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Consequences of price volatility in evaluating the benefits of liberalisation

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Abstract

Many computable general equilibrium models have been set up recently, in order to assess the benefits of trade liberalisation, especially in agriculture. Although figures magnitudes differ from one model to another, they cannot reach any other conclusion than positive benefits. On the other hand, historical experience shows that liberalisation, far from being a new idea, has been tried at several occasions during the two last centuries, repeatedly ending in crisis, and hasty return to various forms of protection. A possible explanation could be in the comparative static approach of most liberalisation proponents, and their neglect of dynamic aspects. Especially, because risk is necessarily tied with unfulfilled expectations, it should play a decisive role in modelling. A new model is developed along this line, showing the possibility of a chaotic price regime, which would prevent full liberalisation to be feasible.

Resumen

Muchos general equilibrio computables modelos se han instalado recientemente, para determinar las ventajas de la liberalización comercial, especialmente en agricultura. Aunque las figuras magnitudes diferencian de un modelo a otro, no pueden alcanzar ninguna otra conclusión que ventajas positivas. Por otra parte, la experiencia histórica demuestra que la liberalización, lejos de ser una nueva idea, se ha intentado en varias ocasiones durante los dos siglos pasados, terminando en crisis, y vuelta precipitada a las varias formas de protección. Una explicación posible podría estar en el acercamiento de estático comparativo de la mayoría de los autores de la liberalización, y su negligencia de aspectos dinámicos. Especialmente, porque el riesgo se ata necesariamente con expectativas incumplidas, debe desempeñar un papel decisivo en modelar. Un nuevo modelo se desarrolla a lo largo de esta línea, demostrando la posibilidad de un régimen caótico del precio, que prevendría la liberalización completa para ser factible.

Consequences of price volatility in evaluating the benefits of liberalisation

Since the very beginning of economic science, the potential benefits from trade are well known. Although he was not the first to put shame on trade impeding laws, David Ricardo cast the most famous argument in favour of trade with his parabola about the Portuguese wine and the English cloth. After him, the benefits from trade, and the importance of dismantling trade barriers are universally acknowledged among economists.

Real life, nevertheless, contradicts this unanimity. Trade barriers have been effective in most countries during the 19th and the 20th century. This is not by chance: at regular intervals, economists persuaded decision-makers and citizen that "trade barriers were bad". They were removed several time during the period, and re-established afterward (be it under the form of tariff, or any other bureaucratic obstacle to free trade). There should be serious reasons for that…

At present, since the early 1980's, trade barriers are low, in general, and they are lowered each year. Agriculture is somewhat an exception in this respect: although variable according to commodity and country, trade barriers are still high in agriculture. It was precisely a major purpose of the Doha round to lower these "abnormal" trade barriers in agriculture, supposedly preventing development. In addition, there were all the reasons to liberalise agriculture, because, in agriculture, the comparative advantage theory should apply even more than elsewhere : one may wonder why producing computers in Hong Kong is better than in New York, while producing wine is obviously easier in Portugal than in Scandinavia[1].

And yet, contrary to all expectations, the Doha round seems to end, if not with a total failure, at least, with very modest results. Again, there are here deeper reasons than the mere egoism of a few nations or lobbies, so powerful as they may be.

In this paper, possible explanations for this situation will be sought for. They can be found in the shortcoming of the models which are at the origin of the creed according to which "trade barriers are bad". It will be demonstrated that, although trade is almost always "good", the necessity for trade to pass through markets may – at least in some circumstances, especially likely to be found in agriculture - lead to inefficiencies, the negative consequences of which may be larger than the benefits created by increased trade. We shall see that such an outcome is particularly likely in the case of agricultural commodities, which should therefore be given a special treatment.

We shall first describe the traditional general equilibrium model at the core of the "liberal" reasoning. We shall see that, even along this line of reasoning, difficulties arise with respect to employment flexibility, distributional effects and externalities. But such difficulties could probably be overcome by suitable policies.

Thus, the heart of the "anti-liberal" argument is not there, but in the difficulty of maintaining market efficiency when equilibriums are dynamically unstable. This may explain why liberalizing "luxury" products is quite feasible (and desirable), while the same policies applied to basic inelastic commodities leads to failures and efficiency losses. We shall illustrate this

[1] Any body having once tasted a glass of Hastings wine can measure how much preferable is it to drink Port!)

contention by a new "disequilibrium" model of the world economy, tailored on the same patterns and data as are the classical CGE World Bank and other institutions models which have been used to "sell" liberalisation to decision makers, but slightly modified in order to incorporate the above considerations. Before tackling the heart of the matter, let us begin by an historical sketch of the controversy.

I - Historical sketch of theory and practice

The Ricardian parabola of wine and cloth is extremely powerful in the justification of trade, showing that, as soon as production conditions are different in two or more economic entities, everybody can gain, and nobody can loose from trade. Yet, this model is too general, and, at the same time, too rough and simple to specify at which prices will exchange occur.

Nowadays, rather than on Ricardo, the "main stream" theory of trade relies on the set of theorems known as "HOS" (standing for Hecksher - Ohlin – Samuelson, from author's names). Here, the basic Ricardo intuition is cast into a maximising device (the original article by Samuelson was based on "linear programming"), with price transmitting information between producers and consumers. As a consequence :

a) a (hopefully unique) market equilibrium arises, showing how are prices affected by trade. Moreover, trade does not occur only because of natural advantages.

b) Differences in factor endowment do matter as well, trade standing as a substitute to factors mobility. Therefore, trade expansion should ultimately end with all countries being "homothetic", each with the same ratio land/labour/capital (and any other factor…), and each with about the same price system. Although growth should "naturally" achieve this outcome by the virtue of the "turnpike theorem", provided the same technology be available everywhere, trade considerably accelerate the convergence process. This is the contribution of trade to growth.

c) Finally, because trade changes prices, it also changes income distribution, with a very important consequence: even if trade globally improve welfare (by expanding the production possibility set, as demonstrated by Ricardo) it may also hurt some segments of the population, by decreasing the price of certain factors in certain countries (hence, the incomes of the owners), by comparison with what it could be without trade. This is the famous "Samuelson Stopler theorem", which implies that if trade is meant to create a full "win-win" situation, compensations should occur between the "losers" and the "winners" (at the same time, such a compensation is surely feasible from a fraction only of the winners' gains).

All this should encourage decision makers to speed the path toward liberalisation. At the same time, the Samuelson-Stopler theorem provides a straightforward explanation of all resistances: of course, the vested interests of the few potential losers induce them to do all what they can to avoid losses, or, at least, to be overcompensated. Even more, potential "small" winners may be induced to disguise them into losers, in the hope of benefiting from (unjustified) compensations… Is it possible that such egoist strategies can prevent the whole world of benefiting from productivity and general welfare increase?

