Sugar Market Liberalization: Modeling the EU Supply of "C" Sugar

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Abstract: The various assessments of the effects of a liberalization of world sugar markets are largely inconsistent. One cause seems to be the modeling of the EU supply response. We investigate three possible linkages between production quota sugar and the out-of-quota or "C" sugar supply: *i/* the existence of fixed costs covered by the in-quota sugar; *ii /*the "overshooting" behavior as prevention against poor yields; *iii/* the production of C sugar as "reference building" in view of expected reforms. Modeling these effects results in the introduction of an implicit cross-subsidy between in quota sugar and C sugar. The resulting specification is included in a detailed model of EU agricultural sector so as to account for intersectoral linkages. We simulate the effects of the reform of the sugar sector proposed by the EU Commission in July 2004 and the effects of a ban on sugar export subsidies. The cuts in production and prices required to eliminate export subsidies are larger than those proposed by the Commission. However, the reform proposal makes large a decrease in tariffs possible. The need to eliminate export subsidies appears more constraining than the constraints on tariffs reduction for the EU. As expected, different assumptions on the interaction between in-quota prices and C sugar supply have a significant impact on the results and explain some of the differences observed in the literature regarding the effect of sugar market liberalization.

Keywords: Common agricultural policy, sugar, modeling, general equilibrium models

JEL Classification: D58, Q17, Q18

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Introduction

Sugar remains one of the most heavily subsidized sectors in many OECD countries. High tariffs have persisted in the United States (US), Japan and the European Union (EU). It has been estimated that 80 percent of world sugar production benefits of some form of support (Michell, 2005). In the EU, sugar is one of the very few sectors where the mechanisms for supporting prices have remained intact, in spite of 15 years of deep reforms of the Common Agricultural Policy (CAP).

However, major reforms seem to be under way. Multilateral negotiations under the World Trade Organization (WTO) should result in significant tariff cuts in the sugar sector, since the August 2004 framework agreement states that the most protected products will face higher cuts (WTO 2004). Pressures for reforms also come from bilateral or non-reciprocal trade agreements. The US has already increased tariff rate quotas, and imports of Mexican sugar will be granted duty free access in 2008. The EU will also grant duty free imports to sugar originating from Least Developed Countries (LDCs) in 2009 under the Everything But Arms (EBA) initiative, making the present Common Market Organization (CMO) unsustainable. The EU Commission has proposed dramatic changes in the sugar sector in July 2004, involving a large cut in intervention price and a reduction in production quotas.

Several authors have recently investigated the effects of changes in sugar policies. Studies have focused on multilateral trade liberalization, either on the effect of an extension of preferential regimes (e.g. the EBA), or on the effect of domestic reforms. Perplexingly, the different studies provide results that are largely inconsistent, even for similar scenarios. Some authors find that market liberalization will result in large welfare gains and significant changes in international trade. Others believe that the overall gains will actually be limited, due to inelastic demand (i.e. small initial Harberger triangles on the consumer side), supply control (quotas) and because rents will be reduced before reforms actually become binding and affect output. The degree of incoherence in the quantitative results is troublesome. The inconsistencies exceed what is normally observed between different modeling approaches (general *vs* partial equilibrium) in the agricultural sector. Here, the effects of trade liberalization are sometimes contradictory and the magnitude of the differences in, say, world price variations or change in welfare are striking. This raises legitimate suspicion about the results.[1]

[1] The International Sugar Organization points out, somewhat ironically, that "a recent IMF study shows that elimination of government support for refined sugar (…) in industrialised countries could boost world prices of these goods by between 2 to 8 % only. (…) the ABARE projected a world market price rise of between 5% and 41% depending on the extent of liberalisation. The CIE asserts that full liberalisation would boost sugar price by 63% as against the situation of full protection. The FAO estimated that complete global liberalisation would lead to a rise of 30% of world market price while a USDA study shows a more modest figure of a 16% price rise under full policy reform (…)". The author concludes that, "at most, the existing quantitative studies provide a range of views about uncertain outcomes" (Jolly 2003).

While there are several explanations for the diverging results regarding the effects of reforms on the world market, the changes in EU sugar net trade appear to be of particular importance. There is a large degree of uncertainty as to the level of EU sugar supply under different policy conditions. Because producers have been largely isolated from world market signals for decades, there is little statistical variability to exploit and the "guesstimates" of supply elasticities and production costs rely on thin evidence. We also believe that not enough attention has been paid to some specific characteristics of EU production, and in particular to the determinants of the supply of "C" sugar, i.e. sugar produced outside production quotas. One objective of this paper is to model EU sugar supply, accounting for specific aspects such as a potential cross-subsidy between production quota sugar and C sugar, the possible overshooting in production as insurance to ensure full rent capture even when yields are low, the incentive to build up reference production before future reforms, and the existence of rents in both the farm and processing sectors. Another objective is to provide estimates of the effects of trade liberalization on the world sugar market, following *i/* the reform of the EU sugar sector as proposed by the Commission in July 2004. *ii/* the elimination of EU export subsidies, as a possible outcome of ongoing developments under the WTO. A third objective is to assess how sensitive the results regarding EU trade, world price and welfare, are to the assumptions made about EU supply behavior.

We first provide a brief survey of the various studies assessing the impact of liberalization of the sugar sector. The specification of the EU supply response seems to be a major determinant of the world market equilibrium. We then investigate some specific aspects of EU sugar production, in particular those that might result in a cross-subsidy between in-quota and C sugar. We propose a simple way to model the sugar market that includes these specific aspects of EU producer and processor behavior. We integrate this representation of the sugar sector in a general equilibrium (GE) model of the EU economy in order to assess the outcome of some liberalization scenarios in the EU sugar sector. We then show the impact of the assumptions regarding C sugar supply response on the results.

1. The effects of liberalizing sugar markets

Some ambiguous results. Recent studies have provided some information about the effects of sugar market liberalization. Clearly, the scenarios vary according to authors, but the variation in the findings and conclusions cannot be explained only by differences in the policy changes that are modeled. Some authors find that even a partial liberalization in the sugar market will generate a very large increase in world prices. El Obeid and Beghin (2004)'s results illustrate such findings. Using a partial equilibrium model to simulate the removal of trade distortions, they find a massive increase in the world price, especially when domestic support is reduced, in spite of a large drop in demand that follows the removal of consumption subsidies in some countries. One explanation is the considerable

decrease in the production of sugar in the EU, i.e. a fall of 61% under multilateral liberalization. As a result, the EU becomes a net importer of some 8 million tons of sugar.

Other models that rely on a relatively similar structure (partial equilibrium model, non spatial, etc.), lead to very different results. For a similar increase in the world price, Wolhgenant (1999) finds that EU production increases by 2% and that the EU remains a net exporter of 2.5 million tons. Poonyth et al (2000) also find that EU production is barely affected by the reduction in intervention price required to eliminate EU export subsidies, and that, overall, EU exports would remain relatively stable. The OECD (2005) envisages that EU production would decrease by some 60% under their trade liberalization scenario. Adenauer et al (2004) find that exports would decrease significantly if export subsidies were phased out. Witzke and Kuhn (2003) find a significant decrease in the production of C sugar for a 30% decrease in prices.

The various general equilibrium approaches also lead to different, although perhaps less contrasted, results. Under a reform that liberalizes the sugar market, Frandsen et al (2003) show mainly an erosion of rents, but find that production is only marginally affected by a strong reduction of the intervention price in France, Germany, Austria and the United Kingdom. Bouët et al (2004) find that the reduction in EU supply is significant if tariffs are cut by 60% and export subsidies removed, but the resulting increase in world market price is minimal. Van der Mensbrugghe et al (2003) find that the EU becomes a very large importer of sugar under a multilateral liberalization of the world market.

Why do the results differ so much? There are many explanations for these discrepancies across studies. Some refer to the model specification.[2] Different assumptions about some key factors such as the supply response in LDCs and Brazil also have a significant impact on the world price. The way some side-sectors are treated also plays a role, because the effect of sugar reforms also depends on the behavior of the processing sector and on the linkage with the ethanol market. However, a major explanation of the differences across models lies in the different response of EU supply to a particular policy shock. The EU is the second largest exporter of sugar, principally due to its support policy, and the fourth largest importer, mainly because of its development aid policy. Changes in the EU net trade position have a significant impact on the world market equilibrium.

EU sugar policy is very complex and it is understandable that modelers have taken different routes to cope with the difficulty of representing adequately all the components of the CMO for sugar: two types of production quotas ("A" and "B") facing different supported prices, high specific tariffs, preferential access under import quotas, a safeguard clause, the possibility of producing out of quota sugar for the world market, levies for funding exports of in-quota sugar, etc (see Van der Linde et al,

[2] The sensitivity to the assumption of a homogenous *vs* differentiated good à la Armington is shown by Van der Mensbrugghe et al (2003). Models that include an endogenous supply of land in Brazil (such as Van der Mensbrugghe et al, 2003 or Bouët et al, 2004) tend to show smaller increase in the world price. Partial equilibrium models often provide larger price effects than the GE ones.

2000, for a complete description of the sector, or Frandsen et al 2003 for a briefer one). It is difficult to assess EU production costs and rents: producers expect significant reforms and hope for some compensation, so that information on costs is subject to strategic behavior and can hardly be trusted. Production quotas have been in place for more than 30 years and the administrative price has shown little variability. This makes it difficult to infer the effect of changes that would induce large variations away from the present equilibrium. Because of the complex system of two-tier production quotas, it is unclear how the quantity produced would respond to price changes. The problem is made worse by the interaction between the agricultural and processing sector. Indeed, there is evidence that part of the support to the sector is retained by the processing sector, which will be also affected by reforms. Because of fixed costs, the need to find suppliers of beet within limited distances, strategies of processing firms are likely to interact with those of the farm sector and affect the overall EU supply response, in a way largely unknown to modelers.

