Reform of the CMO Sugar – Impacts on European Agriculture –

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Introduction

Reforms of agricultural policy in the past have passed by the CMO sugar, despite the well known implied negative welfare effects of a quota regime. Some recent developments, make a far reaching reform of the European sugar sector inescapable. The *'Everything but Arms'* concession of the EU to the 48 least developed countries (LDCs) generally allows imports from the beneficiary countries without tariff or quantitative restrictions, after a transition period ending in 2009. Considerable additional sugar import quantities are therefore likely and threaten the functionality of the current market organisation.[i] This and the pressure of Brazil and Australia against European sugar exports which found a preliminary climax in the current WTO panel (OXFAM, 2004)[ii] let the European Commission investigate what the consequences of different reform options might be. In July 2004, they, headed by the retired Commissar Fischler, came up with a reform proposal of the CMO. It envisages a reduction of sugar quotas and supported prices as well as the introduction of quota tradability and compensatory payments to farmers, the abolition of the declassification, intervention and of the distinction of A and B quotas, as well as reduced export subsidies. Against that background it stands to reason that currently there is a high interest of policy makers in economic analyses that tackle the impact of such reform options. Several studies are currently available that analyse possible reform options of the CMO sugar (Adenaeuer et al 2004, Witzke, Kuhn 2004, Mensbrugge et al 2003, Frandsen et al 2003, Cernat et al. 2003 and earlier studies).

An aggregate analysis of the impacts of a reform of the CMO sugar is only possible if the economic incentives driving the behaviour of sugar beet producers are understood. Currently, farmers produce considerable quantities above their quota in different EU Member States which cannot be explained with standard profit maximising behaviour. Recent studies have failed to provide a complete framework to explain the observed sugar production. Adenäuer and Heckelei (2005) examine several alternative behavioural models with respect to their ability to give a better explanation for the supply behaviour and would consequently allow for more realistic simulation responses to policy changes. This paper is based on their findings and organized as follows: The next section addresses the economic incentives of a farmer to supply sugar beets and summarises and extends the results of Adenäuer and Heckelei (2005). Then we explain how those results are used to adjust the regionalised agricultural sector model CAPRI. After that a definition of simulation scenarios is given followed by the simulation results and some conclusions. Quite detailed expositions of the CMO sugar are in Linde et al (2000) or EU Commission (2004a).

Incentives to supply sugar beets

Adenäuer and Heckelei (2005) point out that during the last decade in a number of the 15 EU Member states we observe considerable amounts of sugar beyond the quota – so called C sugar – for which farmers receive only prices based on the world market level. A major part of C sugar on average across the last decade originates in Germany and France. The Netherlands, the United Kingdom, Belgium and Denmark also contribute considerably, while the other countries don't supply high C sugar amounts or even do not fill their quotas entirely (Greece and Portugal). The troublesome implications of underlying profit maximisation – applied to the national averages – are therefore that those C sugar suppliers are assumed to be competitive at C beet prices. At the margin, those countries only react to changes of C beet prices as apparent in Frandsen et al (2003). Vierling (1996) and Bureau et al. (1997) estimate marginal costs of sugar beet production by stacking single farm LPs for major sugar producing regions in the entire EU. Their results show considerably higher marginal production costs than prices received for C sugar beets. Under profit maximization, this seems to contradict the large amount of C-sugar production across the entire EU (15% of total EU production in 1997-1999, going up to 34% for France[iii]). Consequently, profit maximization is not sufficient to explain observed production even considering the aggregation problem of denying farm heterogeneity, because it would require an unrealistically disperse distribution of farm efficiency and C-beet production in the Member States. Adenäuer and Heckelei (2005) provide some alternatives to the profit maximisation hypothesis which are repeated in the following:

Expected profit maximisation

Yield uncertainty is a general phenomenon in agriculture. A farmer cannot perfectly predict the yields of his production activities, because they are influenced by weather and other environmental factors. In a quota system, this becomes even more relevant as there are typically strong economic incentives to fill the quota even in the case of a bad harvest. The inclusion of yield uncertainty in the decision process of sugar beet production means, in mathematical terms, that sugar beet yields are a stochastic variable. Consequently all variables that are based on yields are stochastic as well, like the production quantity and revenues. The decision rule of a farmer, who maximises expected profits of sugar beet production, is therefore that the optimal sugar beet production is found where expected marginal revenues (EMR) equal marginal costs of beet production (+ opportunity costs). The EMR of producing an additional ton of sugar is given by:

$$\begin{aligned} \text{EMR} = {} & p^A \\ & -\left(p^A - p^B\right)\left[\left(1 - F\left(q^A\right)\right) + f\left(q^A\right) Ey_S \left(\sigma^0\right)^2\right] \\ & -\left(p^B - p^C\right)\left[\left(1 - F\left(q^{AB}\right)\right) + f\left(q^{AB}\right) Ey_S \left(\sigma^0\right)^2\right] \end{aligned} \tag{1}$$

where the sugar production y_S is an outcome of a normally distributed random process with the probability density function (pdf)

$$f(y_S) = N\left(Ey_S, \sigma^S\right) \tag{2}$$

and the cumulated density function (cdf)

$$F(c) = \int_{-\infty}^{c} f(y_S) dy_S \tag{3}$$

p^A, p^B, and p^C are the prices for the respective sugar type and q^A, q^{AB} the respective cumulated quotas. Ey_S denotes the expected value of sugar production (planned production) and σ^0 is the coefficient of yield variation. Consequently, EMR of sugar beet production depends on planned production, sugar prices, yield variance, and quota endowments. EMR of sugar beet production can be seen as a probability weighted average of the three prices. Therefore expected marginal revenues could equal marginal costs at positive C-sugar quantities even if marginal costs are above the C-beet price. Similarly, it allows for a quota under utilization if they are below the respective quota beet price. They further find that the introduction of expected profit maximisation is able to reduce the gap between observed production quantities and theoretical optimal production compared to simplistic profit maximisation, but especially for the main C sugar producing countries, it is not sufficient to explain observed production quantities.

Utility maximisation under risk aversion

Expected profit maximization implies risk neutral behaviour of farmers. Risk averse behaviour can be modelled with a utility maximization framework where expected profit and variance of profits enter the utility function as arguments. To some extent risk averse farmers are willing to accept lower expected profits as long as the profit variance is decreasing sufficiently. Which combination of profit mean and variance is optimal depends on the degree of risk aversion. Therefore utility maximization with risk aversion generally rationalizes even higher production quantities compared to expected profit maximization. Adenäuer and Heckelei (2005) show that the observed production of a lot of sugar beet farmers in the EU member states is in a range where it can be explained with a certain degree of risk aversion. Unfortunately, especially in those countries that supply the largest share of C sugar, risk aversion is insufficient to explain the observed production. Consequently there must be other additional economic incentives to supply C-sugar quantities.

Expected quota changes are correlated with C beet production

This theory is based on the assumption that sugar beet producers expect future changes in their quota endowment to be based on current production. The higher current production, the higher the expected quota increase or the lower the expected quota loss. Farmers pay so to say an insurance premium in terms of a higher beet production where production costs are not completely covered.

1. Farmers expect to gain additional quotas.

Imagine that farmers expect that a small amount of sugar beet quota is reallocated every year. This happens when quotas return to the sugar processors from farmers abandoning their production or from quota cuts to farmers that do not fill their quotas. In such cases sugar processors can distribute this amount of quota among all other producers. Assume now that the sugar companies distribute those quotas among the farmers of a region using a certain key that reflects a smaller quota package for a farm with a lower production (relative to its quota endowment) and vice versa. Consequently, each unit of beet production delivers an additional value in terms of raising the expected additional quota allocation to farmers. This additional value is the discounted stream of expected profit gains for the time after quota reallocation.

2 Farmers expect (or fear) that their quota is cut.

This assumption is even more relevant than assumption 1, because the probability of a quota cut seems higher than that of a quota increase to farmers through reallocation, especially in the context of the actual discussions on quota reductions. Modelling the impact of expected quota cuts on the preferability of C sugar production today is very similar to the case of expected additional quotas. The higher the production the higher the probability of a lower quota cut which means a higher future value from the point of view of a beet producer.