To answer such a question, not only a qualitative, but a quantitative model is needed. Indeed, one should be able to determine the magnitude of the gains and losses, and how would it be possible for the winner to compensate the looser. Now, in its original form, the HOS model was not amenable to quantitative experiment. But it can be turned into a true "operational" model if one considers it is easily embedded into a general Walrassian general equilibrium model. Indeed, the original Walrassian is defined over a closed national economy, with various products, factors and consumers. But just consider two similar products (or factor, or consumer) in two different countries as distinct, and you can easily imagine a multi-country Walrassian model.

The only difficulty, then, is in representing trade. But this is easily done by adorning the model with a process which defines good A consumed in country 1 as a suitable mix of good A produced domestically, and good A produced in country 2 (or 3, or 4..). Of course, transportation costs, and possible import taxes are taken into account at this stage. In this way, the world economy is easily pictured as a (very large) closed Walrassian model. Until recently, a very large Walrassian model was not numerically solvable. But thank to the progresses made during the last 50 years in electronic computing, the model size is not an obstacle any more, except perhaps for one important point, the dynamic aspect of the thing. We shall come back to this point later on.

Another problem is with data availability. Setting up a Walrassian model requires input/out data, showing how much of good A is needed to produce good B, consumer behaviour data, showing how much of income consumer j spend on good A and good B, distributional data, showing the revenue share of factor i accruing to consumer j. It is now customary to make use of "Social Account Matrices" (a concept initiated at the World Bank by Pyatt and others), but such matrices are not available everywhere anytime. A pioneer work has been done in this respect by an Australian team under the name of ORANI (Dixon *et al.* 1980). Recently outstanding efforts have been made by Thomas Hertel at Purdue University for setting up a comprehensive world SAM called GTAP (Hertel et al. 1998).

For the time being, let's have a look at sample results, as displayed on Table 1 (next page).

It is clear from this table that estimations vary largely according to sources. This reflects various specifications and data sources for models: For instance, the "GTAP4" SAM was built on data for the year 1997, while "GTAP 5" is for 2001. The Carnegie and CEPII models contain several methodological innovations such as possible unemployment or increasing returns to scale. Moreover, the most recent of them do not start from the same origin: between 1997 and 2001, many national economies have begun to reap the benefits of earlier decisions toward liberalisation, so that the benefits of a residual liberalisation cannot be the same as those of the disappearance of the barriers of the 70's. Such improvements in models specification explain a definite tendency for benefits to shrink as time passes (Ackerman, 2005)[2] . But whatever their precise values, such benefits look huge when expressed in billion

[2] in 1993, the World Bank published a study advertising benefits of more than 600 billion $ (It was sharply criticized by Nobel price winner Maurice Allais in a French daily newspaper, calling these results "an intellectual imposture" : cf Allais, 1993).

$. They are smaller if expressed in $/person or in % of GDP, varying from 30 to 0.5 $ per head, or from 3 to 0.5% of GDP: this is not much, but this is positive, after all.

Table 1: Various models estimations of benefits from trade liberalisation in billion $

Source	Year of publication	GDP gains for poor countries	GDP gains for rich countries	GDP gain for world
GTAP 6[3]	2005	22	62	84
GTAP 4	2002	108	146	254
LINKAGE 2002[4]	2005	189	196	385
LINKAGE[5]	2003	86	201	287
Carnegie (Central Doha scenario) [6]	2006	30,1	28,5	58,6
CEPII[7]	2005	274	62	337

The question of the distribution of these benefits is more controversial: Of course, it is possible to describe how they are distributed between "rich" and "poor" countries. From this approach, although results may vary, there is a relatively wide consensus in favour of a "fifty-fifty" distribution (but population is not distributed fifty-fifty: this means that the average benefit per person is much less for poor than for rich nation citizens). What is more worrying is that "within" may be more preoccupying than "between" country poverty. What happens if liberalisation favours the "rich" in each "poor" country [8] ?

The problem here is not so much with theory rather than with data. There are no theoretical objections, instead of having only one representative household, to increase the number of household categories, for instance "rural rich", rural poor", urban rich", "urban poor"[9]. But statistical bureaus rarely produce information on various household categories consumption levels, and they are even more reluctant to provide information regarding which household category owns which kind of resource. Thus, although it is clear that rich own the bulk of capital resources, while poor are endowed with the main part of labour, it is difficult to be more precise. Especially in agriculture, the determination of who own land (and rent) is difficult.

[3] For GTAP 5 and GTAP6, see Ackermann (2005).
[4] Van Mensbrugghe, D. and J.C. Beghin (2005)
[5] Anderson, Martin and Van der Mensbrugghe (2005).
[6] Polaski, 2006 , table 3.1
[7] Bouet *et al.* (2004)
[8] For instance, Brazil is "poor" because there are many poor in Brazil. As a consequence, charity considerations would lead to allow help and preferential treatment to this poor country. Now, when one see which kind of farmers would benefit of, say, Brazil sugar access to EC, one wonder whether poverty alleviation would not require allowing a special treatment to the "poor" European sugar farmers (who, yet, are not that poor!)
[9] For instance, Robillard (2000) , in a CGE model of Madagascar, defined more than 800 households, with data from an household consumption survey.

Despite these difficulties, some studies tackle the problem directly, introducing "poor" and "rich" households into the models[10] . Results are mixed "some countries experience a small poverty rise, and other more substantial poverty decrease… on balance, poverty is reduced…(but) complementary domestic reforms are required.." (Winter and Hertel, 2006). Indeed, even under the most favourable situations, there does not seem to be any reason to think that the Doha round and other steps toward liberalisation have any chance to reduce poverty significantly. But it does not seem to increase it either. On the other hand, none of these models were designed in order to plan loser compensations from the winners benefits: curiously enough, the point is never tackled, even while if one takes welfare economics seriously, it should be at the core of the analysis. This induces to think that poverty considerations do not seem to be central in this context.

Thus, as said by the US trade Representative Rob Portman in a comment of the Carnegie document: "The scenarios presented are consistent with a view that… economic gains grow as the degree of trade liberalization increases," [11] Thus, the more you liberalize, the better you are!

The questions which arise at this stage are obviously "is this credible? Is this convincing? ". There are two possible lines of answers. The first is to look at history: why is it that for several centuries, the benefits of liberalisation were known, and not made use of? Even more, why is it that in many times places, steps have been made toward liberalisation, eventually followed by steps in the opposite direction? The second is to look at the models themselves: do they contain flaws making them irrelevant or misleading?

II - A few historical reminders

Validating such models – that is, assessing to what extent they reflect reality – is a hard task. The only possibility in this respect would be to run the model within a historically controlled setting, and check whether it behaves as was observed in reality. Unfortunately, such a test is not easy, especially with CGE's, which by construction start from an observed SAM matrix, and forecast events which never occurred : since nobody tried to fully liberalize the world economy in 1998, the base year of GTAP 5, it impossible to observe the prediction results for this year. Hertel *et al.* (2004) nevertheless provide some clues in this direction, but, whatever the merits of this important reference (which, at least, raises the question), the conclusions are not really convincing.

