Sugar Quotas and Crop Production Efficiency

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Abstract:
The paper deals with problems concerning the current sugar policy within the Common Agricultural Policy, especially the efficiency losses due to the combination of high prices and quota on subsidised sugar production. Based on a simple econometric model, the total economic costs of the current policy setting, compared with an unregulated setting, are estimated to be in the area of 20 per cent of the total sugar production, valued at world market prices. Of these costs, some 10 per cent are due to inefficiency in the crop production, as the opportunity costs of land are not taken into account because the sugar price support within the quota overrules these opportunity costs. However, according to the estimates obtained in the present study, the main economic gains by reducing the internal prices are to be found in terms of reduced consumer costs rather than improved efficiency in land use.

Keywords: sugar production, quota, contracts, efficiency loss

1. Introduction

It is a well-known fact that the European Union sugar policy is relatively complex and implies various economic problems. The policy builds on the principle that producers benefit from guaranteed minimum sugar prices for sugar consumed internally within the EU, while excessive production is sold at the world market price. The sugar market in EU is protected through high tariff rates, which imply that the internal sugar price is well above the world market price.

The EU sugar policy divides sugar production into three quantity categories: the A-, B- and C-quota. For the A-quota quantity, sugar is sold at the guaranteed price P_A, and the B-quota quantity is sold at the price P_B, which is lower than P_A, but still above the world market price level, P_C. Sugar production beyond the A- and B-quota (termed C-quota) can be exported at world market prices. The A-price is determined as the politically fixed intervention price net of a levy of 2 per cent. On the other hand, the B-price is determined as the intervention price net of a variable levy (the maximal level of the B-levy is 37.5 per cent). The revenues from the A- and B-levies are used for financing the extra-EU exports of B-sugar in the cases where the sum of the A- and B-quota quantities exceeds the intra-EU demand. In these cases, B-quota sugar is sold at the world market together with C-quota sugar at the prevailing world market price P_C. In the implementation of this regulation, individual producers of sugar beets are given an A-quota and a B-quota for deliveries of sugar beets to the sugar processing industries, based on the countries' A- and B-quotas for white sugar. Producer quotas are linked to land and can only be transferred to other producers through trade or rent of land. The quotas have been distributed to each member country of the EU according to historical production.

As the EU is a major supplier of sugar on the world market, this policy has been criticized due to its distortionary effects on international trade, and reforms of the sugar policy are under consideration (EU Commission, 2000, OECD, 1999, Walter-Jørgensen et al., 2001). Among the considered reform elements are:

- reduction of the internal sugar price (25 per cent), combined with "half" compensation in terms of direct payments (in line with the crop reform undertakings in Agenda 2000)
- progressive reduction of the internal sugar price within a certain time span
- continuation of the current price level and adjustments in the quota size.

Economic problems related to the EU sugar policy have previously been the subject of various studies. For example, Walter-Jørgensen et al. (2001) have investigated some impacts of the above reform elements for EU-countries as well as trade with developing countries, using a CGE model framework. Poonyth et al. (2000) have also analysed the interrelations between EU- and world markets for sugar, however building on econometrically estimated functions for sugar supply in EU countries. Bureau et al. (1997) have analysed the potential welfare gains from introducing quota trade between EU regions, based on supply functions derived from mathematical programming. The objective of the present paper differs from the mentioned analyses in that it focuses on decomposing the costs associated with the sugar policy, with major emphasis on efficiency losses in crop production, using the Danish sugar sector as an illustrative case. The analysis is based on econometric estimates of the sugar supply function.

The paper is organised as follows. After the introductory comments in the present section, section 2 provides an introduction to the theoretical framework of the analysis in the paper, whereas section 3 describes the econometric estimation of key behavioural parameters for the analysis. In section 4, quantitative analyses of the sugar policy are presented and finally, section 5 provides some conclusions and discussion drawn from the analysis.

2. Theoretical framework

2.1 Land allocation in the current sugar policy regime

Assume that crop producers can choose between sugar beets and an alternative crop when determining their production composition. The optimal composition of production (and hence allocation of land) depends on the relative profitability in the two competing crop sectors. Specifically, the profit maximising land allocation is the one, where marginal economic returns to sugar beet production equals the marginal economic return to the alternative crop. Otherwise, the farmers would be able to increase their profits by allocating more land to the crop sector with the highest marginal return.