Henrichsmeyer et al (2003) use exactly this assumption to make C sugar production react to quota- or quota price changes. They point out that the additional values that have to be added to the C sugar prices depend strongly on three variables, the assumption of yearly distributed and reduced quota amounts, the differences between A-, B-, and C sugar beet prices and the production of each producer in the base period. The most insecure variable is the first one because there is only little information on the handling of quota cuts and redistribution of quotas. One recent incident occurred 2003 in Ireland where 132 beet growers under supplied their beet delivery rights by over 10%. Their quotas were cut by the amount of the shortfall (Irish Farmer's Journal Interactive 2003). In regulation 90/45/EEC the European Commission (1990) lays down the rules for the Belgian sugar markets. There it says "….*(29) Following the 1986/87 marketing year, the delivery rights thus allocated to the various growers (or suppliers) concerned can be readjusted according to the following basic rule governing the adjustment of rights: each winter in which an undertaking's average production for the last three marketing years is below its maximum quota, half of the delivery shortfalls of the growers (calculated by the difference between the supply right allocated during the last marketing year and the average of the supplies carried out during the last three marketing years) are allocated to the traditional growers (or suppliers) in proportion to the average of their deliveries during the last three marketing years. The factory committee (1), in agreement with the coordinating committee (2), can allocate a portion of such available quantities to solve special cases. ….*"

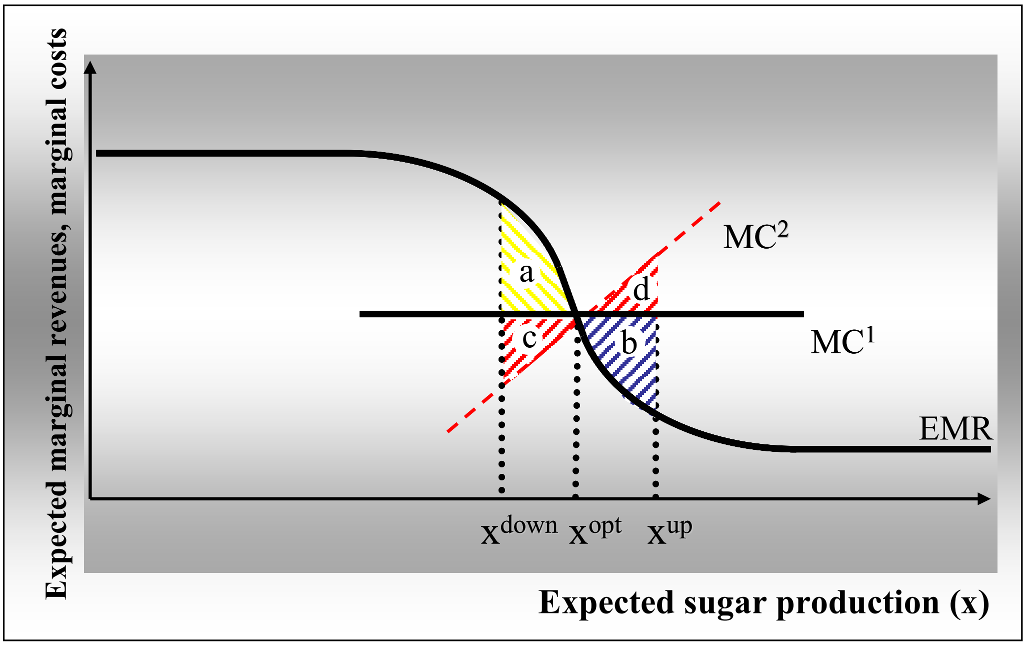
Nonetheless, the amount of quota redistributions in the last decade in the EU Member States can be considered very small. But from the farmer's point of view it is not that interesting how often it occurs as long as processing firms talk them into believing in the possibility of quota cuts.

Discontinuity in land allocation

Possibly, discontinuity in land allocation at the farm level might be relevant. One can imagine that farmers normally do not cultivate more than one crop per plot. Consequently they are faced with a finite number of possible field combinations. Generally economic analysis of sugar land use assumes that land allocation is continuous. Let us assume that sugar beet farmers are expected profit maximisers and calculate their optimal sugar beet land allocation according to the theory derived above. The resulting optimal land allocation has to be approximated by any possible combination of plots. In this case the farmer has to decide whether he supplies above the theoretical optimum or below it if he is not able to meet the continuous optimum exactly.

We now like to examine if there is any reason why farmers would prefer to round up the optimal land allocation according to the next larger field combination. In Figure 1 we show which variables are important to decide whether rounding up or down is the more profitable strategy. Let us assume a farmer to know his expected marginal revenue function as EMR. We further assume that he has constant marginal production costs given by MC^1. The theoretical optimal production x^{opt} is then given at the intersection of marginal costs and expected marginal revenues. For now we assume that this optimum is located exactly in the middle of the smallest last plot the farmer decides to cultivate with beets. If he does not like to divide that plot, he has to decide if he grows sugar beets on the entire plot (round up to x^{up}) or if he forbears from cultivating beets on it (round down to x^{down}). The answer to the question which decision is more profitable is a matter of the two shaded areas (a) and (b) in Figure 1. They represent the loss of expected profits compared to the optimal situation. We have chosen MC^1 such that both areas amount to the same size. In this case the farmer can looses the same independent in which direction he moves. It can easily be shown that shifting the marginal cost function to higher levels leads to a lower size of the shaded area (a). Consequently, rounding down is the better decision in case marginal costs are higher than MC^1. Inversely, lower marginal cost make area (b) increase relative to (a) so that rounding up is the more profitable strategy. In the figure we further define a linear increasing marginal cost function MC^2 in order to show that the clues from this examination are independent from the assumption whether marginal costs are constant or linear increasing. As visible the areas (c) and (d) have the same size so that they compensate each other. The decision remains a matter of (a) and (b).

Figure 1 Discontinuities in land allocation in a framework of expected profit maximisation



Source: Own calculations

The relevance of this effect is, whereas, not very easy to be quantified. Nonetheless, we might get further insights from farm data. Adenäuer (2005) estimates quotas, prices and marginal costs for sugar producing farms in the FADN sample. It is therefore self-evident to analyse if those marginal cost estimates are generally lie below or above the marginal costs indicated by MC^1. The definition of MC^1 in a one quota case is given by the inflexion point of the EMR function. This can be derived by setting the second derivative of the EMR equation (1) to zero. The inflexion point is then found at an expected production

$$Ey_S{}^i = \frac{q^{AB}}{6(\sigma^0)^2}\left[\sqrt{1+12(\sigma^0)^2}-1\right] \qquad (4)$$

$Ey_S{}^i$ is generally lower than q^{AB}. Substituting equation (4) into (1) would give us the corresponding expected marginal revenue at the inflexion point which would be the value the marginal production costs should be compared to. Since this results in a rather unlovely expression, we simply approximate this value with $0.5(P^A+P^C)$, knowing that the real value is even higher so that we do not overestimate that issue. The simplification to a 1 quota system rises further imprecision, but we only intent to show tendencies. Therefore we calculate the share of farms within an EU Member state, where marginal production costs are estimated to be lower than $0.5(P^A+P^C)$. Results are given in Table 1.

Table 1 Shares of farms with marginal costs below the inflexion point of EMRs

	share of farms with marginal costs below 0.5(PA+PC)
Denmark	100%
Austria	99%
France	99%
Germany	91%
Belgium	78%
Finland	77%
Sweden	70%
Spain	66%
The Netherlands	58%
United Kingdom	57%
Italy	54%
Greece	33%
Ireland	23%

Source: Own calculations

Obviously, in most member countries of the EU15, the share of farms where marginal production costs are below the define frontier is above 50%. In the relevant C sugar supplying States Denmark ,Austria ,France and Sweden those farms amount to above 90%. The clue of this analysis is that we can conclude that in those countries there is a clear tendency to fill the last plot entirely with sugar beets rather than to abandon it.

We are well aware that the results of this simulation depend on the assumptions made above. Nevertheless one general conclusion might be permitted: As long as marginal costs of sugar production are not that high, there is a clear tendency to supply more sugar than the continuous expected profit maximisation would suggest and that discontinuities in land allocation might trigger additional sugar supply and therefore contribute to the possible explanations of observed C sugar quantities. Nonetheless, this effect is not easy to quantify because of only small information on regional distributions of plot sizes.

Calculations based on average sugar contents

Farmers sign contracts with processing firms in which at least sugar beet delivery rights and prices are laid down. Those are based on an average sugar content of 16%. Normally a conversion table that shows how beet delivery rights and prices change with sugar contents that deviate from the average is included as well. But what if farmers simply plan with that average sugar content? As long as the effective sugar content lies above that average, which is valid for most of the EU15 Member countries, an underestimation of sugar contents will trigger additional sugar quantities as well.

