Can markets support trade ? The case of sugar.

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Abstract

A model of the world sugar industry shows that sugar prices are naturally chaotic. As a consequence, and contrary to the conventional creed, liberalisation, instead of damping fluctuations out, is likely to increase them. But since decision makers are risk averse, and restrain production when faced with uncertain prices, the average price level without is significantly lower than with liberalisation, thus jeopardising the benefits of a more efficient use of resources due to comparative advantage. The policy implication is that care should be taken not to create undesired situations for the right purpose of a better division of labour between nations.

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Trade is always « good » : As soon as two producing entities are different trade and specialisation widens the joint production possibility set, thus making a general welfare increase possible. Yet, this reasoning is subject to the *ceteris paribus* clause. Nothing else than mutually profitable exchange should occur when passing from the situations « without » to the situation « with trade ». In practice, it is not necessarily the case. If trade is led by defective markets, it may very well happen that the situation « with » is worse that the situation « without trade ». The reason for that does not lies in trade, but in market.

Such a statement will be shocking for many economists. Yet, as suggested 70 years ago by EZEKIEL (1938), and his famous « cobweb theorem », there exist situations, especially those deriving from low demand elasticity's, where markets may not converge to equilibrium. Rather, prices bounce up and down, and loose their capability to transmit reliable information between producers and consumers. Instead, they generate risk, which is not neutral toward production, because risk induces producers to be cautious, and to reduce investments and production. As a consequence, it may happen that, during the liberalisation process, increased risk cause the production to shrink instead of growing larger, in such a way that, at the end, the situation is worse « with » than « without ». During the last few years, the point as been made by several authors (BOUSSARD, 1996 ; CHAVAS and HOLT, 1993 ; BURTON, 1993) using theoretical models. Others (FULPONI, 1994) have noticed that commodity markets do no reflect the evolution underlying « fundamentals », as hypothesised by theory.

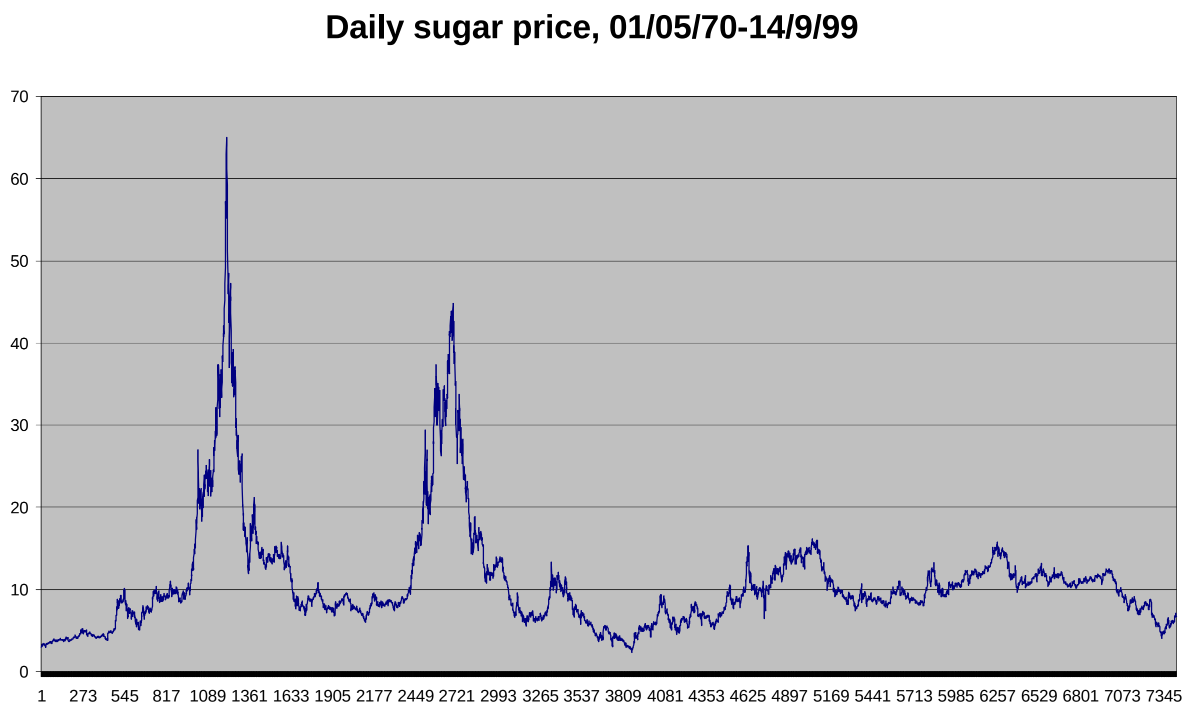

Figure 1 : Actual sugar price
Source : ***Chadwick investment Group (www.chdwk.com)***

