Modelling the EU Sugar Policy
- A study of policy reform scenarios

Søren E. Frandsen, Hans G. Jensen, Wusheng Yu and Aage Walter-Jørgensen

SJFI – Working Paper no. 13/2001

Modelling the EU Sugar Policy
A study of policy reform scenarios

by

Søren E. Frandsen
Hans G. Jensen
Wusheng Yu
Aage Walter-Jørgensen

Danish Institute of Agricultural and Fisheries Economics[1]

E-mail: soren@sjfi.dk, hans@sjfi.dk, wusheng@sjfi.dk and walter@sjfi.dk

Abstract

In this Working Paper we present and model in an applied global general equilibrium framework the EU sugar policy, and undertake a few illustrative policy reform scenarios. Particular attention is given to the modelling of the quite complex quota regime and the calibration of the model, including the determination of the marginal cost of producing sugar beets in the EU member countries.

Two scenarios are analysed using the developed model and database. The chosen scenarios are both motivated by the recent reform proposal by the EU Commission. They include 1) a 25 per cent reduction in intervention prices and with without direct compensatory payments and 2) a 13 per cent reduction in the sugar quota. The analysis focuses on production, trade and macro economic effects.

It is concluded that the EU sugar policy is highly distortionary and that it affects not alone the allocation of the European sugar production but also the volume of world trade as well as it depresses the production of sugar in a number of developing countries. The analysis illustrates that a reduction in border protection is a far more efficient instrument to achieve the overall objectives of reform than a reduction of quotas that has little impact on the total production of sugar in the EU. It is also found that a reduction in border protection in the EU will enhance production considerably in developing countries, and that the higher production may balance the loss of quota rent accruing to developing countries, resulting from the lower market price in the EU.

[1] This Working Paper is a part of the research project "WTO Negotiations and Changes in National Agricultural and Trade Policies: Consequences for Developing Countries", primarily financed by the Royal Danish Ministry of Foreign Affairs, DANIDA, Denmark.

1. Background and objective of study

The EU is under pressure to reform its sugar regime. Following the Uruguay Round Agreement on Agriculture, the EU is bound to reduce border protection and to limit the quantity of supported exports of sugar. In addition, the prospective enlargements of the EU will greatly increase the potentials for surplus production of sugar in the EU, and make it difficult to comply with the commitments of the GATT (Huan-Niemi, 2001).

In an attempt to tackle these problems, the European Commission is heading for a major revision of the sugar regime, involving three options (European Commission, 2000a):

- a price reduction following the Agenda 2000 model combined with a compensation to the producers for the loss of income,
- a progressive reduction in prices over a number of years,
- a continuation of the present price level and minor adjustments of the quota level.

In the first option, the Commission envisages a 25 per cent price cut and a 50 per cent compensation to farmers for loss of income. According to the report, this could have important budgetary consequences for the EU, and necessitate reopening the discussion of the financial framework of the Agenda 2000 reform. The second option is expected to require significant price reductions to have any real effect on production, competitiveness, and on the market. Even if distributed over several years it would – according to the report – entail substantial cumulative effects on producers' income, raising a demand for compensation from producers. The third option builds on an extension of the present regime, involving minor revisions including a reduction in sugar quotas of 115,000 tons in order to fulfil the WTO obligations on restrictions of supported exports.

As the sugar regime is scheduled for revision by 1 July 2001, the EU Agricultural ministers met in May 2001 to discuss the reform paper presented by the EU Commission. The outcome of that meeting was an interim continuation of the present regime for 5 years, maintaining the present price level, and reducing the quota as mentioned (Agra Europe, 2001). The EU ministers also agreed to discuss the EU sugar regime again in 2003.

This paper presents in an applied global general equilibrium framework the modelling of the EU sugar regime at the member level. The model is used to investigate the impact of a reduction in the EU guaranteed prices for sugar of 25% with and without compensating farmers for loss of income by way of direct payments. In order to demonstrate the effects of different market regimes, a quota reduction scenario is also investigated.

2. The EU sugar scheme

The EU market regime for sugar features high border protection, guaranteed prices for limited quantities of production (quotas), and public support for re-export of sugar imported on preferential terms (Box 1).

The total production of sugar in the EU amounts to about 17 million tons. Total exports have in recent years accounted for about 6 million tons, of which 2-3 million tons is C-sugar exported without support from the EU. The remaining export is either A- or B-sugar (financed by levies on internal production) or re-exports of imported sugar (financed by the EU). Imports of sugar have amounted to 2.3 million tons annually for the period 1996/97-98/99, the most of which is imports on preferential terms from ACP-countries. The rate of self-sufficiency in sugar is in the range of 130 - 140 per cent.

Box 1
The EU Sugar Scheme

The market regime for sugar
The EU-scheme for sugar combines restrictions on imports (high import tariffs) with a multiple pricing system that provides sugar refineries with guaranteed prices for A- and B-quotas of sugar. The quotas are distributed to member countries according to historical production and are non-transferable between countries. Production in excess of quotas (C-sugar) is paid the world market price. The price to consumers is determined by the intervention price for white sugar that also determines the prices to producers. The intervention price has been frozen in nominal terms since 1984/85. The scheme is self-financing in the sense that production of A- and B-sugar in excess of internal demand is exported at the world market price, the cost being covered by taxes on primary production.

Import of sugar is subject to the use of Tariff Rate Quotas allowing for imports at preferential terms mainly from ACP-countries and India. The scheme allows for a similar quantity of sugar to be exported at the world market price, the cost being covered by the EU.

Regulation of primary production
Producers of sugar beets are allocated A- and B-quotas for deliveries of sugar beet to refineries, the total amount of individual quotas being limited to the national quota for sugar as described above. Producers of sugar beet receive a base price for A- and B-quotas, net of tax. The base price is linked to the price of white sugar through a formula allowing for standard costs of refinement, transportation etc. Producers of sugar beet receive the equivalent of the price of C-sugar for excess quota deliveries.

The principle of the EU sugar market regime is illustrated in Figure 1 where the production of sugar is divided into A- and B-quotas and C-production. The production of A-sugar is paid the guaranteed price P_A, and the production of B-sugar the price P_B whereas the production of C-sugar is paid the world market price P_w. The prices of A- and B-sugar are linked to the intervention price (P_I) by charging the production of A-sugar a tax of 2% and the production of B-sugar a tax of maximum 37.5%.[2] Domestic consumption of sugar in the EU (Q) is determined by the internal consumption of sugar in the EU (Q) is determined by the intersection of the intervention price (P_I) and the demand curve (D). Excess supplies of A- and B-sugar (A+B-Q) are exported to the world market at the price (P_w), the costs of exports (equal to the shaded area c+d) being covered by the revenue of taxes on A- and B-production (equal to the shaded area a+b+c). The provision of export support for B-sugar through taxes on production (cross-subsidisation of exports) is incompatible with the regulations of WTO and is subject to reduction commitments according to the GATT-agreement.

FIGURE 1. **The EU sugar scheme**

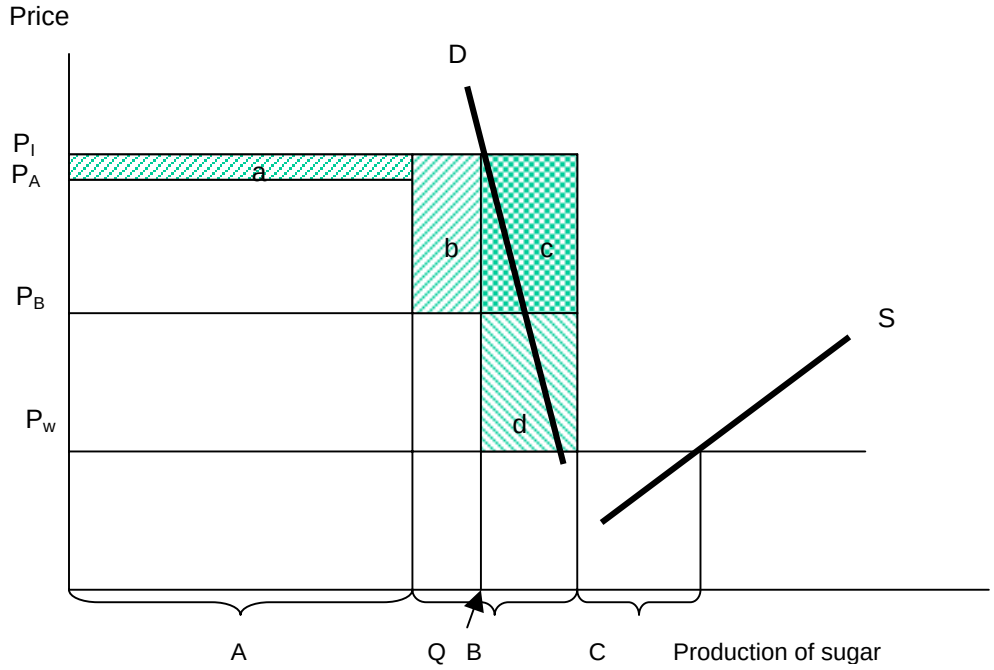
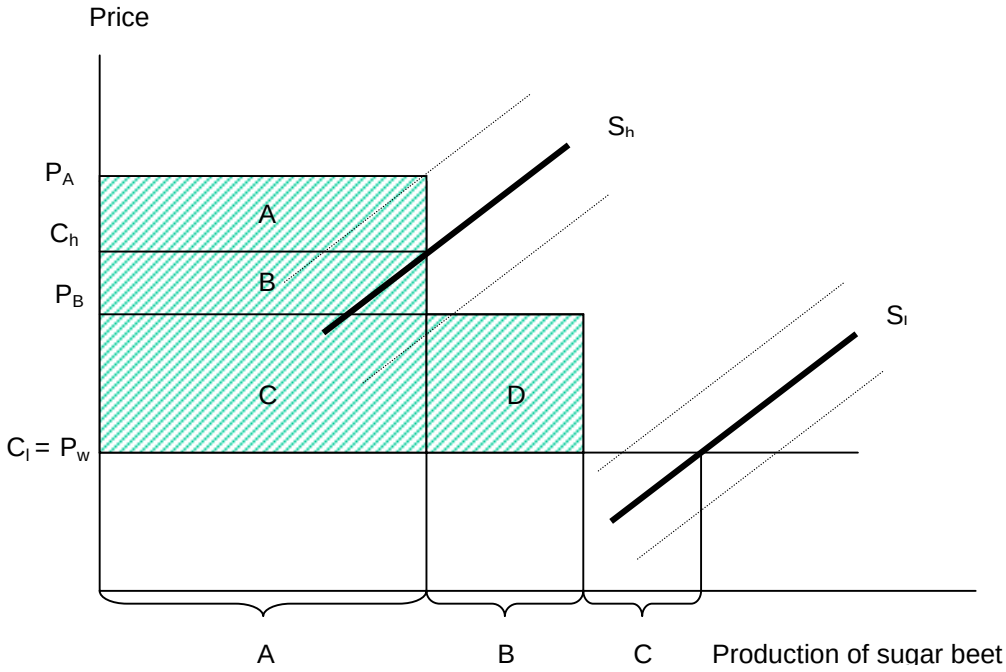


Figure 2 illustrates the market scheme for sugar as viewed from the primary producers. A high cost producer (represented by the marginal cost curve MC_h) will receive the price P_A for all his production. With a marginal cost equal to C_h, the producer will receive a quota

[2] If necessary, a supplementary levy (in addition to the A- and B-levies) can be applied to cover losses in a marketing year caused by the disposal of Community production in excess of internal consumption.

rent corresponding to the shaded area A (the quota rent is equal to the difference between the price P_A and the marginal cost MC_h multiplied by the production of A-sugar). A low cost producer (represented in the figure by the supply curve MC_l) having marginal cost equal to the world market price, will get the high price (P_A) for A-production, a lower price (P_B) for B-production, and the world market price for production in excess of quota deliveries (C-production). The quota rent will in this case be equal to the total shaded area ABCD.

FIGURE 2. **The value of sugar quotas in primary production**



Note: Dotted supply curves indicate variation in yields of production (see later).

Figure 2 indicates that the producers will react differently to price changes. The high cost producer will maintain his level of production as long as the quota rent (A) is positive, but the production will decline if the price P_A is reduced below the marginal cost C_h. In the case of the low cost producer, the production is determined by the world market price and is therefore unaffected by changes in the internal prices.[3] It is therefore crucial to know the position of producers with regard to cost of production when investigating the effect of policy changes.

[3] The production may augment if the world market price increases as a result of the reduction in internal prices.

3. Modelling the EU sugar regime

Modelling the EU sugar policy regime in an applied general equilibrium model is a difficult task that requires both a correct specification of the institutional mechanism and calibration of the data at the EU country level.