In brief, the uncertainty about EU supply response under different policies is a particular problem, and assumptions in this area appear crucial in explaining the outcome of any given model. Two issues appear particularly important: the level of costs and rents under A and B (hereafter A&B) production quotas, and the modeling of the supply of C sugar. By driving the EU supply response, these two factors play a large role in the results obtained by the different authors.

EU production costs. A major problem in modeling EU sugar supply is to assess which prices and costs actually drive production. The EU CMO sets an intervention price for sugar, from which a base price for beets is derived, but market prices may be higher than regulated prices (Swedish Competition Authority, 2002). Moreover, the actual price received by producers depends on local agreements and there is no reliable statistics on the price of beets within the A and the B quotas. Van der Linde et al (2000), Eurocare (2003) have compiled some information on costs of production. Estimates relying on budget generators and engineering data suggest that costs of production are close to the intervention price for sugar and the administrative ("base") price for beets (i.e. roughly 47 €/ton of beet). However, econometric or non-parametric estimates of marginal costs or 'opportunity costs' (i.e. the cost of producing one unit of beet instead of alternative crops) are much lower (Bureau et al. 1997). Recent estimates for France suggest that they were below 18 €/ton of beet (before the June 2003 CAP reform, see Rozakis and Sourie, 2004).

EU production of C sugar is significant, representing 4 to 13% of the 18 to 20 million tons of sugar produced in the EU-25, depending on the year. Not all regions have low marginal costs that would make it possible to produce at the world price, and only a few regions produce C sugar. Some EU countries do not even fill the quota they have been allocated, suggesting that their marginal cost is higher than the 631€/tonne of sugar intervention price. Simulations suggest that mobility of quotas could result in large transfers towards efficient areas and boost competitiveness of the EU as a whole (Bureau et al, 1997; 2001). After some reorganization and reallocation across areas, EU potential for

producing at low prices could be significant. It is therefore tempting to believe that, in the most efficient regions, producers respond to the world price. Several authors make such an assumption, but an indirect implication of this assumption is that the resulting EU supply curve is such that a fall in the intervention price would mainly erode rents, but not affect production. Even though this seems consistent with the existence a production of sugar for the world market, the assumption that aggregate EU production responds to the marginal costs of the most efficient producers might lead to an underestimation of the impact of reforms on EU outptut.

C sugar. Cross-subsidization of out-of quota C sugar by A and B sugar is sometimes seen as driving C sugar production. Three possible effects can be identified.

- Some authors consider that the high supported price for the production under A and B quotas covers fixed costs. This would allow production of C sugar at low prices, given the need to recover only variable cost (Van der Linde et al, 2000; Schmidt, 2003). If this is the case, it is not only marginal (variable) costs that drive EU sugar production, since any change in the in-quota price will affect the possibility of recovering fixed costs.
- During the recent period, world prices of sugar have been very low. There is some empirical evidence that this price hardly covers the cost of even variable inputs, such as intermediate consumption (Rozakis and Sourie, 2004). This suggests that some producers, if not all, lose money on some of the C sugar quantities they produce. A possible explanation is that some producers grow C sugar beets as an insurance strategy against revenues foregone when there are poor harvests. Again, if it is the case, one cannot model EU supply as a function of marginal cost only. It is necessary to work out more carefully the interaction between the supply of C sugar and the level of the rent drawn from the production of in-quota sugar.
- Finally, another possibility is that C sugar is produced so as to build references when producers expect that the ongoing reforms will result in a particular allocation of future production rights, premium rights or compensation. Again, if it is the case, this feature must be included in the modeling of EU sugar supply.

These points may result in interactions between in-quota sugar and C sugar, and could play a role in the response of EU sugar production to price changes. This may occur both at the beet production level and at the refined sugar production level. In the next section, we address these three possible cases in a more analytical way.

2. The EU sugar supply behavior

Cross subsidization through fixed costs. The potential cross-subsidization between in-quota and C sugar can be modeled using a simple short run comparative static framework. The profit maximizing problem of the beet producer can be written as (1).

$$\underset{Y1,Y2}{Max}\ \pi = P1.Y1 + P2.Y2 - C^{SR}(Y1 + Y2; w; z) - p_z.z \quad (1),$$

subject to $Y1 \le Quota$,

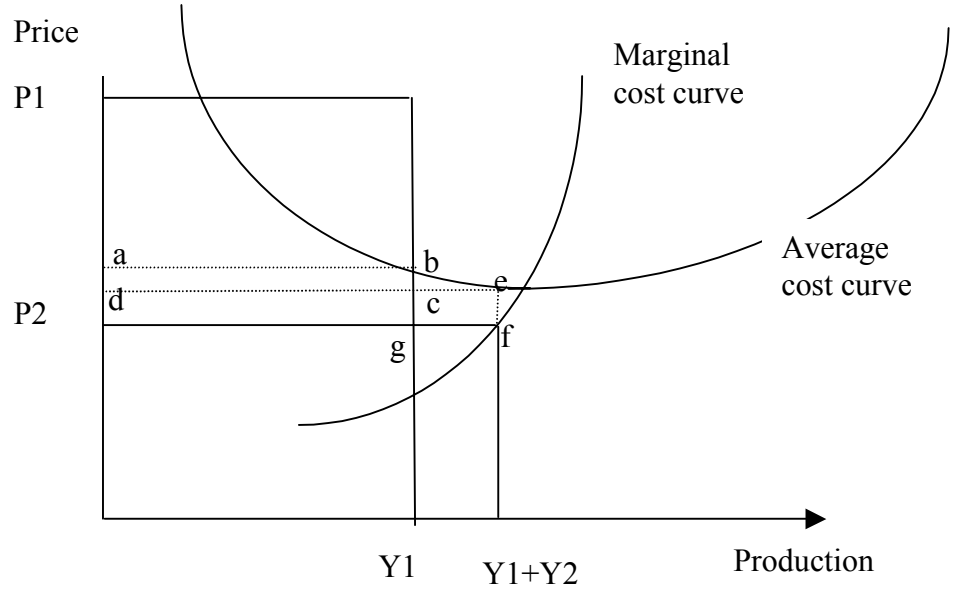
where z denotes an aggregate of quasi-fixed primary factors (capital, self-employed labor and land owned or subject to long term leases) whose (exogenous) price is p_z, w denotes the price of variable inputs, *P1* denotes the price of in-quota sugar beets, *P2* the price of out of quota beets, *Y1* the quantity produced in the quota, and *Y2* the quantity produced out of the quota (quantities of beets are in sugar equivalent, so as to adjust for the sugar content). C^{SR} denotes the restricted or short run cost function and Cm^{SR} its derivative relative to output, i.e. the marginal cost function; η denotes a Lagrange multiplier. The first order (Kuhn-Tucker) conditions are:

$$P1 - \eta - Cm^{SR}(Y1 + Y2; w; z) \le 0 \quad \perp \quad Y1 \ge 0 \quad (2a)$$

$$P2 - Cm^{SR}(Y1 + Y2; w; z) \le 0 \quad \perp \quad Y2 \ge 0 \quad (2b)$$

For certain levels of the marginal cost function, of the quota and of the price of C beets, the existence of quasi-fixed inputs may result in a cross-subsidy between A&B and C beets (a similar pattern applies to sugar production, so we will use "sugar" to describe both). This happens when *P2* and *Y1* are such that the production of C sugar induces a lower average cost due to a larger production scale. In such a situation profit maximization may result in a larger output than if the quantity *Y1* was not subsidized, i.e. if there was only one sugar price *P2*. Figure 1 shows a special case where the price of C sugar is higher than the marginal (variable) cost of producing at *Y1*, explaining that a quantity *Y2* of C sugar is produced, while the price of C sugar does not cover its production cost (*P2* lies below the average cost curve). The fixed costs are covered by the in-quota sugar. The production of C sugar is positive provided that the area *abcd* is larger than the area *cefg* in Figure 1.

Figure 1: A case of cross-subsidy between A&B and C sugar due to fixed costs



However, such a cross-subsidization cannot hold in the long run. If quasi-fixed factors can adjust to their optimal level for production *Y1*, then there is no point producing C sugar at loss as in Figure 1. The simple expression of the long run producer's profit maximization problem (2) and Hotelling's lemma shows that such a cross-subsidy is not optimal. Obviously, there might be production of C sugar in efficient firms where the long run marginal cost is lower than *P2* at the production level *Y1*, but in such cases, the difference between *P1* and P2 is a simple rent, and there is arguably no cross subsidy.

$$\underset{Y1,Y2}{Max}\ \pi = P1.Y1 + P2.Y2 - C^{LR}\left(Y1 + Y2; w; p_z\right). \quad (3),$$

As pointed out by Witzke and Kuhn (2003), the quota regime has been in place for many decades almost without modification, and it is difficult to believe that the current situation is merely a short run equilibrium. Major non-convexities (indivisible inputs) could prevent firms from adjusting their production structure to the optimal input level corresponding to the quota as in (3). However, in the beet sector, there are many opportunities to share machinery, to buy second hand machinery, and to purchase contract work. Contract harvesting or planting costs are only slightly decreasing with the size of operation. The fixed component in the cost of contract work is not large enough to provide a significant incentive for producing C beets so as to spread this fixed cost on a larger output. Overall, the argument that the fixed costs of C sugar are covered by the A&B quota, and that this explains the production of C sugar in the EU is not compelling.

However, a recurrent problem in production economics is to define how long is the "long run". In Europe, there is evidence that some equipment have a long service life.[3] In addition, in the processing sector, some equipment might be less divisible, or less easily adjustable than in agriculture, and fixed costs in refineries could be a reason for sugar processors to encourage farmers to produce C sugar.[4] For this reason, we keep open the possibility that the production of C sugar benefits from the high price of A&B sugar, i.e. that there is some form of cross-subsidy, when modeling the EU sugar sector.