C sugar from quota beets

Anecdotal evidence and persistent rumours in some Member States (e.g. Germany) suggest that sugar refineries distribute delivery rights above quota quantities (Schmidt 2002, Schmidt 2003). In this case, the aggregate C-beet production as perceived by growers is smaller than the quantity inferred from national statistics. Unfortunately, the relevance of this practice in the different EU countries is difficult to assess. Generally processing firms are not allowed to distribute more delivery rights than their quota amounts, but the CMO Sugar shows some windows of opportunity. Schmidt (2003) points out that the CMO defines the average processing losses at 3%. That means, sugar beets with an average sugar content of 16% are processed to 13% sugar. Consequently the sugar plants have to calculate the distributed delivery rights based on 13% effective sugar content to fill their sugar quotas. In reality, however, the processing losses have been reduced down to about 2% since the early days of the CMO, where those processing losses where defined. If beet delivery rights have not been adjusted since then, today we would face a certain percentage of C sugar coming from quota beets.[iv]

The incentives for sugar processors to engage in these practices might be to fully use existing capacities. Schmidt (2003) addresses further that about 65% of the sugar production costs are fixed costs that are likely not to be allocated to the C sugar production. It can therefore not be excluded that distributing delivery rights above their quotas in order to trigger a high level of capacity utilisation might be a profitable strategy from the processors point of view. To a certain extend it might also be likely that they cross subsidise C sugar production by quota sugar production for the same reason. If this is practiced in the C producing EU Member States, the above discussed models become more relevant than ever because sugar quotas would be extended, so that observed production might be explained by a mixture of yield uncertainty, discontinuities in land allocation and yield underestimation for all EU Member States.

As the major result of this section we might conclude that all presented theories have a certain potential to explain parts of the observed sugar production across the EU13 but none of them is able to explain it solely. In reality several hypotheses will apply but we do not know which contributions they make. For modelling purposes this insight is somewhat frustrating because modelling means applying certain behaviour models that are able to explain observed economic variables. Nonetheless, based on the analysis in this section we will modify the sugar (beet) supply part of the agricultural sector model CAPRI as explained in the subsequent section in order to obtain a more realistic sugar supply response on quota and price changes.

Modeling the European sugar sector with CAPRI

In this section we provide an overview on the agricultural sector model CAPRI and show how the model was adjusted to care for the specialties of sugar beet economics, discussed in the previous section. We further provide a small sensitivity analysis to show how the model's supply response depends on underlying assumptions.

Model overview

The regionalised agricultural sector modelling system "CAPRI" (**C**ommon **A**gricultural **P**olicy **R**egional **I**mpact) was developed in the context of the Fourth Framework Project (FAIR3-CT96-1849)[v] from 1997 until end of 1999. It has been further developed under the "CAPSTRAT" (2001-2004) and in the current "CAPRI-DYNASPAT" project. Over the whole time period a lot of applications of the modelling system have provided quantitative analysis of special agricultural policy reform proposals.[vi]

An overview is provided in the following. It applies to the model version as it was provided by the end of the CAPSTRAT project in 2004. The model is generally designed as a projection and simulation tool for the European agricultural sector based on:

- A physical consistency framework, covering balances for agricultural area, young animals and feed requirements for animals as well as nutrient requirement for crops, realised as constraints in the regional supply models.
- Economic accounting principles according to the definition of the Economic Accounts for Agriculture (EAA). The model covers all outputs and inputs included

in the national EAAs for the 15 EU Member States (new members not yet included), and the revenues and costs are broken down consistently to NUTS 2 regions and production activities.

- A detailed policy description, capturing all relevant payment schemes with their respective ceilings on the supply side and covering tariffs, intervention purchases and subsidised exports on the market side
- Behavioural functions and allocation steering strictly in line with micro-economic theory. Functional forms are chosen to be globally well behaved, allowing for a consistent welfare analysis.

A model can only perform well if it is based on a comprehensive data basis. As indicated by its name, CAPRI is a regionalised sector model, so that regionalised data is essential. On national level the CAPRI modelling system makes use of the COCO data base (Britz et al (2002) which is consistent with the EAA and completed using simulation estimation techniques under data consistency constraints in order to fill gaps. The only uniform data sources at EU level for regionalised data are the REGIO database from EUROSTAT and the FADN data. Both sources are exploited in order to build the CAPRI regionalised database. Given the regional resolution of these sources, NUTS II is chosen as the minimum level of regionalisation. REGIO is used to define acreage, herd sizes and yields at NUTS II level. Data at national level (cropped hectares, slaughtered heads, herd sizes and production quantities) are taken over without changes from COCO and data from REGIO are corrected as to allow for a consistent desegregation. FADN data provide parameters for input demand functions to estimate the input allocation and income indicators for activities at a regional level. In total there are about 200 regions in the database and modelling system, covering the whole of EU15.

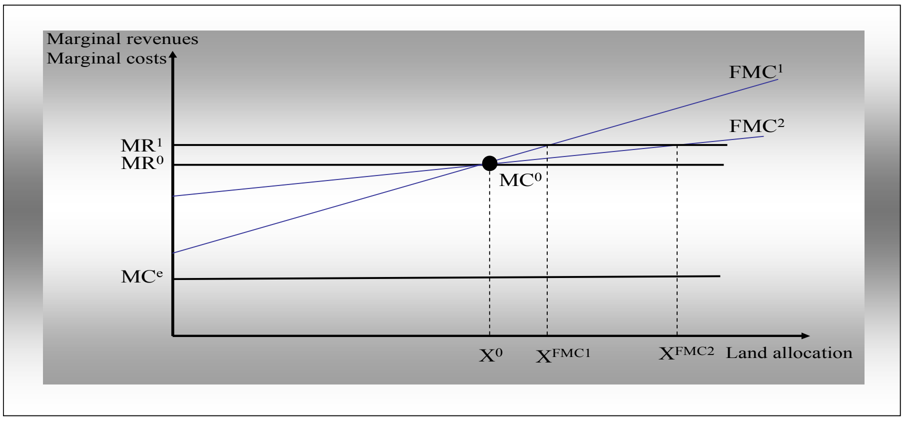
The model distinguishes a supply and a market module, which are iteratively coupled. The supply module consists of aggregate programming models at NUTS 2 level, working with exogenous prices defined at Member State level during each iteration. After being solved, the regional results of the NUTS 2 supply models – crop areas, herd sizes, input/output coefficients, etc. – are aggregated to Member State level. Member State models build with an identical structure as the NUTS II models are then calibrated to the aggregated results of the NUTS II models. Next, young animal prices are determined by linking together these Member State models. Afterwards, supply and feed demand functions of the market module are calibrated to prices of the current iteration and aggregated Member State results on feed use and supply. The market module is solved. Producer prices at Member State level, as calculated by the market module (a Multy Commodity Model based on the Armington Approach in Armington, P, 1969) drive the next iteration with the supply module. Equally, in between iterations, premiums for the activities are adjusted if ceilings are overshot according to the results laid down in the Common Market Organisations. To provide a better understanding of the supply response from the CAPRI supply module we explain the general functionality in the next section. This is essential to understand the adjustments that are made in the sugar beet supply part, presented afterwards.

Land allocation in the regional programming models of CAPRI

One of the general philosophies on which the CAPRI model is based is that such a model should be able to reproduce observed production, land allocation, herd sizes etc. as a result of an optimisation process. In our case we choose a three year average around 2001 as base year. Each NUTS 2 region acts like one farm. Several exogenous variables enter the non linear programming models that are set up for each region. The most important ones are: Regional area endowments, yields per hectare for all production activities observed in the base year, per hectare production costs that were estimated from FADN, quota endowments, product prices (as resulting from the market module), CAP premiums and set aside rates. Given those exogenous factors in the base year, an optimisation of regional profits using linear programming models won't reproduce observed quantities, because linear programming models would expand the most profitable production activity as long as it does not hit upon a bound. This general problem of overspecialisation is further stressed in Howit (1995a) where the author provides an alternative: Positive Mathematical Programming (PMP). The idea of PMP, which has become very common in the last decade, is to introduce a non linear cost function, quadratic in land allocation (or production) and define the parameters of that function such that marginal profit in the base year is equal to zero, characterising a profit maximum. Unfortunately the definition of such a cost function is not unique since there may exists infinite possible choices. One only knows that marginal revenues equal marginal costs (including opportunity costs) in the base year, but that is not enough to define the two parameters of a linear marginal cost curve. Heckelei (2002) explains, how such cost functions could be estimated using first order conditions as restrictions from time series data, but his approach is not yet implemented for the CAPRI supply system.

The importance of the parameters of the non linear cost functions is visualized in Figure 2, simplified to the one product case. The only hard information in the calibration is the point MC^0, defined by the marginal revenue (MR^0) at the observed land allocation (X^0). MC^e gives the explicit defined production costs per hectare based on allocated inputs and obviously, there is a gap between marginal costs and marginal revenues which we want to close by the PMP approach. Therefore we define a marginal cost function through the point MC^0. FMC^1 and FMC^2 are two of infinite possible choices. It becomes apparent how important the choice of the function's slope is with respect to the response of land allocation. If we shift the marginal revenue – due to rising product prices or premiums – to MR^1, the resulting new land allocations X^{FMC1} and X^{FMC2} that refer to the two different marginal cost curves are quite different. Heckelei (2002) (or Heckelei (2005) for an overview) points at the importance of the PMP slopes and the arbitrariness of the original approach of Howit (1995a) to choose those parameters of the quadratic cost function.