The situation is illustrated graphically in figure 1.

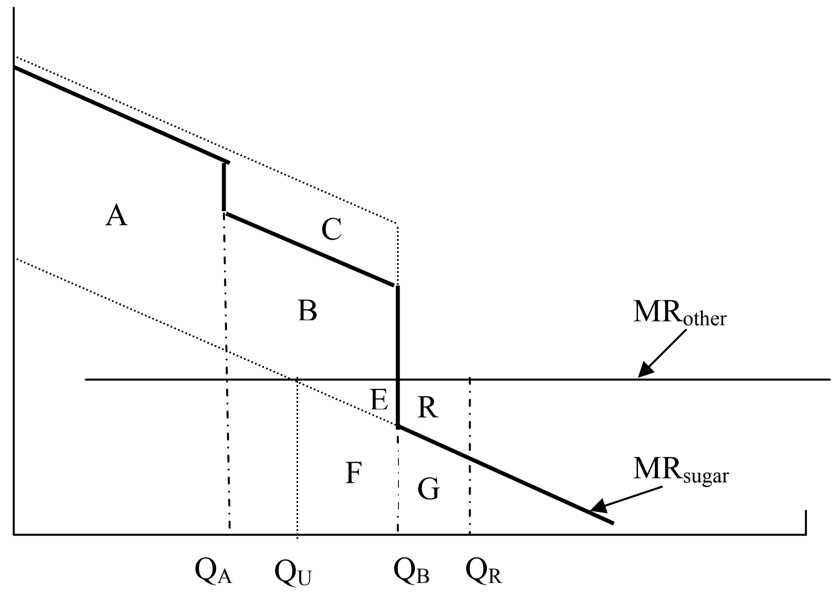

Figure 1. Equilibrium composition of crop production under the current EU sugar policy

The MR_{sugar}-curve represents the marginal economic returns from production of sugar beets. Marginal returns are assumed to be a decreasing function of the scale of sugar beet production due to crop rotation effects, etc. Due to the quota regime the marginal return curve (the full-drawn curve) is kinked. The first part of sugar beet production (Q_A) can be sold at the highest price (PA), whereas the next part of the production (Q_B-Q_A) can be sold at a lower price (P_B). The remaining part of the production (Q_R-Q_B) is sold at the world market price (P_C). In absence of the price support and quota regime (where the entire production were sold at the world market price), the marginal returns curve would continue along the dotted line instead of the kinks caused by the quota and the higher prices. MR_{sugar} is given as the difference between sugar price and marginal costs, mc(Q_{sugar}) at the output level Q_{sugar}. For the straight "no quota"-line the price is $P(Q_R) = P_C$.

The MR_{other} curve represents the corresponding marginal returns for alternative land uses. Consider the simple case with only one alternative crop (e.g. wheat), the alternative marginal return is given by the difference between crop price P_{other} and marginal cost in the alternative crop sector, mc_{other}, both assumed to be independent of the scale of production (as sugar beets only represent a small share of total land use, the impacts of variations in the sugar beet area on the cost structure in alternative crop production are assumed to be diminutive). As the total area available for crop production is limited, production of the alternative crop is a (decreasing) function of the activity level in the sugar beet production, i.e. $Q_{other} = Q_{other}(Q_{sugar})$, $Q'_{other} < 0$.

Total profits from crop production can be determined as the sum of the integrals below the two MR curves, i.e.

$$\Pi(Q_{sugar}) = \int_0^{Q_{sugar}} MR_{sugar}(x)dx + \int_0^{Q_{other}(Q_{sugar})} MR_{other}(x)dx$$

In a situation without quotas and policy-determined prices, the profit maximising sugar production would be given by the first order condition $\partial\Pi(Q_{sugar})/\partial Q_{sugar} = 0$, corresponding to the intercept between the two MR curves (in figure 1 represented by the production level Q_U).

In the current quota regime, the profit maximising production is however given by the size of the quota, Q_B, if the quota is binding, i.e. the marginal returns to sugar production at world market prices is lower than the marginal returns in a competing land use. Under the quota regime, producers obtain an economic gain corresponding to the areas A+B in figure 1, whereas the consumers are levied an extra expenditure corresponding to the areas A+B+C+E. The area C represents the levy on the sugar price used for financing extra-EU exports, and the area E represents an efficiency loss in crop production. This efficiency loss represents that some areas in the EU are used for sugar production due to the regulated prices and the quotas, although these areas could have provided a higher net value added in alternative uses. The efficiency loss can be determined as $E = \Pi(Q_U) - \Pi(Q_B)$.