C sugar as insurance. Because of the high price received for in-quota sugar beets, producers may overshoot so as to make sure that they will capture the rent in case of poor harvests. A rational beet producer will accept losses on the C sugar, or on a share of the C sugar, in order to maximize expected profit. The non-linearity in prices caused by the quota and the asymmetry between gains and losses caused by the dual price system result in kinked marginal returns, showing similarities with the

[3] A reasonable distribution around the average service life estimated by some national institutions (40 years for buildings in France, 15 years for some machinery), suggests that the "long run" can be… very long for some individual firms (Ball et al, 1993).

[4] It is reported that, at least in one anecdotal case in France, some sugar plants require that some of their supplier farmers produce beets beyond their individual quota, even though this is not necessarily profitable for these farmers (the refinery accepts in-quota beets only if supplemented by a certain percentage of C beets). If there are some large unused capacities, it is also possible that processors also pay above the nominal price for C sugar beet, given that the exact nature of contracts between beet producers and processors is a bit of a grey area.

classical concavity of the expected utility function. In such a case, even a risk neutral producer will overshoot as prevention.[5]

A defendable assumption is that all costs are experienced by the time of harvesting.[6] In such a case, if the output harvested is one unit lower than the target quantity *Y1*, the loss is *P1*. If it is one unit larger, the extra profit is *P2*. Let us call *q* the subjective probability that the actual yield exceeds the expected one by one unit. The expected profit of the producer targeting a production *Y1* is *P1.Y1-C(Y1)-q.P1+(1-q).P2*. Here, *C* denotes the long run cost function (rather similar behavior can be derived with a restricted cost function) and *Cm* denotes the marginal cost. The expected profit of a producer targeting one unit of production above *Y1* (i.e. overshooting) is *P1.Y1+P2-C(Y1+1)+(1-q).P2-qP2*., with $C(Y1+1)-C(Y1) \approx Cm(Y1)$). That is, overshooting is rational provided that $Cm(Y1) - P2 < q(P1-P2)$. The higher the difference between the two prices, the more likely the overshooting.

More formally, the introduction of an "insurance" behavior modifies the standard marginal conditions that characterize optimal production. The producer's expected profit maximization problem takes the form of a discontinuous function as in equation (4), where δ denotes the Kronecker symbol, and μ_r is the expected yield (unit sugar content times quantity of beets per hectare), under the assumption that variable costs are experienced before climatic conditions affect the final yields. L denotes the quantity of land (acreage), r denotes the actual yield and the bar over *Y1* denotes the quantity under quota.

$$\underset{L}{Max}\, E\left(P2\,.\left(r.L-\overline{Y1}\right)+P1.\overline{Y1}-C\left(\mu_r.L;w\right)-\delta_{rL\le\overline{Y1}}\left(P2-P1\right).\left(r.L-\overline{Y1}\right)\right) \qquad (4),$$

or

$$\underset{L}{Max}\, P2.\left(\mu_r.L-\overline{Y1}\right)+P1.\overline{Y1}-C\left(\mu_r.L;w\right)-\left(P2-P1\right).\mathrm{Prob}\left[rL\le\overline{Y1}\right].E(r.L-\overline{Y1}\,;\,r.L-\overline{Y1}\le 0)$$

The first order conditions involve

$$P2.\mu_r-\mu_r Cmg(\mu_r.L;w)=\left(P2-P1\right).\left\{\begin{array}{l}\dfrac{\partial \mathrm{Prob}\left[rL\le\overline{Y1}\right]}{\partial L}.E(r.L-\overline{Y1}\,;\,r.L-\overline{Y1}\le 0)\\ +\mathrm{Prob}\left[rL\le\overline{Y1}\right].\dfrac{\partial E(r.L-\overline{Y1};r.L-\overline{Y1}\le 0)}{\partial L}\end{array}\right\}. \qquad (5).$$

Note that equation (5) can be simplified by dropping the first term between brackets if we assume that yields are not correlated to the acreage L, so that the term in "Prob" is independent of L. Three conclusions can be drawn from equation (5) and from the fact that the bracketed term is positive, and

[5] A similar behaviour can be observed for "B" sugar in some regions, where farmers only with to fill their A quotas, as pointed out to us by H.G. Jensen.

[6] When the actual yield (i.e. the quantity of beets per hectare and the sugar content) becomes apparent to the farmer, the variable costs of inputs and fertilizers have been incurred. It is also reasonable to assume that most remaining (post-harvest) costs are not a function of the quantity produced. A large share of the yield variability depends on the sugar content, a function of sun exposure during the pre-harvest period, when fertilizers and pesticides have already been spread. It is true, however, that the level of some inputs used (pesticides, herbicides) affects the degree of yield variability caused by pests and weeds.

therefore the right hand side of (5) is negative. First, producers will overshoot and produce C sugar, since the determination of the optimal supply behavior responds to the condition that marginal costs equals the price *P2* plus a positive term. Second, this term depends positively on the probability of a bad harvest. Third, this positive term depends positively on the difference *P1-P2*. This point is important because it shows that, under such an "insurance" behavior, there is a cross-subsidy between in quota and C sugar even in the long run, without the fixed cost effect described above. Indeed, the higher *P1*, the more it becomes profitable to produce C sugar for insurance. Note that this cross-subsidy is obviously linked to the fact that the quota is binding, otherwise equation (5) would collapse into the traditional condition *Cm=P1*.

This relation does not prove that C sugar is formally cross-subsidized in the EU. The incentive to overshoot is mitigated by the possibility of "carrying over" sugar quotas rights from one year to another under the present CMO. This possibility would reduce significantly the cross-subsidy resulting from (5). Some sugar plants also have an internal procedure giving flexibility to beet suppliers to smooth the supply over several years, so as to prevent overshooting. In addition, empirical evidence suggests that the insurance behavior is unlikely to explain all the C sugar production in the EU15 (Adenauer et al, 2004). Indeed, the level of EU15 production is only consistent with expectations on yields that would be unrealistic. However, the "overshooting" factor may explain a share of the C sugar production, and we believe that the resulting implicit cross-subsidy needs to be included in the modeling of EU supply response behavior.

Expectations. Given the ongoing reforms and the uncertainty that surrounds them, it is possible that farmers produce beyond the (static) optimum level, expecting that historical references will be used in the future. Indeed, in the past reforms of the CAP, many quota allocations, premium rights or compensations have been given on the basis of historical references. A precautionary behavior so as to "build up" potential references would be rational under particular expectations by producers and/or processors regarding future reforms (such a phenomenon was observed in the US during the 1980s, see de Gorter and Fischer, 1993). Assume that producers expect that future quota mobility across the EU, which is a component of the recent EU Commission proposal, will result in closing sugar plants in some regions. This assumption is realistic, since some sugar processors have already closed profitable plants in anticipation of the reform.[7] Consider an efficient producer who expects that, in his area, local processors will manage to increase their sugar quota, and that the level of present production of C sugar will be used as a variable in allocating the new quota between individual beet producers. (Other patterns of expectation are possible, but it is likely that farmers will end up with the idea that the more they produce C sugar beet, the more they will be eligible for extra compensation, or future reference

[7] In Ireland, a sugar factory closed in March 2005, at a time where the reform was still a simple Commission proposal. This plant made a significant profit in 2004 and the owners have indicated that they expected that production of beets would not be profitable in the future because of the reform and future international arrangements.

values). Let us use a subscript *t+1* to denote expected prices and quantities in future period, a subscript *t* for the present period, and the variable τ to represent a discount factor. The profit maximization problem of a producer like the one described above is:

$$Max\pi = P1_t.Y1_t + P2_t.Y2_t - C\left(Y1_t + Y2_t; w_t; z\right) + \tau\left(P1_{t+1}.Y1_{t+1} + P2_{t+1}.Y2_{t+1} - C\left(Y1_{t+1} + Y2_{t+1}; w_{t+1}; z\right)\right) \quad (6),$$

subject to $Y1_t < \overline{Y}1_t$ and $Y1_{t+1} < \overline{Y}1_t + \lambda Y2_t$, where λ represents the degree to which the producer estimates that future quotas will be based on the present production of C sugar. Maximization in $Y2_t$ leads to a first order condition stating that $Cm_t = P2_t + \tau\lambda(P1_{t+1} - Cm(Y_{t+1}))$. That is, the optimal production of C sugar verifies the condition that *Cmg=P2* plus a positive term. This term depends on future rents, i.e. on future in-quota prices. While it is likely that producers expect future in-quota prices to be lower than the present ones, the prospect that these prices will remain higher than the world price may explain present production of C sugar.

Does this show that the C sugar is cross-subsidized? Formally, there is no direct linkage between the A&B sugar price and the supply of out-of-quota sugar, since the production of C sugar depends on future in-quota prices, and not on present in-quota prices. However, if the "reference building" behavior does not introduce a formal cross-subsidy, it may be one of the explanations for the relatively high levels of C sugar produced during the recent years in the EU15, in spite of low world prices.

Rents and production costs: some econometric identification The three cases presented above suggest that modeling of EU production under the usual assumption that producers maximize profit so that marginal revenue equals marginal costs may incorrectly represent EU supply response. If one calibrates the supply curve assuming such a relation, and then uses the prices observed to infer marginal costs, this may lead to construct a EU supply curve which lies below the actual one. This might lead to underestimation of the fall in EU production that would take place under market liberalization. Overall, it may have a significant impact on the results obtained for world prices and trade.