Figure 2 Implications of PMP calibration



Source: Own calculations

Ideally, the slope of the marginal cost function should be based on observed supply behaviour. In the CAPRI calibration process, the slopes are currently specified according to supply elasticities based on expert knowledge for each product and NUTS2 region. In case of sugar beet production, we make a number of adjustments to the supply module of the model, explained in the subsequent section.

Sugar specific adjustments in the CAPRI supply module

In the first model versions, the treatment of sugar beet production in CAPRI was very simple. Production quantities were fixed at base year levels. Impact analyses of changes in the economic environment of sugar beet production were therefore impossible. Sugar quotas are only available on national levels from official statistics but not for each sugar producing NUTS 2 region. In order to model the regional impact of changes in the CMO sugar, we need at least an estimate of sugar beet delivery rights that are located within one region. We are well aware that something like a regional sugar quota does not exist because regional borders do not necessarily meet the patch of processing firms. But since we do not intent to model the sugar industry and the impacts of transportation costs or possible mergers of processing firms, our assumption is that regional sugar beet delivery rights are the weighted sum over all farms within that region of estimated sugar beet quotas from FADN (Adenäuer 2005).

Sugar beet prices, as a further important economic variable, were also not included in the CAPRI model so far. Generally, the model works with equal prices within EU Member. In this paper, the linkage between each sugar beet price and market sugar price - as it results from the market model – is based on a reduced form equation given in equation(5). We link the farm-gate price ($P^{beet}_{MS,x}$) of a type of sugar beets (x) to the relevant derived revenue from sugar and molasses (R^{mola}_{MS}), taking into account the applicable levy and the processing coefficient sugar per ton of beets ($\Phi_{MS,suga}$). The parameter α is calculated so that consistency with an average beet price derived from the Eurostat Economic Agricultural Accounts (EAA) is achieved, meaning that the sum over the product of the base year quantities of each sugar beet type multiplied with the respective price meets exactly the production value of sugar beets in the base year. Data on market sugar prices per EU Member State (P^{suga}_{x}) are taken from Blume et al (2003) and sugar world market prices are included in that CAPRI system. The revenue of molasses, hence, is fixed on the basis of the by product revenue defined in the official calculation the basic beet price (Linde et al 2000, p 9). Levies are calculated by the price differences between the average EU market price for sugar and the world market price multiplied by the difference between A + B sugar production and domestic demand.

$$P^{beet}_{MS,x} = \alpha_{MS}\left[\left(P^{suga}_{MS,x} - levy_x\right)\phi_{MS,suga} + R^{mola}_{MS}\right] \tag{5}$$

We are well aware that our representation of the sugar processing industry is extremely simplified and that introducing an optimisation framework that is based on the economic conditions in the processing industry would greatly improve the supply response of the model. However, an explicit modelling of the processing industry is beyond the scope of this paper. [vii] But we have to be careful with the interpretation of model results. The base year estimates of the variables in equation (5) are given in Table 2. It becomes apparent that the parameter α ranges from 0.41 to 0.66 meaning that processing firms pass between 41% and 66% of their sugar revenues to the farmer. If we keep in mind that minimum beet prices are calculated with the rule of thumb sugar revenue multiplied by 58 percent (EU Commission AGRI/63362/2004), we see that our estimates range around this percentage, confirming their reasonable magnitude.

Table 2 Sugar and sugar beet prices in the base year (2001)

	A-beet price (€/t)	B-beet price (€/t)	C-beet price (€/t)	MS sugar price (€/t)	α
BL	51.8	51.8	16.0	691.8	0.50
DK	50.3	43.4	15.7	672.5	0.48
DE	54.9	47.5	16.8	680.5	0.53
EL	53.5	46.5	17.2	682.7	0.66
ES	54.7	54.7	17.4	703.0	0.54
FR	44.7	38.8	13.2	706.1	0.46
IR	49.7	49.7	15.6	694.6	0.53
IT	39.8	39.8	13.1	685.2	0.48
NL	52.4	52.4	16.6	683.6	0.51
AT	51.2	44.3	15.8	685.6	0.48
PT	53.8	46.8	17.1	691.8	0.41
SE	52.4	45.4	15.9	687.8	0.48
FI	54.1	47.0	16.9	691.8	0.53
UK	52.2	52.2	15.5	725.4	0.50

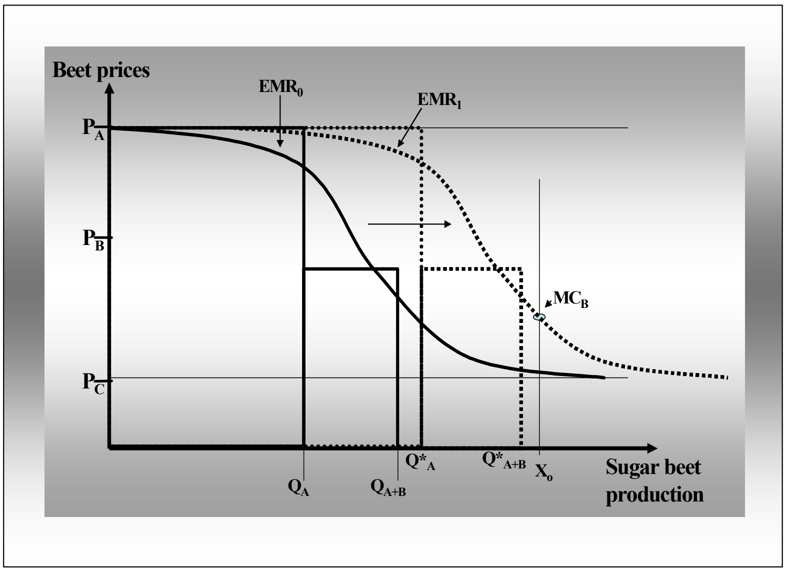
World market price sugar = 194 €/t

Source: Own calculations

The supply response of the regional supply models is greatly affected by the profit maximisation assumption. We stressed above that this behavioural model is an insufficient assumption in case of sugar beet production, because every region that supplies C beets is assumed to be competitive at C beet prices because they are the corresponding marginal revenues at the observed base year production quantity to which marginal costs are calibrated. Therefore those regions won't react on changes in quotas or quota beet prices at all. Consequently we replace it by expected profit maximisation under yield uncertainty which has proven to be an improvement compared to profit maximisation. Technically we substitute the regional sugar beet profit definition by the definition of expected sugar beet profits given in equation (1). Sugar beet yield variances, which are required, are calculated from FADN as the standard deviation across all sugar beet producing farms within a region and the years 1995 – 1999.

As the discussion in the first section of this paper has shown, this alone would not cause regional sugar beet supply react to quota or quota price changes as long as we observe very high C beet productions in the base year because such a region would still be calibrate to very low marginal costs. Adenäuer (2005), Bureau et al (1997) or Vierling (1996) estimate regional marginal cost from farm data, which appear to be considerable above C sugar beet prices. One of the most important sugar specific adjustments of CAPRI is to take the estimates from Adenäuer (2005), which include opportunity costs as well, as given for now. But if we change marginal costs in the base year, we have to change expected marginal revenues as well, to ensure that observed production quantities are still 'optimal'. To reconcile the observed production with the marginal costs estimates, we follow the method applied in Adenäuer et al (2004) who calibrate the CAPRI model to estimates of marginal production costs taken from Bureau et al (1997). The idea of their concept is to define a virtual quota mark up such that the expected marginal revenue function equals the estimated marginal costs of sugar beet production at the observed supply level.

Figure 3 Determination of virtual quota mark ups



Source: Own calculations

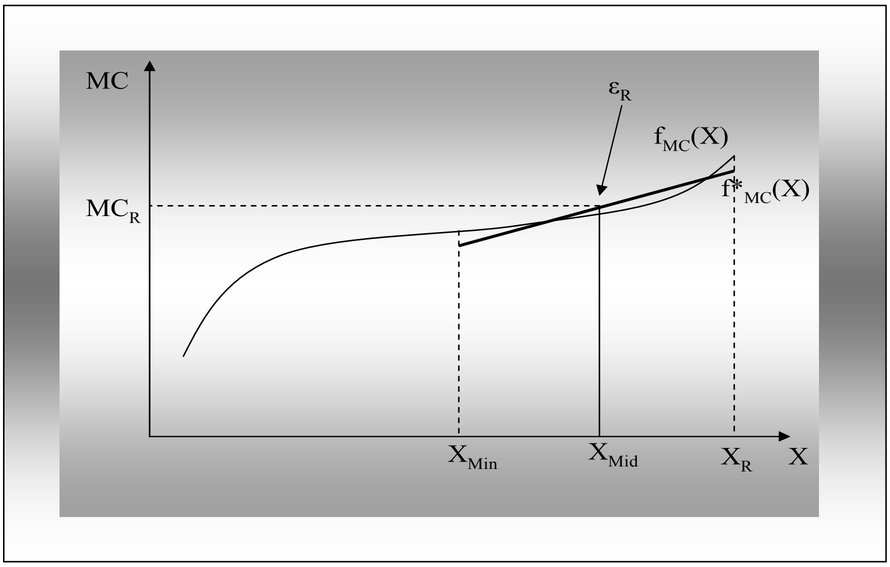
As shown in Figure 3, the expected marginal revenue (EMR) function is simply moved to the right (EMR_0 to EMR_1). The virtual quota mark up is defined relative to the regional sugar beet quota and is taken to be constant in simulations. The difference of original and translated EMR functions can be interpreted similarly as an insurance that beet growers pay for the motives discussed above. The marginal cost MC_B corresponds to the marginal cost estimates which are assumed to hold at the observed supply X_0. While the actual quota endowment is at Q_{A+B}, we envisage that the beet grower behaves as if his quota endowment is at Q^*_{A+B} because with this quota endowment, the expected marginal revenue equals the estimated marginal costs. This procedure guarantees that the EMR function is relatively steep at the observed supply level, which in turn leads to a stronger and more reliable response to quota and price changes that might be more realistic. This procedure is repeated for every NUTS 2 region where sugar beets are grown.