Linearity is assumed for the marginal cost functions and scale-independence is also assumed for the alternative crop production, i.e.

$$mc_{sugar}(Q_R) = \alpha_0 + \alpha_w w + \alpha_Q Q_R$$
$$mc_{other} = \beta_0 + \beta_w w$$

where w represents input prices and α's and β's are parameters in the two marginal cost functions.

Assuming further that the output units in the alternative crop sector can be transformed to a scale comparable with sugar beet production (i.e. $Q_{other} = \overline{Q} - Q_{sugar}$), the total profit (assuming sugar beet production is valued at world market prices) can be determined as:

$$\Pi(Q_{sugar}) = ½\alpha_Q Q_{sugar}^2 + (P_C - \alpha_0 - \alpha_w w)Q_{sugar} - \alpha_Q Q_{sugar}^2 + (P_{other} - \beta_0 - \beta_w w)(\overline{Q} - Q_{sugar})$$
$$= -½\alpha_Q Q_{sugar}^2 + (P_C - \alpha_0 - \alpha_w w)Q_{sugar} + (P_{other} - \beta_0 - \beta_w w)(\overline{Q} - Q_{sugar})$$

Provided estimates for the α- and β-parameters, as well as for the relevant input prices, the total crop production profit (net of the value of higher A and B quota prices) can be determined for different output levels in the sugar beet sector.

2.2 Implication of delivery contracts

In order to ensure proper input of raw materials for sugar processing (such that the entire quota is utilised), the sugar processing industries have contracted with sugar beet producers. These contracts impose an obligation for farmers to deliver an amount of sugar beets corresponding to the A + B quota – otherwise their future deliveries at high prices for both quotas will be reduced. In order to meet this obligation, sugar beet producers have to take into account variations in the sugar beet harvest due to yield fluctuations etc. Thus, to ensure proper deliveries, producers tend to plan a higher production than the sum of their individual A and B quotas, even though production beyond this quota is loss-giving from a partial perspective. Effectively it works as a risk premium. In return for this premium, producers reduce the risk of not being able to fulfil the contract with the processing company and consequently loose future parts of their contract.

The expected sugar beet production is given by $E(Q_{sugar}) = Z_{sugar} \cdot E(y_{sugar})$, where Z_{sugar} is the area devoted to sugar beet production and $E(y_{sugar})$ is the expected sugar beet yield per hectare of sugar beet area. Due to yield variations, there will be an expected absolute deviation from the expected production level given by $\sigma_{Q_{sugar}} = Z \cdot \sigma_{y_{sugar}}$, i.e. the standard deviation for total sugar beet production equals the standard deviation for sugar beet yield per hectare multiplied by the total sugar beet area, where the latter is assumed to be non-stochastic. Assume for example, that the producer plans to produce the quantity Q_B, and thus determines his sugar beet area as $Z_B=Q_B/E(y_{sugar})$. If the actual sugar beet yield is below average, the expected yield per hectare will be $E(y_{sugar}|low) = E(y_{sugar}) - \sigma_{y_{sugar}}$, and thus the conditional expected total production will be $E(Q_{sugar}|low) = E(Q_{sugar}) - \sigma_{Q_{sugar}} = Q_B - \sigma_{Q_{sugar}} \leq Q_B$. In this case, the producer does not fulfil the contract with probability ½. This prevents him from utilising the favourable prices fully, and furthermore it deteriorates his future contract with the processing company.

In actual practise, the contracts are based on average delivery over three years, so a poor harvest in one year does not necessarily ruin the entire delivery right away. One or two bad years of harvesting can be compensated for by an expanded production the following year. This fact will reduce the risk for the farmers, that is, the risk premium they will be willing to pay will be lower for a given year. In the model we thus assume that farmers will consider a modified expected yield risk regulated by a corresponding scaling of the σ.

As an alternative, the producer can plan to produce the quantity Q_R above the sum of the A- and B-quota quantities. In this case, he reduces the risk of not being able to fulfil the contract, and thus increases the probability of utilising the favourable prices and maintaining his contract conditions for future years. On the other hand, in case of production beyond the quota, he will have to sell the exceeding production at a low price (which may eventually be below the marginal cost). The optimal extent of planned "over-production" (and hence "insurance", cf. above) will in this case be given by the condition that the marginal expected economic gain due to the insurance effect of overproduction offsets the marginal expected cost of overproduction (in terms of having to sell the product at a price below marginal cost.