The EU sugar regime is modelled in the GTAP model (cf. Hertel (1997)), adding the following key components, cf. appendix B:

- **A base price for sugar beet (P_b) and the A- and B-quota system**. This is modelled as a "tax-quota system", where different input taxes are levied on sugar refineries' intermediate demand for domestically grown sugar beet, cf. Figure 1.

- **An input tax levied on the input of beet in sugar refineries**. This tax - being endogenously determined - finances the EU costs of exporting B-sugar (export subsidies). Thereby the A- and B-sugar beet prices adjust endogenously in line with changes in the tax. In the case of ceasing B sugar export, this imply that sugar beet growers will get the same price for both A- and B-sugar beet.

- **A quota rent** being generated from the gap between the base price (adjusted for the tax) and the actual cost of production, cf. Figure 2.

- **A border protection (import tariffs, tariff rate quotas and export subsidies).** The border protection supports the high EU price for sugar and the EU market price is determined endogenously by the world market price and the border protection. For the ACP countries – having preferential access to the EU market - the imports are determined endogenously by a tariff rate quota system (TRQs)[4].

- **A contract agreement between the growers and the refinery.** It is assumed – given the rather complicated institutional fixed relationship between the price of white sugar and the one for sugar beet, cf. Box 1 – that the base price of beet follows the changes in the market price for sugar. The allocation of the total quota rent is therefore endogenously determined. The total quota rent is divided between a pure economic rent accru-

[4] The rent associated with the tariff rate quota system is assumed to be divided between the ACP countries in question (the exporter) and EU (the importer) on a 80-20 per cent basis given the administration of the tariff rate quota system, cf. Walter-Jørgensen et al (2001). It is also assumed that the initial quota fill rate is one.

ing to the sugar refineries (modelled as an output subsidy) and a quota rent accruing to the land used for producing sugar beet (modelled as a subsidy to land)[5].

The first component, the tax-quota system, is not only the important but also the most difficult part as it is conceptually and technically difficult to model. Thus, the following presentation focuses mainly on this part.

The EU sugar regime is much like the Tariff Rate Quota system (TRQ), which includes one low tariff rate for in-quota import and one high tariff rate for out-of-quota import. The multi-quota system of EU sugar regime is more complicated than the TRQ due to the presence of an additional regime switch when production exceeds the total quota (thus C sugar). However, the TRQ modelling approach by Elbehri and Pearson (2000) can be extended to describe the behaviour of the sugar regime, to delineate the positions of EU member countries under the regime, and to determine changes in these positions after possible policy shocks.

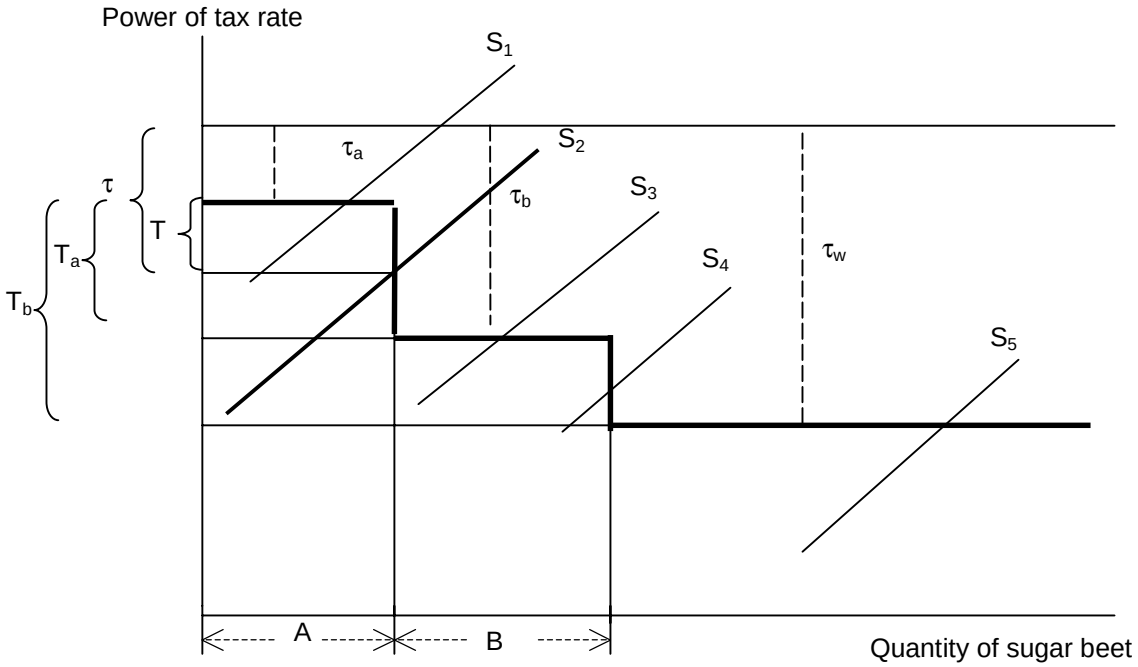
To fully describe the sugar regime, the following variables are needed: the power of input tax[6] for in-quota-A sugar beet (denoted as τ_a), the power of input tax for out-of-A-quota (within B quota) sugar beet (denoted as τ_b), and the power of input tax for out-of-total-quota sugar beet (denoted as τ_w). Figure 3 shows these three tax wedges and the two quotas of the sugar regime. Five possible types of producers are also shown in the figure (S_1-S_5).

However, to decide one country's exact position in this structure, the actual power of input tax (denoted as τ), the ratio of actual sugar beets produced over the A quota (denoted as γ_a), and the ratio of the total quota over the A-quota (denoted as γ_b) are also needed. With these five variables we can uniquely identify for a given country the exact position of sugar beet production with respect to its assigned quotas and the EU base price for sugar beet. For example, with supply curve S_2, the actual power of input tax, τ, is between τ_a and τ_b, and the ratio of actual production to quota A, γ_a, is 1.

[5] We are aware that in reality the split of the total quota rent between growers and refineries are much more difficult to determine. By splitting the total quota rent between the two agents we assume that the sugar refineries do have a willingness to pay (accepting a part of the adjustment) to avoid that the production of sugar beet decline "too much" (excess capacity). The chosen strategy implies e.g. that a 20 per cent cut in the sugar price will be translated into a 20 per cent fall in the refinery's purchase price of sugar beet.

[6] The power of tax is the ratio of the post-tax value over pre-tax value, or one plus the tax rate. This concept is used extensively in the GTAP model. See Chapter 2 of Hertel (1997).

FIGURE 3. **An illustration of modelling the EU sugar regime**



Elbehri and Pearson (2000) used the actual extra power in addition to the power of in-quota tax to measure the actual power of import tariff, which has simplified their model. They also showed that to determine one's position in the TRQ regime, it is necessary to know the actual extra power of the tax and the actual import relative to the quotas. Following their approach, denote T as the actual extra power of tax in addition to in-quota-A tax (τ_a), T_a as the extra power of in-quota-B tax, in addition to τ_a, and T_b as the extra power of out-of-total-quota tax, in addition to τ_a. These are defined as:

$$T = \tau/\tau_a$$
$$T_a = \tau_b/\tau_a$$
$$T_b = \tau_w/\tau_a$$

With this terminology, we can describe each of the 15 country positions in the sugar regime. In Figure 3, with supply curve S_1, the actual total power, τ, is the same as τ_a, thus the actual extra power of the input tax, T, is just 1. With supply curve S_2, T is between 1 and T_a, and the ratio of actual production to quota A, γ_a, is 1 since quota A is binding[7]. With supply curve S_3, T is equal to T_a, and γ_a is greater than 1 and less than γ_b. With supply curve S_4,

[7] Note in Figure 3, the actual extra power of input tax is drawn as if the true supply curve of sugar beet growers is S_2.

quota B is binding. Thus, γ_a is equal to γ_b, and T is between T_a and T_b. With supply curve S_5, T is equal to T_b, and γ_a is greater than γ_b. This behaviour of the regime is summarised in the following table.

TABLE 1. **Summary of behaviour of Tax-Quota system**

Supply curve	τ	T	γ_a
1	τ_a	1	<1
2	(τ_a , τ_b)	(1, T_a)	=1
3	τ_b	T_a	>1 and < γ_b
4	(τ_b, τ_w)	(T_a, T_b)	= γ_b
5	τ_w	T_b	> γ_b

The conditional inequalities entailed in Table 1 pose a challenge in the modelling of the sugar regime in GTAP and also the computation using GEMPACK. We follow the approach similar to Elbehri and Pearson (2000) in dealing with these implementation and computational issues.

This modelling structure on the tax-quota structure and the other components of the model, are summarized in Table 2.

4. Estimation and calibration of the supply response and quota rents

The base price, world market price, the three tax wedges, as well as each member country's two designated quotas and marginal cost of production are needed to decide its position in the sugar regime. These data, together with the core GTAP database, form the basis for simulating the effects of alternative policy scenarios. In this section we estimate and calibrate the supply response and quota rent for each member country.

Bureau et al. (1997) have found that there is a considerable variation in quota values among member countries in the EU. Unfortunately, the study does not include all 15 Member countries of today and is therefore insufficient as basis for estimation of quota rents in the present study. Member countries are therefore ranked according to their production of C-sugar and the rate of quota fill, from which information on quota rent might be inferred.

TABLE 2. **Summary of the modelling of the EU sugar regime**

Sugar policy instrument	**Exogenous variable**	**Endogenous variable**	**Remarks**
Border protection, sugar, exclusive ACP countries	Tariffs and export subsidies	Imports and exports	
Tariff rate quota system for sugar, ACP countries	In- and out-quota tariff rate	ACP export to EU	Initial fill rate is 1. Import tariff is equal to out-quota tariff rate[8]
Intervention price, sugar		Market price for sugar	Determined by border protection
Base price, beet, for medium and low cost beet producers		Price for beet delivery to refinery. Pure profit in refinery and quota rent in beet production adjust	Equation added: base price for beet follows market price for sugar
Base price, beet for high cost beet producers	Pure profit unchanged and equal to zero	Land price in beet production adjust	No equation added
Self-financing of B-export at EU-level (tax on beet production)		Total EU Tax to finance export subsidy of B-export	Equation added: Tax determined by sugar price, world market price and B-export.
Price on A- and B-quota		Price of A- and B-quota at national level	Equation added: taxes are subtracted from base price
Quantity of A- and B-quota	Quantity of A- and B-quota at national level	Input subsidy to land used in beet production	Equation added: linking size of quota rent and market price of land in beet

The method builds on the observation that the pattern of supply seems to be quite stable over time, i.e. some Member countries produce C-sugar in quite large quantities year after year, whereas others never manage to fill their quota (cf. Appendix Table 1). To explain these differences, the countries must have different marginal cost functions as indicated earlier by Figures 2 and 3. However, it should also be taken into account that farmers are contractually bound to deliver a fixed portion of sugar beet to refineries each year regardless of variations in yield. Producers failing to fulfil the contract may forfeit their quota rights. The

[8] The chosen calibration implies that the EU import demand schedule for both ACP sugar as well as sugar from other exporting countries is determined by the EU domestic (protected) market price. We also assume that the initial tariff rate quota fill rate is one, i.e. the ACP countries fully fill their quota right and that there is no export to the EU market above this level. Further, the price received by the ACP exporters is divided between a TRQ rent (goes to the exporting agency) and the world market price (the price received by the ACP sugar producer). The approach implies that an increased EU import demand benefits both the ACP exporters and exporters from other countries equally with an almost unchanged relative competitiveness between ACP exporters and other exporters as a consequence.

observed production of C-sugar may therefore reflect that farmers deliberately overshoot their quota in order to fulfil the contract in years of low yields.

In the present analysis, it is assumed that the producers plan to fill their quota in all years (illustrated by the left-hand variation interval of the supply curves in Figure 2). In other words, the high cost producer (S_h) is assumed to be aiming at filling the A-quota, but not to produce B-sugar beet, whereas the low cost producer (S_l) is planning for a certain production of C-sugar beet. In the calculation of the country positions, it is assumed that the farmers in their planning consequently overshoot their quota by an amount corresponding to two times the standard deviation of variation in total production for the country. The result of the analysis is presented in Table 3 that documents the data used to calibrate the model and the positions of individual EU member countries with respect to marginal costs.