Several authors have acknowledged that the different effects above should lead to a modification in the traditional modeling of supply. Witzke and Heckelei (2002) or Adenauer et al (2004), Adenauer and Witzke (2005) introduce shifts in the supply curve in order to account for some of the phenomena described above. They identify the problem as the assumption of a representative agent. They account for the diversity of situations by using a larger number of representative farms. Within their framework, the "insurance effect" described above, for example, affects producers, with different levels of marginal costs, differently. Once these individual behaviors are aggregated, the resulting supply curve is such that beet growers behave like if their quota endowments were higher than the actual ones. Their criticisms of the representative agent assumption are well-grounded. There is

clearly a distribution in producers' efficiency in each region, and producers who will never produce C sugar have a supply function different from those who will. However, we believe that one can deal with the issues mentioned above by using an aggregate function that summarizes heterogeneous individual behaviors. That is, we see no fundamental problem in assuming aggregate supply curves as done by Frandsen et al (2003). Instead, we alter the behavior of a representative producer so as to depart from the assumption that EU supply responds to out-of quota prices under the usual marginal conditions, a point already raised by Witzke and Heckelei (2002). We believe that the usual marginal conditions could lead to the unrealistic conclusion that, because the EU produces C sugar, EU producers act as if they responded to the world prices regardless of the in-quota price (which would mean, implicitly, that they are competitive with a world price of sugar resulting in a price of beets of 20 €/ton or less).

The existence of a gap between marginal revenue and marginal costs for the aggregate producer is central in our approach. A common feature of the three effects described above (fixed costs, uncertainty on future yields and the asymmetry of gains/losses, expectation on future references) is that the producer's behavior leads to conditions between the marginal cost *Cm* and the out of quota price *P2* of the type $Cm=P2+\theta$, where θ is a positive function of *P1* and a negative function of *P2*. In order to charcterize θ, we estimate econometrically the linkage between the decision toplant *L* hectares in sugar beet and sugar prices. We assume that *Cm* is a linear (increasing) function of *L*, i.e. $Cm=a+bL$, *a* and *b* being coefficients to be estimated.[8] The variable θ is also assumed to depend in a linear way on the in-quota and out-of quota sugar prices, i.e. $\theta = c+d(P1-P2)$, *c* and *d* being coefficients to be estimated. Combining the expressions of *Cm* and the expression of θ, a synthetic representation of the land acreage decision is therefore:

$$L= (c-a)/b + d/bP1 + ((1-d)/b)P2. \quad (7).$$

Adding an error term reflecting all other variables omitted in this specification, we estimate (7) using ordinary least squares for France (due to availability of data). We rely on data from Eurostat for acreages and *P2* (spot sugar prices). Data for *P1* including various taxes are taken from van der Linde et al (2002) and from Confédération Générale de la Betterave, and all prices are deflated by the GNP price using Eurostat data. Various specifications with trends and lagged variables were tested, but the naïve expectation specification fit the data best. Table 1 provides estimates of the parameters, the cost of production and rents for France, from which we derive the implicit subsidy between A&B and C sugar. The estimate of parameter *b* is consistent with the classical Ricardian of decreasing land marginal productivity. The parameter *d* provides indication on how the price subsidy (*P1-P2*) affects the production level of sugar (which is the implicit solution to $Cm=P2+\theta$). That is, *d* plays a key role in characterizing the degree of cross-subsidization. In the case of France, *d* is positive and is

[8] Other specifications (for example quadratic) did not improve the econometric calibration presented in Table 1.

statistically different from zero. While this cannot be considered as formal evidence that there is cross-subsidization in all EU production, it suggests that the rent in A&B sugar indeed affects the production of C sugar and that marginal costs are higher than the world price of sugar.

Table 1. Econometric estimates of the supply behavior for France

Parameter estimates	Estimate (t Student)	Regression analysis (OLS)
c-a=254	(c-a)/b: t=4.1	R2=0.64
b=1.08	d/b: t=1.92	N=22
d= 0.56	(1-d)/b: t=2.4	DW=1.7
	Sample average	Year 2004
P1	534 €/t	577€/t
P2	227 €/t	174€/t
Unit subsidy to C sugar	171 €/t	225€/t
Unit tax to A&B sugar	42 €/t	48€/t
Actual unit revenue of A&B sugar	492 €/t	529€/t
Total quota rent	300 mn €	425 mn €

3. The simulation framework

The GE model. The modeling of EU sugar sector is included in a larger general equilibrium (GE) framework in order to assess the effect of trade liberalization and policy reforms on the EU economy. At first glance, this may seem an "overkill" strategy, since the sugar sector is unlikely to be large enough to have significant macroeconomic effects. However, there is no serious obstacle to including a more detailed sector within a broader framework. GE is appropriate for modeling multi-output production, consistent with the fact that sugar is always produced in combination with other crops. In addition, proper modeling of the EU sugar response to policy changes requires that one takes into account the interaction of the farm sector with both the processing sector (refineries) and the food sector that uses sugar, an issue better dealt with in a GE framework. GE also makes it possible to assess on some particular effects of reforms, such as the impact on employment, an issue of particular interest, since the closure of sugar plants is presently fueling opposition to reforms in some EU countries. Welfare effects are more easily addressed within a GE framework in the case of second best equilibria (see Gohin and Moschini, 2004). Finally, GE approaches impose an internal coherence because of accounting equalities, which, for example, make production costs at the different levels more consistent than in many partial equilibrium approaches (Hertel, 2002). Because production costs play a significant role in the characterization of sugar supply, a proper endogenization of returns to primary factors accounting for interesectoral linkages is an asset.

The model focuses on the agricultural and food processing sectors of the EU; other countries and sector are treated in a less detailed way. The model used this paper is static, with perfect competition in most sectors and a neo-classical closure. Investment is savings driven and balance of payment equilibrium is ensured by financial flows. A Social Accounting Matrix (SAM) was constructed for the EU, using original data for the year 1995. The sectoral coverage distinguishes 75 products, including 18 products in the arable crops sector, 29 products in the animal sector. There are three primary

factors (capital, labor and land), whose quantities remain constant, but which are mobile across sectors. The EU is a large country whose trade affects other regions' exports prices trough a series of export supply and demand functions. The model has four main original features, which are: *i)* the use of flexible forms which globally sastify regularity conditions for production technology, household preferences and factor mobility *ii)* a detailed disaggregation of the agricultural sector; *iii)* a detailed representation of all instruments of the CAP; *iv*/ the use of Mixed Complementarity Programming (MCP) methods in order to represent changes in regimes.

The specification used to represent preferences, technologies and factor mobility makes use of latent separability as originally proposed by Gorman (1980). By allowing some overlapping in the grouping of commodities, this separability concept offers much more flexibility than other separability structures since substitution between goods/factors run through many channels. As shown by Perroni and Rutherford (1995), this concept is very convenient as it allows one to introduce a regular pattern of price and income elasticities in all supply and demand functions. As an example, we use it on the production side in order to allocate a CES aggregate of labor and capital across all agricultural activities.[9] Latent separability fits nicely here because *i)* many farms are multi-product farms and *ii)* farm labor and capital are not perfectly homogenous (i.e. an arable crop farmer cannot become a livestock farmer without significant adjustment costs) and thus imperfectly mobile between all farm sectors (Gohin, 2003).

The modeling of the sugar sector. The sugar sector includes the sugar beet activity which supplies "A&B beets", "C beets" and the sugar processing sector which offers "A&B sugar", "C sugar", "pulps", "molasses". The in-quota and out-of quota beets (respectively sugar) are distinct products, but perfect substitutes. They differ in terms of prices, levies and constraints. Isoglucose is modeled as a substitute for sugar. Sugar beets are assumed to be nontradable while we assume that sugar is a perfectly homogenous product. Accordingly, a net trade (rather than an Armington) specification is used so that the difference between EU sugar exports (A&B and C sugar) minus preferential imports meets a net export demand function from non-EU countries. EU imports are limited by tariff rate import quotas, which generate rents, assumed to be retained by the exporting countries.

The modeling of both the beet and the processing sector allows for a cross-subsidy between A&B and C productions at both stages. We first determine the gross margin of both beet productions (in and out of quota beets). We use input/output coefficients for a vector of intermediate inputs, and returns to land from various sources, including Eurostat SPEL and the Farm Accountancy Data Network. The sum of the margin of A&B and C beets is exhausted in returns to the labor and capital bundle and quota rents. The econometric estimates of (7) presented in Table 1 are used to calibrate the cross-

[9] Here we draw on the approach of Peterson et al. (1994) which requires no prior information about the allocation of labor and capital in each agricultural sector. Accordingly, we first define a CES aggregate of labor and capital which is then split among all agricultural sectors using a latent approach. Then in each agricultural sector, this aggregate is combined with all other inputs (including land) again using alatent separability approach.

subsidies between in-quota beets and C beets, assuming that the unitary implicit subsidy on C beets adjusts to satisfy budget neutrality (i.e., the total implicit tax on in-quota beets equals total implicit subsidy on C beets). This makes it possible to measure the value of the rent and the value of the returns to the capital and labor aggregate. In order to allow the subsidy to vary and perform sensitivity analysis, we leave the possibility of varying the degree of cross-subsidization, a particular case being zero cross-subsidy. In that case, the true returns to capital and labor are assumed to be equal to the gross margin of C sugar, while the difference between the gross margin for A&B and C sugar is assumed to be pure quota rent. Under this alternative assumption sugar beet producers have lower marginal cost and are thus more competitive, all other things being equal

A similar calibration procedure is done for the refining sector but with some modifications. Here, only A&B sugar beets are used to produce A&B sugar, and unit labor costs are kept constant. Profit is exhausted in returns to capital and in quota rent. Again, econometric estimates of (7) are used to calculate the rent. The A&B beet and sugar are linked through a Leontieff technology, and, under perfect competition assumptions must be made regarding the share of the rent passed to the farm sector and retained by the processing sector. The convention that is adopted here is the one used by Frandsen et al (2003), with a constant proportion of price decrease between the two sectors as long as there remains rents at the two stages. If this is not the case, we assume that the overall rent is either fully captured by processors or by beet producers (this does not affect market equilibrium). The impact of different allocation of the rent on farmers and processors surplus is discussed when presenting the results.