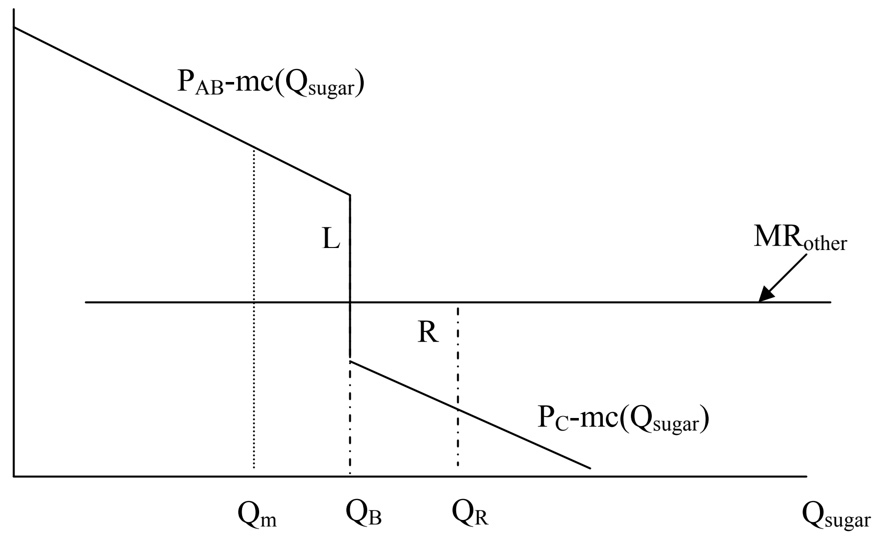

Figure 2. "Insurance" motive for producing above the sugar quota

Since the marginal economic returns to sugar beet production is a linear function of the planned quantity Q_R by assumption, and the assumed probability of a below-average crop yield is ½, the total expected economic gain from a planned excess production of Q_R-Q_B at Q_R can be determined as

$$L = ½ \cdot \lfloor MR(Q_R - Z_R \cdot \sigma_{y_{sugar}}) + MR(Q_B) - 2 \cdot MR_{other} \rfloor \cdot (Q_B - (Q_R - Z_R \cdot \sigma_{y_{sugar}}))/2$$

When the producer supplies below his A+B quota, he will not exploit the advantages of both the A price and the B price, and their quotas will be reduced in the entire future. This loss is represented by the area L in figure 2. The price corresponding to the lifted MR curve is P_{AB}, which is a weighted average of the A- and B-prices representing the average value of what the producer will loose if he do not fulfil his quota.

The expected total economic loss due to the planned excess production (where the probability of an above-average crop yield level also is assumed to be ½) can be determined as

$$R = ½ [2 \cdot MR_{other} - MR(Q_B) - MR(Q_R)] \cdot (Q_R - Q_B)/2$$

Given these expressions, the optimal planned sugar beet production level can be determined by the condition:

$$\frac{\partial R}{\partial Q_R} = -\frac{\partial L}{\partial Q_R}$$

$$\Downarrow \qquad (1)$$

$$Q_R = -\frac{\alpha_0}{\alpha_Q} + ½\sigma_Q - \left[\frac{\alpha_w}{\alpha_0}\right] \cdot w + \frac{1}{\alpha_Q}\left[\frac{P_C + P_{AB}}{2} - MR_{other}\right]$$

Hence, the optimal planned sugar beet production depends positively on the supported prices as well as the world market price, positively on the yield variation and negatively on the input prices and the net returns in other crop sectors.

In the absence of quotas and contracts (or if the quota is not binding in the sense that production at the world market price is profitable), the optimal planned production would be determined on the basis of equality between output price (P_C) and marginal costs, yielding the supply function

$$Q_U = -\frac{\alpha_0}{\alpha_Q} - \left[\frac{\alpha_w}{\alpha_0}\right] \cdot w + \frac{1}{\alpha_Q}\left[P_C - MR_{other}\right] \qquad (2)$$

When the within-quota prices are sufficiently favourable, producers will have the incentive to pay the "insurance costs" of keeping their price support privileges by planning an excess production corresponding to the quantity Q_R. This leads to an additional efficiency loss corresponding to the area R in figure 1, representing that a further area is held in sugar beet production, although this area would be able to provide a higher net value added if used for production of the alternative crop.