TABLE 3. **Calibrated/estimated sugar beet prices, power of input tax and supply curves, 1997**

	Price						Power of tax				
Country	Calibrated Base	A beet	B beet	C beet	Average	Marginal cost	τ_a	τ_b	τ_w	τ	Supply curve type
Belgium	47.67	46.72	32.42	19.89	39.76	32.42	1.02	1.47	2.40	1.47	3
Denmark	47.67	46.72	32.42	19.89	38.97	32.42	1.02	1.47	2.40	1.47	3
Germany	47.67	46.72	32.42	19.89	39.79	19.89	1.02	1.47	2.40	2.40	5
Greece	47.67	46.72	32.42	19.89	45.42	46.72	1.02	1.47	2.40	1.02	1
Spain	49.92	48.92	34.62	19.89	44.79	34.62	1.02	1.44	2.51	1.44	3
France	47.67	46.72	32.42	19.89	36.86	19.89	1.02	1.47	2.40	2.40	5
Ireland	49.61	48.62	34.32	19.89	46.28	47.33	1.02	1.45	2.49	1.05	1
Italy	50.78	49.76	35.46	19.89	47.50	49.76	1.02	1.43	2.55	1.02	1
Netherlands	47.67	46.72	32.42	19.89	40.27	43.74	1.02	1.47	2.40	1.09	2
Austria	47.67	46.72	32.42	19.89	39.46	19.89	1.02	1.47	2.40	2.40	5
Portugal	49.61	48.62	34.32	19.89	47.61	48.62	1.02	1.45	2.49	1.02	1
Finland	49.61	48.62	34.32	19.89	44.33	48.62	1.02	1.45	2.49	1.02	1
Sweden	47.67	46.72	32.42	19.89	44.29	39.57	1.02	1.47	2.40	1.20	2
UK	49.61	48.62	34.32	19.89	40.19	19.89	1.02	1.45	2.49	2.49	5

Note: Supply curve types refer to the types in Figure 3.

The ranking of Member countries is illustrated schematically in Figure 4. We assume that France, Germany[9], Austria, and UK are capable of producing sugar for the world market. Furthermore that Denmark, Belgium, and Spain can fill the national quotas; that cost of production in Sweden, The Netherlands[10], and Ireland may prevent these countries from utilising the B-quota; and that Italy and Finland and notably Portugal and Greece will have difficulties in filling the A-quota.

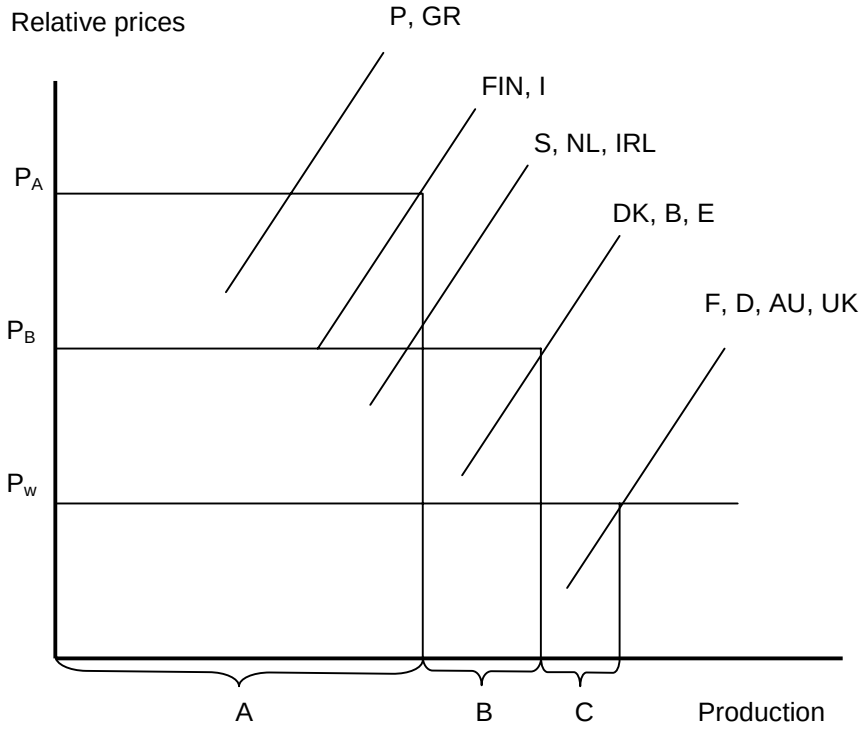
[9] The result for Germany is supported by studies of the cost of producing sugar beet in Bavaria (Zimmermann & Zeddies, 2000).

[10] Bureau et al. (1997) have found that the production of sugar would cease in the Netherlands if the sugar quota was made transferable.

A few examples may help elucidate the principle of analysis. In France, the year-to-year variation in production of white sugar is fairly low with a standard deviation corresponding to 4.9 per cent of total production (column 7, Appendix Table 1). Yet, the production of C-sugar amounted to 21.5 per cent of total production (column 8, Appendix Table 1), indicating that the production of C-sugar can hardly be explained by precautionary circumstances. In other words, France seems to be able to produce sugar at the world market price.

Denmark is also producing C-sugar in a fairly large scale, but the ratio of production of C-sugar to the standard deviation is considerably lower (less than 2:1), indicating that the production of C-sugar may be a precautionary act by farmers. For Ireland and The Netherlands the position is influenced by the use of pooled A- and B-prices (not modelled), which tend to expand production beyond the optimal level in a quota system. In the case of Sweden, the analysis indicates that the producers are capable of producing A-sugar only, however to take account of an increasing trend in production after the accession to the EU, marginal cost is reduced relative to the applied principle of analysis.

FIGURE 4. **Country position with regard to supply of sugar in the EU**



Note: AU: Austria; B: Belgium; DK: Denmark; D: Germany; E: Spain; GR: Greece; F: France; IRL: Ireland; I: Italy; NL: Netherlands; P: Portugal; FIN: Finland; S: Sweden; UK: United Kingdom.

To verify the method, the costs of producing sugar beet in Denmark are investigated from farm account data. Using the total cost of large-scale producers as indicator for the level of marginal cost for the sector[11], the ratio of marginal cost to the value of production in Denmark was about 0.80 in 1997, cf. Appendix Table 2. In comparison, the ratio of marginal cost to the average price of sugar beet for Denmark in Table 3 is equal to 32.42/38.97 = 0.83, indicating that, at least for Denmark, the method seems to provide a decent answer. A similar information is not available for other EU countries.

The initial quota rents allocated to land and sugar refineries, and the initial difference between the marginal cost (MC) of sugar beet production and the base price paid by the sugar refineries, are not present in the standard GTAP database[12]. Therefore the so-called altertax program is used to introduce these wedges in the standard database. The power of the input tax (τ) between the marginal cost and the base price for sugar beet is taken from Table 3. The value of the quota rents allocated to land is calculated as ((A price – MC) multiplied by the quantity of A sugar beet produced plus (B price – MC) multiplied by the quantity of B sugar beet produced) divided by the MC of total production. The calculated relation between the MC and initial quota value is used to calibrate the initial value of the quota rents allocated to land. The quota rents/profits allocated to the sugar refineries are calculated on the assumption that the refineries have the same relative MC of production as the sugar beet producers. Therefore in regions with high cost producers of sugar beets, the refineries are also classed as high cost refineries with no quota rents/profits to either sugar beet producers or refineries.

5. Scenarios

Three scenarios are analysed to illustrate the effects of the above mentioned reforms: 25 per cent price reduction without compensation, 25 per cent price reduction with compensation, and reduction of quotas without compensation (Box 2). The European Commissions proposal for a 50 per cent compensation is interpreted as half the acreage payment for wheat in the EU, understanding that the full acreage payments would be paid to sugar beets if the border protection for sugar was reduced to the level of wheat.

---

[11] Being the most competitive producers, large-scale producers will on the margin set the level of production costs.

[12] The analysis is based on GTAP database, version 5 (final release), and the model is solved using GEMPACK (Harrison & Pearson, 1996).

Box 2
Scenarios and country representation

The basis for assessment is the actual situation in 1997 (comparative static analysis).

Scenario 1a: Price reduction without compensation
The border protection for white sugar in the EU is reduced by 25 per cent, resulting in approximately the same reduction in the average market price for sugar. Because of the 'self-financing' system, the (endogenously determined) base prices to producers of sugar beet may fall less, as the levies on A- and B-production will be reduced when the production and exports decline.

Scenario 1b: Price reduction with compensation
The same as scenario 1a, but producers of sugar beet are compensated by area payments corresponding to *half* the compensation to wheat for the EU as a whole. The compensation does not fully cover farmers' loss of revenue. The payments are allocated as flat rate compensation per hectare to the total area of sugar beet in 1997 (including areas used for production of C-sugar).

Scenario 2: Reduction of the EU sugar quota without compensation
The total quota of white sugar in the EU is reduced by 13,1 per cent, corresponding to an elimination of exports of B-sugar. The quota reduction is distributed on member countries relative to the stipulated coefficients for quota reduction in Regulation (EC) No 2038/1993 (both A- and B-quotas are reduced, but at different rates in different countries), cf. Table 6 below.

Countries represented in the analysis
EU-countries: Belgium, Denmark, Germany, Greece, Spain, France, Ireland, Italy, Netherlands, Austria, Finland, Sweden, and United Kingdom. Luxembourg has no production of sugar and Portugal is omitted due to negligible production.

Non-EU countries: Australia, USA, Mexico, Central America and Caribbean, Brazil, India, China, Thailand, Rest of South Asia, Malawi*, Tanzania*, Zambia*, Zimbabwe*, Uganda*, Other South African Countries (incl. South Africa)*, and Rest of World.

* ACP-countries.

Macroeconomic closure
The macroeconomic closure used is a neo-classical closure where investments are endogenous and adjust to accommodate any changes in savings. This approach is adopted at the global level and investments are then allocated across regions to equalise the marginal rate of return in all regions. The numéraire used is the global primary factor price index.

The analysis is based on an assumption that the foreign trade structure is characterised by a very high elasticity of substitution (Armington elasticities), implying almost perfect substitutability between domestic and foreign sugar.

6. Results

Scenario 1a: Price reduction of 25 per cent without compensation

A 25 per cent reduction in border protection for sugar in the EU reduces total production of sugar beet in the EU by almost 19 per cent (Table 4), eliminating exports of B-sugar. The impact on production varies, however, between the Member states. In Greece, Ireland, Italy, Finland and the Netherlands, production of sugar is reduced 80 to nearly 100 per cent, whereas the production in other EU-countries with the exception of Sweden is little affected.[13] The impact on the other primary agricultural sectors and industries in the European economy is minimal as sugar production and sugar refineries are of relative minor importance in general. The major adjustments are in terms of lower return to land used in the production of sugar beet, and declining quota rents.

The differences across the individual EU countries in the production adjustment are explained partly by the mentioned country positions with regard to cost of production (Figure 4), partly by different changes in the price to producers of sugar beet. As the exports of B-sugar ceases in this scenario, producers of sugar beet receive only one price after the reduction of border protection (the reduced base price), which then becomes the marginal price for producers in countries not producing C-sugar.

For Germany, France, Austria and United Kingdom, the price of sugar beet declines by 23-24 per cent, but - since the production at the margin is based on the world market price - production is only marginally affected. The results are illustrated for France in Figure 5 where the price of A sugar beet (measured relative to the base price) is reduced from 0.98 to 0.76, whereas the price of B sugar beet increases from 0.68 to 0.76 (also measured relative to the base price).[14] The quota rent - being equal to the doubled shaded area in the figure before the price reduction - is reduced by the area (a) but increased by the area (b) corresponding to a reduction (per ha) in quota rent of 30% (Table 4). A similar picture is observed for Germany, Austria and the UK.

---

[13] In most countries, the change in the production of refined sugar typically follows the production of sugar beet, but in a few countries this is not the case. Italy is one example, the difference being explained by only 30 per cent of the production of sugar beet being delivered to the sugar industry according to the GTAP database. According to our knowledge this might not be correct (inconsistency of data). A similar inconsistency, but less pronounced, is found for Spain, France, Austria and the UK.

[14] Legend: Pa = initial A-price; Pb = initial B-price; Pw = world market price; P' = common price after reduction of guaranteed prices; MO = marginal costs.