4. Policy changes simulations

The baseline. We first define a reference scenario or baseline where we assume, in the central case, that C productions are subsidized by quota productions. It corresponds to the situation that will take place in 2008, assuming the full implementation of the Agenda 2000, the June 2003 CAP reform and the enlargement of the EU. The GE model is calibrated on the year 1995, and we construct this baseline scenario as a pre-experiment simulation. Because the SAM does not include detailed information on the 10 new members of the EU, we present only the results for the EU15. The EU10 are treated as foreign countries within a free trade area. Some variables describing the macroeconomic environment are set exogenously, using data from different institutions, including the Food and Agricultural Policy Research Institute. Assumptions are also made about technical change in different sectors. Table 2 presents the baseline, given the calibration of the cross-subsidization presented above. In the "baseline" column, the July 2004 reform proposal of the Commission is not implemented, export refunds are only limited by the Uruguay Round agreement framework, and we assume that the EU does not face any additional constraint due to the WTO dispute on export subsidies or to the Doha

Round. The first column provides some information on the corresponding figures for the 1995 year used in the original calibration of the model.

In the baseline, the EU produces C sugar and exports some 1.8 million tons of C sugar in addition to the 2.9 million tons of in-quota sugar. Note that production costs account for cumulative technical change up to 2008, which explains the ability of the EU to produce C sugar at a price of 225 € per ton. The C sugar benefits from a unit cross subsidy of 14 € per ton of beet and 78 € per ton of sugar respectively, taken out of the quota rents. It is noteworthy that the baseline situation in 2008 is consistent with the maximum subsidized exports under the Uruguay Round agreement, under the assumption that the re-exportation of imported preferential sugar is not counted as part of the maximum allowed export subsidies (which is precisely what has been successfully challenged by Brazil and other countries under the WTO).

Table 2. EU15 sugar markets under the baseline, after the reform proposal and a ban of export subsidies

	Model calibration (1995)	Baseline (2008)	Reform proposal (Scenario 1)	Ban of export subsidies (Scenario 2)	Scenario 2 /scenario 1
EU15 production of in quota beets	99.570 mt**	102.629 mn t	92.367 mt *(-10%)*	86.590 mt (-16%)	*(-63%)*
EU15 production of C beets	11.961 mt	12.464 mn t	0 mt *(-100%)*	0 mt *(-100%)*	-
EU15 production of in-quota sugar	14.157 mt	14.592 mn t	13.133 mt *(10%)*	12.311 mt (-16%)	*(-6.3%)*
EU15 production of C sugar	1.701 mt	1.773 mn t	0 mt *(-100%)*	0 mt *(-100%)*	-
EU 15 imports of sugar*	1.950 mt	1.724 mn t	1.724 mt *(0%)*	1.304 mt *(-24%)*	*(-24.3%)*
EU15 exports of in quota sugar*	2.888 mt	2.910 mn t	1.295 mt* *(-55%)*	0 *(-100%)*	(-100%)
EU15 exports of C sugar*	1.701 mt	1.773 mn t	0 mt *(-100%)*	0 *(-100%)*	-
EU 15 consumption of sugar	12.863 mt	12.997 mn t	13.155 mt *(+1.3%)*	13.211 mt *(+1.6%)*	*(+0.4%)*
Domestic price of in quota beets	50 €/t	45 €/t	18.2 €/t *(-59%)****	17.1 €/t *(-62%)*	*(-6.4%)*
Domestic price of C beets	22 €/t	8.2€/t	10.5€/t *(+29%)*	9.4 €/t *(+15%)*	*(-10.8%)*
Domestic price of in quota sugar	687 €/t	620 €/t	421 €/t *(-32%)*	360 €/t *(-42%)*	*(-14.4%)*
World price (white sugar)	306 €/t	225 €/t	274 €/t *(+22%t)*	287 €/t *(+27%)*	*(+4.6%)*
Export subsidies	1 311 €/t	1 150 mn €	190 m€ *(-83%)*	0 *(-100%)*	*(-100%)*
Rents (sector)	1 074 mn € (beet) 1 119 mn (sugar)	1 634 mn € (beet) 360 mn € (sugar)	685 mn € (sugar by assumption)***	0 *(-100%)*	*(-100%)*
Cross subsidy (sector)	136 mn € (beet) 128 mn € (sugar)	186 mn € (beet) 137 mn € (sugar)	0 *(-100%*	0 *(-100%*	-

** outside EU10 (note: 555 000 tons of exports in 1995). ** note that in 1995, the overall EU quota was underfilled due to particular price conditions. *** note that this result is dependent on particular assumptions on the sharing of the rent between farmers and processors, see the text.*
Source: simulations by the authors.

Policy scenarios. The model is used for simulations of two scenarios that appear relevant in the present policy debate. These are:

- Scenario 1: the July 2004 proposal of reform of the sugar sector by the Commission, with no other adjustment coming from international pressures.
- Scenario 2: the ending of export subsidies in the sugar sector (assuming no other reform in this sector). This scenario is a possible outcome of the ongoing developments under the WTO.[10]

The EU sugar reform. In Table 2, the "Scenario 1" column presents the outcome of the EU Commission proposal for a reform of the sugar sector. The figures between parentheses are variations in percentage compared to the baseline. Note that we assume that the compensation for the reform provided to the beet producers are decoupled payments, and has no impact on output. We apply the price cuts proposed by the EU Commission, and we simultaneously remove producers levies on quotas which were initially intended to finance export subsidies on domestic production (except for re-export of ACP sugar).

The reform leads to a fall in EU production, but the quotas remain binding. The EU15 no longer produces C sugar. This comes from two effects. First, because of the structure of the model, which considers an aggregate supply, sugar quotas are implicitly assumed to move freely across regions and countries, as stated in the Commission's proposal. That is, the fall in the production of C sugar reflects the fact that some regions will no longer produce C sugar, but will produce some of the in-quota sugar previously produced by other (less efficient) regions. Second, after the reform, the decrease in intervention price reduces the incentive to "overshoot". Indeed, the asymmetric loss described in equation (4) between one unit below or over the targeted quantity is now reduced to a few euros per ton, an amount too small to justify overshooting of a risk neutral producer.

In Table 2, we present figures showing that the fall in beet prices is larger in percentage, than the fall in sugar price. These figures may seem inconsistent with the Commission's proposal, which specifies both a new institutional price for sugar and an institutional price for beets. Indeed, we obtain a 59% reduction in the price of beets, while the Commission's proposal states that a reduction of 33% of the intervention price for refined sugar should translate in a 37% reduction of the beet price (EU Commission, 2004).[11] This apparent contradiction deserves some explanation. First, our figures are obtained under the assumption that that unit labor costs do not adjust in the processing sector, while the returns to the aggregate primary factor does adjust in the beet sector. We believe that some of the

[10] Under the WTO dispute, Brazil and other countries have challenged the re-exportation of preferential sugar and the treatment of C sugar. Formally, exports subsidies for A&B sugar were not challenged. However, the August 2004 framework agreement sets the principle of ending of all export subsidies.

[11] The Commission motivates this figure by stating that "In order to keep a parallelism between the price cuts at farm, factory and refinery level, the minimum sugar beet price, which is the price paid to farmers for their sugar beet, has been established taking into account a similar percentage reduction in the effective price of both sugar and sugar beet." (EU Commission 2004).

costs of the processing sector is hardly compressible, e.g. energy and labor costs, and processors are likely pressure the farm sector and act so as it bears the largest share of the adjustment. Second, the figures in Table 2 correspond to the assumption that the remaining quota rent, i.e. 685 million euros, is kept by the processing sector. If we assume that the processing sector passes all the rent to beet producers, the price of beets falls less, and is25.6 € per ton (rather than 18.2 €) in our simulations. This is consistent with Commission's figures regarding the impact of the July 2004 reform proposal (EU Commission, 2004). Because we have no reliable information on the sharing of the rent under this scenario, all we can say is that, depending on the bargaining power between beet growers and processors, the price of beets will range between 18 and 26€ per ton.

As a consequence, if processors are constrained to pay beets at a minimum price of 27.4 € per ton by a future EU regulation (as proposed by the Commission), the rents remaining in the sector will be fully passed to the farm level of the chain. This is consistent with the fundamental objectives of the CAP, which is not targeted to support the shareholders of the processing sector. However, the consequence would be a significant shift in the sharing of the rents compared to the present situation, rather than the "parallelism" in cuts along the supply chain stated by the Commission in its proposal. In addition, because agreements between processors and farmers are a bit of a grey area, the exact price paid to farmers is subject to local negotiations, side conditions, and varies according to the structure of ownership of the processing sector (cooperative or not). In practice, the actual price received by farmers might be closer to our 18 € per ton than to the official 27.4 € per ton institutional price.

The fall in prices only results in a slight expansion of consumption. Demand for sugar is very inelastic in the EU. The possibilities of substituting sweeteners for sugar are limited: unlike the US one, the EU soft drink sector uses mainly saccharose and there is little isoglucose used that could be substituted for sugar. It is noteworthy that EU sugar consumption has remained unchanged for decades, in spite of changes in real income and prices of substitute prices. Other studies also find little expansion of consumption following lower sugar prices (Eurocare 2003).

The results of Scenario 1 suggest that the reform proposed by the Commission is not sufficient to comply with a future WTO agreement abolishing all export subsidies. Further adjustment will be needed, such as a decrease in the level of quotas. However, the reform provides a considerable degree of freedom for lowering EU tariff protection. Indeed, without the reform, the minimal protection that is necessary to prevent sugar (outside tariff quotas) from flowing into the EU in 2008 is 395 € per ton. This requires the activation of the special safeguard clause in order to top the 339 € per ton tariff. If the reform proposal is implemented, the special safeguard becomes unnecessary, and the EU community preference can be maintained with a 57% decrease in MFN tariff. Clearly, the reform would be a major step towards compatibility with a WTO agreement under the Doha Round.