The additional efficiency loss can be determined as $R = \Pi(Q_B) - \Pi(Q_R)$, and the total efficiency loss due to quota regime and contract arrangements can be calculated as $E + R = \Pi(Q_U) - \Pi(Q_R)$.

2.3 Summing up on the theoretical framework

If the marginal cost (including the opportunity cost of land) is close to the B-price, a third situation might occur. In that case, there is no gain in producing more than the sum of the A- and B-quota, because the marginal quota value is small, and thus not much is lost if the sugar beet producer looses some of his right to delivery. In that case $Q_R = Q_B$. If marginal costs are higher than the B-price, three more types of situation might occur, namely that where marginal costs are substantially below the A-price, below but close to the A-price or above the A-price. As these situations are considered unlikely in Denmark, we abstract from them in the following.

Summing up, the combination of price support and quota may attract land into sugar production and thus increasing sugar production and profits earned in sugar production (by the area F in figure 1). Due to the area limitation, however, this land is prevented from other uses, which imposes an economic loss in the crop production sector (corresponding to the area E+F), and the incentive to produce beyond the quota despite a low marginal return at world market price (the "insurance" motive) imposes an extra net cost (represented by the area R), which can be considered as a risk premium for covering yield fluctuations. If the economic loss is higher than the gains, measured at world market price level, the regime imposes an economic loss on the crop sector, and this loss may be termed as an efficiency loss.

In addition to the efficiency losses, measured at world market price level, there are also profit impacts due to the A- and B-prices above world market level. Hence, producers obtain a gain due to these supported prices corresponding to the measures $\left(P_A - P_C\right)\cdot Q_A$ and $\left(P_B - P_C\right)\cdot Q_B$, represented by the areas A and B+E in figure 1. This gain is termed the quota rent.

On the other hand, consumers pay a price above the world market level for sugar, and thus face an economic loss. Assuming that consumers pay a price corresponding to the pre-levy P_A level, and that the consumption corresponds to Q_B they face a loss of $C = P_A/(1-\tau)\cdot Q_B$, where the current levy τ on the A-quota is 2 per cent as mentioned above. The consumer loss is represented by the areas (A+B+C) in figure 1. The C area represents the excessive price due to the A- and B-levies, which are imposed for financing export of B-sugar to third countries.

3. Estimation

3.1 Empirical formulation of the model

In the previous section we derived the two estimation equations describing the planned production Q*, when the producers fulfill their A+B quotas, equation (1), and when the producers supply more than their quotas, equation (2). Notice, that the α-parameters are the same in both equations, since the slope of the marginal cost function is assumed independent of whether the quota is binding or not. The annual observations are divided between the years when the quota is not binding and the years when it is binding defined in the model as those years where the actual production of white sugar is less than or close to the A+B quota amount.

The planned production of sugar beets is not observable. However, the producers decide how many hectares of land should be devoted to sugar beets harvesting, so movements in the planned production (Q*) is in the model approximated by movements in the actual sugar beet area. The estimation equation for sugar beet area is according to equation (1) and (2):

$$Z^*_{sugar,t} = -\frac{\alpha_0}{\alpha_Q} + \frac{1}{\alpha_Q}\left[\frac{P_{C,t} + P_{AB,t}}{2} D_t + P_{C,t}(1 - D_t) - MR_{other,t}\right] + \gamma \cdot D_t + u_t \qquad (3)$$

where

$$Dt = \begin{cases} 1\text{, when the quota is binding} \\ 0\text{, when the quota is not binding} \end{cases}$$

The included dummy variable takes into account that producers cannot produce more than the quota amount at the higher P_{AB} when the quota is binding. Furthermore, the dummy variable adjusts for the "insurance" motive.

Equation (3) is estimated by linear regression. As the analyses below focus on the production of white sugar, the estimated coefficients from (3) are transformed into the corresponding α - coefficients relating to the production variable Q*, using the average sugar beet yield per hectare, multiplied by the average fraction of white sugar vs. sugar beets production (=0.15 for the considered period).