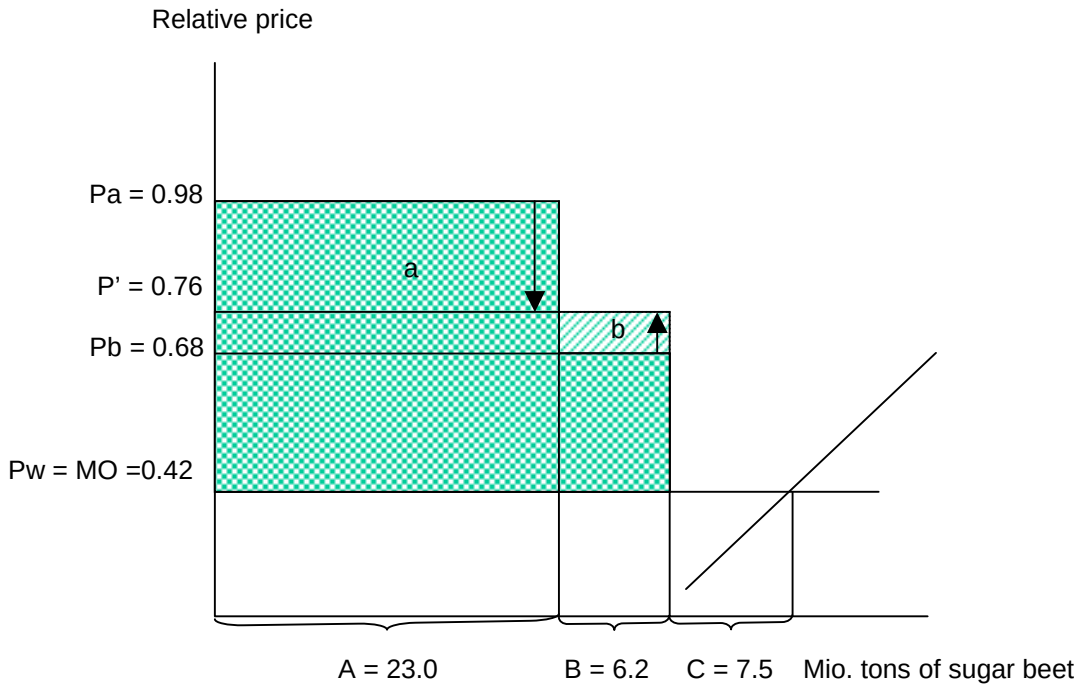
TABLE 4. **Scenario 1a: 25 per cent reduction in border protection (no compensation)**

	EU total	Belgium	Denmark	Germany	Greece	Spain	France	Ireland	Italy	Netherlands	Austria	Finland	Sweden	United Kingdom
Production	Percent change													
Sugar beet	-18,7	-0,1	0,0	-1,6	-73,6	0,0	-0,7	-87,1	-30,5	-76,1	-0,7	-59,9	-24,4	-1,3
Sugar	-18,8	0,0	0,0	-1,6	-79,4	0,0	-2,1	-97,1	-97,7	-83,4	-1,6	-88,3	-24,8	-5,7
Cereals	0,1	0,2	0,4	0,3	0,0	0,1	0,1	0,3	-0,1	0,5	0,2	-1,2	0,3	0,5
Other crops	0,1	0,4	0,1	0,1	0,1	0,0	0,1	0,2	0,0	0,3	0,1	0,0	0,2	0,2
Export value (fob)	Change, Million US$													
Total	-1059	-100	-17	-130	-11	-33	-342	-58	-95	-142	-3	-15	-52	-58
- Intra EU	-340	-31	3	-9	0	0	-165	-35	-40	-57	7	-3	-36	28
- Extra EU	-719	-69	-20	-120	-11	-33	-177	-22	-56	-85	-10	-12	-16	-87
Import value (fob)	Change, Million US$													
Total	1009	-185	-36	-54	14	-101	-33	9	593	191	-4	561	25	27
- Intra EU	-340	-199	-48	-78	-14	-124	-71	-15	292	11	-19	3	3	-79
- Extra EU	1349	13	13	24	28	23	38	24	301	180	15	558	22	106
Prices	Percent change													
Sugar beet[1]	-	-24	-24	-23	-14	-24	-24	-9	-7	-16	-23	-8	-18	-24
Sugar[2]	-	-24	-24	-23	-21	-24	-24	-23	-23	-22	-23	-22	-18	-24
Quota rent[3]	-	-73	-71	-29	0	-79	-30	-100	0	-100	-29	0	-100	-31
Land rent[4]	-	-51	-45	-24	-98	-40	-21	-100	-67	-99	-21	-94	-82	-25
Macroeconomic indicators	Percent change													
GDP	-	-0,1	0,0	0,0	0,0	0,0	-0,1	0,0	0,0	0,0	0,0	0,4	0,0	0,0
Price of land	-	-9,8	0,3	-0,8	-0,2	-0,4	-0,4	-0,7	-1,0	-4,2	-0,6	-5,3	-2,8	0,7

Note: Portugal omitted due to negligible production.
[1] Base price of sugar beet.
[2] Average market price.
[3] Change in total quota rent divided by production.
[4] Change in land rent (per hectare) for sugar beet.

For Greece, Italy, and Finland, the price of sugar beet falls by only 7 to 14 per cent. Since producers are assumed to plan for A-production only, there is no quota rent to exhaust (reflected in a zero change in quota rent in Table 4). The reduction in the price of sugar beet is therefore reflected in a stiff fall in production, causing land rent in sugar beet production to fall by up to 100 per cent.

FIGURE 5 **Scenario 1a, France**



In the case of Denmark, the price of sugar beet is reduced by 24 per cent. However, since the B-price is increasing, the quota remains binding and production is therefore not affected by the reduction in border protection. This is illustrated in Figure 6 where the A-price is reduced, and the B-price is increased like in France. Production is unchanged but the quota rent (per ha) declines by 71 per cent, and the land rent in sugar beet production is reduced by 45 per cent. A similar picture is observed for Belgium and Spain. For Sweden, the Netherlands and Ireland, the cost of production is somewhat higher (marginal cost is somewhere between the initial A- and B-price), which implies that quota rent is fully exhausted, production is reduced subsequently, and the land rent in sugar beet production declines accordingly.

FIGURE 6 **Scenario 1a, Denmark**

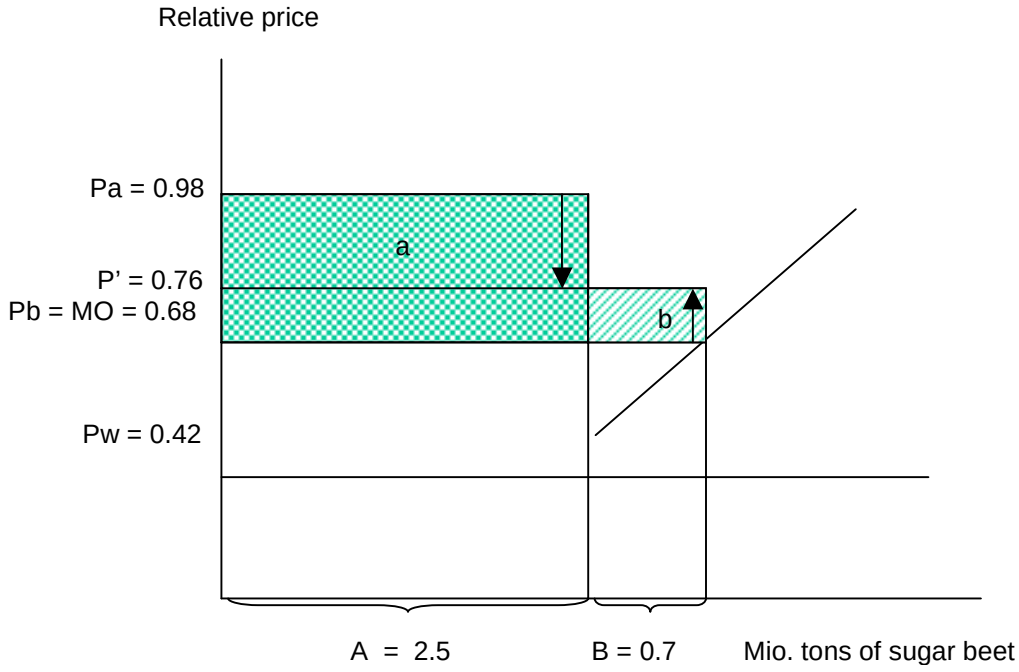
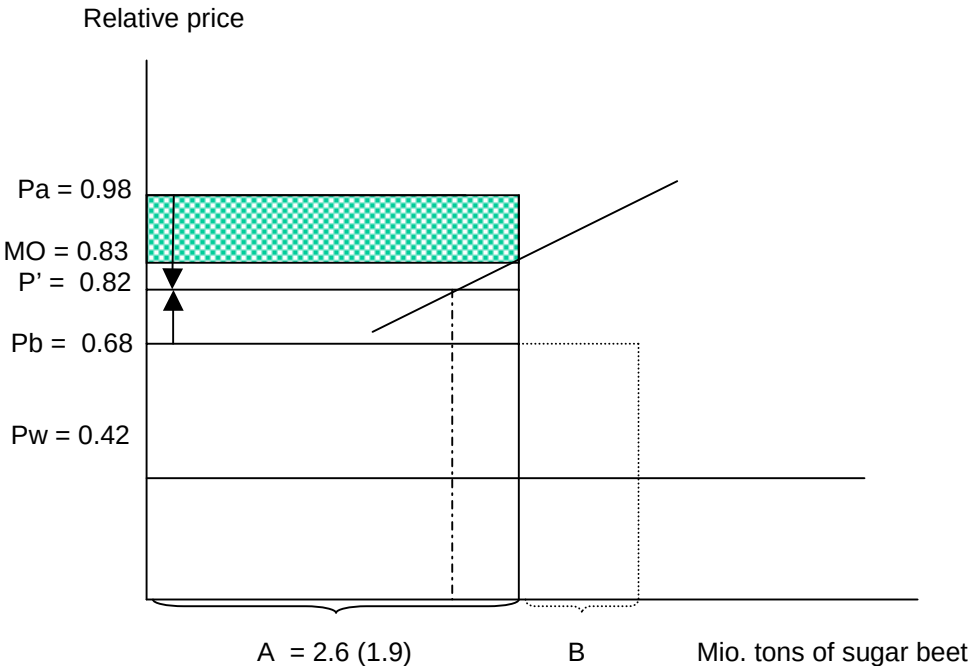


FIGURE 7 **Scenario 1a, Sweden**



The result for Sweden is illustrated in Figure 7, indicating that the production initially was restricted to the A-quota (2.6 mio. tons of sugar beet). At this level of production marginal costs (represented by the intersection of the supply curve and the A-quota) amounted to

83% of the base price (MO = 0.83) and quota rent was represented by the shaded area. As a result of the reduction in border protection the A-price is reduced from 0.98 to 0.82, reducing production from 2.6 mio. tons of sugar beet to 1.9 mio. tons. Hence, the A-quota is not filled after the reduction of border protection, and the quota rent ceases (indicated by a 100% reduction in quota rent in Table 4).

As reported in Table 4, total EU exports to third countries are reduced by US$0.7 billion whereas imports increase by US$1.4 billion corresponding to a reduction in exports of 27% and an increase in imports of 146%. In all EU countries, exports to and imports from third countries, including the developing countries, are affected. Due to a significant geographical reallocation of the EU production of sugar, EU-intra trade will increase, the fall in production in e.g. Italy being substituted by imports notably from France, Germany and UK.

Scenario 1b: Price reduction of 25 per cent with compensation

Scenario 1b deviates from the former scenario only by providing compensatory payments to producers of sugar beet. In general, payments linked to the use of land for a particular purpose (a coupled payment), such as sugar beet will increase the return to land in that particular crop, and thereby influence the allocation of land. Assuming only a minor impact on the yield per hectare, the production of sugar beet will increase accordingly. The effect depends critically on the size of the payment and the conditions under which it is given. A high compensatory payment could for example make it attractive for those countries, that more or less stops producing sugar beet in scenario 1a, to continue the production.

The analysis shows that the total production of sugar in the EU is reduced by almost 17 per cent in scenario 1b, cf. Table 5, as compared with 19 per cent in scenario 1a. Hence, the suggested compensatory payment will not influence the cost of production sufficiently to maintain the level of production prior to the 25 per cent price cut. The fall in quota rent is approximately the same in the two scenarios, but land rent is declining somewhat less in scenario 1b due to the compensatory payments. In Ireland, Italy and Finland, return to land in sugar beet production is increased, although at a considerably smaller area.