Yet, another approach is feasible: looking back on the history of protectionism during the last two centuries. Of course, it will not provide a detailed assessment of CGE models. But since, during that time, even without models, liberal lobbies have been very active (and sometime successful), using arguments which are essentially the same as those implemented in models, it should be interesting to see whether they were confirmed by experience.

Indeed, the first time liberalism became to be a political issue seems to have been in the 1770's in France. At that time, the French royal bureaucracy was protectionist and interventionist, prohibiting trade even within the country, on the ground that each province had to be self sufficient in grains, and that royal manufactures had to be protected against

[10] For instance : Savard, 2005, Filho *et al.* 2005; Hertel and Winter, 2006

[11] Cf Office of the US trade representative press release March 15th 2006 : "Carnegie study reveals benefits increase with deeper trade liberalisation".

"unfair" practices (especially from England!). A debate - not unlike the contemporaneous controversies - ragged regarding the relevance of these regulations. The proponents of liberalism were called the "physiocrats" – meaning "those who wish to govern according to nature". Ferdinand Galiani (1770) brought contradiction with a still topical message : liberalism is very good for manufactures, but very dangerous for agriculture. Galiani was poorly understood[12]. Various prime ministers from the declining monarchy launched liberalisation plans, most of them quickly abandoned in front of famine riots or other social unrest. The French revolution, which was all but liberal, ended the process. Notice England, at that time, was probably more liberal than France concerning domestic trade between provinces, but just as much protectionist regarding foreign trade, ruled by the "corn laws" passed by Cromwell.

After the Napoleonic wars, in 1815, the question of foreign trade aroused again in France. The then in power land aristocracy was liberal: with relatively large farms, and good agronomists, most landowners considered they were in the position of "feeding Europe". They preferred a liberal regime, which would allow them selling wheat in exchange of manufactured goods (mostly made in Britain). The "restauration" government was more prudent, and (from a Galiani's idea) set up a "moving scale" tariff: external custom duties were raised in case of "good harvest" and lowered in "bad time", thus keeping domestic prices fairly constant[13].

The liberal ideas made a come back in the 1840's, and 50's, as England, at the end, abolished the Corn Laws. The reason for that was double: first, in view of the demography, self sufficiency seemed out of question for England; second, the colonial era was opening, with the discovery "virgin lands", while progresses in transportation techniques, for the first time, were giving sense to the Ricardian assumption of negligible transportation costs. France followed, as well as most European countries, while the nascent US power was ferociously protectionist, at least for manufactures[14]. In Germany, to Friedrich List's despair[15], the *zollverein* was moderately active, unable to promote German unity by its own virtue.

In England, liberalism did not cause any harm (except perhaps to the agricultural sector), quite the contrary, no more than protectionism in the US. In France, the liberal period was short, because after 1870, Bismarck, the German prime Minister more or less imposed a mild protectionism to the whole Europe (except for England, and largely against it: the rational here, was a direct application of Friedrich List ideas concerning nascent industries. But contrary to List recommendations, agriculture was involved too, on the ground that Europe

[12] He was rehabilitated by Joseph Schumpeter who devote him more than 10 pages (which is not a small honour) of the *history of economic analysis* „ calling him "one of the ablest minds that ever became active in our field" (Schumpeter, 1954, P. 292). .

[13] This system is not so different from the Thaï technique of paddy price stabilisation during the 60's and the 70's – which enabled Thaïland to develop the most efficient rice production system in the world. See Kajisa and Akayama (2003).

[14] Among other causes of the Civil War, the protection question was significant: the South was liberal, hoping exporting cotton. The North was protectionist, avoiding "nascent industry" from Britain competition. The most notorious theorician of protectionism, Friedrich List, derived his book *Das nationale System der politischen Ökonomie* from his US experience (although born German, he was a US citizen).

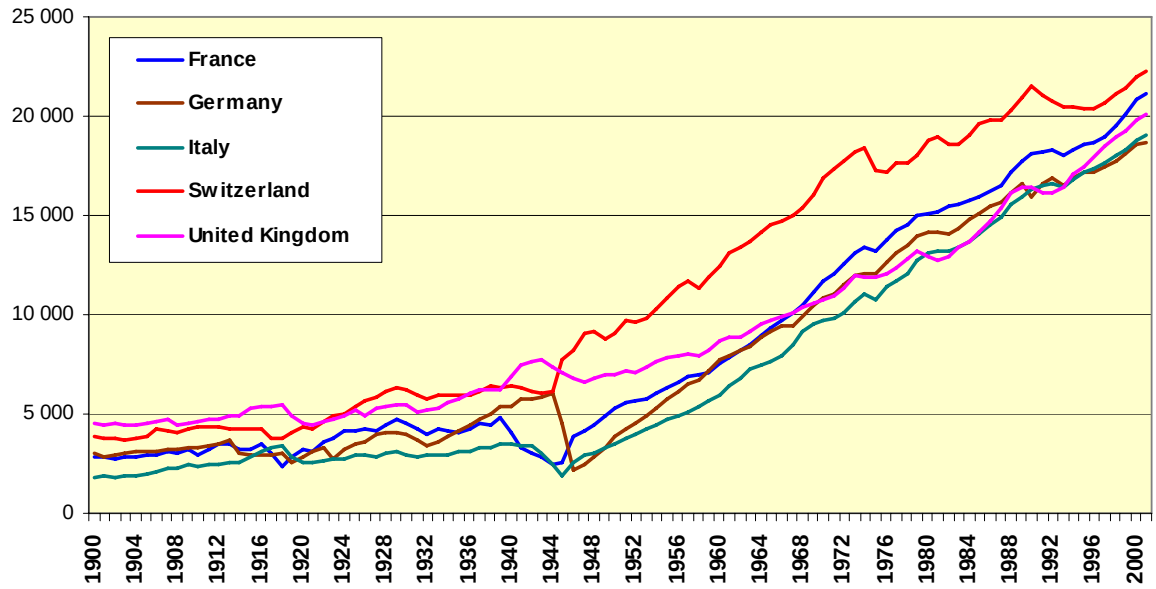
[15] Notice List was protectionist for manufactures, not for agriculture. In his view, "cheap food" was necessary to lower wages, and making manufactures competitive. In this sense, he was in complete opposition with Galiani, and, indeed, much less clever.

had been on the eve of the famine[16] several time since 1850, and that it was out of question leaving such events reproducing themselves).

This situation lasted until the First World War. During the war itself, State intervention became the rule for all belligerents. It was followed by a liberal period of euphoria, which ended with the "great depression" of the 1930's. The later was the point of departure of a new wave of protectionism and interventionism, which was reinforced by the second world war, and lasted until now (even if liberalism is fashionable since the 1980's..). It must be stressed that, in Europe at least (it is probably also true elsewhere), the economy never growth more rapidly than between 1945 and 1975, precisely the time of the most prominent State activism in the history …(see figure 1).