It is generally questionable to impose a behavioural model which has been shown to be insufficient to reproduce observed sugar beet supply quantities. That virtual quota mark up is further a very pragmatic solution. Nonetheless, above we have shown that there are a number of motives to supply additional C beet quantities, but the magnitude of their effects is unknown. The definition of that virtual quota mark up is meant to capture all those effects.

The last adjustment of the supply part is to use estimates for supply elasticities from FADN as well. Those are calculated as follows. Given marginal costs estimates for a number of FADN farms for the three year average 1999 (Adenäuer 2005), it is possible to derive regional marginal cost curves by horizontal aggregation of their production quantities. The resulting functions have generally the shape similar as $f_{MC}(X)$ in Figure 4. X denotes the sugar beet production and MC marginal costs. There are a few farms with low marginal costs, lots with an average magnitude, and again a fewer number with high marginal costs. A very simple, but common assumption is, that those curves are the true marginal costs curves for a region what is only valid as long as marginal costs on each farm are constant and adjustments on farms are neglected. A farm would therefore stop sugar beet production if marginal revenues fall below their marginal costs. If we follow that assumption, the supply response of our regional supply models should approximate those curves. For this purpose, we proceed pragmatically again to exploit some empirical information from FADN for CAPRI.

First, we estimate a linear function ($f^*_{MC}(X)$) but only over 40% of the farms that have the highest marginal costs (X_{Min} to X_R). 40% offered a reasonable compromise between focus on the relevant range and number of observations for safeguards against outliers. We choose only the right part of $f_{MC}(X)$ because there the regional supply quantity (X_R) is located and if the model supply response shall aim to simulate the leaving and entering of farms, it is the more relevant scope. The next step is to calculate the marginal costs $f^*_{MC}(X_{MID})$ the supply elasticities ε_R at the same point. Both are passed over into the calibration process of CAPRI. This method is only applied to regions with at least 30 observations. In all other regions we use marginal costs and elasticities derived from applying that calculation to the whole Member State.

Figure 4 Regional marginal costs curves from FADN



Source: Own calculations

To illustrate the importance of our choice of elasticities and marginal costs, we perform now a small sensitivity analysis exemplary for Denmark[viii]. For this purpose we calculate the supply response and effective supply elasticities based on a 10% quota reduction ceteris paribus in the base year. Marginal costs are reduced in five steps from 95% of the A beet based year price to 105% of that of C beets. PMP slopes are initialised with elasticities from 1 to 5.[ix]

Table 3 Supply response induced by a 10% cut in quotas for different marginal costs and initial supply elasticities in Denmark

initial elasticity marginal costs (€/ton of beets)	1	2	3	4	5
16	-1.3%	-2.5%	-3.4%	-4.1%	-4.8%
24	-6.2%	-7.7%	-8.4%	-8.7%	-9.0%
32	-7.0%	-8.2%	-8.7%	-9.0%	-9.2%
40	-6.6%	-7.9%	-8.5%	-8.8%	-9.0%
48	-4.1%	-5.6%	-6.5%	-7.1%	-7.5%

Source: Own calculations

In Table 3 we see the supply response of Denmark to a quota reduction of 10% depending on marginal costs and elasticities. The importance of the estimate of both variables with respect to model results is here pointed out. Denmark could follow a 10% quota cut by only

1.3% up to 9.2%. The magnitude of marginal costs in the base year is obviously very important with respect to the sugar beet supply response. We further see that marginal costs are more important than elasticities, because within one row the maximal and minimal supply reduction varies only by about 3% while it varies about 6% in the columns. This somewhat troublesome result is dampened a little if we exclude the two outermost rows. Estimated marginal costs fall generally in a range around the mid point between A and C beet prices so that we might conclude that we act in a range where the resulting supply response is not that sensitive to a small misspecification of marginal costs. Elasticities range generally from 1 to 4 with two outliers in Italy and two in France. The vast majority of regions shows supply elasticities between 1.5 and 2.5.[x]

Sugar specific adjustments in the CAPRI market module

In the market part of the model, we make only a few adjustments. One of them is to raise the Armington elasticities to ten in order to reflect that sugar is a relative homogenous good. Even higher elasticities might be more realistic, but due to numerical problems during the model solve with higher ones than 10, we left them on that value. Subsidized export quotas are defined as the official determined WTO limit (2.6 Mio tons according to EU Commission AGRI/63362/2004) plus the produced C sugar because for the rest of the world it is as if all exported EU sugar was subsidised. Generally, the EU sugar exports are not allowed to exceed the C sugar quantities + WTO limits. Unfortunately the square system of our market model does not allow for fixing or bounding variables. In order to ensure that the European Union does not export more sugar than allowed, we introduce a term in the import price function of all other regions that import EU sugar. This term adds a high number to the price as soon as subsidised export quantities are overshot, making EU sugar unattractive to be imported.

The regional disaggregating of the standard CAPRI market module is, however, not adequately suited to simulate the impact of the EBA initiative because the country group of the 48 Least Developed Countries (LDCs) that benefit from the EU trade concessions is not explicitly modelled as one regional aggregate in contrast to Henrichsmeyer et al. (2003a). Most LDCs are spread across the regional ACP country aggregate, the regional free trade developing country (CAD) aggregate and the rest of the world (ROW) aggregate. Because the aggregation of the 48 LDCs in one regional aggregate in the market module was not feasible within the scope of this study, we proceed as following. We define a certain export potential of the three regional county groups that contain LDCs. Those are chosen to be in line with Henrichsmeyer et al (2003) and Sommer (2003) to sum up to about 2.4 Mio tons of additional sugar imports into the EU 15. This amount is added to the existing tariff rate quota of the relevant county groups. They receive preferential tariffs equal to zero and prohibitive out quota tariffs. This A comprehensive modelling of international sugar markets would require a lot of research regarding production costs and export potentials of each single LDC country what was not feasible within the scope of this paper. Finally note that the new EU Member countries are treated as if they where not included in the CMO sugar, results are therefore only for EU15.

We further introduce a sugar quota trade module that moves quotas between European regions until the quota rents per ton of sugar produced are equalised, assuming that transaction costs do not exist.

Empirical analysis of reform options

In this section we apply the CAPRI modeling system to analyze the following theoretical future developments of the CMO sugar:

- The reference run: Here we assume that there will be no changes in the sugar market. The CAP reform (2003) and WTO commitments excluding the EBA agreement are fully implemented. Simulation year is 2009. The decoupled premium scheme is explicitly modeled as described in Britz et al (2002). All product prices, yields and costs are shifted by trend estimates. The reference run is modeled with the purpose to distinguish exogenous shocks from the analysis of reform options in the following scenarios.
- The EBA scenario: All settings are the same as in the reference run but now we include the *Everything But Arms* concession by defining additional TRQ quantities for LDC countries as described above. With this scenario we analyse how the actual CMO Sugar regulations would accommodate the additional sugar imports by a quota reduction.
- The Fischler proposal (2004) without tradable quotas: In July 2004 Franz Fischler came up with a reform proposal of the Common Market Organisation for sugar. The main elements are discussed below.
- The Fischler proposal (2004) with tradable quotas: The same settings as before but now including the proposed quota trade

- The Fischler proposal (2004) with abolition of C sugar production. In this scenario we reflect a possible outcome of the current WTO panel namely that C sugar exports may be found inconsistent with WTO rules.

The latter 3 scenarios are called Fischler scenarios in the following but before we concentrate on them, we are going to compare key variables on the agricultural sector of the reference run (009) to the base year (2001).