The reallocation of inputs to other sectors than sugar results in limited changes in the price of agricultural products. A small increase in the production of vegetables, cereals can be observed and a lower cost of feedstuffs benefits to livestock producers. The reform results in welfare gains estimated at 760 million euros. However, this results from conflicting effects, since the loss for sugar beet producers is considerable (2.3 billion euros). The compensation proposed by the Commission amounts to 1.19 billion euros, and if the institutional price for beets is actually paid to farmers, they will benefit from a shift in the sharing of the remaining quota rent (685 million euros) . The net losses for beet producers should therefore range between 430 and 1 100 million euros. The production of refined sugar falls by 20%, corresponding to a decrease of some 300 million euros in value added for the processing sector (under the assumption that this sector retains the remaining quota rent). Employment decreases by some 4800 jobs in the farm sector and 6100 jobs in the food sector in the EU15. EU taxpayers save roughly some 1 billion euros of export subsidies. The reform does not reduce the imports of preferential sugar, but the exporters such as the African, Caribbean and Pacific (ACP) countries or India lose some 335 million euros because of the lower EU domestic price.

The elimination of export refunds. Scenario 2 corresponds to the elimination of all export subsidies in the sugar sector (we assume that the reform proposed by the Commission is not implemented). In order to clear the market, we assume that the EU adjusts the intervention price. Preferential imports may also adjust to the domestic market price. In Table 2, the figures in parentheses indicate the change relative to the baseline. The elimination of export subsidies requires a considerable decrease in sugar prices (42%), due to the inelastic demand and the need to clear the market without the possibility of disposing excess supply in the world market. The fall in the price of sugar beets is even larger because we assumed that wages and some input prices could not decrease in the processing sector. All rents disappear, and there is no cross-subsidy between the two types of sugar. The production of C sugar disappears at the EU level. The fall in domestic price leads to lower imports of preferential sugar. Those that face a non-zero duty, i.e. mainly those corresponding to the tariff rate quota opened for the 1995 enlargement (presently benefiting mainly Cuba and Brazil) and the 334000 tons of Special preferential sugar, are no longer imported for re-exportation. Duty-free imports of ACP and Indian sugar are not affected because of the persisting gap between the domestic and world price, but the preferential rent decreases significantly.

The last column on the right hand side of Table 2 indicates the change relative to the situation in 2008 after the implementation of the reform proposed by the Commission in July 2004. It shows that if the WTO discipline requires banning all export refunds, prices and production will need to go down further than under the reform proposed in July 2004. However, the fall in domestic prices resulting from the elimination of export subsidies would make larger cuts in tariffs possible.

Sensitivity to the cross-subsidy assumption. Clearly, our calibration of the cross-subsidy between in-quota and C sugar relies on fragile econometric estimates such as the ones presented in Table 1.

Because other authors make different assumptions (either that there is no cross subsidy, or that supply responds to the in-quota price) we need to assess how this affects our results. Here, we need to recalibrate the model for the year 1995, since the costs of production compatible with this assumption are now different, then simulate the 2008 baseline as a new pre-experiment. Under the assumption that the cross-subsidy is zero, the calibration of the model results in lower production costs and larger rents than the ones described in the "baseline" section above. Simulations of the effects of the sugar reform proposal and the elimination of export subsidies under the alternative assumption that there is no cross subsidy between A&B and C sugar are presented in Table 3.

Under this alternative assumption, the trends in world markets and in technical change used to construct the baseline are such that there is no production of C sugar in 2008. That is, without cross subsidy, the EU15 is unable to produce sugar competitively at the world price of 251€/t.[12] Consequently, the two scenarios cannot be compared directly with those in Table 2, since the baseline is different regarding the overall EU supply.

The effects of the reform proposal (Scenario 1 in Table 3) do not differ much from the effects previously described in Table 2. The main differences relate to larger rents, driven by the calibration of production costs. Quota rents reach 2150 millions euros if we assume that C sugar is not cross-subsidized, compared to 685 millions euros in Table 2. A consequence is that EU15 producers are more able to cope with a decrease in prices resulting from liberalization scenarios, before production adjust downwards.

The elimination of export subsidies would require a larger decrease in sugar price, if we assume that the C sugar is not subsidized (Table 3, to be compared with Table 2). The domestic price would be equal to the world price, and all rents would be eroded. The ACP countries and India would draw little benefit from their preferential access. Domestic production would replace some of the imports, but the EU would be a net importer of sugar. When export subsidies are removed, the price equilibrium is such that protection is no longer needed. It is noteworthy that,the alternative specification regarding cross subsidy between in-quota and C sugar mainly affects prices.

[12] The calibration of the model for 1995, when high sugar prices were quite untypical may explain the absence of C sugar in the baseline 2008. We believe that this suggests that the specification where C sugar is not subsidized is not the most adequate to describe the sugar sector. Indeed, with our central version of the model (with cross-subsidization), the production of C sugar is consistent with what has been observed during the 1995-2003 period.

Table 3. Sensitivity analysis: EU15 sugar production and exports (no cross subsidy)

	Calibration 1995	Baseline 2008 (no cross subsidy)	Scenario 1 (no cross subsidy)	Scenario 2 (no cross subsidy
EU15 production of in quota beets	99.570 mt	102.629 mn t	92.367 mt *(-10%)*	92.367 mt (-10%)
EU15 production of C beets	11.989 mt	0	0 *(-)*	0 *(-)*
EU15 production of in-quota sugar	14.157 mt	14.592 mn t	13.133 mt *(10%)*	13.133 mt *(10%)*
EU15 production of C sugar	1.701 mt	0	0 *(-)*	0 *(-)*
EU 15 imports of sugar*	1.950 mt	1.724 mn t	1.724 mt *(0%)*	566 tht *(-67%)*
EU15 exports of in quota sugar*	2.888 mt	2.917 mn t	1.294 mt* *(-56%)*	0 *(-100%)*
EU15 exports of C sugar*	1.701 mt	0	0 *(-)*	0 *(-)*
EU 15 consumption of sugar	12.863 mt	12.989 mn t	13.156 mt *(+1.3%)*	13.295 *(+2.4%)*
Domestic price of in quota beets	50 €/t	46 €/t	15 €/t *(-68.1%)*	15 €/t *(-68%)*
Domestic price of C beets	22 €/t	15€/t	15€/t *(0%)*	15€/t *(0%)*
Domestic price of in quota sugar	687 €/t	632 €/t	421 €/t *(-32%)*	280 €/t *(-56%)*
World price (white sugar)	306 €/t	251 €/t	274 €/t *(+9%t)*	280 €/t *(+10%)*
Export subsidies	1 311 mn €	1 113 mn €	190 m€ *(-83%)*	0 *(-100%)*

** outside EU10. Source: simulations by the authors.*

4. Conclusion

The various assessments of the effects of a liberalization of world sugar markets are quite inconsistent. We believe that a significant explanation of the observed differences in results lies in the specification of the supply response of the EU, and in particular relates to the assumption regarding C sugar production. Because there a significant production of C sugar in the EU, one may be tempted to assume that production responds to the world price and that the high price of in-quota sugar only provides rents, at least in the C producing regions. However, we believe that this may lead one to underestimate the effects of policy reforms on EU production by overestimating the production-neutral rent erosion effect. Alternatively, some authors model the EU supply as mainly driven by the price of in-quota sugar. Such an approach could overestimate marginal costs, underestimate rents in the most efficient EU regions and overstate the changes in EU supplyif sugar prices go down.

The supply of C sugar can be affected by the support provided to A&B sugar through three channels: *i/* the existence of fixed costs covered by the in-quota sugar, that may explain that C sugar can be sold at prices that cover only marginal (variable) costs; *ii/* "overshooting" behavior, as insurance against poor yields; *iii/* the production of C sugar as "reference building" in view of expected reforms.

Overall, the case for formal cross-subsidization is not entirely compelling. Indeed, the fixed-costs effect cannot explain a cross-subsidy in the long run, and under the "reference building" effect, the

supply of C sugar only responds to expected (future) in-quota prices. However, they are uncertainties about the time horizon and the divisibility of inputs in the processing sector. The "overshooting effect" may also make the supply of C sugar depend on the level of the in-quota price. We therefore introduce some interaction between the A&B quota rent and the supply curve of C sugar in the model. We calibrate the marginal conditions of supply of C beets and sugar using simple econometric estimates. We then include such a specification in a GE model including a detailed representation of the sugar sector.

Our simulations suggest that the proposed reform of the EU sugar sector will lead to the end of exports of C sugar, and that the fall in prices will provide a considerable degree of freedom for coping with the need to reduce tariffs. The losses for sugar beet producers will be large, although partially compensated under the Commission's proposal. The reform will result in savings for taxpayers and consumers. Overall, the reform will result in a higher welfare for the EU15, although it is debatable whether price decrease for consumers can actually be interpreted as welfare gains in the particular case of sugar.[13]

The elimination of export subsidies would require larger cuts in the intervention price of sugar to clear the market. With such cuts, the EU sugar quotas become non-binding, and some of the preferential imports would be replaced by EU sugar. Tariffs could be reduced by more than 60% without any further change in the market situation. However, the sector would experience large losses.

Our results suggest that the EU proposal of reform will not make it possible to eliminate all export subsidies. Their elimination would require larger decrease in EU production and intervention prices. This suggests that, in the case of sugar, the main external constraint imposed by the Doha negotiations is perhaps not the reduction in tariffs, but the reduction in export subsidies. This finding contrasts with most of the literature depicting market access as the main constraint on the CAP imposed by the WTO negotiations, compared to export competition and domestic support.

