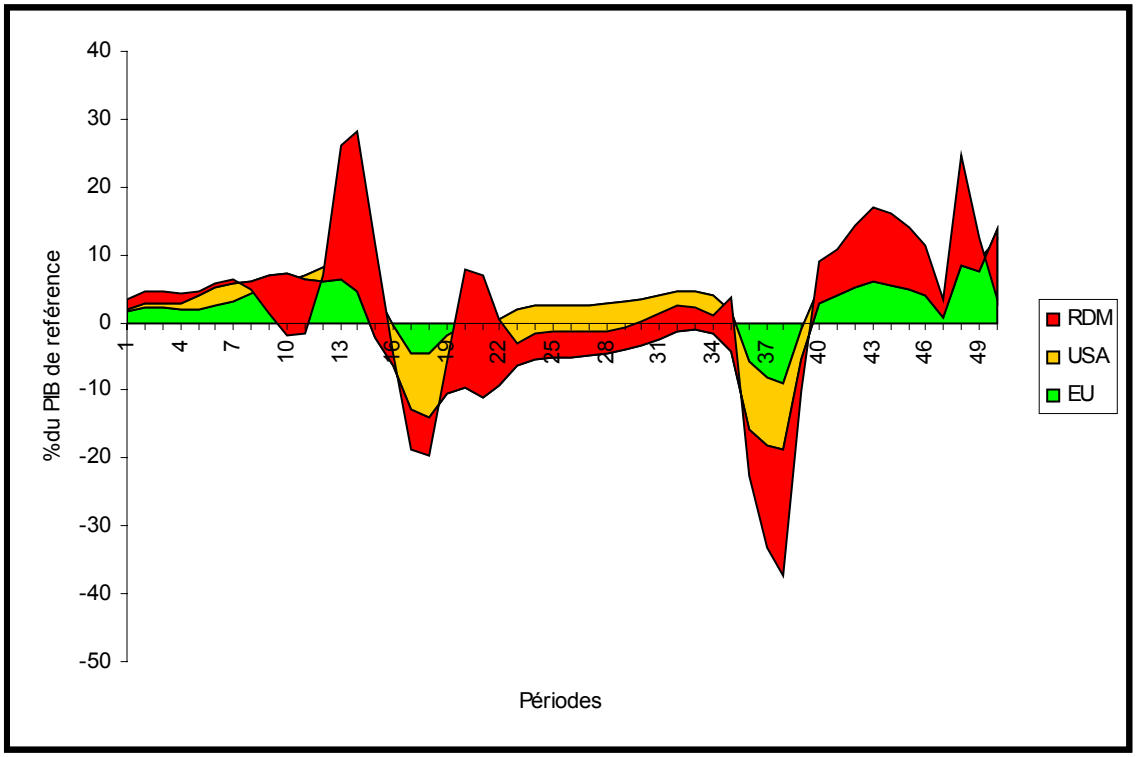


Figure 3 : Change in household income after trade liberalization in the perfect information model % of base-run