The reference run – development of key indicators on agricultural markets

The model results for the agricultural sector for all products but sugar beets are almost perfect in line with results carried out in chapter 4 of the Mid Term review of DG Agri (Commission of the European Communities, 2003). This is not very surprising because compared to the version we use, the CAPRI modelling system applied there did not change except for the sugar part. We refrain therefore here from presenting any results for other products, given the relative small importance of the sugar sector in European agriculture as a whole. The reference scenario is characterised by a real decrease in sugar prices on the European market. The world market price for sugar is decreasing, as well. Domestic demand is forecasted to stay basically on the base year level and sugar quotas don't change as well. EU15 sugar production rises by 2% while the trade figures stay almost constant. In Table 4 we see that the increase in sugar production on European level does not mean an increase in each EU15 Member State. Some of them, especially those with negative yield developments, reduce their production. Generally the development depends mainly on how the decoupled premium that raises relative competitiveness of sugar beet production compensates the decrease in real prices. The income per hectare of sugar beet production rises in most countries. In the Netherlands this increase is obviously very high. This is mainly due to a very high premium that is about twice above the EU15 average value due to high amounts of animal premiums that are now distributed across the land. In contrast, very low premium per hectare cannot compensate the decrease in sugar beet prices in Portugal. The reference run is a theoretical construct with respect to developments on the sugar markets because the EBA agreement will not allow for its settings. It was only meant to show other exogenous developments. Our next scenario serves as a more realistic reference to the remaining scenarios. It forecasts how the current regulations of the CMO Sugar deal with additional sugar imports into the EU15.

Table 4 Development of sugar beet production in the EU15 Member States in the reference scenario

	Base Year (2001)				Reference Run (2009) percent deviation to : Base Year (2001)			
	Income Euro/ha	Hectares 1000 ha	Yield kg/ha	Supply 1000 t	Income Euro/ha	Hectares 1000 ha	Yield kg/ha	Supply 1000 t
European Union	1697.52	1880.56	59765.92	112393.29	1826.25 7.58%	1853.17 -1.46%	61897.59 3.57%	114706.57 2.06%
Belgium	1841.55	94.28	64702.99	6100.48	1962.57 6.57%	97.28 3.18%	62964.01 -2.69%	6125 0.40%
Danmark	1656.98	57.76	57004.38	3292.59	1833.23 10.64%	56.73 -1.78%	59688.14 4.71%	3386.23 2.84%
Germany	1965.07	452.96	58416.76	26460.19	2292.04 16.64%	424.87 -6.20%	64424.2 10.28%	27372.1 3.45%
Austria	1888.72	44.23	63124.32	2791.92	1935.51 2.48%	44.05 -0.41%	65055.24 3.06%	2865.48 2.63%
Netherlands	1390.82	108.61	58075.41	6307.76	1669.6 20.04%	106.73 -1.73%	60291.12 3.82%	6434.61 2.01%
France	1620.68	425.47	71607.11	30466.9	1731.44 6.83%	414.26 -2.63%	75456.24 5.38%	31258.31 2.60%
Portugal	2120.05	7.44	61912.88	460.83	1782.45 -15.92%	7.88 5.91%	54775.38 -11.53%	431.53 -6.36%
Spain	2821.83	115.18	65518.98	7546.46	2774.17 -1.69%	109.31 -5.10%	69553.86 6.16%	7603.18 0.75%
Greece	2795.79	44.52	63708.29	2835.99	2721.87 -2.64%	44.09 -0.97%	66404.1 4.23%	2927.9 3.24%
Italy	1451.37	239.13	49333.82	11797.37	1502.06 3.49%	254 6.22%	47260.23 -4.20%	12004.31 1.75%
Irland	1725.73	31.52	49076.67	1546.84	1664.96 -3.52%	33.53 6.38%	45731.59 -6.82%	1533.22 -0.88%
Finland	694.72	31.18	34302.04	1069.38	759.58 9.34%	29.51 -5.36%	36890.69 7.55%	1088.56 1.79%
Sweden	376.92	55.04	47998.42	2641.73	420.35 11.52%	52.37 -4.85%	51290.37 6.86%	2686.15 1.68%
United Kingdom	1219.87	173.24	52383.44	9074.85	1299.99 6.57%	178.56 3.07%	50347.08 -3.89%	8989.99 -0.94%

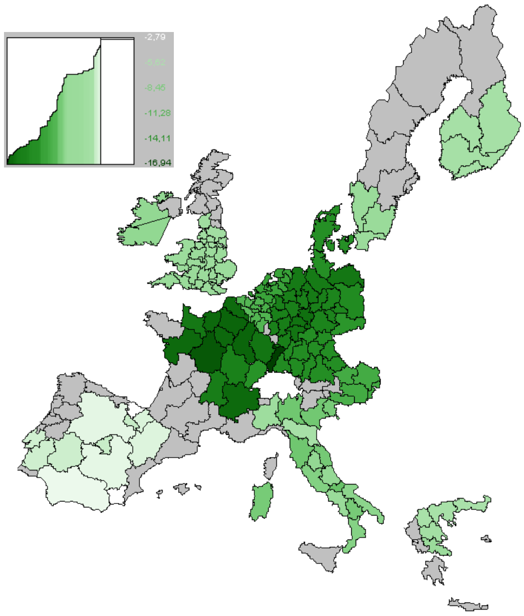
Source: CAPRI modelling system, monetary values in 2009 terms,

Income = market revenue + premiums –costs

The EBA scenario – what means EBA under the current CMO sugar?

The regulations in the actual CMO sugar includes a regulation mechanism that comes into play when subsidised export limits are in danger to be overshot. The so called declassification leads to a reduction of production quotas so that WTO commitments are met again. A special feature of the declassification is that EU Member States with high B quota shares receive a higher cut than others. In Spain e.g. B quotas amount to only 10% of the A quota, while this share in France and Germany amounts to about 30%. The declassification penalises obviously those countries that tend to be more competitive in sugar production. Technically, quotas are endogenously adjusted so that WTO restrictions are complied with and the price level from the reference run is basically met. This quota reduction is found at about 14% on EU level, ranging from 6% in Spain to 18% in France. The results of the current scenario in terms of production changes are basically an image of this quota reduction as visible in Figure 5.

Figure 5 Change in sugar beet production EBA scenario to reference in the EU15 NUTS2 regions



Source: CAPRI modelling system

Brighter shaded regions, like the Spanish ones, show a smaller relative supply reduction induced by the quota cut. Across the entire EU15, the supply reduction follows the quota reduction incompletely indicating rising C sugar quantities. The results of this scenario are very similar to those in Adenäuer et al (2004) and detailed there.

The Fischler proposal – three different assumptions

The following three scenarios are based on the proposal made by Franz Fischler in July 2004 (EU Commission, COM 2004, final). We now briefly discuss their main elements and the technical solution in CAPRI. The proposals envisage the abolition of intervention for sugar and the replacement of the intervention price by a reference price that serves as a kind of price floor to derive minimum beet prices. It will be 421€ per ton of white sugar in our simulation year. Technically this is not imposed in our model, but the European market price for sugar does not fall below that value in our simulations. Quotas are envisaged to be reduced by 16% and A- and B quotas are merged to one single quota. Since quotas enter the model exogenously, technical problems occur just as little as with the abolition of the declassification. In contrast to the EBA scenario all EU15 Member States face the same percentage reduction in quotas. It is further envisaged to partly compensate sugar beet farmers by a direct payment. National envelopes are defined and each Member State is to incorporate those payments into the single farm payments defined in the CAP reform 2003 either based on the quota beet production or total beet production in the historical reference period. Assuming that those payments do not affect the crop allocation, they are not included in the optimisation process but only in the income calculation and EU budget outlays. The last important change is the reduction of subsidised exports to 400.000 tons of white sugar. Further features, like the private storage system and the conversion scheme that compensates sugar factories that are forced to leave production, are not modelled within this paper.

The three Fischler scenarios have those adjustments in common. In the second one we additionally allow for quota transferability. All sugar beet producing regions are hereby linked together and quotas are moved until the quota rent per ton of sugar is equalised across all regions. Finally the third scenario adds to the first one the assumption that C sugar production is simply forbidden. Although the realisation of such an option is not simple because of yield uncertainty, this scenario goes beyond the Fischler proposal and acknowledges the panel decision that sugar exports beyond the WTO limits for subsidised exports are not WTO conform.

The model results of those three scenarios compared to the EBA scenario are presented in Table 5. Compared to the EBA scenario, quotas are additionally reduced by 2.5%. In the first Fischler scenario we see that the abolition of the declassification scheme benefits the former looser of this system like Germany and France, who gain additional quotas compared to the old system. On European level production is here reduced by 15% as a result of the price drop down to about 459 € and the quota cut. This price drop is based upon reduced subsidised exports that require a reduction in domestic production what can only be achieved by a lower market price for sugar and in turn beet prices at the given quotas. We further see that the Member States respond differently. The most striking reduction is found in Italy. While Italian producers basically filled their quotas in the EBA scenario, the production is reduced to only about half the quota amount. Given the relative high marginal cost level in the Italian regions as apparent from Figure 6 combined with comparable low prices (Table 2), this is not astonishing. The lowest supply reduction is found in France, partly due to rising quotas.

