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Agricultural trade liberalization in a world of uncertainty : discussion of the results of a world CGE model.

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Abstract :

In this paper, we try to evaluate the change in welfare gains due to agricultural trade liberalization when imperfect information is considered . The results of two versions of a 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 included 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.

Introduction

Since the seminal paper by Johansen (1974), making use of Computable General Equilibrium Models (CGE) have been a widespread practice in designing public policies. Presently, with the facilities offered by software like GAMS, and the availability of social account matrices, almost any student in economics has the occasion to study one of them, and comment the results. As a consequence, policy makers have a much better understanding of the multiple indirect interactions between sectoral policies. They take more accurate decision, and can reduce inefficiencies and eventual bottlenecks. This is a significant contribution of the economic science to growth and poverty alleviation.

Yet, since there is no coin but with two sides, there is a risk that many people find the instrument so logical and beautiful that they come to think the real world is exactly similar to what they observe in models. Although many caveats have been issued in this respect by many famous authors – such as Leontief himself – there is still a high propensity toward this fallacy in the economic profession. A good illustration is provided by the evolution of ideas concerning trade and agriculture.

Until the Marrakech agreement (1994), the agricultural sector has been considered as a special-case sector in the international trade liberalization negotiations. One main reason was the fact that, in the aftermath of the Great Depression, the agricultural sector had been disconnected from market in almost all developed countries. There was a deep theoretical reason for that, as shown by Ezekiel (1938) : There exists a very large price instability in agriculture because the agricultural demand function is specific. It leads to permanent price risks for farmers, and these risk are large enough to jeopardize agricultural growth and development. As a consequence, large efficiency gains can be expected from a direct administration of agricultural prices.

The intellectual success of this line of reasoning was enormous in the 50' and 60's. Only later on critics came from two directions. First, sociologists as Olson (1987), and later on, Gardner(1992), pointed out that the administered prices were a very nice field of maneuvers for any kind of lobbyists. As a consequences, agricultural prices were unduly large, for the benefit of a few wealthy farmers, and to the detriment of consumers. Since the scandal, if any, was small, after all, in comparison of others, this argument may not have been pushed in the forefront of the stage if another problem had not aroused : The technical success of the Roosevelt line of policy was so large that agricultural supply was growing apparently without limits. The question thus aroused of how to tame the dragon thus imprudently awakened.

Quite naturally, market solutions were envisaged. And, quite naturally also, CGE model's were made us to picture the physiognomy and main features of a "free trade world"[1]. The

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[1] Welfare gains of including the agricultural sector into the liberalization process have been the subject of many partial or general equilibrium models . The precursors (among others:Parikh et al. 1988, Burniaux and Vander Mensbrugghe, 1990 ; Hoff and Moredu, 1990 ;Tyers and Anderson, 1990) were reviewed, in the early nineties, by Goldin and Knudsen (1990). Additional contributions, with new model features, include Hertel et al., (1997), Van der Mensbrugghe, (1998), Ianchovichina and al. (1999), Burniaux and Oliveira-Martins (2000,)Burniaux (2001) and many others. Thanks to the GTAP network, enormous progresses have been realized on the data side. The various models differ with respect to their closure rules, assumptions on price flexibility of production factors, regional coverage and desegregation. Some are dynamic (dynamic optimization or temporary equilibria) while other are static . Assumptions on factor movement between sectors and flexibility of factor prices, on one hand, and assumptions on international trade (perfect or imperfect substitutes) as well as the level of saving largely determine the level and distribution of the gains associated with trade liberalization.

latter is considered "better" than the "old administered world", because as shown by standard Neoclassical theorems, such a proposition must hold in any case within the theoretical framework of general equilibrium[2]. Yet, the (invaluable) contribution of CGE model's in this respect was to suggest numerical scenarios indicating how the cards would be reshuffled between the different stakeholders, and, therefore, how should the negotiation be designed to guarantee success by compensating losers from a fraction of the winner benefits.

Yet, tackling the problem this way comes to the same as assuming the difficulty already miraculously solved. Not to forget that the true reason for having entered the process of administered agriculture does not come from the irresponsible lobbyism, nor from bureaucracy, but from the observation of the occurrence of a dramatic market failure, which was bound to destroy rural America. Now, by assuming markets are always well functioning, the solutions derived from CGE models fail to recognize the very nature of the problem they should solve : will liberalization be compatible with the minimum of price stability, necessary for the solutions being really obtained ?