Figure 1 :

Per Capita GNP, Selected European Countries, 1900-2001
Sources: Maddison, OECD, 2001



Notice that, despite the above mentioned divergence between Galiani and List on precisely that point, up till the 1930's , protectionism, at least at decision makers level, was envisaged globally, without making distinction between agriculture and other activities : for instance, when France decide to raise duties in the 1870's, it is out of question to raise duties for manufactured goods only: agricultural commodities must follow, even if France, at the time, is a net food importer. The only exception is for tropical commodity, and even there, the true reason is that French imported tropical commodity comes from colonies, which are, in this respect at least, considered as parts of the "metropolis".

Now, this question is at the forefront of discussions in the aftermath of the great depression. The question was not only protectionism: Under the FD Roosevelt mandate, the question was

[16] In 1856 (to be checked), the French govenent was obliged to send steam powered battleship to tow away merchant sailing boats bringing wheat from Ukrain through the Gibraltar strait, in order to enable them reaching French harbours where famine was threatening.

indeed disconnecting agriculture from market. It was not a small decision: the first Farm bill was partially cancelled by the Supreme Court, and the proponents of the new course of agricultural policies were obliged to proceed by ruse. Among the many papers published at that time, one (Ezekiel, 1938) is of particular interest: Ezekiel gave the first clear exposition of the "cobweb theory", explaining that "parameters do matter". While a "luxury good" market is bound to converge toward equilibrium from whatever starting point, an "inferior good" market, with a low demand price elasticity, can "diverge", and never reach equilibrium. This was a reason not to deal with agriculture in the same way as with luxury goods. Therefore, President Roosevelt was not a "socialist" in disconnecting agriculture from market, only a pragmatist.

The "special treatment" of agriculture was an article of faith in the GATT, under J.M. Keynes's intellectual inheritance. It was questioned only during the Uruguay Round, , in the 1980's, ending with the Marrakech treatise in 1993. And we are in a phase of liberalism since then. The question now is: will last for long? Probably, as for the preceding cases, this will depend upon the delay before the next general crisis. Up till now, there has not been any global catastrophe that the new liberalism could have been made responsible for, even if many "small catastrophes", such as the East Asian crisis of 1998, did occurs. But this might occur. Models which do not assume producer's "perfect information" provide clues in this direction. They are worth to be examined right now.

III - Alternative models

Thus, we do not see the historical development of liberalism as a uniform motion from "backwardness" to "progress". Rather, it can be interpreted as a succession of cycles, the merits of liberalism being clearly perceived during the protectionist periods, while periods of liberalism frequently end by economic collapsing, which justifies a movement back to protectionism and State intervention. In addition, the most perspicacious analysts seem to make a distinction between economic goods, recommending a different treatment for Agriculture (as well as other "low elasticity goods") and other commodities. Is it possible to set up models explaining these characteristics?

A- The Ezekiel (and followers) theoretical cobweb model

The simple "cobweb" model by Ezekiel (1938) is a step in this direction[17]: as noticed above, it shows that "parameters do matter", and that nothing (but suppressing the market) can prevent market failure, with prices and quantities falling below zero. The cobweb model, nevertheless, is insufficient, in that it does not explain why are "cycle" lasting. Indeed, it shows that while luxury goods markets are stable, just as a ball in the bottom of a cup, which comes back to the

[17] Let q_t and p_t being quantity and price over a market, with :

(1) $p_t = \alpha q_t + \beta$, (demand curve, α and β are parameters) , and:

(2) $\hat{p}_t = a q_t + b$ (supply curve , $\hat{p}_t$ is expected price for year t, a and b , are parameters

(3) $\hat{p}_t = p_{t-1}$, (Naïve expectations)

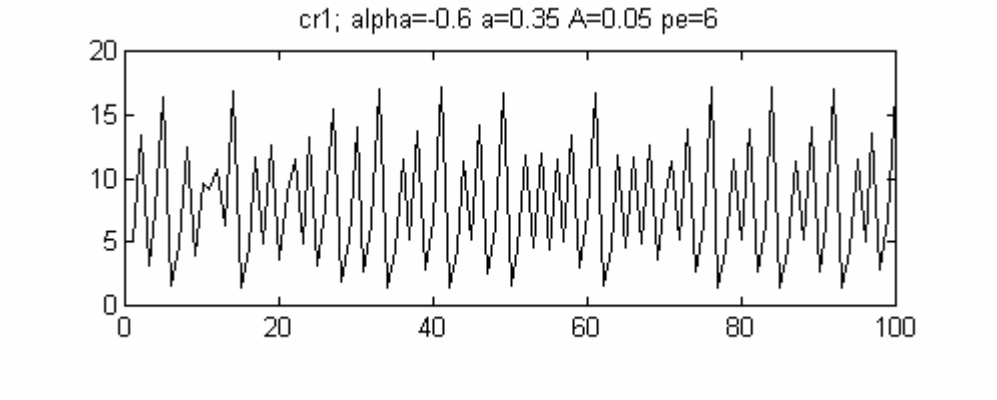
Then, if $\alpha/a < 1$, it easy to show that the model "converges" toward equilibrium, where $\alpha q_t + \beta = a q_t + b$.
But if $\alpha/a > 1$, the model diverges, with prices and quantities growing to infinity in absolute value while alterning in sign. The solution is periodic in the (unlikely) case where $\alpha/a = 1$

Such a simple model is easily programmed onto a spreadsheet.

bottom when the cup has been shaken, low elasticity commodities are just as a ball at the sharp end of a pencil: even if it is formally in a static equilibrium, the later is unstable, and the ball falls down at the least motion of the pencil.

What is needed, then, to explain cycles in the market historical development, is a "return spring", something like the string of a cup-and-ball game, which prevents the ball completely falling. Such possible return springs are indeed easy to find. One could imagine that when prices fall too much, producers are short of money, and cannot replace decaying capital (early explanations of the "pork cycle" rely on such a mechanism, more credible than the straightforward cobweb, which assumes producers being so stupid as not imagining their interest is in counter-cycling production). More than one century ago, Wicksell (1905) invoked risk aversion, which Boussard (1996) formalized in a "risky cobweb" model[18] (figure 2), which shows a price series over 100 "years" as obtained from this model.

Figure 2: example of a chaotic cobweb



Source: Author's computation, from equations listed on footnote 18 with indicated parameters

Obviously, in such a case, price never equates marginal cost, meaning that either producer or consumer loose each "year". Of course, each time the producer is the loser, the consumer is the winner, and *vice versa*. But as it is well known, losses are always greater than gains, so that, at the end, and over a long time, everybody is loosing at this game. This is a conspicuous

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[18] using the same notations as in footnote 17 above, here we take:

(3bis) $\hat{p}_t = = p°$, constant.