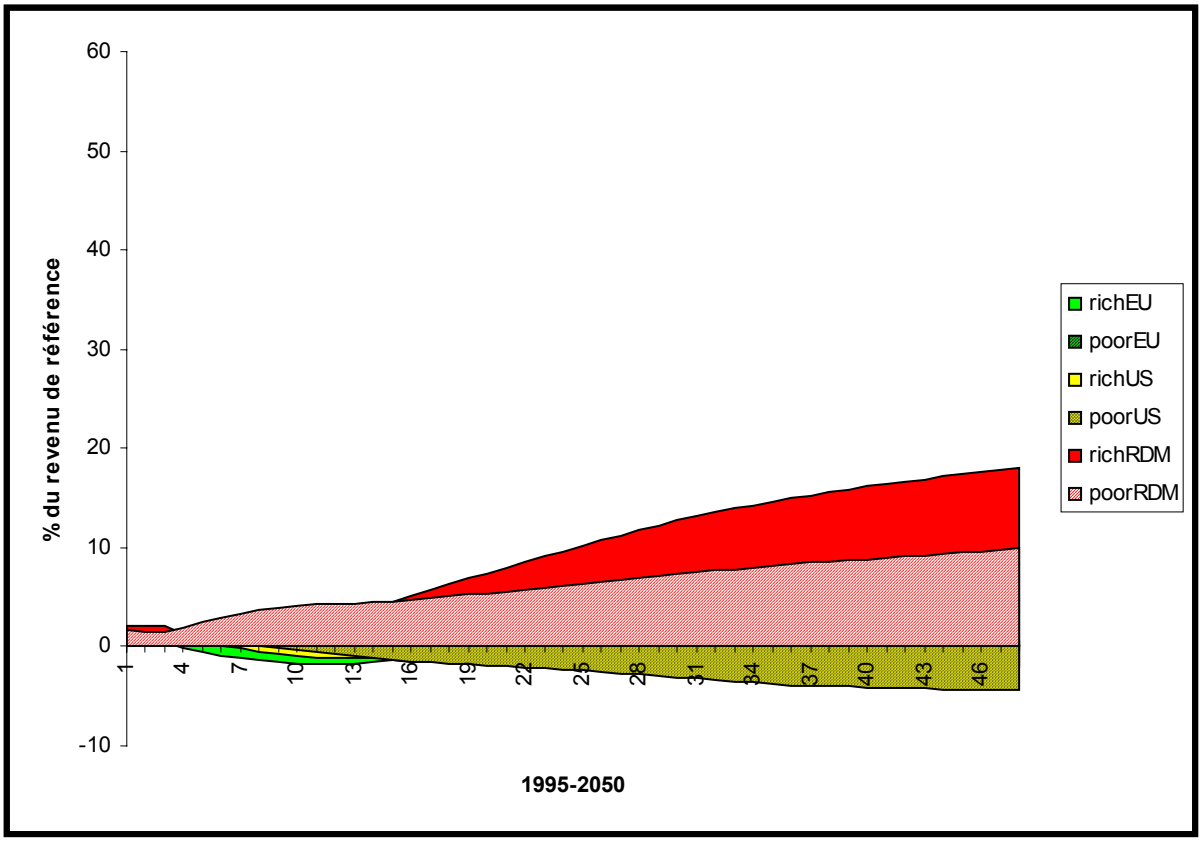
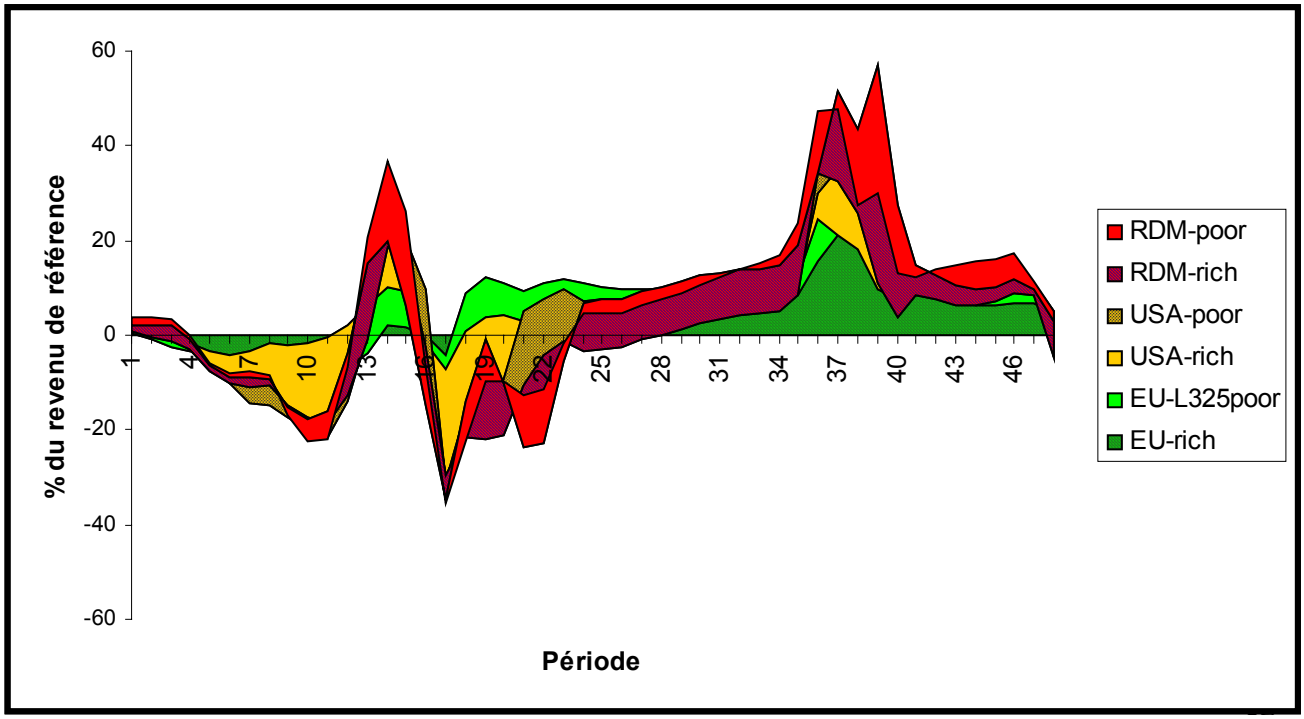


Figure 4 : Change in household income after trade liberalization in the imperfect information model % of base-run



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