In this sense, there is a real risk of confusion between models and reality : The properties of the model are not necessarily those of the real world. At least, if there is a similarity between the two, it should be demonstrated. It has been done, but only partially. This is the main contention of this paper. We shall first set the theoretical stage, then describe an alternative model, and, at the end, present a few disturbing (but not yet properly validated) results.

Setting the theoretical stage

It is not true to say that the instability problem has not been addressed by early liberalization studies. For instance, Bale and Lutz (1979) contended that price instability may be removed, or at least largely alleviated, by world markets globalization. Indeed, if instability originates from normally distributed exogenous shocks, the larger the market, the smaller the impact of shocks on price deviation. Thus, globalization may kill two birds with one shot : first, by harvesting the benefits of comparative advantages. Second, and above all, by solving the agricultural price instability problem. Given the sensitivity of agricultural supply to risk, the benefits of this second effect may very well largely exceed those of the first one.

Yet, because CGE, usually, do not take price volatility into consideration, this second aspect of the effect of liberalization is neglected in most CGE addressing the question of the consequences of liberalizing the world agricultural markets.

Ezekiel (1938) convincingly demonstrated that market equilibriums may be locally unstable in the case of agriculture, and, more generally, for any low price demand elasticity commodity. In that situation, the market equilibrium is just like a ball at the sharp end of a pencil. Yet, he was wrong at least on one point : since nobody never saw a market with negative prices and quantities, it is clear that the cobweb model, even if it is right "near" the equilibrium, cannot say anything sound when the situation "away from equilibrium" is at stake. In effect, as with the more general "business cycle", the real problem here is to

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[2] For example, Hertel (1999) evaluate the potential annual gains associated with a full trade liberalization at 349 billions $, agricultural liberalization ranking first accounting $164 billions.

understand why does the system, after a departure from an unstable equilibrium point, tend to come back toward it again – as if the ball at the end of the pencil was also attached by a return string.

Concerning the business cycle, an old tradition, which can be traced back up to Wicksell, is to seek the return string among risk and unfulfilled expectations considerations. Actually, several authors, such as Day (1999), Nerlove (1979, 1994) Boussard (1996), Rosser (2000), and many others, obtained theoretical "sustainable" cobweb models from such ingredients. These models are sustainable in the sense that, unlike the original Ezekiel's cobweb model, they can be run indefinitely without collapsing into negative magnitudes for obviously positive variables. At the same time, they never converge toward equilibrium, since the equilibrium point is unstable, in such a way that the system can never stay in the vicinity for long. Some are periodic, although periodicity should logically be excluded from the possibilities, because as soon as a period can be detected, operators can make use of it to make profit, thus eliminating the series' periodic feature. Others are chaotic, that is, exhibiting an infinite number of periods.

Such a line of thought is obviously disturbing for the CGE approach : If the economy is permanently far away from the equilibrium, then why do we bother building this kind of models ? At the same time, it is clear that the above criticism of the very notion of equilibrium does not question some of the essential features of CGE models, such as their links with real world data, or their multisectoral aspects. It may be possible to cast the preceding observations into the traditional CGE approach, and interesting to see how the results are affected. We shall now see how is this possible.

Modifying the basic CGE .

Let us define the sets I for factors, J for commodity, H for institution, t for time (with the above footnote (3) proviso concerning the planning horizon). 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 ; ϕ_{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[3] CGE can be described with the following equations :

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

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[3] "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.

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

utility)

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

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

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

constraint)

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

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

The model is closed by writing the first order equation for the producer's and consumer's optimality, that is 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.

How should such a model modified include imperfect information ?

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

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

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

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

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

Here, as in Boussard (1996), $\hat{p}_{jt} = \tilde{p}$, that is, expectations are constant . But it is clear that different expectation schemes can (and should) be envisaged[4]. 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

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[4] 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 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.

on expectations for year t+1, which implies that firms may suffer losses or gain profits. Thus, they bear risks, and this is the last and most important aspect of this model.

In fact, risk plays it role in two different ways : in the producer's utility function (2bis), and in the recurrence equation (7).