If such effects are to be observed, the sugar market should make them evident. Sugar (figure 1) is a strange commodity. It is produced from two completely different vegetal species, one which growths only within a tropical, and one within a temperate environment. Firms producing sugar range from the tiny peasant to the giant « industrial » plant. Consumption levels per head are also extremely diverse, ranging from 6 kg / head / year in China to 35 in Denmark (but also in Morocco, which shows that wealth is far from being the key factor here). With this degree of heterogeneity in production and consumption, one may expect sugar is a good candidate for smoothly functioning markets, with a continuous adaptation of marginal producers and consumers to the slowly evolving techniques and tastes. But this is not true. On the contrary, sugar stands as a remarkably volatile commodity, with a volatility index considerably larger than average [1]/.

Two alternative bodies of theory can explain this paradox. A first one, as noticed above, relies on the difficulty of commodity markets to converge in the present of a low elasticity of demand with respect to price. A second one is more recent, and perhaps more subtle. The market is submitted to random shocks, due to meteorological or similar causes. They should in principle be damped out as time passes. However, because the sugar market is far from being « free », these shocks, instead of being absorbed by a large pool of consumers, are amplified by the behaviour of « state market » countries which, in a way or another, provide a price guaranty to their producers, thus distorting markets when spilling over unexpected temporary overproduction. The latter theory of price instability has been exposed by many authors such as BALE and LUTZ (1979), who claim that liberalisation would stabilise markets by the very virtue of the law of large numbers

Which of this two explanations is more conformable with facts ? It is very difficult to answer without making a full size liberalisation experiment. Yet, it is possible to find some clues using a suitable model of the industry. The results of such a pseudo experiment are reported here. It is based on a simulation of the world sugar market which reproduces stylised facts, without relying on random shocks in any way. Thus, the old Ezekiel explanation of fluctuations is supported against the more modern, but conceptually more demanding theory of random shocks. We shall first describe the model which has been used for that, and then, discuss results.

I – A model of the world sugar industry

Setting up a world industry wide model requires simplifications and assumptions which cannot be free from *ad hoc* considerations. Here, we have tried to avoid them as far as possible, by sticking to practitioners judgement about what was important in their decision making process. For instance, we decided to keep ethanol out of the model, on the ground that ethanol, especially in Brazil, was a purely artificial outlook for cane. Its connections with the sugar industry are loose, and can be neglected. Similarly, a major importance was given to stockpiling decision, because all professional consider it to be a major concern. Yet, the model is embedded in traditional economic theory, in the sense that every decision is taken on the basis of maximising an utility function under technical constraints. Also, markets clear up through equilibrium prices at each transaction level, even if behaviours are most of the time led by expectations pertaining to means and variances.

Figure 2 gives an organigram of the model, the basic unit for time being month. The model cycle begins with the farmers planting decision. Farmers are submitted to a production function, which relies

[1]/ BOURGES (1998) exhibits volatility indexes four time larger for sugar than for maize or wheat prices.

the production cost to the quantity of sugar produced per km^2. They maximize a Markowitz utility function : $U = \bar{z} - A s_z^2$, where z is profit, with mean $\bar{z}$ and variance s^2, and A is risk aversion coefficient, which is given a value 1/w, where w is the assumed average wealth of farmers (thus producing a significant discrepancy in behaviour between « poor » and « rich » countries).