But since p is apparently random, with expected variance $\hat{\sigma}_t^2$. instead of equating marginal cost with expected price, as in (2),the producer equates marginal cost with the price certainty equivalent, that is (according to the classical Von Neuman model) :

(4) $$p^c_t = \hat{p}_t - A\hat{\sigma}_t^2 q_t ,$$

where p^c_t stands for the certainty equivalent of $\hat{p}_t$, and *A* is an absolute risk aversion coefficient. Thus (2) becomes:

(2bis) $$p^c_t = a\, q_t + b$$

Finaly, the model is closed by a naïve estimate of the expected variance (4):

(5) $$\hat{\sigma}_t^2 = (p_t - p_{t-1})^2$$

q_t is determined by solving recursively equations (1), (2bis) , (4) and (5), from an arbitrary initial q_0.On figure 2, *A*=0.05, a=0.35, b=0, $p^\circ = 6$, $\alpha = 0.6$, $\beta=10$, $x_0 = 5$; Any other parameters would produce a quite different curve. Similar (but different) curves can be obtained from more complicated models, with capital decay, adaptative expectations, etc… Again, this is easily programmed using a spreadsheet.

example of market failure, justifying state intervention (and, therefore, unavoidably, "distortions").

Yet, this theoretical exercise lacks the persuasive power of the CGE models described above. Would it be possible to incorporate the present analysis into a general equilibrium (one should rather say a general disequilibrium) model similar in spirit those which have been mentioned above, but slightly modified to take account of expectations and investment ? The CIRAD[19]'s ID^3 model[20] provides a partial answer to this question.

B – The CIRAD "ID^3" model

a) The standard CGE model

Let us define the sets I for factors, J for commodities, H for institutions, 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 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_{hjt} the demand of commodity j by consumer h for investment, e_{hi}, the quantity of factor I belonging to institution k ; $\pi_{jt,}$ 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.

The, reduced to skeleton, a standard recursive[21] CGE can be described with the following equations:

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

(2) $\phi_{jt} = p_{jt} F_j (... x_{ij}..) - \sum_{i \in J} p_{it} x_{ijt} - \sum_{i \in I} \pi_{i\,t} x_{ijt,}$ $j \in J$; (producer's utility)

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

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

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

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

[19] CIRAD means « Center for international research in agriculture and development ». It is a French governmental institution devoted to agronomic research overseas.

[20] It has been the subject of many publications, among which Boussard, Gérard,*et al* (2006), Boussard, Gérard and Piketty (2005),

[21] "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 period ahead in all applications below.

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

The model is solved by writing the first-order conditions for producer's and consumer's optima, that are 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 the only intertemporal equation is (7), which generalises the basic equation of capital dynamics. The standard version of the model is derived from these equations. In the imperfect information version, the following modifications have been included:

b) A first modification to the standard model : a lag between production and consumption

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

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

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

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

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

We chose a Nerlovian adaptative expectations scheme[22]:

$$\hat{p}_{jt} = \hat{p}_{jt-1} + 0.05*(p_{jt} - \hat{p}_{jt-1})$$

Notice that actual equilibrium prices are used for inputs, so that expectations are important only for next year output. At the same time, since incomes are distributed immediately, incomes for year t depend heavily on expectations for year t+1, which implies that firms may suffer losses or profit gains. They hence bear risk: 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).

c) A second modification to the standard model: introducing risk in production decision

[22] The coefficient of revision is very low. However, It may be justify as an approximation for rational expectations in a highly fluctuating environment. In the absence of sufficient information, rational actors may indeed decide to keep their expectations nearly constant, at the initial cost level, for example.

In the producer's utility function, some sort of/a risk premium is introduced. Although there are many possibilities in this respect, the simplest Markowitz utility function was opted for. Thus, (2ter) replaces (2bis):

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

where $\hat{\sigma}^2_{jt}$ is the expected variance of p_{jt}, and A_{jt} some/a risk aversion coefficient.

Of course, this implies the expectation function $E_v(.)$ to be defined for variance. With naïve expectations, E_m,, it seems logical to take $\hat{\sigma}^2_{jt} = (\hat{p}_{jt-1}\ -\ p_{jt})^2$, although more complicated expectation schemes could be envisaged. The order of magnitude of A_{jt} (the absolute risk aversion coefficient) is important. It should be commensurable with 1/w, where w is the average wealth of the decision-maker. This remark opens the way for introducing wealth and wealth distribution (in addition to income) considerations into CGE's – and this not the least interest of this approach.

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 decide to distribute it just as the income from capital, on the (fragile[23]) ground that profit is the reward for taking risk, and that profit accrue in general to capital holders.

d) A third modification to the standard model: the recursive equation

In most standard CGE's, the function G, which, in equation (7) specifies how the year factor endowment is derived from the year t-1 solution, is straightforward: changes in total labor force is driven by demography, while capital is easily shifted from one sector to another, so that it is "rationally" 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 is not very realistic. Other more realistic models have been set up with sector-specific labor force and capital. The difficulty of specifying the "recursive" relations between factor endowments of two successive years then become apparent.

In the present model, although it might be poorly realistic, no special care has been taken for labor: it shifts freely within groups of sectors (agriculture, manufactures, etc..). 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. With :

k_{jt} : capital of branch j, time t
S_t : total saving period t
$\hat{\pi}_{jt}$: expected profitability of capital in branch j

[23] Without quoting the whole enormous literature pertaining to distribution theory and the sociology of labor, it is well known that workers may benefit from the profits of a successful firm, especially if the latter enjoys some monopoly power, and even if this kind of advantage is vanishing nowadays under the pressure of competition.

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

A_k : risk aversion parameter for institution k

Pk_{jt} : price of the capital good for branch j

$\hat{P}k_{jt}$: expected value of Pk_{jt}

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

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

(8) $$\sum_j \hat{\pi}_{jt} Pk_{jt} I_{jt} - A_k \hat{V}(\pi_{jt}) I_{jt}^2$$

subject to :

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

with a naïve expectation scheme :

(10) $$\hat{\pi}_{jt} = \pi_{jt-1}$$

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

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

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

(13) $kj_{t+1} = kj_t (1-\delta_j) + I_{jt}$, where δ_j is capital depreciation rate.

In this way, the two mechanisms likely to constitute the above described "return spring" leading an unstable market to chaos (risk and capital accumulation, as noticed above) are represented in the ID^3 model. Notice that, although exchange rate variability has not been taken into account, such a model could be extended to cope with this important source of volatility.

e) Results

The Gtap data base (version 5) has been used to represent the world through 13 regions, 5 production factors and 17 sectors, including 8 for agricultural production and 4 for agri-business. 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.

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[24].