The supply of sugar in France and Austria appears to increase slightly when producers are compensated for the reduction in border protection. In general, however, the effect on production and trade is small, indicating that it would require considerably higher area pay-

TABLE 5. **Scenario 1b: 25 per cent reduction in border protection (with compensation)**

	EU total	Belgium	Denmark	Germany	Greece	Spain	France	Ireland	Italy	Netherlands	Austria	Finland	Sweden	United Kingdom
Production	Percent change													
Sugar beet	-18,2	-0,1	0,0	-1,0	-73,0	0,0	0,9	-87,1	-30,5	-75,9	0,6	-59,8	-23,7	-0,0
Sugar	-16,9	0,0	0,0	-1,0	-78,7	0,0	2,5	-97,2	-97,7	-83,2	1,8	-88,3	-24,1	-1,9
Cereals	0,1	0,1	0,4	0,3	0,0	0,1	0,1	0,2	-0,1	0,3	0,2	-1,3	0,2	0,5
Other crops	0,1	0,4	0,1	0,1	0,0	0,0	0,1	0,2	-0,1	0,2	0,1	0,0	0,1	0,1
Export value (fob)	Change, Million US$													
Total	-862	-91	-17	-111	-11	-30	-211	-58	-95	-142	3	-15	-52	-29
- Intra EU	-250	-31	2	-3	0	0	-93	-35	-40	-57	12	-3	-36	37
- Extra EU	-613	-60	-19	-108	-11	-30	-118	-22	-56	-85	-9	-12	-16	-66
Import value (fob)	Change, Million US$													
Total	1021	-173	-35	-52	15	-94	-41	10	614	193	-6	561	24	4
- Intra EU	-250	-183	-48	-72	-13	-113	-71	-13	337	16	-19	4	3	-76
- Extra EU	1271	11	12	20	27	19	30	23	278	177	12	557	21	80
Prices	Percent change													
Sugar beet[1]	-	-24	-24	-24	-15	-24	-24	-9	-8	-16	-23	-9	-19	-24
Sugar[2]	-	-24	-24	-24	-21	-24	-24	-23	-23	-22	-23	-22	-18	-24
Quota rent[3]	-	-71	-69	-29	0	-77	-34	-100	0	-100	-32	0	-100	-34
Land rent[4]	-	-39	-31	-18	-23	-18	-6	7	19	-36	-8	16	-52	-12
Macroeconomic indicators	Percent change													
GDP	-	-0,1	0,0	0,0	0,0	0,0	-0,1	0,0	0,0	0,0	0,0	0,4	0,0	0,0
Price of land	-	-7,6	0,7	-0,4	-0,0	-0,0	0,1	0,5	-0,2	-1,2	0,1	-4,1	-1,6	1,2

Note: Portugal omitted due to negligible production.
[1] Base price of sugar beet.
[2] Average market price.
[3] Change in total quota rent divided by production.
[4] Change in land rent (per hectare) for sugar beet.

ments to compensate farmers for the loss of price support.[15] The value of EU exports of sugar to third countries is reduced slightly less, and the value of imports from third countries is increased slightly more than in scenario 1a. The macro economic effects are by and large the same in the two scenarios.

Scenario 2: Reduction in the quota

The distribution across the individual EU member countries of the reduction in the total EU sugar quota is shown in Table 6 below. The cuts are determined by the stipulated coefficient for quota reduction as outlined in the EU regulation No. 2038/1993 (cf. Box 2). A 13 per cent reduction in the total EU sugar quota (reducing exports of B-sugar by 100%) only leads to a 0.4% per cent fall in the overall EU production of sugar beet (Table 7). However, the effect on production varies considerably among Member countries.

TABEL 6. **Scenario 2. The assumed reductions of the EU's sugar quota, per cent**

	A-quota	B-quota	Total
Belgium	-13.0	-13.0	-13.0
Denmark	-15.9	-15.8	-15.9
Germany	-16.3	-16.3	-16.3
Greece	-8.1	-8.0	-8.1
Spain	-5.3	-5.3	-5.3
France	-14.9	-15.5	-15.0
Ireland	-8.2	-8.4	-8.2
Italy	-12.0	-12.0	-12.0
Holland	-14.8	-14.8	-14.8
Austria	-13.7	-13.6	-13.7
Portugal	-7.1	-7.2	-7.1
Finland	-8.1	-8.5	-8.1
Sweden	-8.2	-8.0	-8.2
UK	-8.2	-8.2	-8.2
EU-15	-12.8	-14.5	-13.1

[15] Introducing a compensatory payment to land used for producing sugar beet in these countries affect their average cost of production and thereby the competitiveness of sugar beet production in the applied general equilibrium model. In order to reduce this effect, and the impact on the reallocation of land, we assume in all scenarios an elasticity of transformation of land to equal -0.1. We have, to take account of these aspects, considered changing the representation a bit allowing the elasticity of transformation to vary across the individual EU countries, depending on the location of the supply curve. It is also under consideration to separate the production of C sugar completely from the production of A- and B-sugar as these two types of sugar clearly are under different institutional regimes (producers responds to very different relative prices). In this case, compensation payments would not be allocated to the production of C-sugar.

For France, Germany, Austria and United Kingdom, production is hardly affected by the reduction in quotas, but the amount of production receiving the high prices will be reduced. As indicated by Figure 8 for France, producers will loose quota rent corresponding to the shaded area (a) in the figure. However, due to the elimination of exports of B-sugar, the A-price will increase from 0.98 to 1.00 and the B-price from 0.68 to 1.00 enhancing the quota rent by the shaded areas (b) and (c). The production of sugar in France may even increase slightly because of higher prices on exports to third countries. The main effect for the mentioned counties is therefore a reallocation of A- and B-production to C-production.

In Denmark, where the quota initially is binding, the reduction of quotas will result in a proportionate reduction in the supply of sugar (14.1% reduction in the production of sugar beet). However, because of higher A- and B-prices and lower marginal cost of production, the total quota rent will be enhanced (shown by the shaded areas (a), (b) and (c) in Figure 9). The return to land in sugar beet production and the price of land will also increase. A similar picture is observed for Belgium and Spain although the effect on production is somewhat smaller.

FIGURE 8 **Scenario 2, France**

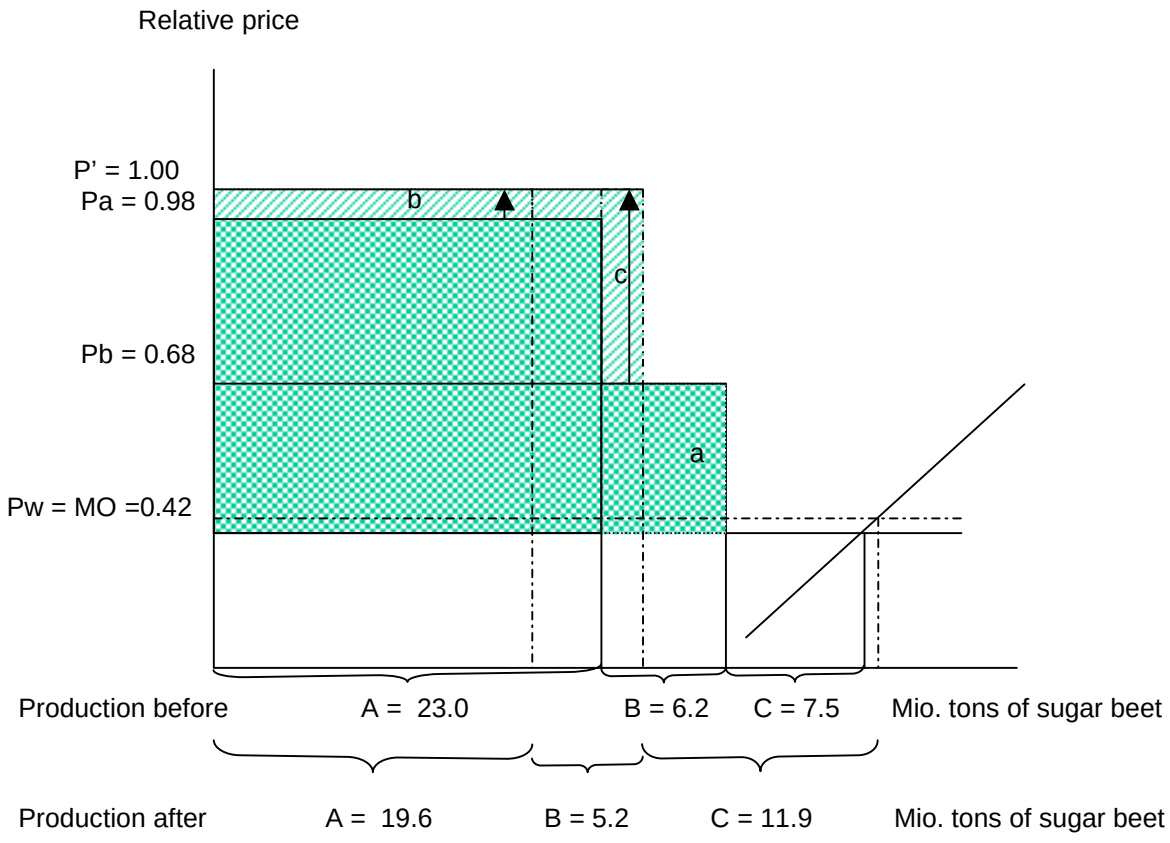
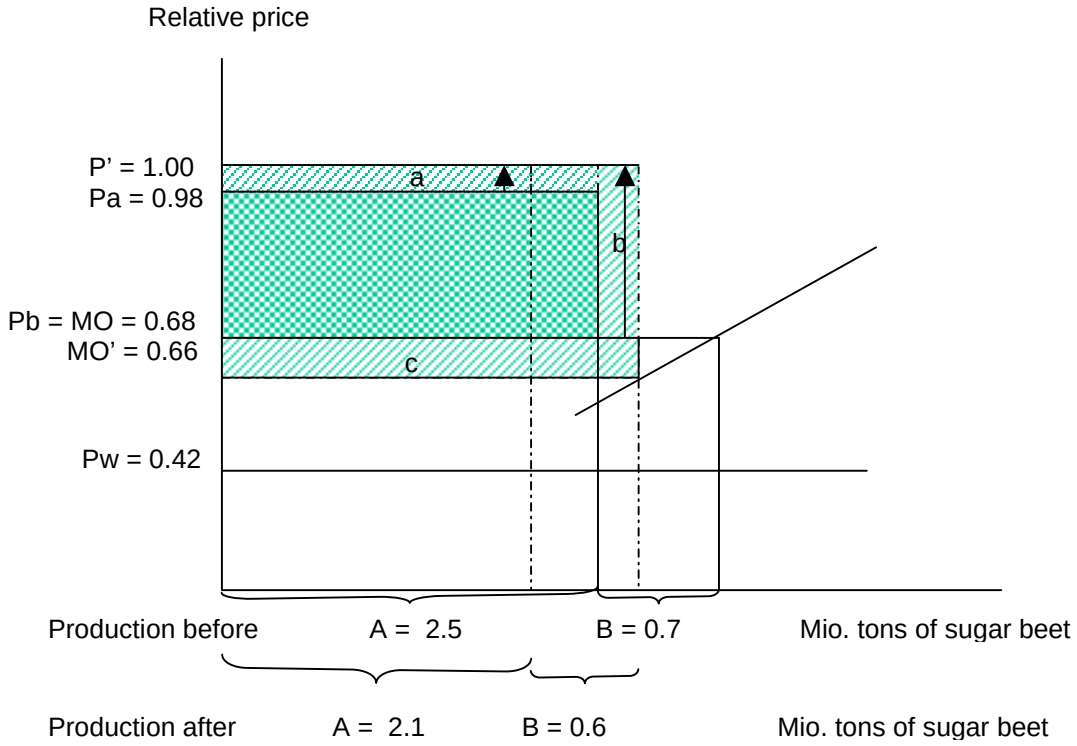


FIGURE 9 **Scenario 2, Denmark**



For the remaining countries, production will increase when quotas are reduced. The increase in production is explained mainly by the self-financing system that has the effect of enhancing the price to producers when exports of B-sugar are reduced, making it more profitable for producers to fill their quotas. The Netherlands for instance is expected to increase its production by 7%, and Greece that has not filled its A-quota so far is expected to enhance production by 5.6%. The quota rent is expected to increase in Ireland, the Netherlands Sweden but will remain zero in Greece, Italy and Finland.

The applied reduction in quotas has only a minor impact on the EU trade in sugar. Total exports to third countries decline by US$93 million, whereas imports are hardly affected (Table 7).