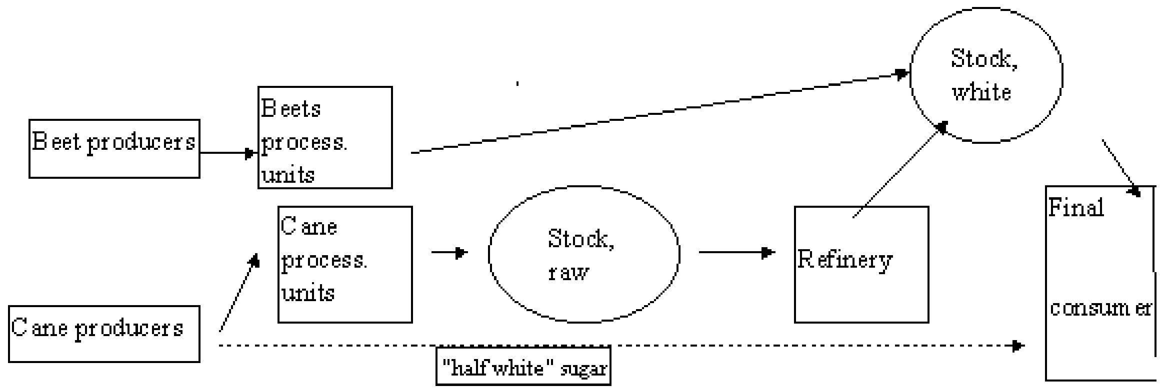

Figure 2 : A scheme of sugar industry

According to a well established practice, farmers pass a contract with processing units, which promise to buy the whole production at current price at harvest time. Thus, the expected supplied quantity in a given country depends upon the production density, controlled by farmers, and upon the area contracted by processing units. This area itself is decided upon at planting time by a market equilibrium. Processing unit maximises a Markowitz utility function of expected receipts minus costs, under the constraints of having to buys promises of plantation for a certain density, within a given radius which provides the surface collected. Farmers also maximise a Markowitz utility function of expected incomes (for the price paid to farmers is not known at planting time). Market equates supply and demand of beets or cane resulting from the first order conditions of these two maximisation problems. It must be noticed that collecting costs are proportional to the power ½ of the collected area [2]/. In addition, the contract allows for hedging, since it specifies the share of price variance at the charge of each contractors [3]/. Notice also processing facilities are bounded from above, but can be increased by reinvesting a fraction of benefits from previous years.

At harvest time, the processing unit takes care of the production, and sells the processed material to a stockholder. During the year after harvest, stockholders each month decide to sell a certain quantity spot. They are sure of the equilibrium price at which they sell and they have expectations pertaining to price and variance for next month. They are sure of the equilibrium price at which they sell now and they

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[2]/ Collecting a given area requires a random walk over a disc. The density of production is assumed to be uniform over the disc. In this case, total production is proportional the surface of the disc,B*R^2, where R is the radius. At the same time, it is easy to check that the mean distance from any point on a disc to the centre is 2/3 R. Thus, collection costs increases as 2/3*R*Q = 2/3*y*R^3, where Q is the production and y the yield. This part of the model was intended to discriminate between developing countries, where collection costs are relatively high and risk aversion large, and developed countries where the opposite characteristics hold.

[3]/ Of course, this holds only in the case of «liberalised» markets. If the price is decided by the government, the problem varnishes.

have expectations pertaining to price and variance for the next month. They decide between selling now at a certain market price, or later, at an expected price, depending on past period equilibrium prices and on world sugar stocks levels. Stocks must always be positive, and sales cannot exceed stocks. At the end of the year, stocks must be zero.

Buyers on this market are either final consumers, for white sugar, or refineries, for raw sugar. Refineries buy row sugar on spot market, transform it into white sugar at some cost, and sell it to final consumer next month. They have a limited refining capacity, which can be increased by reinvesting savings from previous benefits. They maximise a Markowitz utility function.

Finally, consumers buy sugar on the spot market, at equilibrium price. Consumers incomes and numbers are exogenous. They do not explicitly maximise anything, but are submitted to a rough linear expenditure system.

Despite its apparent complication, this model is extremely simple. The key features are expectation schemes at each levels. Instead of a « rational expectation » system, where expected prices are equilibrium price and variability is ignored, here, price and variability are the object of decision makers' guesses. The later are mostly but not only [4] based on « backward looking » expectation schemes. Numerous discussions with actual decision makers suggest that this scheme is close to reality. It is certainly amenable to improvement. Details can be found in BOUSSARD and PIKETTY (2000).

III - Results and implications

Figure 3 and 4 show the results of two simulation for the model just described. Figure 1 presents the result of a simulation intended to describe the present world sugar situation, with the US and EC continuing a severely regulated price policy, based on production and import quotas. The presentation of such a series is necessary to « check » the model, and discuss its ability to reproduce « real » facts. Figure 4 represents a more « liberal » policy, with the suppression of all production quotas and guaranteed price in Europe and USA and of all importation taxes in Europe, ex-USSR, East Europe, USA and Japan.