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

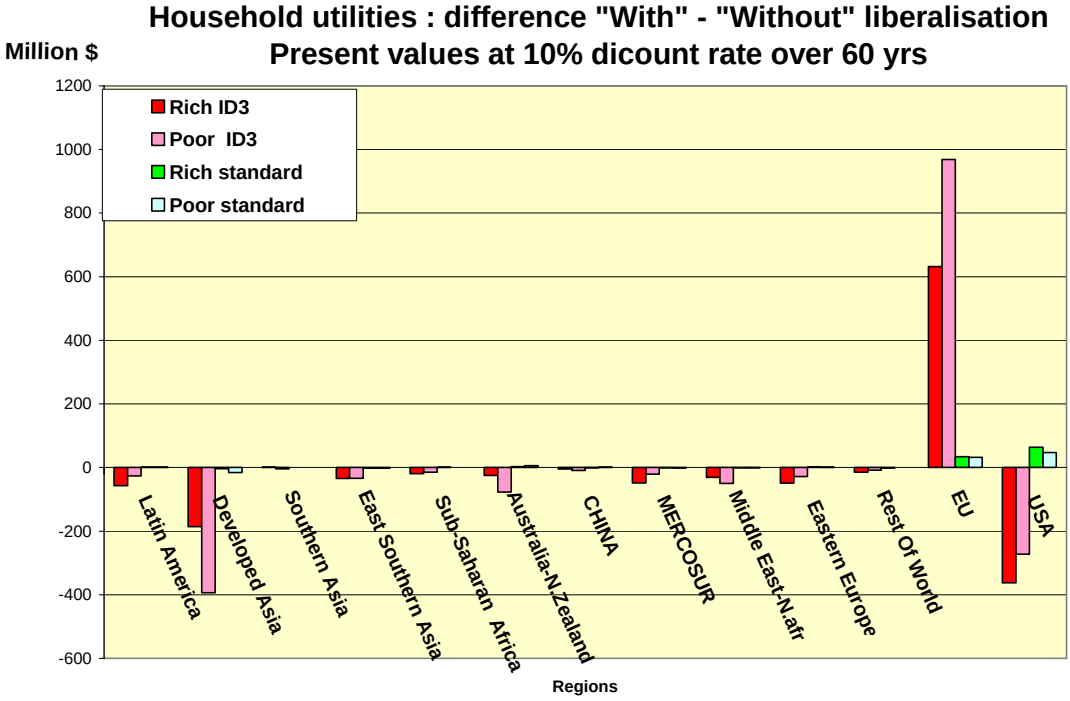
[24] Detailed equations of the model can be found in Boussard et al. (2002).

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

Armington assumption of imperfect substitutes of products from different countries holds. Parameters as well as transport costs are taken from the GTAP data base. Although exchange rate variability has not been taken into account, such a model could be extended to cope with this important source of volatility.

With such modifications, the results of a "total liberalisation experiment" are quite different from what they are with a standard model. Figure 2 shows the present values of benefits for poor and rich[25] at a 10% discount rate, under the two hypothesis "standard model[26]", and "ID^3 model

Figure 2



While the differences between "with" and "without" liberalisation are fairly small in the case of the "standard" model, they are very significant with the ID^3 model. In addition, while the

[25] These are not GNP, but the values of household utility functions. The later are standard LES's, with "committed consumptions" (especially for what concerns food products) and constant shares of products in .budgets over committed consumptions. Thus, utilities do not sum up to GNP, but to GNP less committed consumptions. At the same time, passing through utility functions is necessary if one wants looking at welfare of population segments (such as "rich" and "poor")

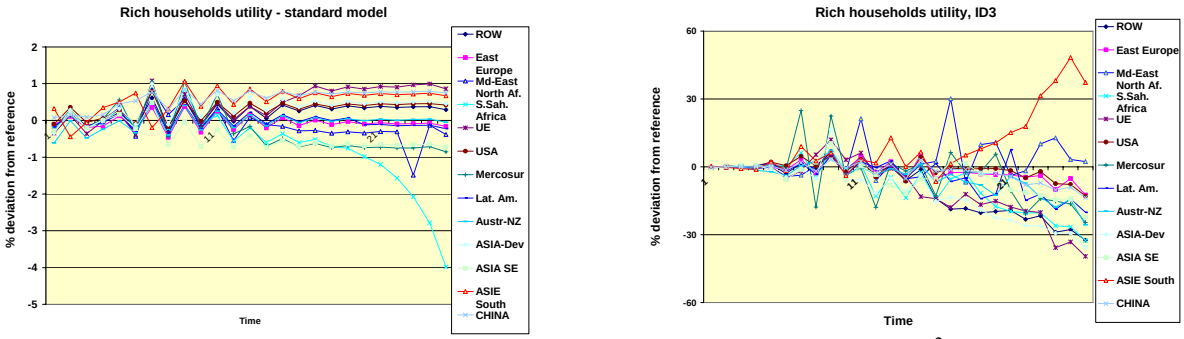
[26] Actually, the standard model here is not completely standard, since the « Markowitz sub model » described above (for allocating new capital between sectors) is still in action. Only the producer expectation and risk aversion submodels have been removed. Yet, in the absence of the volatility engendered by expectation errors, the Markowitz submodel plays a negligible role in results.

standard model suggest that modest gains are distributed across regions, only one region, Europe, gains with ID^3.

This last result is probably an artefact of the model: it is a consequence of the definition of the "reference" scenario, the "business as usual" assumption. In 1998, the reference year, EC rules were guaranteeing a low protection rate, especially for grains, while keeping a constant (medium) domestic price. As a consequence, in this reference situation, each time the world prices of grains were below the EC guaranteed domestic price, the EC was obliged to stock the excess world excess supply, at the cost one can imagine. The liberalisation frees the EC from the burden of stabilizing the world price, thus creating a large welfare increase in this region.

Yet, such a scenario is not very plausible: obviously, as soon as the EC authorities will be aware of the problem, they would redraft policy rules in order to avoid such a costly duty. Of course, this is not taken in account in the model. The model has also been run with this rule removed: in this case, it is simply impossible to get more than 10-20 years solutions, because, after this time, the system locks itself into a "no solution" situation. This does not mean that the model is "false" or inconsistent. Actually, nobody has ever seen a policy lasting for 20 years without change. And the reason for changing is precisely the awareness of going toward some inextricable situation. It is therefore not surprising that the ID^3 gets such an outcome.

The deep reason for this outcome is the volatility of prices, and, therefore, of benefits, in the "liberal" situation. Figures 3 and 4 illustrate this statement.



a: standard b: ID^3

Figure 3 : Time path of benefit from liberalisation for rich households in various regions with the standard model and with ID^3

Figure 3 shows the time path of the benefits from liberalisation, in % deviation from reference, in the case of the rich households (we could have drawn a similar graph for the poor) as determined by ID^{3}and by the standard model : one can easily see that the scales are not the same, deviations from reference varying around ±-5% in the case of the standard model, and ±60% in the case of ID^3. Indeed the volatility of benefits in this case is extreme, and certainly unbearable for those being in the worse situation (which is the case of almost every region, at an time or another). Such results can explain the people reluctance to liberalisation…

The volatility of benefits itself is a consequence of the volatility of prices, as shown on figure 4 for "other cereals" (that is, all cereals but wheat and rice), in the case of the Mercosur.

Clearly, prices are much more volatile in ID^3 than in "standard" simulations: They vary between 0.5 and 3 with ID^3 while staying between 1 and 1.5 with the "standard model". At the same time, one sees also on this graph that liberalisation does not increase the volatility significantly. This is because the Mercosur agricultural prices are not very protected in the reference situation, where they are already submitted to a more or less chaotic regime.