The corresponding transformation of production prices consists in converting sugar beet prices into white sugar prices by the average fraction of sugar beet vs. white sugar prices (=15,6 for the period 1993-1999). All price variables in the model have been converted to the 1980 level using a GDP-deflator. As the input price development is assumed to follow the general price development given by the GDP-deflator, the deflated input price index is included in the constant term.

3.2 Data

Data for the area harvested and the yield per hectare of sugar beets and wheat, the market price of wheat and the GDP-deflator are all found in the AgrIS database. The wheat price is regulated with respect to compensation payments. Data on quota amounts and actual production of white sugar is obtained from Walter-Jørgensen et al. (2001), whereas data on the world market sugar price is otained from the USDA website. Data on A- and B-prices for sugar beets have been supplied by the Danish Farmers of Sugar Beets. Finally, the average returns of wheat production are found in Danish Institute of Agricultural and Fisheries Economics.

The C-price is in Denmark announced in advance and paid to the farmers by the factory, but the actual amount received – the actual world market price - will be regulated backward. In the model farmers are assumed to base their production on an expectation to the actual C-price based on an average of the three preceding years.

The standard deviation in the yield per hectare of sugar beet production (σ_y) is estimated by the square root of the variation of the yield around a linear trend (= 7,7 tonnes sugar beet/ha * 0,15 white sugar/sugar beet production) and in addition it has been scaled by a factor two assuming that farmers will only accept a 5 per cent probability of not fulfilling their quota when the crop yield is below average.

3.3. Estimation results

Estimating equation (3) the coefficients were found as α_0 / α_Q = 66.6685, $1/\alpha_Q$ = 0,002988 and γ = -3.6392. Transforming these estimated coefficients into parameters representing the planned production of white sugar yields the equation

$$Q^*_{sugar,t} = 476577.44 + 21.36\left[\frac{P_{C,t} + P_{AB,t}}{2} D_t + P_{C,t}(1-D_t) - MR_{other,t}\right] + 26014.67 \cdot D_t + u_t$$

The price coefficient corresponds to a supply elasticity at 0.05[1].

Comparing the actual white sugar production with the fitted planned production gives picture outlined in figure 3.

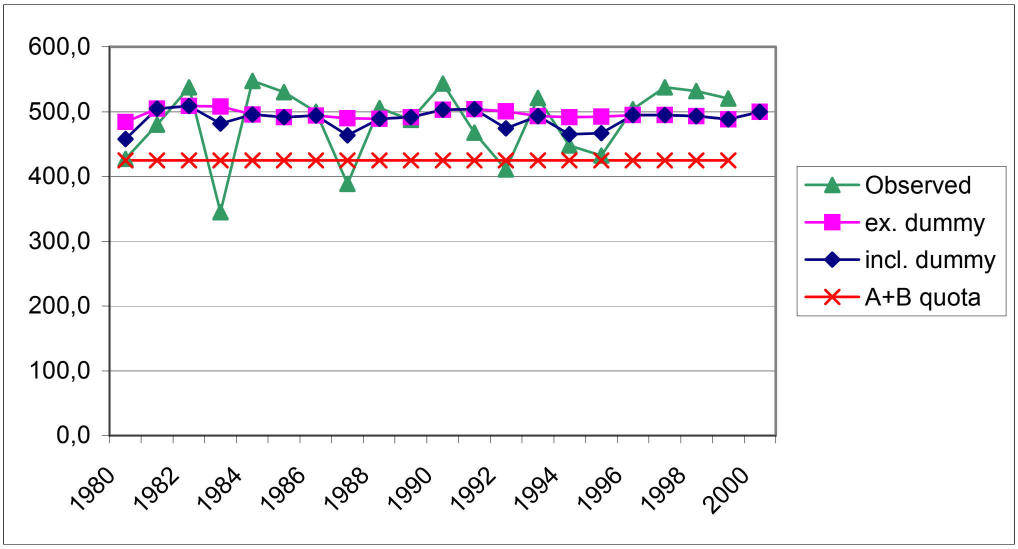

Figure 3. Observed and fitted sugar production 1980-1999

The fitted series is shown, both excluding and including the effects of the dummy variable representing the observations where the quota were binding or almost binding. The curve including the dummy variable effect is the one to be compared with the series for observed production. Compared with the observed production, the fitted curve seems to represent the major movements in the observed production, although the fitted movements are more moderate than the observed ones, especially in the years where actual production dropped to the quota level. This is mainly due to drops in the sugar beet yield level per hectare in these years, which is not assumed to be represented in the area-based model estimated here.