[4]/ Since, each month, the observed level of world stock plays a significant role in stockpiling decisions.

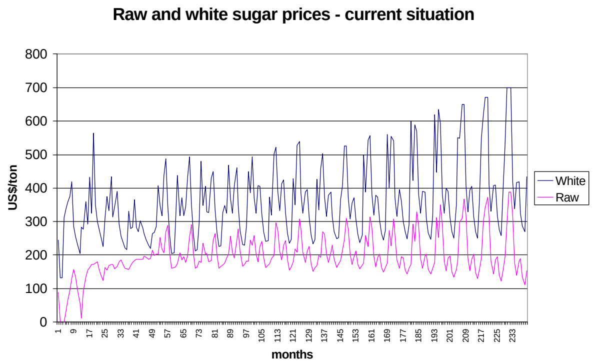

Figure 3 : Results of model simulation
World prices for raw and white sugar, present situation

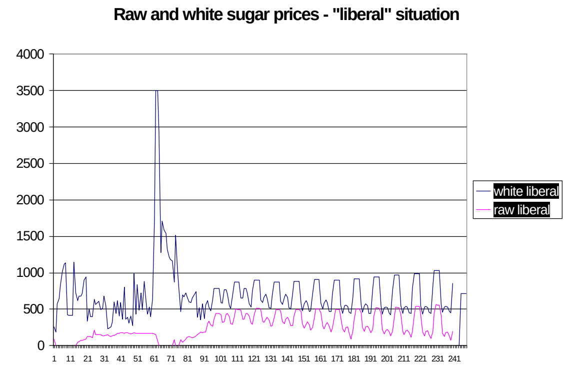

Figure 4 : Results of model simulation
World prices for raw and white sugar, liberalized

a - Validation

In standard econometric, model validation relies on some measure of the distance between model and reality, such as the sum of squared «residuals». Here, the problem is complicated from the fact that the model outcome is chaotic, which means that residuals are not independent of time, and should logically growth to infinity. As a matter of fact, this specificity of chaotic series is one of the reasons for why so many excellent econometric models performed so poorly in the past. With chaotic series, the predictive capacity of a model is not a good quality criterion anymore. To be precise, the model should still be judged in the basics of its predictive capacity. But what it is supposed to predict is certainly not "natural" endogenous variables such as price levels, or supplied quantities. Rather attention should be focused on the general shape of series.

In that framework, comparing figure 3 and figure 1, makes clear that series display some similarities, despite obvious differences. In fact, the figure 3 curve is quite similar to any other commodity price series, and somebody who do not know the curves being the outcome of a model could very well be caught if told it is a fragment of a « true » one. The main discrepancy comes from the fact that the "model" series is generally moderately « high », with, from time to time, a dramatic collapse, while the " true " series is "below the mean" most of the time, with a few dramatic upsurge from place to place. This means that something is wrong with our model, although, certainly, not « that much » , if one bears in mind that this kind of model is perfectly capable of either « diverging » or converging.

This impression is reinforced by the examination of figure 5. Here, the 120 first periods of the powers of the Fourier transforms of figure 3 and figure 1(white sugar) series have been plotted in parallel. For any particular point of these curves, a « high » ordinate value means that the underlying period (as defined by the number of month along the x axes[5]) is « important » in explaining the general shape of the series. Obviously, these "spectrum curves" present striking similarities, thus showing that our model captured a large fraction of the short term variability of sugar prices.

[5] To be precise, the peak at abcissa "20" means a perturbation which occurs every 120/20 month, that is, every 6 month.