The impact on third countries

The lower level of domestic market prices in scenario 1a and 1b and the implied lower level of sugar production in the EU affects world trade significantly. The volume of world trade

TABLE 7. **Scenario 2: Reduction of quotas (no compensation), change in production, trade and prices**

	EU total	Belgium	Denmark	Germany	Greece	Spain	France	Ireland	Italy	Netherlands	Austria	Finland	Sweden	United Kingdom
Production	Percent change													
Sugar beet	-0,4	-12,9	-14,1	0,0	5,6	-2,0	0,1	0,8	1,3	7,0	0,0	0,3	1,1	0,1
Sugar	-1,2	-13,0	-15,9	0,0	6,0	-5,3	0,3	0,9	4,1	7,6	0,1	0,4	1,1	0,2
Cereals	0,0	-0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	-0,1	0,0	0,0	0,0	0,0
Other crops	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	-0,1	0,0	0,0	0,0	0,0
Export value (fob)	Change, million US$													
Total	-85	-106	-44	2	3	-22	18	1	18	34	0	2	5	3
- Intra EU	8	-28	-14	2	0	-1	22	0	5	15	0	0	5	0
- Extra EU	-93	-78	-30	0	3	-21	-4	0	13	20	1	1	-1	3
Import value (fob)	Change, million US$													
Total	11	26	10	0	0	18	-4	-1	-22	-14	1	-1	-2	-1
- Intra EU	8	25	9	0	1	15	-6	-1	-20	-12	2	0	-3	-1
- Extra EU	3	1	2	0	-1	3	2	0	-3	-1	-1	-1	1	0
Prices	Percent change													
Sugar beet[1]	-	3	4	0	-1	2	0	0	-2	-1	0	-2	0	0
Sugar[2]	-	1	1	0	0	0	0	0	0	0	0	0	0	0
Quota rent[3]	-	48	66	-1	-	21	-1	221	-	70	-1	-	26	-1
Land rent[4]	-	13	15	0	33	5	0	46	19	41	-1	20	17	0
Macroeconomic indicators	Percent change													
GDP	-	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Price of land	-	2,5	0,5	0,0	0,1	0,1	0,0	0,6	0,2	2,2	0,0	0,3	0,8	0,0

Note: Portugal omitted due to negligible production.
[1] Base price of sugar beet.
[2] Average market price.
[3] Change in total quota rent divided by production.
[4] Change in land rent (per hectare) for sugar beet.

in sugar increases by 10-11 per cent in these two scenarios whereas volume of the world trade is almost unaffected in scenario 2. Furthermore, the exporting countries outside the European Union all receive an average higher export price for their sugar export in the two first scenarios, whereas export prices are unchanged in scenario 2, cf. table 8.

TABLE 8. **Change in sugar export prices, per cent**

	Scenario 1a	Scenario 1b	Scenario 2
Australia	0,5	0,4	0,0
China	0,5	0,4	0,0
Thailand	0,6	0,5	0,0
India	0,0	0,0	0,0
Rest of South Asia	0,2	0,2	0,0
USA	0,4	0,3	0,0
Mexico	0,3	0,3	0,0
Central America and Caribbean	0,5	0,4	0,0
Brazil	0,3	0,3	0,0
Malawi*	0,5	0,5	0,0
Tanzania*	0,1	0,1	0,0
Zambia*	0,9	0,8	0,0
Zimbabwe*	0,5	0,5	0,0
Other South African countries (incl. South Africa)*	-	-	0,0
Uganda*	0,1	0,0	0,0
Rest of the world	0,4	0,4	0,0

* ACP-countries.

Note: Scenario 1a: 25 per cent reduction in the EU border protection without any compensation to the producers.
Scenario 1b: 25 per cent reduction in the EU border protection with compensation to the producers.
Scenario 2: 13 per cent reduction in the EU sugar quota without any compensation to the producers.

As mentioned earlier, the EU trade with third countries expands significantly in scenario 1a and 1b, increasing EU-imports by US$1.3 billion in both scenarios. In particular exports to the EU from India, the rest of south Asia, Central America and Caribbean and Brazil (and the rest of the World) expands in value terms. The value of exports from the ACP countries, although less, increases as well, cf. Table 9. In the case of Malawi, for instance, total exports in 1997 amounted to US$14 million. In scenario 1a exports will increase by US$4 (29%) all of which goes to the EU. It is also evident from the table that the global trade pattern changes somewhat due to the lower level of European net export, as trade among non-EU countries and regions increases significantly in both scenario 1a and 1b.

For the ACP countries the increase in trade with the EU translates into relative large increases in the production of sugar given the importance of the EU market for in particular this group of countries (Table 10).

TABLE 9. **Third countries export of sugar, 1997 Mill. US$**

	Export level 1997	Scenario 1a		Scenario 1b		Scenario 2	
		To EU	To others	To EU	To others	To EU	To others
		Change in export values					
Australia	625	9	29	9	25	0	3
China	144	9	5	9	5	0	1
Thailand	903	9	12	8	10	0	2
India	196	124	33	114	29	1	2
Rest of South Asia	50	111	1	104	1	0	0
USA	75	55	6	54	5	0	1
Mexico	142	9	17	9	15	0	2
Central A. and Caribbean	1524	139	51	126	45	0	10
Brazil	1668	182	191	176	163	-1	22
Malawi*	14	4	0	3	0	0	0
Tanzania*	6	4	0	4	0	0	0
Zambia*	17	2	0	2	0	0	0
Zimbabwe*	74	1	3	1	2	0	0
Other S. Africans countries* [1]	257	79	-6	75	-6	1	0
Uganda*	0	0	0	0	0	0	0
Rest of world (excl. EU)	2045	614	130	578	112	2	13
Total	7740	1349	472	1271	406	3	56

*ACP Countries
[1] Inclusive South Africa.

The economic impact of the value of the preferential access to the EU market given to the ACP countries and India is by definition affected negatively through the lower import protection analysed in scenario 1a and 1b[16]. Therefore, the value of the economic rent associated with the tariff rate quota system falls in line with the lower domestic market price of sugar in the European countries. The ACP countries and India therefore suffers a significant loss of quota rent, cf. Table 11.

In total, the TRQ rents are reduced by around US$185 million or slightly more than a 50 per cent reduction in scenarios 1a and 1b. In macro economic terms, however, the two scenarios have only marginal impact on the economy of ACP-countries (cf. Table 10), indicating that the loss of quota rent is largely balanced by the higher production of sugar, leaving GDP almost unaffected in all cases.

[16] Imports on preferential terms are administrated through the issuing of import licences. The holders of import licenses are sugar refineries in the EU who are obliged to pay as a minimum the guaranty price for raw sugar for imports from the ACP-countries. In principle, the ACP-countries should therefore get the quota rent. In practice, however, quota rents may be shared between importers and exporters, meaning that a reduction in the internal price in EU would only in part affect the net receipt, the ACP-countries receive from exporting to the EU market.

TABLE 10. **Non-EU countries: Trade and production of sugar with the EU and selected macro economic indicators**

	Total	Australia	China	Thailand	India	The rest of South Asia	USA	Mexico	Central Am. & Caribian	Brazil	Malawi	Tanzania	Zambia	Zimbabwe	Other South African Countries	Uganda	The rest of the world
Trade	Change Million US$ and (per cent)																
Scenario 1a																	
Exports to the EU	1349 (146)	9 (339)	9 (195)	9 (185)	124 (265)	111 (332)	55 (669)	9 (171)	139 (81)	182 (922)	4 (40)	4 (75)	2 (14)	1 (11)	79 (32)	0 (-)	614 (178)
Imports from the EU	-719 (-27)	0 (-)	-10 (-26)	0 (-)	-5 (-29)	-14 (-42)	-5 (-31)	0 (-)	-4 (-27)	0 (-)	0 (-)	0 (-)	0 (-)	0 (-)	-4 (-17)	0 (-)	-675 (-27)
Scenario 1b																	
Exports to the EU	1271 (137)	9 (334)	9 (179)	8 (179)	114 (243)	104 (312)	54 (653)	9 (163)	126 (74)	176 (894)	3 (35)	4 (66)	2 (12)	1 (10)	75 (31)	0 (-)	578 (168)
Imports from the EU	-613 (-23)	0 (-)	-8 (-21)	0 (-)	-4 (-23)	-13 (-39)	-4 (-26)	0 (-)	-3 (-22)	0 (-)	0 (-)	0 (-)	0 (-)	0 (-)	-3 (-14)	0 (-)	-576 (-23)
Scenario 2																	
Exports to the EU	3 (0)	0 (-)	0 (-)	0 (-)	1 (2)	0 (-)	0 (-)	0 (-)	0 (-)	-1 (-4)	0 (-)	0 (-)	0 (-)	0 (-)	1 (0)	0 (-)	2 (0)
Imports from the EU	-93 (-4)	0 (-)	0 (-)	0 (-)	0 (-)	0 (-)	0 (-)	0 (-)	0 (-)	0 (-)	0 (-)	0 (-)	0 (-)	0 (-)	-1 (-7)	0 (-)	-91 (-4)
Production	Percent change																
Scenario 1a	-	2,3	2,1	0,7	1,7	6,6	1,2	0,8	7,2	3,9	20,3	48,5	7,4	4,0	24,5	0,8	3,3
Scenario 1b	-	2,1	1,9	0,7	1,5	6,2	1,1	0,7	6,5	3,5	18,0	42,6	6,6	3,6	23,0	0,7	3,0
Scenario 2	-	0,2	0,1	0,1	0,0	0,0	0,1	0,0	0,64	0,2	1,0	0,8	0,2	0,3	0,3	0,3	0,2
GDP	Percent change																
Scenario 1a	-	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,1	0,0	0,0	0,0	-0,1	0,0	0,0	0,0	0,0
Scenario 1b	-	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,1	0,0	0,0	0,0	-0,1	0,0	0,0	0,0	0,0
Scenario 2	-	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

Note: Scenario 1: 25 per cent reduction in border protection for sugar in the EU. No compensation paid to producers.
Scenario 2: 25 per cent reduction in border protection for sugar in the EU. With compensation paid to producers.
Scenario 3: Reduction in quotas. No compensation paid to producers.

TABLE 11. **Tariff Rate Quota rents captured by exporters, Mill 1997 US$**

Exporter	Initial TRQ rents	Change in TRQ quota rents		
		Scenario 1a	Scenario 1b	Scenario 2
India	30	-13	-13	0
Malawi	10	-4	-4	0
Tanzania	7	-3	-3	0
Zambia	19	-8	-8	0
Zimbabwe	13	-6	-6	0
Uganda	0	0	0	0
Other S. African countries[1]	274	-150	-153	0
Total	352	-184	-187	0

[1] Inclusive South Africa.

7. Qualifications

This paper addresses the issue of modelling the EU sugar policy at the detailed member country level – a task that is difficult given the complexity of the policy and the very different conditions for producing sugar beet in the member countries. As indicated in the paper, our approach has presented a possible way forward while, at the same time, identifying areas for further research and alternative avenues for representing the sugar policy and its impacts at the individual country level.

Clearly, the results depend critically on the chosen calibration of the model and, in particular, the identification of the individual member countries as either high, medium or low cost sugar beet producers. Nevertheless, given such a categorisation of the member countries, the model results – being quite rich in terms of interesting qualitative and quantitative results - clearly illustrate the very different regional impacts of a given reform scenario.

8. Conclusion and policy recommendation

The EU sugar policy

The objectives of the European Union's sugar policy are twofold: (1) to secure a sufficient and stable supply of sugar within the EU, and (2) to provide farmers with a stable income from the production of sugar beet or sugar cane. Both these objectives are intended to be met without imposing a significant financial burden on the EU budget. Further, it is implicitly understood that the regional dispersion of the production of sugar in the EU should be maintained, allowing for a broad spectrum of farmers to participate in this production. Production of sugar in the EU is mainly based on sugar beet.

The EU sugar policy combines restrictions on imports of sugar from third countries with price guarantees for sugar produced for domestic consumption within the EU. The price to consumers is guided by an institutionally determined intervention price that has been 2-3 times above the world market price for a number of years. So-called A- and B-quotas for sugar beet, receiving the intervention price net of producer taxes, regulate the production of sugar. The producer taxes are determined such that the tax revenue will cover the cost of bridging the gap between the internal price and the world market price for exports of B-sugar, making the scheme self financing. Production in excess of the A- and B-quota is exported to the world market without any support from the EU. The costs of other exports of sugar (mainly raw sugar imported on preferential terms from ACP-countries and India which has been refined within the EU) are, however, covered by the EU budget.

Although the producers of sugar beet are paid only the world market price for exports of sugar, the use of A- and B-quotas provides an incentive for expanding production beyond domestic consumption (cross subsidisation). This tendency is further strengthened by the fact that producers plan for excess production of sugar beet so as to be able to fulfil the contractual agreements for deliveries to sugar refineries. The costs of the sugar scheme are therefore shared between consumers in the EU, who pay the high price for the product, and producers in countries outside the EU, who face lower world market prices due to the supported exports of sugar from the EU.

The EU is under pressure in the international trade negotiations to reduce export support and to increase market access for sugar from third countries. The restrictions imposed by the Uruguay Round Agreement on Agriculture (URAA) have become binding. A continuation of the existing policy regime will therefore make it difficult for the EU to maintain its liberalisation commitments, notably if the enlargement of the EU proceeds as planned.

Possible reform scenarios

A possible target for a reform of the sugar regime could be the elimination of the current practise of cross-subsidisation of exports of B-sugar. The EU is one of the largest exporters of sugar in the world. Between 30 and 40 per cent of EU sugar production is exported to third countries, 60 per cent of the exports being B-sugar. This leaves the EU with mainly two options: a) a quota reduction, and if necessary, combined with the introduction of transferable quotas for sugar, or b) a reduction of the border protection for sugar in the EU. The findings of the present analysis illustrate that both options would impact significantly on the regional distribution of sugar production in the EU. The study also demonstrates that the

impacts of the two options would have very different effects on the level of border protection and the degree of market access, thereby having significantly different consequences for countries outside Europe.