Sugar imports into the EU are decreasing because of the reduced market price that makes exporting to the EU15 less attractive for the ACP country aggregate that forms the highest trade flow in that direction. Exports are going down to about 1.8 Mio tons which exactly is the C sugar quantity produced plus the subsidised exports that amount to 400.000 tons.

Table 5 Scenario results – key indicators on the European sugar market

European Union	2009 + EBA percent deviation to : Reference run (2009)	Fischler proposals no quota trade percent deviation to : 2009 + EBA	Fischler proposals + quota trade percent deviation to : 2009 + EBA	Fischler proposals no quota trade no c sugar percent deviation to : 2009 + EBA
Market price Euro / t	728 *0.54%*	459 *-36.92%*	435 *-40.24%*	468 *-35.74%*
Unit value exports Euro / t	209 *1.16%*	237 *13.31%*	240 *14.67%*	249 *18.84%*
Production 1000 t	14439 *-11.92%*	12252 *-15.15%*	12415 *-14.02%*	10960 *-24.09%*
Quotas 1000 t	11929 *-14.07%*	11647 *-2.37%*	11647 *-2.37%*	11647 *-2.37%*
Total domestic demand 1000 t	13193 *0.03%*	13368 *1.32%*	13383 *1.44%*	13361 *1.27%*
Imports 1000 t	4299 *139.11%*	3249 *-24.43%*	2627 *-38.89%*	3216 *-25.18%*
Exports 1000 t	4945 *3.10%*	1755 *-64.50%*	1381 *-72.07%*	443 *-91.04%*

	Quotas 1000 t	Production 1000 t	Quotas 1000 t	Production 1000 t	Quotas 1000 t	Production 1000 t	Quotas 1000 t	Production 1000 t
Belgium	703 *-13.48%*	835 *-10.78%*	682 *-3.03%*	760 *-9.07%*	779 *10.73%*	803 *-3.94%*	682 *-3.03%*	682 *-18.34%*
Danmark	348 *-16.52%*	450 *-14.08%*	349 *0.50%*	404 *-10.09%*	348 *0.09%*	391 *-13.02%*	349 *0.50%*	350 *-22.28%*
Germany	2807 *-16.98%*	3568 *-14.70%*	2837 *1.06%*	3241 *-9.17%*	2937 *4.65%*	3205 *-10.15%*	2837 *1.06%*	2838 *-20.46%*
Austria	329 *-14.23%*	390 *-11.85%*	322 *-2.19%*	359 *-8.02%*	548 *66.40%*	519 *33.16%*	322 *-2.19%*	322 *-17.27%*
Netherlands	725 *-15.39%*	856 *-12.63%*	718 *-0.84%*	751 *-12.31%*	659 *-9.04%*	677 *-20.95%*	718 *-0.84%*	724 *-15.49%*
France	2673 *-17.87%*	3620 *-15.95%*	2731 *2.15%*	3387 *-6.43%*	3408 *27.47%*	3957 *9.33%*	2731 *2.15%*	2731 *-24.56%*
Portugal	74 *-7.33%*	76 *-4.02%*	67 *-9.46%*	60 *-21.00%*	59 *-19.15%*	53 *-30.08%*	67 *-9.46%*	61 *-19.91%*
Spain	940 *-5.42%*	1042 *-3.31%*	834 *-11.30%*	890 *-14.62%*	1142 *21.48%*	1027 *-1.44%*	834 *-11.30%*	811 *-22.12%*
Greece	289 *-8.40%*	312 *-5.83%*	265 *-8.40%*	235 *-24.75%*	210 *-27.40%*	198 *-36.31%*	265 *-8.40%*	239 *-23.18%*
Italy	1354 *-12.38%*	1330 *-7.55%*	1297 *-4.24%*	654 *-50.84%*	464 *-65.72%*	443 *-66.68%*	1297 *-4.24%*	695 *-47.77%*
Irland	182 *-8.40%*	195 *-6.92%*	166 *-8.40%*	128 *-34.06%*	44 *-75.72%*	42 *-78.56%*	166 *-8.40%*	138 *-29.34%*
Finland	133 *-8.40%*	146 *-5.90%*	122 *-8.41%*	112 *-22.99%*	101 *-24.36%*	93 *-36.29%*	122 *-8.41%*	115 *-21.35%*
Sweden	336 *-8.40%*	395 *-6.50%*	307 *-8.41%*	325 *-17.74%*	264 *-21.37%*	277 *-29.82%*	307 *-8.41%*	308 *-22.09%*
United Kingdom	1038 *-8.40%*	1225 *-6.38%*	950 *-8.41%*	947 *-22.68%*	684 *-34.05%*	729 *-40.52%*	950 *-8.41%*	947 *-22.68%*

Source: CAPRI modelling system, all prices in 2009 value

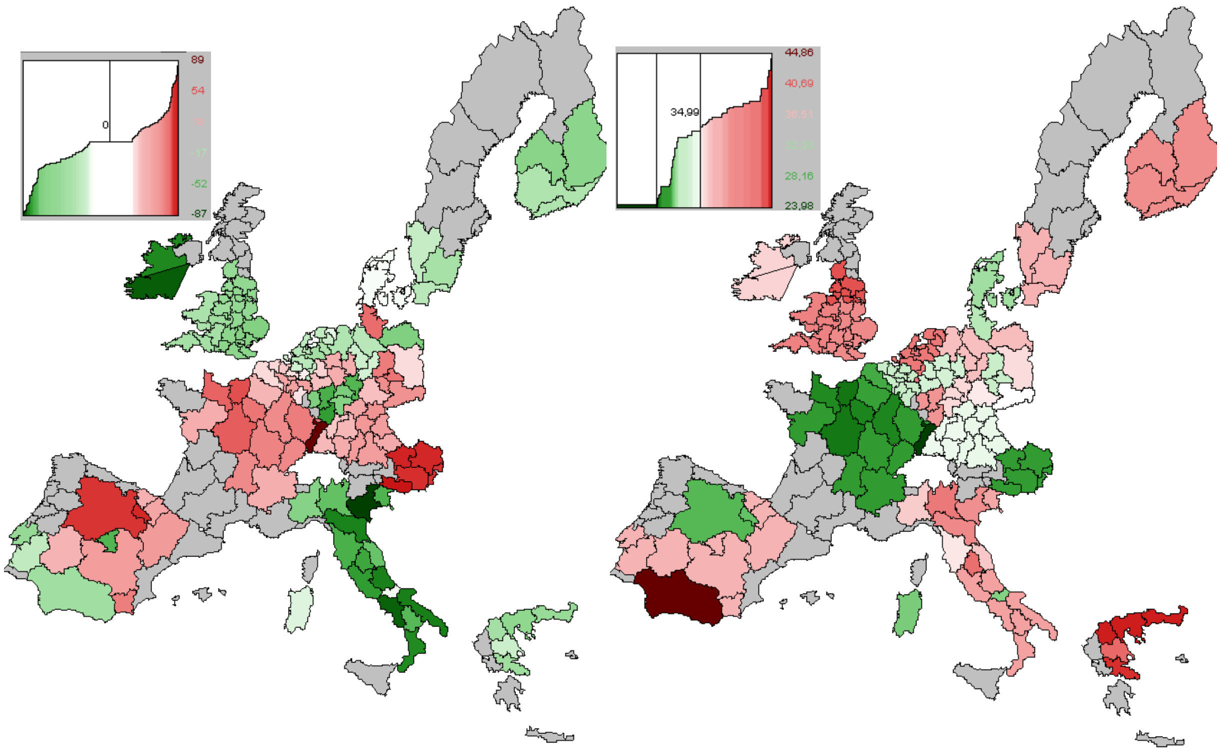
Introducing quota trade on EU level leads according to our model results to an increasing sugar production compared to the previous scenario although prices are decreasing, because induced by the quota trade the same amount of sugar can be produced at lower costs. As a consequence imports are reduced as well. Exports are decreasing because the trading of quotas leads to a substitution of C sugar by quota sugar which is eligible for sales on EU15 markets. Quotas are traded at a final price of 12 € per ton of sugar which equals the regional quota rent per ton of sugar in the trade equilibrium.