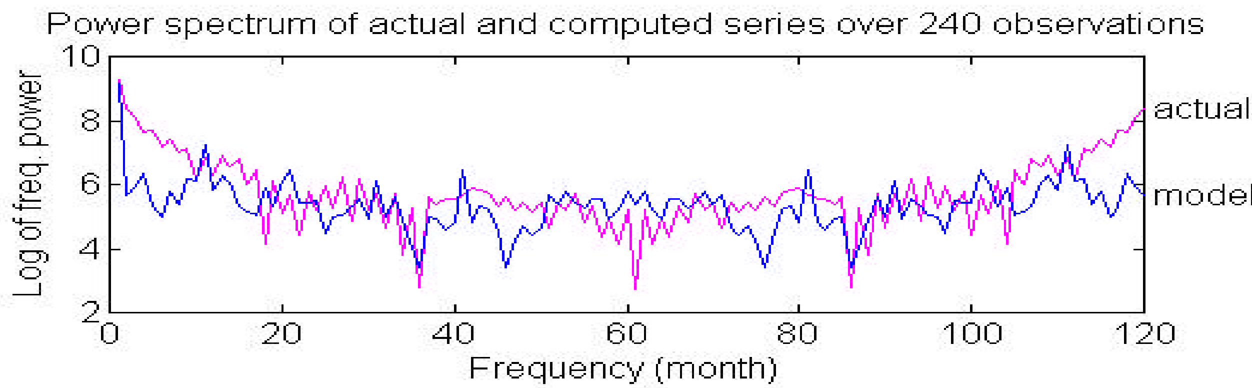

Figure 5 : Power spectrum of price series Fourier transform, first 120 months

The fact that this spectrum is very different from the "typical spectral shape of an economic variable", as described by Granger (1966) must be noticed: The power "should not" increase after passing through a minimum. This is typical of chaotic versus "normal" series.

In fact, the most striking inconsistency in this model lies in the figure 4 curve, which represents the « liberal » situation. It is almost periodical after nine years, which is completely incompatible with real world. If such a regularity could have been observed on any real price series, it would have been noticed by many speculators which would have taken advantage of it to make easy money. In so doing, they would have wiped periodicity out. Thus, periodicity cannot be found in the real world, and the model which generates it is surely defective. We are in the process of identifying the corresponding flaw, which seems to be linked with a too naïve expectation scheme. The model will be improved in this respect later on, by tacking account of backward periodicity in expectations.

b) Distribution effects

Because it is made of several "regional" submodels, with, in each region, a representation of the behaviour of a variety of agents, the model under examination provides also information on "who gains" and "who looses" from liberalisation.

Not surprisingly, governments loose, (figure 6) because imports taxes and duty are suppressed. Farmers loose too (figure 7), except in a few third world countries (but their gains are extremely small by comparison with the losses of EC farmers), because prices do not increase in comparison with the reduction of production (itself determined by the necessity of being cautious in presence of risky prices). Finally, consumers loose also, (figure 8) because the reduction of production causes consumers prices to rise.

Are there any winners ? Some traders really can benefit from the liberalisation, but not all of them (For instance, Brazilian traders suffer heavy losses, cf figure 9). Factories (here called "producers", in practice, very often the same firms as "traders") can benefit , but may loose as well. The only indisputable beneficiaries from liberalisation are the refiners (figure 11), because the increased uncertainty increases the wedge between raw and white sugar, thus allowing them to get substantial benefits**.**

In any case, the overall result is frankly negative, and the main reason for that is simply that all agents being cautious, the increased volatility induces everybody to be prudent, and to produce only those quantity they are fairly sure to be able to sell.