It should be kept in mind that the present analysis like any other economic analysis, is subject to uncertainty. The results naturally depend on the assumptions applied and, particularly in relation to this study they depend on the estimated costs of production in the individual EU member countries. The results should therefore be treated with caution. Nevertheless, having confronted the results with other studies and expert views, we believe that the qualitative story told and the magnitudes of the quantitative results found correctly reflect the economic consequences of the analysed policy changes.

Reform scenario 1: Reduction of quotas

One option for reform would be to eliminate exports of B-sugar by reducing the sugar quota. The analysis demonstrates that such a strategy would have only a limited impact on the total output of sugar in the EU as the production of C sugar being exported at the world market price would increase while the production of A and B sugar would fall in some countries, but increase in others. This supply behaviour is a direct result of the self-financing system that reduces the need for producer taxes when exports of B-sugar are reduced or eliminated. Lower taxes will lead to higher prices provided to producers of A- and B-sugar beet, making it profitable to expand production within the established quota limits. Due to differences in production costs, the supply response will differ across the individual countries in the European Union.

In France, Germany, Austria and the United Kingdom, countries that are endowed with conditions favourable to growing sugar beet, it is profitable to produce sugar at the world market price. The production of sugar beet in these countries will therefore not be affected by an elimination of exports of B-sugar. In Belgium, Denmark and Spain, however, the production quota is binding. Although the cost of producing sugar beet is higher compared to the first group of countries, it still pays to fill the quota. A reduction of the sugar quota will therefore directly impact on the production of sugar beet, notably in Denmark and Belgium, where producers will reduce the total production of sugar in proportion to the reduction in the national sugar quota

For Ireland, the Netherlands, Sweden, Finland, Italy, Greece and Portugal, higher prices to producers (due to the elimination of exports of B-sugar) would overrule the impact of indi-

vidual quota reductions. Despite higher costs of production compared to the first two groups of countries (Greece and Portugal do not fill the A-quota), production will increase in these countries when the quotas are reduced.

In conclusion, the elimination of exports of B-sugar by reducing the production quotas will only reduce total sugar production in the EU by approximately 1 per cent. The production will fall in notably Denmark and Belgium being neither low nor particularly high cost sugar beet producers, whereas the production in low cost countries such as France and Germany will remain unchanged and the production in high cost countries (such as Greece, Portugal, Italy and Finland) will increase. The ultimate effect of a quota reduction would therefore be a more inefficient distribution of the sugar production within the EU, with the result that the competitiveness of the European sugar production on the world market deteriorates. Elimination of exports of B-sugar through a reduction of quotas will have virtually no impact on production and trade in the developing countries and countries outside Europe.

Quota values

In principle, the EU sugar scheme is based on fixed and non-transferable quotas across the individual EU member countries. In practise, the quotas may be changed, for example to fulfil international obligations, however, given the present objectives of the EU sugar policy, such changes will typically not affect the relative size of quotas allocated to individual member countries. Further, given the original allocation of the EU sugar quota across the EU member countries, and that producers have been facing different development in price relations since the establishment of the sugar scheme, the quota values associated with the administration of the sugar quotas differ significantly among the individual EU member countries.

As a consequence, the underlying pressure to change the allocation of the production of the sugar across the member countries has increased significantly over the years. A future reform of the EU sugar policy should therefore from an economic point of view take account of such pressures and considerations with potentially significant economic gains to be reaped.

Impacts of transferable quotas

The analysis illustrates the highest quota values are observed in the central parts of the EU, where the best conditions for growing sugar beet are found, whereas quota values are low in

the Northernmost areas of the EU and in the Mediterranean area. The differences in quota rent indicate that the current distribution of sugar beet production in the EU is clearly inefficient, and that the efficiency of the industry could be enhanced considerably, if the quotas were made transferable.

The impact of allowing the sugar quotas to be transferable has not been analysed explicitly in this working paper, although the analysis clearly provides indications of the economic consequences. It is found that producers in France, Germany, Austria and United Kingdom may be capable of producing sugar at the present world market price and that the existing quota system therefore mainly has the effect of providing producers with very high quota rents from the production of A- and B-sugar beet. Producers in these countries may therefore be able to pay a relatively high price for additional quotas. Although this may not affect the total EU production of sugar very much (recall that the quotas are not restricting production) it would lead to a redistribution of production within the EU and significant efficiency gains could be made.

Producers in Belgium, Denmark and Spain are typically not capable of producing sugar at the world market price. On the margin, the price of B-sugar will just cover the costs of producing sugar beet, whereas the price of A-sugar provides the producers with a considerable quota rent. Whether this margin will be sufficient to encourage competition for quotas with low cost producers in the central parts of the EU is difficult to conclude from the analysis undertaken.

The analysis also indicates that Ireland, the Netherlands and Sweden might have difficulties in competing for sugar quotas, and that the production of sugar beet in Greece, Portugal, Italy and Finland would definitely cease if the quotas were made transferable between member states. In all countries, however, the efficiency of production could be enhanced considerably by making the individual quotas transferable at the member state level.

In conclusion, the EU could enhance the competitiveness of its sugar industry considerably by allowing the sugar quota to be transferable between member countries. This also applies to the individual quotas within member countries. Allowing the quotas to be transferable would lead to a redistribution of the overall level of production within the EU and - in the long run - concentrate the production of sugar beet in low cost areas of the European Union.

Reform scenario 2: Reducing guaranteed prices

Reducing the guaranteed prices of sugar beet has a significant effect on the production of sugar in the EU. According to the analysis, a 25 per cent reduction in border protection will reduce the overall production of sugar by nearly 19 per cent, consumption will increase, and the production of A- and B-sugar will no longer cover the European domestic demand for sugar. The EU would still, however, be exporting C-sugar to the world market.

The production would fall most in high cost areas notably in Greece, Finland and Italy where the production of sugar beet would more or less cease. The production would also be reduced in Ireland, the Netherlands and Sweden, whereas Belgium and Denmark would maintain their present levels of production. The latter is explained by a buffer effect of the quota rents. The production of sugar beet in France, Germany, Austria and United Kingdom, being determined at the margin by the world market price, is not affected by the reduction of the guaranteed prices in the EU.

The reduced import tariffs and a lower level of production of sugar within the European Union lead to a significant increase in trade with third countries. EU will reduce its exports of sugar and imports will increase, most notably from Brazil, USA, India, South East Asia and the Caribbean (Cuba & El Salvador). Also ACP-countries such as Malawi, Tanzania, Zambia and South Africa, that have specific trade agreements with the EU, would benefit in terms of higher exports to the EU market. If the reduced intervention price were to be supplemented by the introduction of compensatory payments to producers of sugar beet (defined as half the acreage payment to wheat) this would only have a limited effect on EU sugar production and trade as compared to a scenario without such compensatory payments. By definition, such payments would increase the quota rent and boost the return to land in sugar beet production.

The effect of a full liberalisation of the EU sugar policy is not analysed in this working paper. Such a policy change must be considered in a more general scenario where all countries participate in a global reduction of support for agriculture. A full liberalisation would increase export prices to the benefit of countries that have a comparative advantage in the production of sugar, notably Brazil, the Caribbean countries and Australia. But higher world market prices would also benefit developing countries that are currently prevented from exporting sugar to the industrialised world due to high border protection in these countries.

The price scenario analysed in this paper illustrates another important aspect of the European sugar policy and the impacts on developing countries of having preferential access to

the European sugar market: A full or partial liberalisation of the European sugar regime would reduce the economic value of having preferential access to the European market. The EU imports of sugar from the ACP-countries and India are regulated through a Tariff Rate Quota (TRQ) system that allows these countries to export sugar to the EU on preferential terms.

The effect of lowering the out-of-quota tariff rate will, however, depend on who gets the benefit from the TRQ-system. If the producers in developing countries are the beneficiaries (receiving the quota rent), they may find themselves in a weaker competitive position relative to other exporters to the EU, if the border protection in the EU is reduced. Assuming that the quota rent accrues to the governments of developing countries, it is found that the ACP-countries and India would loose the existing quota rent, or part of it, as a result of the price reductions in the EU. However, the scenario analysed illustrates that this loss is more or less balanced by increased production and exports of sugar, leaving the economies as a whole more or less unaffected.

It is concluded that the Tariff Rate Quota system is an inefficient instrument for conveying aid to developing countries. The system is administratively burdensome, it is uncertain who gets the benefit (quota rent), and it would serve the developing countries better to provide free access for their products to the markets of developed countries. If there is a need for assistance, it is recommended that aid should be provided in the form of direct and targeted support.

Concluding remarks

The EU sugar policy distorts the production and trade in sugar. Allowing for cross-subsidisation of exports of sugar, the policy encourages production beyond domestic demand to the disadvantage of developing countries that find it difficult to compete in the international markets with subsidised exports of sugar from the EU. Furthermore, the policy is based upon a very high level of border protection, making it virtually impossible to export sugar to the EU unless the exporter has a specific trade agreement with the EU, allowing for exports on preferential terms. The EU is therefore under international pressure, notably from the other WTO member states, to reform its sugar policy. The target for such a reform should be, first and foremost, to eliminate the cross-subsidisation of exports of sugar to the world market.

The analysis clearly demonstrates that quota reductions are a very inefficient means of achieving improved market access to the European market and to reduce the cross subsidisation of sugar exports. Eliminating exports of B-sugar completely would require a 13% reduction of the quotas. However, as a consequence of the self-financing system and the existence of quota rent, such a reduction would have only a marginal impact on total production, as the main result would be a redistribution of production among A- and B-quotas, and among quotas and the production of C-sugar. Furthermore, it would increase regional disparities in production efficiency and it would adversely affect the competitiveness of the EU sugar industry on the world market. The EU would maintain large exports of sugar based on an inefficient production, and the most efficient producers would gain from higher quota values for A- and B-production.

The analysis supports the view that a more efficient strategy would involve lowering the guaranteed prices to producers of sugar beet in the EU. A reduction of prices will have an immediate impact on production and will reduce the cross-subsidisation of exports of sugar. The impact of such a change of policy would vary from region to region within the EU. Elimination of exports of B-sugar through a reduction of prices could remove the economic basis for production of sugar beet in high cost areas, resulting in a concentration of the production in low cost areas, making the industry more fit for competition in international markets.

A lowering of the guaranteed prices for sugar in the EU would also benefit the developing countries, which would improve market access and less (unfair) competition from supported exports. This conclusion also applies to developing countries that already have preferential trade agreements with the EU, although a reduction in border production in the EU could place such countries in a weaker position relative to other exporters to the EU market (due to the existing tariff rate quota system). The analysis indicates that the granting of preferential market access is an inefficient mean transferring aid to the developing countries, and that these countries would gain by obtaining free access for their products to the markets of developed countries. To the extent that there is a need for financial assistance, it is recommended that such aid be provided in the form of direct and targeted support.

References

Agra Europe (2001), *Agra Europe Weekly*, May 25, 2001.

Bureau, Jean-Christophe, Hervé Guyomard, Laurent Morin & Vincent Réquillart (1997), "Quota mobility in the European sugar regime", *European Review of Agricultural Economics, Vol. 24*, pp. 1-30.

Dimaranan, B. V. and R. A. McDougall (eds.). *Global Trade Assistance and Production: The GTAP 5 Data Base*, Center for Global Trade Analysis, Purdue University.

Elbehri, A.E. and K. Pearson (2000), *Implementing Bilateral Tariff Rate Quotas in GTAP Using GEMPACK.* GTAP Technical Paper No. 18, Center of Global Trade Analysis Project, Purdue University.

European Commission (2000a), *Proposal for a Council Regulation on the common organisation of the market in the sugar sector*, Brussels, 4. October 2000.

European Commission (2000b), *The Agricultural Situation in the Community, Report 1999.*

Harrison, W.J. and K.R. Pearson (1996), Computing Solutions for Large General Equilibrium Models Using GEMPACK, *Computational Economics, 9, p. 83-127.*

Hertel, T.W. (1997), *Global Trade Analysis: Modeling and Applications*. New York: Cambridge University Press.

Huan-Niemi, Ellen (2001), "Pressures for reforms in the EU Sugar Regime due to the Next WTO Round on Agriculture and the Enlargement of the EU", *Paper presented at the 77th EAAE/NJF Seminar No. 325 on Intrernational Agricultural Trade: Old and New Challenges"*, August 17-18, Helsinki, Finland.

OECD (2000) *Producer and Consumer Support estimates, OECD Database 1986-1999*, Paris.