[1] For comparison, Poonyth et al. (2000) find a short-run supply elasticity for Denmark at around 0.02 and a long-run supply elasticity at 0.05.

4. Economic results and their implications

In the following, we compare some economic figures related to sugar production in the current setting (supported prices for the given quota of production, and no price support for the production exceeding the quota) with the setting of no regulation and no price support. The comparison is based on estimated (planned) production figures in the two settings derived from the econometric estimates above. Hence, in the current setting, planned production is determined according to equation (1), i.e. planned production depends on a combination of the A-, B- and C-prices, whereas in the unregulated setting, production is determined according to equation (2), where planned production depends on the C-price alone. In figure 4, the estimated production development for the two settings is shown.

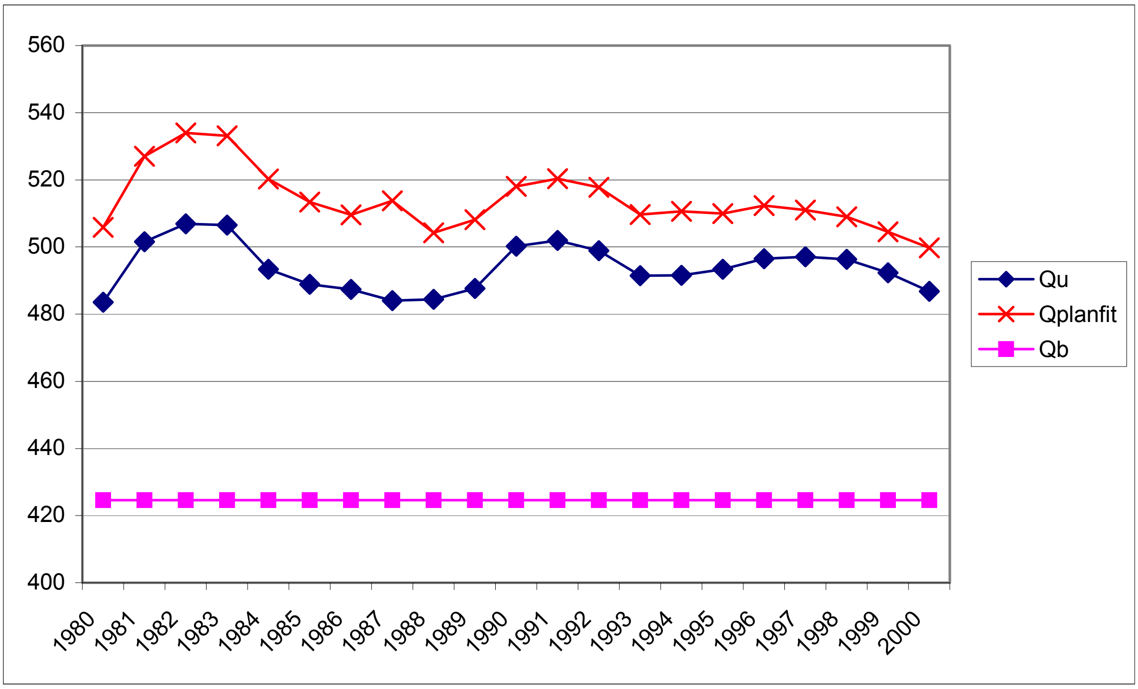

Figure 4. Planned sugar production in the current regime and an unregulated regime, 1980-1999

The figure indicates than the combined price support/quota regime has had an impact on sugar production, in that the estimated planned sugar production ($Q_{planfit}$) was higher than it would have been, if producers were facing world market prices and no quota restrictions (Q_u). It is also worth noting that both the estimated planned production and the estimated production under unregulated conditions are higher than the sum of the A- and B-quota in all the considered years. The fluctuations in the estimated production in both settings are due to variations in the sugar prices. As the A-, B- and C-prices are mutually correlated, the fluctuations in the two curves have a somewhat parallel pattern.

Estimates of the economic consequences of the current setting compared with the unregulated setting, following the principles outlined in section 2, are given in table 1.