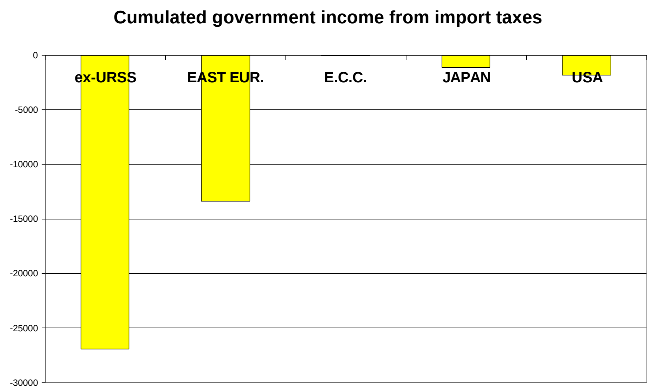

Figure 6 - The effect of liberalisation on governments revenues

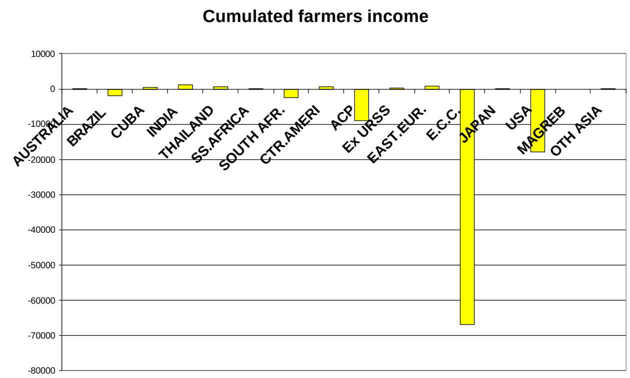

Figure 7 - Effects of liberalisation on farmers incomes

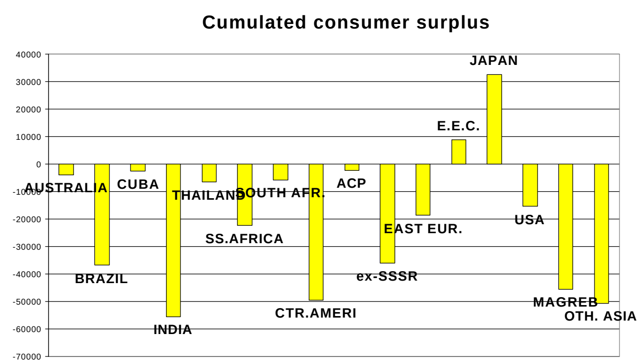

Figure 8 - Effects of liberalisation on consumers

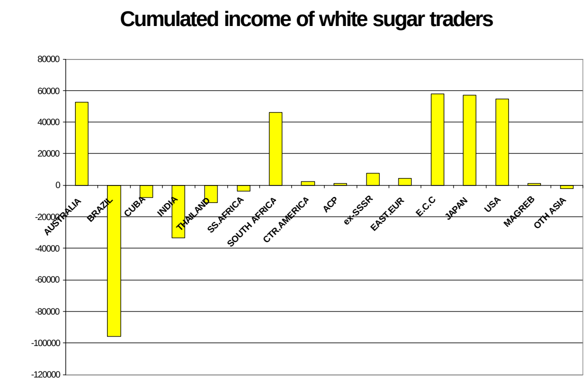

Figure 9 - Effect of liberalisation on traders (White)

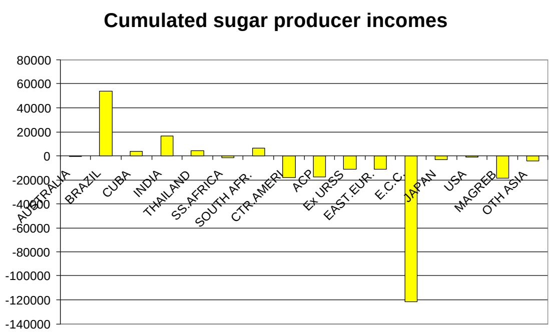

Figure 10 - Effects of liberalisation on factories

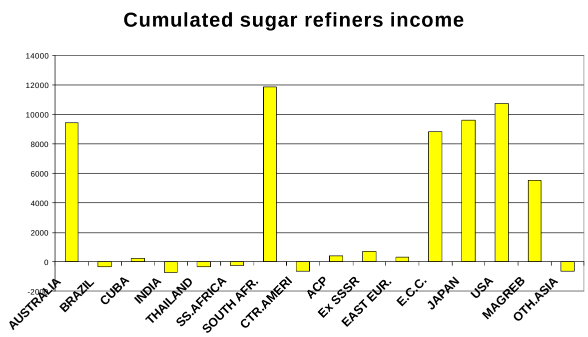

Figure 11 - Effects of liberalisation on refiners

c) Model conclusion

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One must be prudent in deriving practical conclusion from a notoriously imperfect model (but notice that most « general equilibrium model » did not even pass the rough test this one has been submitted to). The following conclusions should therefore be taken as interesting hypothesis rather than policy recommendations. Yet, the reported experiment suggests strongly that:

1°) Price volatility may be much larger in a « free trade » than in a regulated environment.

2°) This implies a smaller average production, a higher average price, a smaller consumer surplus, and probably a smaller global welfare in most occasions.

3°) Such situations occurs as a consequence not of meteorological or other random events, but of endogenous fluctuations, built up from demand rigidity and traders imperfect knowledge. The remedy to such detrimental fluctuations cannot be found by the market itself, but by suitable arrangements, combining as much liberty and as few bureaucracy as possible with correcting market inefficiencies.

General conclusion

. Thus, if tentative results just presented can be more strongly validated, contrary to a pervasive creed, the agricultural price regulation policies which were initiated by President Roosevelt in the aftermath of the great depression were not, or not only, the outcome of rent seeking agricultural lobbyists action, but rather an efficient mean of protecting consumers –especially, poor consumers.

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