In the producer's utility function, after the above remarks, it is quite natural to introduce some sort of a risk premium. Although there is a variety of possibility for that, we opted for the simpler Markowitz utility function. Thus, instead of (2bis), we make use of (2ter) :

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

where $\hat{\sigma}^2_{jt}$ is the expected variance of p_{jt}, and A_{jt} some risk aversion coefficient. Of course, this implies the necessity of defining an expectation function $E_v(.)$ for the variance. With naïve expectations, E_m, it would be natural to take $\hat{\sigma}^2_{jt} = (\hat{p}_{jt} - p_{jt})^2$. However, in the present state of the model, we took $\hat{\sigma}^2_{jt}$ constant. Again, much more complicated expectation schemes can 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), $2A_{jt} \, \hat{\sigma}^2_{jt} \, F^2_{jt}(... \, x_{ij}..)$, is an expected profit. It should be distributed one way or another. We decided to distribute it just as the income from capital.

But (2ter) is not the only equation for which risk matters. As far as growth and accumulation is concerned, equation (7) and the function $G(..v_{hjt}...)$ is of the utmost importance. In the first CGE, 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. Thus, many model have been set up with sector specific labor force and capital. The difficulty, in that case, is that, obviously, nor capital nor labor are stick with any sector for ever. Some flexibility must be added.

In the present model, no special care has been taken of labor : it is freely shiftable 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 constant rate. But the "new" capital owned by each institution is allocated between sectors according to a Markowitz (1970) mean/variance portfolio choice 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 maximisation of :

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

subject to :

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

with a naïve expectation scheme :

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

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

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

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

Then, of course, the capital available for each branch j is updated in the recursive loop over time :

(13) $kj_{t+1=} kj_t (1-\delta) + I_{jt}$

Although, for these results, rate of exchange variability has not been taken into account, such a model could very well extended to cope with this important source of volatility.

A world of perfect foresight versus uncertainty : models presentation

What could be the consequences of such modeling innovations for the results, and for the practical conclusions pertaining to benefits from trade ? In order to answer this question, the Gtap data base has been used to represent the world through three[5] regions (Europe, United States, Rest of the world), five production factors and ten sectors, including five for agricultural production and one for agri-business (see box1 , box2).

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 to be able to include equity considerations when analyzing the results.

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

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[5] An other version of the same model split the world into 12 regions, allowing for a more detailed analysis of gains and losses across the world.

Assumptions on prices flexibility and perfect or imperfect mobility of production factors across sectors are summarized in Box2

Whenever a factor is labeled "commodity specific", as for highly qualified workers of the services sector, it means that the maximum worker available is fixed on a yearly basis, in the

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[6] Four agregated sectors are considered in the model : agriculture, processing, services and energy-resources.

recursive loop over time, according to a migration function based on expected income by sector and preference parameters.

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. There are disaggregated at the second level, using again a CES for the five production factor and a leontieff for inputs. Parameters are taken from the GTAP data base[7].

Demand is a linear expenditure system, estimated by using GTAP income elasticities as well as consumption level and prices.

Exchange rate 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. Both version 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 activity, may differ from the real ones, which will be calculated one year later. Therefore, at least one production factor has return to be distributed with the same lag, to allow the adjustment between expected and real results. Capital returns are calculated ex-post, in order to allow this adjustment.

Results : welfare gains and uncertainty

Preliminary results are presented in figures 1 and 2, representing income variations along 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. The welfare gains increase with 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, the liberalization of agricultural trade is highly beneficial to most participants. As in the conclusion of most other models, the only (slight) looser is EC .

In figure 2 the same simulation is performed with the model modified to include short term supply rigidity of agricultural supply, risk averse behavior and imperfect information. Each succeeding year, bring unstable incomes, gains or more often losses follow the liberalization. Overall, agregate results are negative for all players, except after 50 years.

These results are still preliminary[8]. Would they be confirmed by further research they may change economist prescriptions on trade liberalization when uncertainty is considered. Then price instability becomes one major issue : will price instability on agricultural markets be

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

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

removed by trade liberalization or not ? If price instability is coming from exogenous, normally distributed shocks, it will be largely enlightened by globalization and may then be neglected. By contrast, if it is related to market functioning, imperfect information, risk averse behavior and liquidity constraint, the price instability will remain after trade liberalization and may affect trade liberalization gains.

In any case, the arguments 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.

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 household real income. 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 this model. As underlined by Stiglitz (1998), imperfect information appeared as a constraint preventing the economy to reach the optimal. 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.