We compare our results with the alternative assumption that there is no cross subsidy between in-quota and Csugar. Our results suggest that those authors who assume that the supply of C sugar is independent from the price of in-quota sugar will find a lower decrease, or an increase in EU production under market liberalization scenarios. They are also likely to find a larger negative impact on ACP countries. This finding illustrates the need for further research on the calibration of the

[13] It is questionable whether cheaper sugar actually generates welfare gains. If one assumes that consumption will remain unchanged, lower costs for consumers indeed have a clear welfare improving effect. However, the concept of consumer surplus also embeds the net gains in utility resulting from extra consumption. Recent research under the auspices of the World Health Organization suggests that excess sugar consumption in OECD countries has an enormous negative impact on health and public finances. Cheaper sugar has therefore a strong negative externality. Under the EU proposal, the consumer's bill would be reduced by some 2.5 billion euros, but it is unclear whether this should be counted as welfare gains, without pricing these externalities (even though the increase in consumption is very limited in our results). Pricing externalities is however a Pandora's box, since one may argue that we also need to account for the social costs of the tax revenues raised to subsidize exports.

linkage between A&B and C sugar. A more precise representation of the strategic interaction between the processing sector (which may request C beets from farmers unwilling to supply so) would also be useful.

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Annex

The model

General aspects. The model used in this paper is a static, single-country, multi-sector GE model of the EU15 economy. The model emphasizes the role of agricultural and food sectors and can therefore be referred as a "sector-focused" model. Unlike most GE models (which are in general based on commercial databases such as GTAP, i.e. the database of the Global Analysis Trade Project), it relies on original data. A Social Accounting Matrix that details particularly the EU agricultural and food sector was built using various sources of information, namely from Eurostat, the Farm Accounting Data Network, the SPEL data and the database of other existing models of European agriculture (see below for references). The model is presently being updated in order to include the 25 EU members and a calibration on year 2003, but this work will not be completed before 2006. Here we use the EU15 version, treating the 10 new members as foreign countries in a free trade area. This version of the model is calibrated on data for the year 1995, but a baseline is defined for 2008, introducing information on subsequent policy changes, macroeconomic changes and projections regarding some exogenous factors (technical change, world prices, exchange rates). The baseline is constructed as a pre-experiment simulation

The model is neo-classical, assuming perfect competition in all markets and specifying constant returns to scale technologies. Two exchange zones are considered, the first one being represented by the 10 new Member States that joined the EU on May 2004 and the second being the "Rest of the world". The EU is potentially a large country in the world market for agricultural and food products and, accordingly, export demand and import supply functions with finite price elasticities are specified.

Original features. The first original feature of the model is the disaggregation of the EU economy into activities and commodities. The model identifies 75 products and all major economic agents operating on the food chain: agri-industrial sectors, agricultural sectors, food processing industries, food retailers, traders, as well as domestic consumers. For example, the model distinguishes between six food processing industries: meat, dairy, compound feed, cereal processing, oilseed crushing and sugar beets. Many industries have multi-product technologies; for example the milk processing industry produces six goods, namely butter, skim milk powder, whole milk powder, fluid milk, cheese and an aggregate of other dairy products.

The modeling of CAP instruments is the second original feature of the model. The model includes a detailed treatment of EU Common market organizations (CMOs), namely arable crops, dairy, bovine meat, pig meat, eggs and poultry and sugar. Various policy measures, such as price support, supply control, trade and income support, are also included. For instance, trade measures include export subsidies, tariff quotas, in-quota tariffs, out-of-quota tariffs, *ad valorem* and specific tariffs, and the tariffs from the safeguard clause. The modeling of price support, supply control and trade measures follows previous approaches (Folmer *et al*., 1995; Bach *et al*., 2000; van Meijl and van Tongeren, 2002). However, here, the modeling of direct income support instruments departs from traditional GE models. First, livestock payments (suckler cow premium, breeding ewe premium, male animal premium and slaughtering premium) are modeled as output/input subsidies rather than both capital subsidies and output subsidies (Bach et al 2002; Bouët et al 2004). Unlike GTAP-based GE models, the model does not require the introduction of capital subsidies in the livestock sector because it distinguishes all livestock activities which receive direct payments. For instance, there is a suckler cow activity which produces calves, cattle (i.e. the part of the initial suckler herd that is slaughtered) and suckler cows (i.e. the part of the initial suckler herd that is not slaughtered) using feedstuffs, veterinary products, etc, as well as labor, capital (e.g. cow shed, feed machinery, etc) and the initial suckler herd. Hence, the suckler cow premium can be modeled as a subsidy for the use of the suckler herd. Second, the model differs from existing ones as regard to the treatment of arable crop payments. These are usually modeled as land input subsidies in GE models (Bouët et al 2004). Such an assumption implies that these payments are capitalized in land values. However, available statistics on land rental markets in the EU shows that land rental rates are much lower than arable crop payments in

most countries (Eurostat). Moreover, econometric studies report only a partial capitalization of land direct payments into rents captured by landowners (see Roberts *et al*., 2003 for the US case). The remaining part of the payments is likely to be captured by farmers. Here, arable crop payments are partly land subsidies and partly labor subsidies. The benchmark for this distribution of payments is respectively a 30% and 70% share (Roberts *et al*. 2003). Finally, a third divergence from usual GE models is in the treatment of land set-aside. Professional arable crop farmers receive payments provided that they set-aside part of their land. This supply control measure has been specified in previous GE modeling frameworks as a factor neutral supply shock. Here, a new derived demand in the land market is determined as a fraction (the set-aside rate) of land derived demands of all arable crop activities. Finally, the intervention mechanisms are modeled as variations in inventories, which are then adjusted by a unit export subsidy. The level of export subsidies is capped by the constraints imposed by the 1994 Marrakesh agreement under the Uruguay Round. Under a particular option of the model (used in this paper), the intervention prices adjust so as to clear the market. Market prices follow, and so do external trade.

The third original feature of our model is the specification of price and income elasticities. The model uses regular-flexible functional forms for the specification of production technologies and consumers' preferences. The flexible form developed by Rutherford and Perroni (1995), i.e. the Lower Triangular Leontief Nonseparable N Stage Constant Elasticity of Substitution is used. This form combines the notion of latent separability and a nested CES structure (see Gohin 2003 for the specification of the latent separability used here). This approach allows introducing any regular matrix of price and income elasticities. In order to calibrate the parameters of these regular-flexible functional form, published econometric estimates of price and income elasticities were used. Some of them originating from older models developed by Knut Munk, Yves Surry, Louis-Pascal Mahé, the ECAM group in Amsterdam or by the Aglink group of the OECD (see Salhofer, 2001 for other sources). Because published estimates do not match the product disaggregation of the model, a complete matrix for demand elasticities was constructed using the "two-stage budgeting" approach by Carpentier and Guyomard (2001). The matrix of price and income elasticities of marshallian final demand which is shown is Table A1 provides an illustration. First, information on income and price elasticity estimates are found in Fulponi (1989), Michalek and Keyzer (1992), Tiffin and Tiffin (1999) and Carpentier and Guyomard (2001). Substitution elasticities are then applied to expenditure shares to obtain new conditional elasticities. Finally, Carpentier and Guyomard's formulae are used to determine the unconditional elasticities to be introduced in the model .

[Insert Table A1]

Another original feature of the model is the modeling of production factors. The model distinguishes three production factors, land, labor and capital. Imperfect mobility of land between agricultural sectors is assumed. In order to represent the multiproduct nature of agricultural firms, and to avoid allocating labor and capital to each enterprise (which would raise conceptual as well as data problems), a revenue function is used that combines capital and labor as a composite service. This composite service is then combined to land and intermediate inputs allocated to each enterprise (coefficients on the inputs allocated to each enterprise come from different sources, including the Eurostat's SPEL database and the Farm Accountancy Data Network). This representation of the agricultural technology draws on Peterson et al (1994). Rather than their Constant Difference Elasticity revenue function, the flexible form developed by Perroni and Rutherford (1995) is used.

The modeling of the sugar sector.

The sugar and sweetener sectors include 7 products, i.e. "in-quota sugar beets", "C sugar beets", "A&B sugar", "C sugar", "pulps", "molasses" and "isoglucose". That is, the farm sector supplies two distinct products, in-quota and out-of-quota beets. So does the processing sector. These in-quota and out-of quota products are perfect substitutes, but differ in terms of prices, levies and constraints.

It is assumed that the domestic sugar and the imported sugar are perfect substitutes. The EU10 is distinguished as a free trade area with the EU15, with import and export demand functions. Here, we assumed that the quantity of sugar exported to the EU10 reached 550 000 tons in 2008. This amount is kept fixed in the simulations.

The EU demand of sugar is results from arbitration with isoglucose, using a CES function in the nest for sweeteners in the demand system. The substitution elasticity is set to 3 (Rendelman and Hertel 1993). This results in a somewhat inelastic demand for sugar when prices go down. An explanation is that (unlike in other countries), the EU soft drink sector does not use large quantities of isoglucose, and that substitutions are limited in other sectors, due to technology constraints (Cooper et al 1995). The processing of sugar beets generates pulps and molasses as byproducts. The technology of transformation between beet, sugar and byproducts is Leontieff. The demand for beets and the aggregate of goods and services are also modeled as fixed proportions. However, there is some substitution between capital and labor, both in the beet and in the processing sectors.

The gross margin in beet production is computed using total receipts, levies, and the costs of fertilizers, seeds and pesticides (source Eurostat, SPEL). The returns to land are calibrated so that they equal that of alternative crop not subject to a quota. Here, rapeseed is chosen for the calibration, and the returns to land were set to 250 € per hectare. The difference between the gross margin and returns to land is exhausted in returns to the composite commodity including capital and labor, and the quota rent. The price of C sugar beets provides only a lower bound of the returns to the composite commodity: Clearly it does not include the rent component, but some of the quota rent may be used to subsidized the production of C beets. Then, an econometric estimation (see Table 1 in the main text) is used to calculate the cross subsidy between A and C, assuming that the unitary implicit subsidy on C beets adjusts to satisfy budget neutrality inside the two activities (the total implicit tax on in-quota beets equals total implicit subsidy on C beets).

A similar calibration procedure is done for the processing sector. Here, information on labor costs are fully available, and it is assume that capital is the primary factors whose returns are covered by the price of C sugar. Again, the cross subsidy on refined sugar is calibrated so as to be budget neutral.