Figure 4

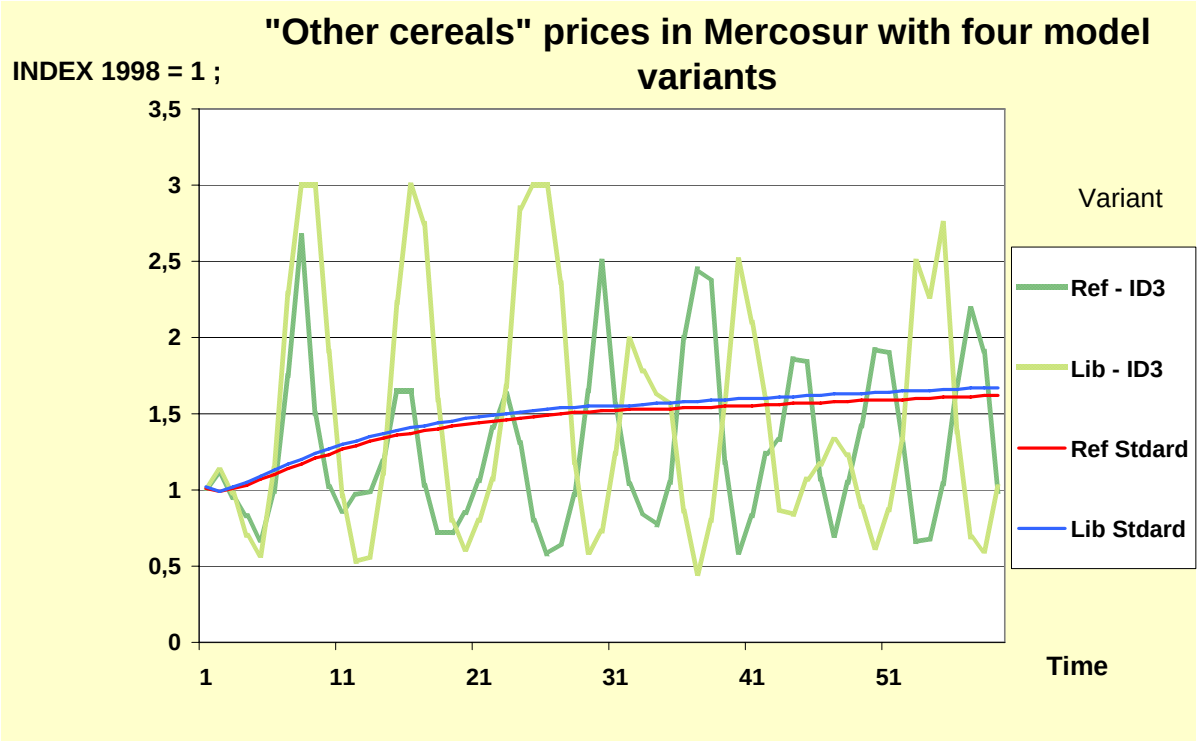
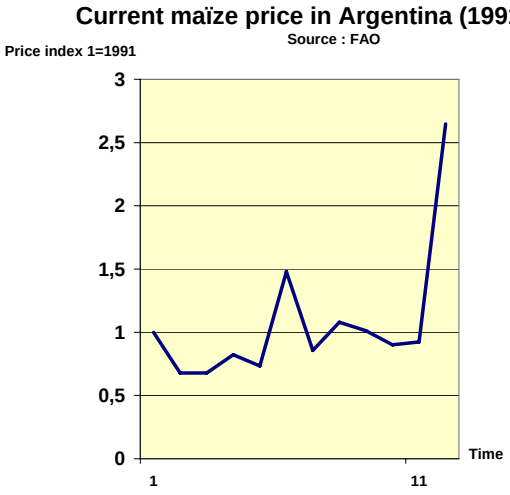


Figure 5 gives the current evolution of the price of maïze in Argentina : although there exist obvious difference between this real life series and the series generated by ID^3, the latter resemble more to reality than those generated by the "standard" model.

Figure 5



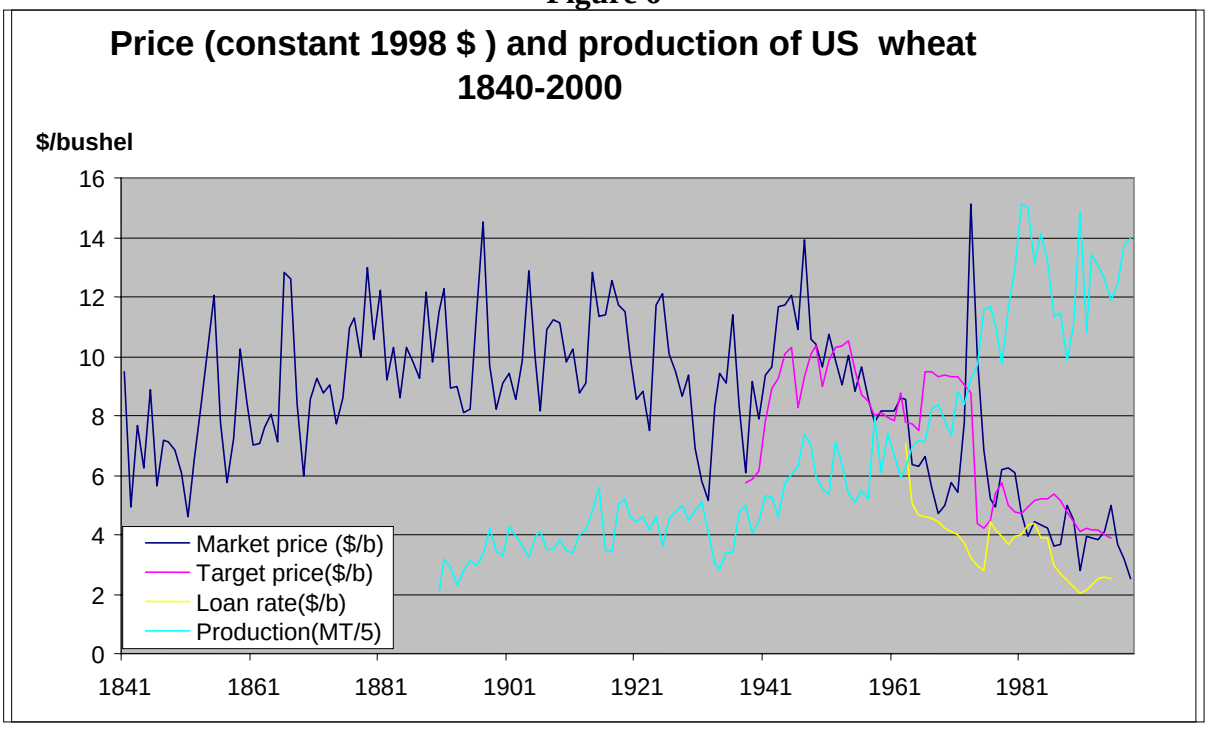
Of course, more general and systematic tests of ID^3 ability to reproduce the general pattern of agricultural price and production series have been attempted, with in general the same sort of conclusion: it is impossible to say that the ID^3 generated series are identical with actual ones, but in any case, they are "more similar" to actual than those generated by the standard model. It is therefore possible to consider the ID^3 model results with some confidence, and assert that the consequences of liberalisation, if they can generate "benefits" at the end, are also capable of generating an enormous instability, perhaps ending with tragic deadlocks. This instability will alternatively harm various segments of population - not the same all the time, but deep enough for that those having the least political influence, when their turn come to be hurt, be very reluctant to continue the experience. Thus, without mechanisms carefully designed for the winner to compensate the loser, it is extremely likely that social unrest and political instability prevent the experience lasting long enough for that everybody could reap the benefits. As we have seen, this is exactly what happened several times during the two last centuries.