On the left side of Figure 6 we see the change of sugar quotas that are located within a NUTS 2 region in the quota trade scenario relative to the first Fischler scenario. Red regions are quota buyers and the green ones are sellers. Given the results of the previous scenario for Italy e.g. it is no wonder that Italian countries belong to the seller group. In fact they sell about 60% of their quotas on national level reaching 90% in the region Veneto. It is further not astonishing that all regions in France are keen on buying quotas. The region Alsace buys here about 90% of its quota in the previous scenario which is the top value across the EU15. This might be surprising because there are other regions in France like Picardie that are better known (compare Vierling (1996)) as 'sugar beet regions'. Austria belongs to the quota buyers as well as parts of Germany and Belgium. Somewhat surprising because Spain is assessed less competitive in sugar production in other studies (Henrichsmeyer et all 2003, Bureau et al 1997), a number of regions in Spain buy high quota amounts.

To get an idea where those regional differences might origin, we find on the right side of Figure 6 the regional distribution of marginal costs (including opportunity costs) to which the model is calibrated in the base year. We see that the quota trade figure basically mirrors the marginal cost distribution. Dark red regions have here the highest marginal production costs and dark green ones the lowest. The pictures are not exactly congruent because opportunity costs of sugar beet production in the different scenarios are different in different regions. But all in all we have to point out how important the amount of regional marginal costs is with respect to the results of the quota trade scenario. Further research should therefore aim in comprehensive estimation of regional marginal cost curves. This scenario further implies that sugar processing firms follow the most profitable farmers without any costs which certainly is no very realistic assumption. The results can therefore be interpreted as a kind of upper bound result.

According to Table 5, abolishing C sugar production leads of course to a further sugar supply reduction. This reduction is bigger in those regions that supply a lot of C sugar in the first Fischler scenario (France, Germany, Austria). While other regions that do not fill their quotas in scenario1 like Portugal, Greece, Italy, Ireland and Finland are not affected by that limitation of production and even gain from slightly increasing EU prices so that their sugar production increases. Exports are basically reduced to the subsidised export limit. Imports into the EU are decreasing, too, although EU prices are increasing. This will be due to the increasing world market price for sugar rising the attractiveness of other export outlets for the ACP countries e.g.

Figure 6 Relative quota change (left) in the quota trade scenario compared to scenario 1 and marginal costs (right) in the base year for EU15 NUTS2 regions



If we concentrate on the development of world market prices (unit value exports) over all scenarios, we see that they are increasing from the EBA scenario (209 €) to the last one (249 €). This trend is highly correlated with European sugar exports. An actual question discussed in the contest of the Fischler proposal is how trading partners that gain today and will gain in future from preferential agreements like the ACP, Indian, the West Balkan and LDC countries, are affected by such a reform. Hereby it is no secret that the envisaged lower price level of EU sugar considerably reduces the revenues of countries exporting sugar into the EU. Our model approves this because sugar imports are decreasing compared to the EBA scenario and consequently revenues for importing countries, as well.

Finally we have a look at welfare measurements in Table 6 where we do not present relative changes as done before, but absolute ones. In the reference run we face the effects of the CAP 2003 reform and several exogenous shifts. Agricultural income is decreasing and FEOGA expenditures are increasing. Consumers on the other side would gain from the reform and population growth etc, so that total welfare is increasing. The EBA scenario leads – compared to the reference – to a reduction of agricultural income, because domestic sugar production is replaced by imports. The outlays of the EU Budget are slightly increasing due to subsidised export quantities of sugar that were not at their upper limit in the reference. The money metric is slightly increasing mainly due to a drop in sugar consumer prices. The overall welfare in the EBA scenario is decreasing compared to the reference.

Table 6 EU 15 Welfare in the analyzed scenarios

	base year	Reference run (2009)	2009 + EBA	Fischler proposals no quota trade	Fischler proposals + quota trade	Fischler proposals no quota trade no c sugar
		difference to : base year	difference to : Reference run (2009)	difference to : 2009 + EBA	difference to : 2009 + EBA	difference to : 2009 + EBA
FEOGA budget outlays first pillar	40626.74	43308.72	43457.26	42292.44	42058.69	41588.99
Mio Euro		2681.98	148.54	1164.82	1398.57	1868.27
Money metric	5229578.12	5436713.77	5437084.5	5440437.67	5440689.61	5440495.53
Mio Euro		207135.65	370.73	3353.17	3605.11	3411.03
Agricultural income	171730.4	160379.03	159833.85	159125.49	159096.4	158978.91
Mio Euro		-11351.37	-545.18	-708.36	-737.45	-854.94
Total Welfare	5426930.78	5627136.2	5626799.91	5631422.56	5631857.93	5632042.01
Mio Euro		200205.42	-336.29	4622.65	5058.02	5242.1

Source: CAPRI modelling system

The three Fischler scenarios have all in common that consumers and the FEOGA budget gain and Agriculture looses money and overall welfare is increasing compared to the EBA scenario. The reduction in FEOGA outlays stems from a positive accounting balance of additional premium expenditures for sugar beets and saved money from reduced export subsidies. Consumers on the other hand greatly benefit by the lower sugar price level in all scenarios. Agriculture, moreover, has to cope with income losses. Those seem to be quite low compared to the absolute income level, but if we consider that this loss has to be carried only by sugar beet farmers, being only a small group, it appears more relevant.

To summarise our empirical analysis of reform option with the CAPRI model we might conclude that the general ability of the model to analyse changes in the CMO sugar has been proven. Sugar beet farmers are greatly affected by the envisaged reform in terms of an overall supply reduction and price drops. Nonetheless sugar beet production will not be abandoned in Europe under the given assumptions. The positive effects of tradable quotas that equalise quota rents across European regions could be shown. Rising world sugar market prices benefit all sugar exporting counties having no preferential access to EU sugar markets.

Conclusions

In this paper we have motivated are a number of different behavioural models that try to explain sugar beet production of European farmers beyond the classical profit maximisation hypothesis. Those might be yield uncertainty, risk aversion, special incentives not to divide plots, underestimation of sugar yields, speculation that future quota endowments are correlated with sugar beet production in the past or kinds of cross subsidisation of C sugar on processing level. To care of them we introduce yield uncertainty and a virtual quota mark up in the CAPRI model that ensures that the regional base year production is associated with marginal costs estimated from FADN. This procedure guarantees a more realistic supply response to quota or price changes than it was found in other studies. Model results, however, strongly depend on those marginal costs the model is calibrated to which rises the need to use reliable estimates for them. The analysis of reform options shows that sugar production is reduced by about 4 Million tons compared to the production in 2001 and that sugar beet farmers are faced with considerable income losses while overall welfare increases.

Nonetheless we have to point out that those results have to be considered tentative because of considerable simplifications especially in the modelling of the processing industry but in that of international markets, as well. Further research should provide better marginal production cost estimates for European regions, an integration of the new EU members and a better modelling of sugar world markets. We further did not allow for imports from countries where no trade flow was observed in the base year, mainly due to the Armington approach that requires trade flows in the base year to calibrate parameters – at least if the underlying technology is CES. Liberalisation options of international sugar markets are consequently of limited reliability.

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[i] Additional imports are likely from the Western Balkans who reap the benefits of quota and duty free exports to the EU since the end of 2001. (EU Commission 2004a)

[ii] In the meantime, the European Union has lost its appeal against that panel decision that rules even C sugar exports to be non WTO conform. This necessitates an even stronger supply reduction of European sugar that envisaged in the Fischler proposals (2004).

[iii] This number may include sugar processed to ethanol. Although France has one of the leading positions in Ethanol production, the share of sugar beets produced to derive ethanol in total sugar beet production is only about 3% (BVEL 2003, p 168)

[iv] There is no real evidence that sugar beet delivery right have not been adjusted to lover processing losses, but at least farmers known by the author in Germany did not receive any reductions since the first time, the delivery rights were allocated to them

[v] Final consolidated report with a detailed model description is available on the project web site: http://www.agp.uni-bonn.de/agpo/rsrch/capri/finrep.pdf .

[vi] A more detailed description of the model and its applications can be found on the web page http://www.agp.uni-bonn.de/agpo/rsrch/capri/capri_e.htm and will soon be available in Britz et al (2005).

[vii] Henrichsmeyer et al (2003) and Adenäuer et al (2004) use an additional coefficient in price linkage function that reflects the variable processing costs of processing beets to sugar. We use a simpler version because it appeared to be easier to handle during the simulation runs.

[viii] It turned out that this sensitivity analysis leads to similar results in different EU regions so that the results for Denmark can be transferred to other European regions.

[ix] We distinguish initial and effective supply elasticities because there is a difference between those elasticities on which basis the non linear cost function is defined and those which result if we change prices in the model ceteris paribus. The reason for this is that we assume in the calibration step, that all other activities stay on the same level. We neglect therefore all interdependencies between production activities. Or to put it in other worlds, the definition of the initial elasticities is based on the one product case while the model optimises the multi product framework.

[x] Supply elasticities are no price elasticities in the context of expected profit maximisation. They have to be interpreted as the relative change of sugar beet supply if the Expected Marginal Revenue increases by 1%.