Figure 1 : Change in real income after trade liberalization in the perfect information model % of base-run
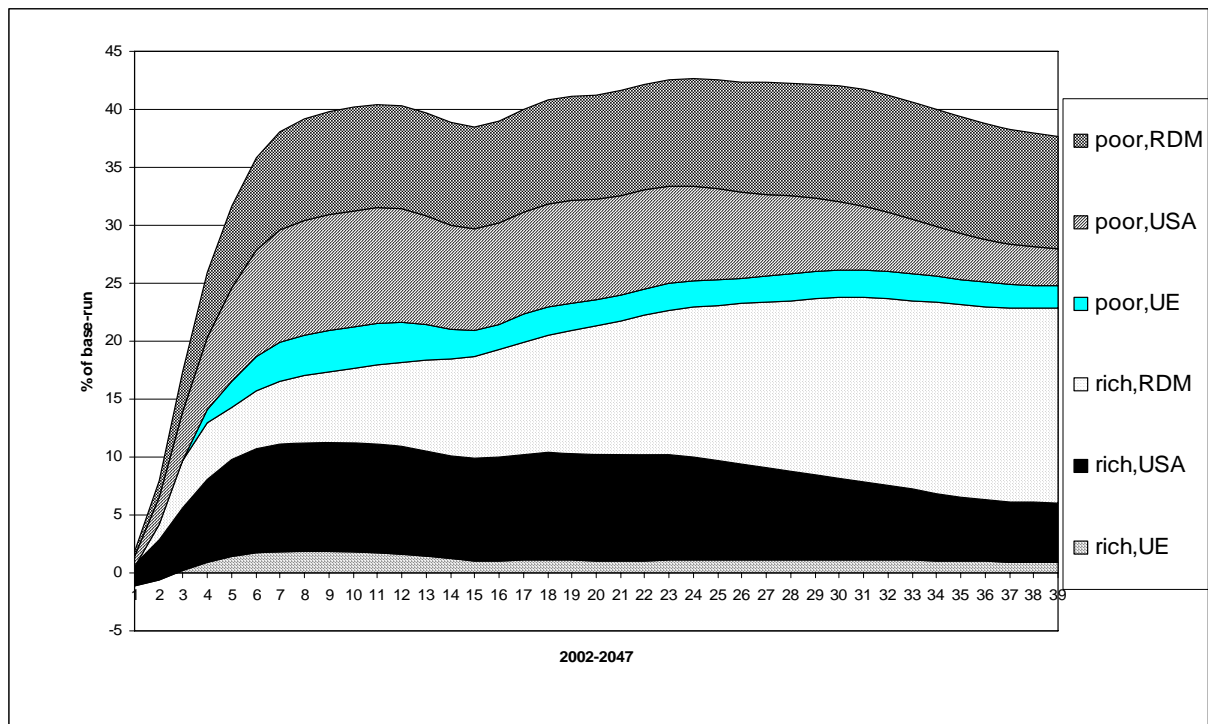
Figure 2 : Change in real income after trade liberalization in the imperfect information model % of base-run
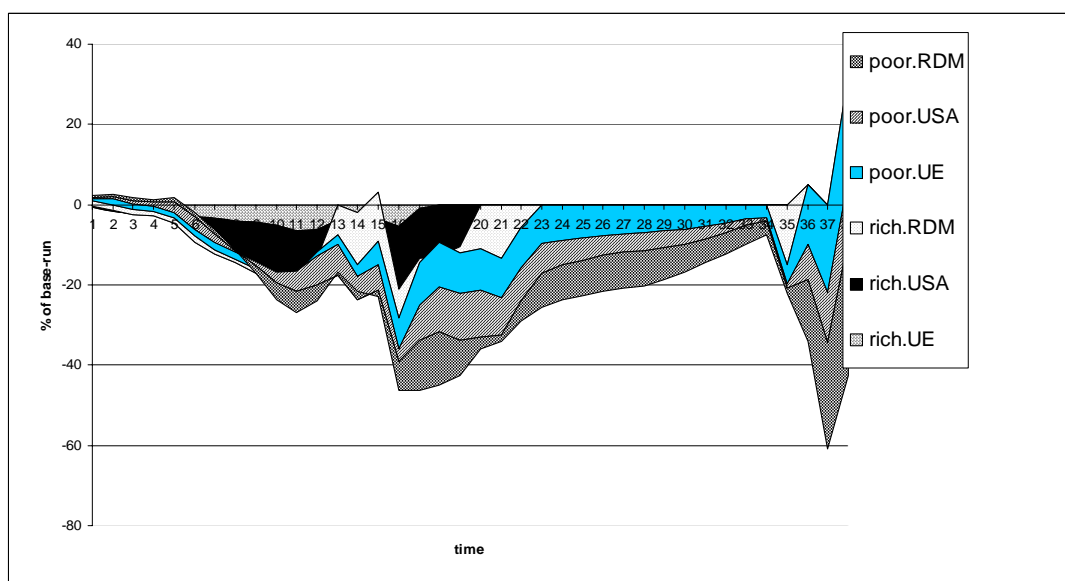
Annexe 1 The modification of the classical model to include imperfect information