IV-Returning to reality

Is possible to interpret real life history in the light of the above consideration? Obviously, this is a hard task, that will not be feasible into a short paper as the present one. Yet, some clues can be provided.

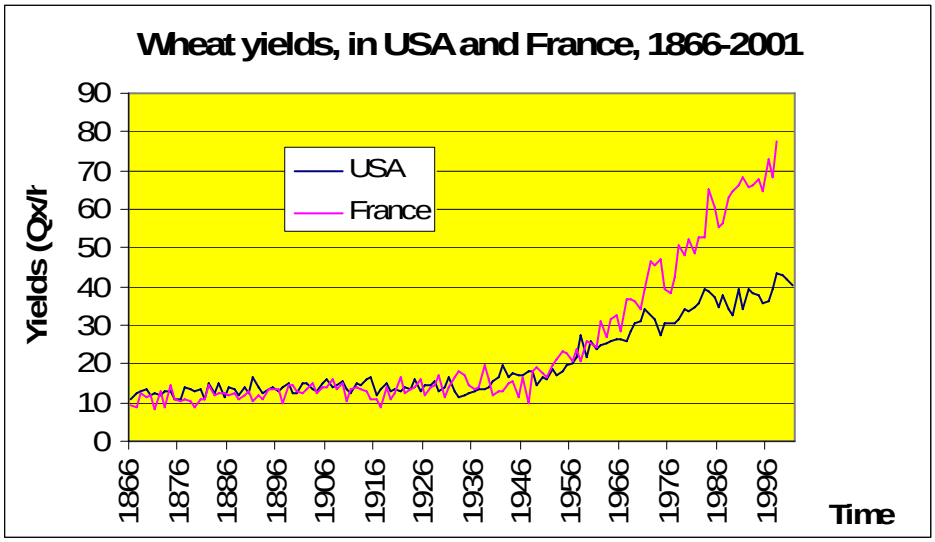
First, let us look at the long term history of US wheat prices (figure 6). It is easy to observe a break in this series, in the 1935's. It is detected by the now standard method for detecting break points (Bai and Perron, 1998, 2003). Before that date, the series is highly fluctuating, but practically stationary (there is a slight increasing trend from 1840 to 1900, and a slight tendency to decline between 1900 and 1930, but it is mild, and no break points are detected around 1900).

Figure 6



On the other hand, a break point is clearly detected in 1934 – the beginning of the Roosevelt's policy of disconnecting agriculture from market. Since that time, the price volatility is considerably reduced. The trend is increasing until 1946, because of the second world war. It is clearly decreasing after, and continues to decrease nowadays[27].
The main conclusion to be derived from this graph is that, contrary to the "farm problem" school allegations (Gardner, 1992), the agricultural US policy has not been at the consumer or taxpayer detriment. More precisely, although it has had a cost to the taxpayer, this cost has been recovered and beyond by the consumer. The reason is that this policy allowed for a fantastic upsurge of technical progress, and not only in the US, but almost everywhere in the world, as illustrated figure 7 regarding the US and France. It is especially interesting to notice that the break in the yield series occurs in 1935 in the US, and only in 1947 in France, when the Roosevelt's style policy begun to be effectively applied in this country.

Figure 7



Of course, it could be said that this progress would have been even greater within a purely liberal setting. One may have doubts in this respect, if one considers that most of the techniques applied in the 30's and the 40's existed for long before. What happened at this moment is that, freed from price volatility, farmers could take credit for heavy investments. In that way, they substituted capital to labour, freeing labour for other sectors growth, and engaging their country into a virtuous development cycle.

CONCLUSION

The main lesson is that, if trade is always "good", the necessity for it to pass through market is not always a blessing. If market does not work efficiently, with long run marginal cost never equating long run price, there are possibilities that the "liberal" situation be worse than the second best "policy driven" situation. Such a situation is likely to occur in the case of low demand elasticity, especially agricultural, commodities[28]. In such a case, of course, trade must

[27] Surprisingly, the price upsurge of 1972-74 does not appear to be remarkable in the Bai and Perron logic. It is treated as an outlier.

[28] Indeed, other commodities, such as petrol, are in exactly the same situation. But petrol is managed by a cartel which have been operating efficiently during the last few decennia , even if the events of the last few months may induce some to think it is now out of control.

not be ruled out. But it should be "regulated" in order to avoid unjustified price surges or declines. Now, since price regulation is not possible without restrictions to trade, such restrictions should be allowed.

On the other hand, whenever, because of high demand elasticity, markets can "converge" toward equilibrium, everything going toward a more liberal situation is desirable. This is exactly what Galiani used to say 250 years ago. This was also the message conveyed by Ezekiel, and which led to the present "modern" agricultural policies (even if most liberal economists would probably deny the word "modern", and reserve it to liberal policies which, in my view, are typically old fashioned). The present situation of the economic profession, which, in its vast majority, unconditionally supports blind liberalism, is the more surprising as all contrary arguments have been exposed and discussed for years.

Why, then, such a situation? A reason is probably because most modern economists are reasoning in terms of comparative static, while problems are essentially dynamic. Indeed, dynamics it the Achill's heal of computable general equilibrium models. In principle, as suggested especially by Arrow, there is no objection in considering a particular commodity at two different times as two distinct commodities (and the same for consumers and factors). This will just expand the model size, up to a point which quickly becomes unbearable, even with modern computers. On the other hand, a model designed in this way will be perfectly consistent with all the information available at a particular time, especially with regard to savings and investment. It can incorporate considerations of risk, especially if insurance markets are complete (and if risk is not endogenously generated, as we shall see below). It will describe the flows of trade over centuries : this is rather appealing !

But here is the problem: how can we have any confidence in a prediction of trade flows over 20 years, when it is so obvious that so many events can occur within this time span? Are complete insurance markets actually existing? Do the above mentioned advantages compensate for the increased computation and data maintenance burden? Because the answers to these questions are so obviously negative, I very much doubt that comparative static can be of any help in designing a development policy either at the national or at the world level. The problem of development is essentially a problem of (physical) capital accumulation: who could imagine treating such a problem from a purely static device, which ignores risk, miscalculations, credit and reimbursement, over and underproductions, and all these things which are the core of economic life ?

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