Table 1. Economic consequences of the current EU sugar policy, million DKR (1980-price level)

Year	Extra net profit in sugar F+G	Extra net profit in alternative crop production -E-F-R-G	Gross quota rent A+B+E	Producers, net gain A+B	Consumers, net loss A+B+C	Total net cost C+E+R
1980	12	-21	1029	1020	1183	163
1981	15	-42	592	565	725	160
1982	17	-54	547	511	684	173
1983	20	-57	572	535	703	168
1984	17	-40	757	734	884	149
1985	14	-30	775	759	892	133
1986	12	-20	1052	1044	1204	160
1987	9	-22	1275	1261	1444	183
1988	9	-15	1230	1224	1435	212
1989	10	-20	1076	1065	1197	132
1990	7	-27	830	811	1007	196
1991	8	-30	811	788	958	170
1992	8	-30	879	858	1056	198
1993	8	-22	1055	1041	1248	207
1994	7	-25	1025	1008	1214	207
1995	7	-23	943	926	1107	181
1996	6	-25	765	746	921	175
1997	5	-22	731	714	880	166
1998	4	-19	745	729	896	167
1999	4	-17	707	694	839	146
Average	10	-28	870	852	1024	172

As was shown in figure 4, the current policy attracts more land to sugar production than would have been the case in an unregulated setting. Hence, the total profits (valued at world market prices) gained in sugar production is on average in the order of 10 million Danish kroner on an annual basis, however with a declining pattern. At the same time, as retaining land in sugar production prevents this land from being used for other purposes, the opportunity cost is higher (on average 28 million Danish kroner). Thus, from a pure production efficiency perspective, the current setting is providing sugar producers with an economic loss. This can be compared with an average total sugar production value at around 8-900 million Danish kroner, when production is valued at world market prices. However, since the main part of their production is sold at prices above the world market level, the current regime is still profitable for the producers. The average extra revenue due to higher prices is estimated to 870 million Danish kroner per year, and consequently, the net economic impact of the current policy on producers is around 850 million kroner (that is around 50 per cent of the total revenue from sugar production in the current setting).

On the other side, consumers are paying a higher price for sugar in the current setting. The total average extra economic consumer cost is estimated at 1024 million kroner. The difference between this amount and the economic gain on the production side is due to the above-mentioned inefficiency effect, as well as the A- and B-levies on the price of sugar within the quota. Deducting the producer gain from the consumer loss, leads to an average net loss of 172 million Danish kroner per year, of which some 20 million stems from inefficiency in production and the rest from levies used to finance subsidisation of sugar to third countries.

5. Discussion

The present paper has dealt with some of the problems concerning the current sugar policy within the Common Agricultural Policy, especially the efficiency losses due to the combination of high prices and quota on subsidised sugar production. Based on a simple econometric model, the total economic costs of the current policy setting, compared with an unregulated setting, are estimated to be in the area of 20 per cent of the total sugar production, valued at world market prices. Of these costs, some 10 per cent are due to inefficient crop production, as the opportunity costs of land are not taken into account because the sugar price support within the quota overrules these opportunity costs. In most recent years, this inefficiency cost has however been slightly decreasing.

Considering these results when addressing the question of sugar policy reform, as raised in the introduction, the results indicate that there are economic gains to be collected from a deregulation of the sugar policy, e.g. in terms of reducing the internal prices. However, according to the estimates presented here, the main economic gains by reducing the internal prices are to be found in terms of reduced consumer costs rather than improved efficiency in land use – and this potential efficiency gain even seems to be decreasing.

One major challenge in empirically analysing EU sugar production is the issue of econometric estimation of producer behaviour, taking the effects of the quotas into account – and especially the three-tiered price regime existing in EU (as also pointed out by eg. Bureau et al., 1997). This paper has offered a proposal to the treatment of this issue. Still, however, there is room for improvements and refinements to the analyses carried out in this paper. For example, the analyses have been carried out in a linear framework, which is at best a reasonable approximation to marginal changes in the considered variables. As the historical situation analysed in the paper has showed relatively modest fluctuations in e.g. sugar production, this may be reasonable for the current analyses, but if more radical situations were to be analysed, more sophisticated functional forms might be considered. It should also be noted that the current analysis builds on a partial framework in that possible interactions with e.g. demand behaviour and other sectors (through changes in price relations) are ignored. Walter-Jørgensen et al. (2001) have addressed some of these aspects at an international level, using a CGE-framework in terms of the GTAP model, however with less emphasis on empirically founded behavioural parameters.

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