The calibration of the model uses different data sources. The main figures used in the sugar sectors are provided in Table A2. In 1995, EU exports of refined sugar amounted to 5145 thousand tons. The value of A&B sugar exported (1055 Mn €), i.e. 3 343 000 tons, was made possible by the 1311 Mn € of export subsidies. It was therefore assumed that the domestic value of these exports of A&B sugar was 2366 Mn €, i.e. a unit value of 687 €/ton.

[Insert Table A2]

The data for 1995 is adjusted to account for changes in market access taking place after the Uruguay Round agreement. Preferential imports include 1 304 700 tons of zero duty imports (ACP and India) under a tariff rate quota, a 85463 tons of tariff rate quota (98€/ton duty) corresponding to the enlargement of the accession of Finland, and the special preferential sugar (334 000 tons equivalent sugar), facing a 54.1€/ton plus a levy of 29.8 €/ton. Tariffs come from the EU TARIC database of the EU customs. The special safeguard clause for sugar is introduced as an extra tax on imports if protection does not ensure community preference for out of tariff quota sugar.

Baseline

The parameters and the exogenous variables of the GE model are calibrated using 1995 data. A baseline is constructed that accounts for the changes brought by the Uruguay Round, and changes that have occurred in the CAP since 1995, including the June 2003 reform. The benchmark is designed so as to represent the EU15 economy in 2008, and the enlargement is treated as a free trade area with the EU10. Assumptions are made about factor productivities, macro-economic conditions, changes in dietary patterns, evolution of world market conditions and agricultural policy developments.

Regarding agricultural policy, the baseline includes the full implementation of the Agenda 2000 and the June 2003 CAP reform (see Gohin and Latruffe, 2004). The enlargement is accounted for by abolishing all tariffs and export subsidies between the EU15 and the EU10, treated as a separate region. Regarding international trade rules, all the provisions of the Uruguay Round are included, but

it is assumed that there are no new agreements under the Doha Round and the EU can subsidize exports within the limits agreed under the Uruguay Round (i.e. we do not account for the conclusions of the WTO dispute initiated by Brazil). The EU can also provide farmers "blue box" direct payments. The new import regime for soft wheat and barley, which started in 2003, are included in the baseline.

The baseline accounts for the observed changes in the economic environment that have occurred between 1995 and 2004, and on projections for 2008, as far as exogenous variables are concerned. The euro is assumed to stabilize around 1.05 against the US dollar in 2008. Labor and capital endowments are assumed to increase by 3% and 30% respectively over the 1995-2008 period (based on Hertel et al, 2004). Factor productivities in the different sectors are calibrated in order to get an increase of real GDP of 2.25% per annum. Unitary marketing margins operated by food retailers are assumed to increase by 1.5% per annum. As far as changes in dietary patterns are concerned, a 2% annual decline in beef consumption is assumed, compensated by a 1% increase of white meat consumption in the EU15. Additional assumptions include a 0.5% annual decline of butter consumption in favor of vegetable oils, and that the fat content of cheese, fluid milk and ODP decreases by 0.5% per annum. The recent trend towards a lower consumption of soybean oil and a higher consumption of rapeseed oil is assumed to continue. Yields per hectare for arable crops and milk yields by cow both are assume to increase each year by 1.5%. The productivity of feed ingredients in the pig and poultry productions increases annually by 1%. A 1% annual increase in total factor productivity in the food industries is also assumed. In addition, the impact of banning meat meal results in changes in the animal feed sector, while the by products of the meat industry is treated as stocks funded by the government. All these assumptions are based on observed trends that are extrapolated between 2004 and 2008.

The evolution of the EU15 economy until 2008 also depends on the evolution of foreign markets and policies. However, these factors are not explicitly integrated in the model, but only implicitly through the parameters of our linear export demand and import supply functions. The intercepts of these functions are scaled using the information given by FAPRI 2004 projections of world market prices.[14]

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[14] Formally we specify the export demand function for the product i as follows: $E_i = a_i - b_i.P_i$, where E_i is the volume of exports, P_i is the world price and a_i, b_i are parameters calibrated using initial data. For the definition of the benchmark, we assume that the latter parameter is constant (following the usual assumption of constant foreign price response) while the former is adjusted so as to reproduce the FAPRI projections on EU exports and world price. Note that the final value of export and world price will also depend on the capacity of the EU economy to export. Export supply functions are determined by the whole GE model, and, consequently, estimates of world prices are ours.

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Table A1. Price and income elasticities at the final demand level

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	-0.959	-0.003	-0.027	-0.012	-0.011	-0.005	-0.008	-0.019	-0.008	-0.002	-0.003	-0.002	-0.001	-0.010	-0.009	-0.005	-0.005	-0.001	-0.003	1.092
2	-0.033	-0.139	-0.002	-0.002	0.003	0.001	0.009	0.004	0.001	0.001	0.001	0.001	0.024	-0.008	0.166	-0.089	0.004	0.001	0.001	0.061
3	-0.386	-0.001	-0.152	-0.006	-0.007	-0.003	-0.005	-0.011	-0.004	-0.001	-0.001	-0.001	-0.001	-0.005	-0.006	-0.003	-0.003	-0.001	-0.002	0.600
4	-0.165	-0.001	-0.006	-0.144	0.039	0.004	0.062	0.029	0.009	0.004	0.003	-0.001	-0.001	-0.007	-0.024	-0.003	-0.006	-0.001	0.004	0.200
5	-0.355	-0.001	-0.017	0.027	-0.470	0.033	0.044	0.013	0.003	0.002	0.001	-0.002	-0.001	0.005	0.041	0.001	0.017	-0.001	-0.002	0.663
6	-0.116	-0.001	-0.006	0.009	0.092	-0.234	0.014	0.004	0.001	0.001	0.001	-0.001	-0.001	0.001	0.013	0.001	0.006	-0.001	-0.001	0.216
7	-0.395	-0.001	-0.021	0.053	0.048	0.003	-0.904	0.145	-0.090	0.036	0.067	0.001	-0.001	0.023	0.131	0.006	0.043	0.001	-0.003	0.856
8	-0.163	-0.001	-0.008	0.015	0.013	0.001	0.088	-0.455	0.122	-0.014	0.042	0.001	-0.001	0.006	0.037	0.001	0.012	0.001	-0.001	0.304
9	-0.134	-0.001	-0.006	0.012	0.011	0.001	-0.125	0.315	-0.374	0.018	-0.012	0.001	-0.001	0.005	0.030	0.001	0.010	0.001	-0.001	0.249
10	-0.200	-0.001	-0.010	0.018	0.016	0.001	0.192	-0.127	0.063	-0.465	0.070	0.001	-0.001	0.008	0.045	0.002	0.015	0.001	-0.001	0.373
11	-0.129	-0.001	-0.006	0.012	0.010	0.001	0.297	0.317	-0.035	0.059	-0.809	0.001	-0.001	0.005	0.029	0.001	0.009	0.001	-0.001	0.240
12	-0.021	-0.001	-0.001	-0.001	-0.003	-0.001	0.018	0.009	0.003	0.001	0.001	-0.125	0.001	0.003	0.017	0.001	0.004	0.055	-0.001	0.040
13	-0.033	0.081	-0.002	-0.002	0.003	0.001	0.009	0.004	0.001	0.001	0.001	0.001	-0.197	-0.008	0.166	-0089	0.004	0.001	0.001	0.061
14	-0.131	-0.002	-0.006	-0.008	0.012	0.001	0.035	0.014	0.004	0.002	0.001	0.001	-0.001	-0.790	0.464	0.144	0.017	0.001	0.001	0.244
15	-0.468	0.032	-0.022	-0.029	0.042	0.002	0.125	0.051	0.015	0.007	0.005	0.001	0.009	0.366	-1.001	-0.073	0.062	0.001	0.002	0.874
16	-0.077	-0.042	-0.004	-0.005	0.007	0.001	0.020	0.008	0.002	0.001	0.001	0.001	-0.012	0.270	-0.161	-0.164	0.010	0.001	0.001	0.143
17	-0.043	0.002	-0.002	-0.011	0.051	0.006	0.103	0.051	0.016	0.007	0.005	0.001	0.001	0.034	0.153	0.010	-0.468	0.001	0.002	0.080
18	-0.021	0.001	-0.001	-0.001	-0.003	-0.001	0.018	0.009	0.003	0.001	0.001	0.119	0.001	0.003	0.017	0.001	0.004	-0.189	-0.001	0.040
19	-0.021	0.001	-0.001	0.019	-0.003	-0.001	-0.004	-0.003	-0.001	-0.001	-0.001	-0.001	0.001	0.003	0.017	0.001	0.004	0.001	-.050	0.040

1: Products of the rest of the economy
2: Eggs
3: Other agricultural products
4: Fruits
5: Vegetables
6: Potatoes
7: Beef
8: Pork
9: Poultry
10: Sheepmeat
11: Veal
12: Butter
13: Milk powders
14: Cheese
15: Other dairy products
16: Fluid milk
17: Processed cereals
18: Vegetable oils
19: Sugar
20: Income

Table A2: Calibration of the sugar sector of the model (1995)

	Volume (M tonnes)	Price (€/tonne)	Value (mn €)
Production			
Production A&B	14157	687	9726
Production C	1702	306	521
Production total	15859	646	10247
Imports from RoW			
Value CIF	1950	505	986
Duties	-	30	57
Refining	-	71	138
Rent importer	-	81	159
Domestic value	-	687	1340
Rent exporter	-	270	528
Value at world price	-	235	458
Imports from EU10			
Value CIF	19	368	7
Availability			
Sugar A&B	16126	687	11073
Sugar C	1702	306	521
Total	17828	650	11594
Export to RoW			
Sugar C	1702	306	521
Sugar A&B, value FOB	2888	306	885
Sugar A&B, refunds	-	381	1100
Exports to EU10			
Sugar A&B, value FOB	555	306	170
Sugar A&B, refunds	-	381	211
Domestic consumption	12683	687	8707