As said above, we follow the methodology applied in RUNS (Van der Mensbrugghe, Burniaux, 1991) using GTAP data. Then, only the equations modified to include imperfect information are given here.
First order conditions hold for producers as well as for consumers.
The production of the ith sector from the rth region, $XD_{i,r}$ is a CES of $CI_{i,r}$ (aggregated intermediate consumption) and $VA_{i,r}$ (aggregated added value). *To* are production subsidies, *pinp*$_{i,r}$ is CI price and *pva*$_{i,r,}$, VA price

(1) $\quad XD_{i,r} = \chi_{i,r} * (\eta_{i,r} * CI_{i,r}^{-\phi_{i,r}} + (1-\eta_{i,r})*VA_{i,r}^{-\phi_{i,r}})^{-1/\phi_{i,r}}$

Then first order conditions lead to
(2) $\quad VA_{i,r} = ((p_{i,r} + to_{i,r})/pva_{i,r})^{1/1+\phi_{i,r}} * \chi_{i,r}^{-1/1+\phi_{i,r}} *(1-\eta_{i,r})^{1/1+\phi_{i,r}} *XD_{i,r}$

(3) $\quad CI_i = ((pd_{i,r} + to_{i,r})/pinp_{i,r})^{1/1+\phi_{i,r}} * \chi_{i,r}^{-1/1+\phi_{i,r}} * \eta_{i,r}^{1/1+\phi_{i,r}} *XD_{i,r}$

Similarly, the quantity of product i consumed by household of type h, in the region r is determined by first order conditions, assuming utility is a Linear Expenditure System, with *consmi*, committed consumption, *conspar,* the marginal propensity to consume (LES parameter), *Y*, the income, *mps* the marginal saving propensity, *P*, price of the product and *tc* consumption taxes

(4) $HHDEM_{h,i,r} = consmi_{h,i,r} + conspar_{h,i,r}\left((1-mps_{h,r})Y_{h,r} - \sum_i P_{i,r}*(1+tc_{i,r})*consmi_{h,i,r}\right)$

Balance equations between supply and demand determines the prices of production factor when flexibility holds. The quantity demanded by the firms is adjusted for highly qualified workers, characterized by rigid wages.
Prices are determinate by balances equations at the domestic level, including external trade :
(5) $\quad XD_{i,r} = XXD_{i,r} + \sum_{rr} M_{i,rr,r}$

with *XD*, domestic supply, *XXD*, selling on domestic market, *M* exports

Including risk aversion and production lag in the model
The modifications described here aims to include :
   - imperfect information,
   -risk averse behavior for agricultural producers,
   - short term rigidity of agricultural production

It concerns only the 5 agricultural productions sector considered in the model.

Risk averse behavior is included following the model of Markovitz(1959). Then, equations (2) (3) become :

(2Bis) $VA_{i,r} = ((PT\_1_{i,r} + to_{i,r} - avprod_{i,r} *XD_{i,r})/pva_{i,r})^{1/1+\phi_{i,r}} * \chi_{i,r}^{-1/1+\phi_{i,r}} *(1-\eta_{i,r})^{1/1+\phi_{i,r}} *XD_{i,r}$

(3Bis) $CI_{i,r} = ((PT\_1_{i,r} + to_{i,r} - avprod_{i,r} *XD_{i,r})/pinp_{i,r})^{1/1+\phi_{i,r}} * \chi_{i,r}^{-1/1+\phi_{i,r}} * \eta_{i,r}^{1/1+\phi_{i,r}} *XD_{i,r}$

With **PT_1$_{i,r}$**, price expectation and avprod, risk aversion parameter.

Various processes of expectations have been tested. To approach the Rational Expectation Hypothesis (Muth 1961), expectations are fixed at the production costs level.

To include the short term rigidity of agricultural supply, a lag of one year is included between agricultural decisions and delivery on markets. Then, equation (5) becomes :

(5Bis) $XDT_{-1i,r} = XXD_{i,r} + \sum_{rr} M_{i,rr,r}$

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