SFJI (1999), "Økonomien i landbrugets driftsgrene 1997/98 (Economics of Agricultural Enterprises 1997/98)", *Serie B nr. 82*, Danish Institute of Agricultural and Fisheries Economics.

Walter-Jørgensen, A. H.G. Jensen and S. E. Frandsen (2001), Reform af EU's sukkerpolitik, Konsekvenser for EU og udviklingslandene, Report No. 126, Danish Institute of Agricultural and Fisheries Economics.

Zimmermann, Beate & Jürgen Zeddies (2000), "Productivity Development in Sugar Beet Production and Economic Evaluation of Progress in Breeding", *Agrarwirtschaft 49, Heft 5,* p. 195-205.

APPENDIX TABLE 1. **Production of white sugar in the EU, average 1996/97-98/99**

Member country[1]	Quota		Production				Standard deviation total production[3]	Share of C-sugar in total production
	A-quota (1)	B-quota (2)	A-sugar (3)	B-sugar (4)	C-sugar (5)	Total[2] (6)	(7)	(8)
	---------- Thousand tons ----------						per cent	per cent
Belgium	680	146	680	146	101	921	9.2	10.9
Denmark	328	97	328	97	85	524	10.2	16.7
Germany	2637	812	2637	810	616	4083	5.5	15.2
Greece	290	29	266	10	0	276	17.7	0.0
Spain	960	40	960	40	175	1175	10.7	14.9
France	2996	806	2812	759	980	4651	4.9	21.5
Ireland	182	18	182	18	16	217	7.3	7.6
Italy	1320	248	1320	223	1	1591	9.8	0.1
Netherlands	690	182	690	166	104	960	11.4	10.8
Austria	316	74	317	74	86	489	9.4	18.1
Portugal	73	6	44	2	0	46	161.9	0.0
Finland	134	13	133	9	6	148	14.8	4.0
Sweden	336	34	336	34	15	398	7.5	4.0
UK	1040	104	1040	104	336	1500	10.1	22.7
EU-15	11982	2609	11746	2493	2521	16979	5.2	15.0

[1] No quotas are assigned to Luxembourg.
[2] Due to different sources of information, production of A-, B- and C-sugar may not add to total production.
[3] In percent of total production. Based on data for 1990/91-98/99. For Austria, Finland and Sweden 1994/95-98/99.
Source: European Commission (2000b) and own calculations.

APPENDIX TABLE 2. **Cost of producing sugar beet in Denmark, 1997**

	Acreage of sugar beets per farm, hectare						
	2-5	5-10	10-15	15-25	25-35	35-50	50 -
	ECU per hectare[1]						
Value of production	2 148	2 227	2 353	2 548	2 597	2 545	2 618
Cost I[2]	785	745	712	645	610	578	525
Cost II[3]	1 059	1 013	971	992	859	925	1 004
Cost III[4]	258	275	263	314	301	295	327
Opportunity cost of land[5]	97	89	116	155	266	302	261
Total cost	2 199	2 122	2 062	2 106	2 036	2 100	2 117
Total cost/value of production	1.02	0.95	0.88	0.83	0.78	0.83	0.81

[1] "Green" exchange rate DKr 7.49997 per ECU.
[2] Seeds, fertilisers, chemicals, water, energy, rental of machinery.
[3] Labour, maintenance and depreciation of machinery.
[4] Land tax, energy tax, insurance, cost of automobile, maintenance and depreciation of farm buildings.
[5] Return to land in wheat production on farms producing sugar beets.
Source: SJFI(1999).

APPENDIX B: Modelling the EU sugar regime in GEMPACK TABLO code

In this appendix the GEMPACK TABLO code used to model the EU sugar regime is shown together with some short comments explaining the code. The sugar regime TABLO code is added to the Global Trade Analysis Project (GTAP) standard GTAP.tab file. For readers who have no prior experience in reading this type of code my find it difficult to follow. A more in-depth explanation of the GEMPACK TABLO code can be found in Gempack users documentation (Harrison and Pearson, 1996) and the standard GTAP model (GTAP.tab) is documented in Global Trade analysis: Modelling and Applications (Hertel, 1997).

The structure of the Tablo code presented below is as follows.

1. Input tax quota for A and B sugar.
2. Quantity of A, B and C sugar being produced
3. B sugar exports
4. Financing B sugar exports (tax on A and B sugar)
5. Quota rent and its allocation.

The technical representation of the tariff rate quota system is not included here as it follows closely the description in Elbehri and Pearson (2000).

1 Input tax quota for A and B sugar.

The first step in modelling the EU sugar regime is to introduce A and B quotas for the delivery of sugar beet (C_B_COMM) to sugar refineries (PSGR_COMM) in each EU country (EU_REG). This has been done by adapting Aziz Elbehri and Ken R. Pearson's code on Implementing Bilateral Tariff Rate quotas in the GTAP using Gempack (Elbehri and Pearson, 2000). In their technical paper they introduce a tariff rate quota between the values of imports at world market prices (VIWS) and the values of imports at market prices (VIMS). In the EU sugar regime code this has be altered to an input tax-quota for A and B sugar between the value of sugar refineries' demand of sugar beet at market prices (VDFM) and the value of sugar refineries demand of sugar beet at agents prices (VDFA).

Below the first section of code shows the tax-quota system with two quotas and three wedges of tax, as illustrated in Figure 2 and summarized in Table 1 of the paper. Together with the calibrated database, it also offers the positioning of each EU member countries in the tax-quota system.

Variables related to the tax wedges and the quotas are explicitly declared and defined in the following. Under each variable declaration, a comment line explains the meaning of the variable using the terminology used in the modelling development part of the main text.

```
VARIABLE (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG) VDFM_L(i,j,r) ;
# value of  sugar refineries' demand of sugar beet at market price #;
FORMULA (Initial)   (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)
VDFM_L(i,j,r) = VDFM(i,j,r);
EQUATION (Linear) E_VDFM_L   (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)
p_VDFM_L(i,j,r) = qfd(i,j,r) + pm(i,r) ;
```

p_VDFM_L is the percentage change (which is donated by p_ in front of the variable name) in the value of VDFM_L . This is equal to qfd the percentage change in the quantity of sugar beet demanded by the sugar refineries and pm the percentage change in the market price of sugar beet (see Hertel,1997 for further explanations). In the following code all lowercase variables like pm and qfd refer to percentage change.

```
VARIABLE (all,i,TRAD_COMM)(all,r,EU_REG)                    PM_L(i,r) ;
# market price of trade goods #
FORMULA (Initial)   (all,i,TRAD_COMM)(all,r,EU_REG)         PM_L(i,r) = 1 ;
# set initial values of PM equal to 1;  used to set volume unit #
EQUATION (Linear) E_PM_L   (all,i,TRAD_COMM)(all,r,EU_REG)  p_PM_L(i,r) = pm(i,r) ;

VARIABLE (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)    TFDTRQOVQa(i,j,r)
# extra power of tax on out-of-A-quota  (T_a)  # ;
VARIABLE (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)    TFDTRQOVQb(i,j,r)
# extra power of tax on out-of-B-quota  (T_b)  # ;
VARIABLE (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)    VDFM_TRQa(i,j,r)
# initial value of A quota #
VARIABLE (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)    VDFM_TRQb(i,j,r)
# initial value of total quota (A+B) #
VARIABLE (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)    VDFAINQ_TRQ(i,j,r)
# value of A quota at refineries price #

FILE                                                        QDATA
# TFDTRQOVQa, TFDTRQOVQb, VDFM_TRQa, VDFM_TRQb and
  VDFAINQ_TRQ are read from this data file. The code is omitted here # ;


VARIABLE (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)    TFDINQ(i,j,r)
# A-quota  tax (τ_a) # ;
VARIABLE (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)    TFDOVQ(i,j,r)
# B-quota tax (τ_B ) # ;
VARIABLE (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)    TFDWLD(i,j,r)
# out-of-total-quota tax (τ_m) # ;
VARIABLE (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)    TFD_L(i,j,r)
# actual power of  input tax on sugar beet  used in sugar refineries(τ) # ;
```

```
VARIABLE (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)        TFDTRQ(i,j,r)
# actual extra power of tax in addition to in-quota-A tax (T) # ;

# the above 5 variables are computed here #
FORMULA & EQUATION E_TFDINQ (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)
  TFDINQ(i,j,r) = VDFAINQ_TRQ(i,j,r)/VDFM_TRQa(i,j,r) ;

FORMULA & EQUATION E_TFDOVQ    (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)
 TFDOVQ(i,j,r) = TFDINQ(i,j,r) * TFDTRQOVQa(i,j,r) ;
FORMULA & EQUATION E_TFDWLD    (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)
 TFDWLD(i,j,r) = TFDINQ(i,j,r) * TFDTRQOVQb(i,j,r) ;
FORMULA (Initial) (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)
   TFD_L(i,j,r) =  VDFA(i,j,r)/VDFM(i,j,r) ;
EQUATION (Linear) E_TFD_L   (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)
p_TFD_L(i,j,r) = tfd(i,j,r);
FORMULA & EQUATION E_TFDTRQ (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)
   TFDTRQ(i,j,r) = TFD_L(i,j,r) / TFDINQ(i,j,r) ;
```

The following code is related to the computing aspect of the tax-quota system. See Elbehri and Pearson (2000) for details of implementing TRQ structure in GEMPACK.

```
Coefficient SMALL_VDFM # Do not do TAX_QUOTA unless VDFM is larger than this # ;
FORMULA SMALL_VDFM = 0 ; ! It is ESSENTIAL to prevent TAX-QUOTA if VDFM=0 !

VARIABLE (Linear, Change) (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG) TFD_slack(i,j,r)
  # Exogenous in first multi-step run. Endogenized in the second run. Slack variable for equation E_TFDTRQ # ;

VARIABLE (LINEAR, NO_SPLIT)                                              del_Newton
# Shock this by one to do Newton corrections at each step # ;
```

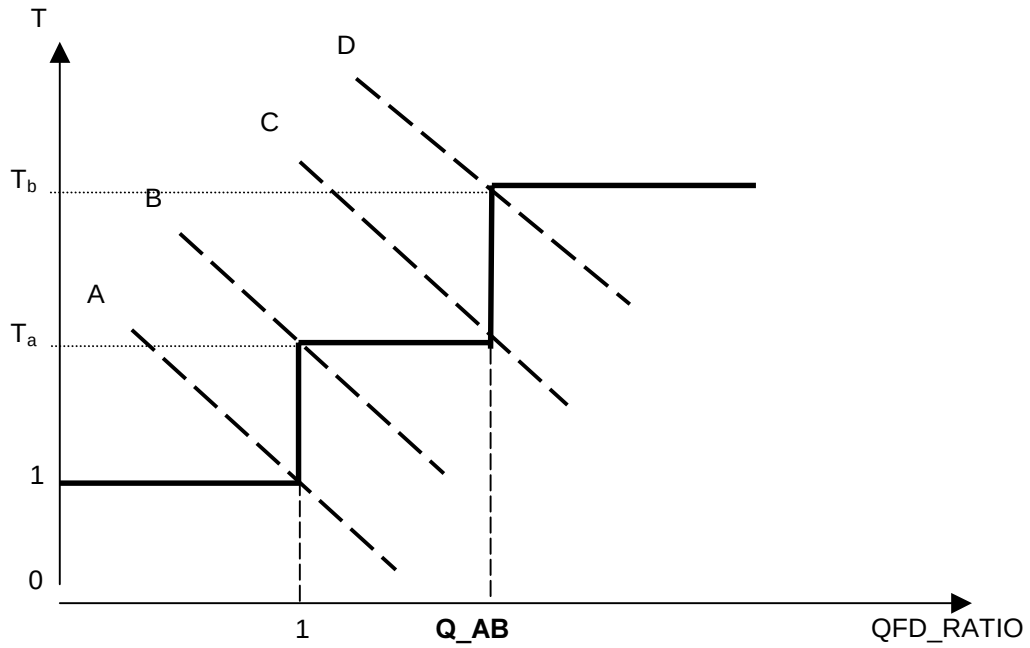
Now the quantities of the quotas and the relevant quantity ratios are computed. Two ratios and two quantities are declared and defined here.

```
VARIABLE (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)          QFD_RATIO(i,j,r)
 # Ratio of total production (A+B+C) over A quota # ;
FORMULA & EQUATION E_QFD_RATIO
(all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)
  QFD_RATIO(i,j,r) = VDFM_L(i,j,r)/VDFM_TRQa(i,j,r)
VARIABLE (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)          Q_AB(i,j,r)
 # Ratio of quota A+B over quota A # ;
FORMULA & EQUATION E_Q_AB (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)
  Q_AB(i,j,r) = VDFM_TRQb(i,j,r)/VDFM_TRQa(i,j,r);
VARIABLE (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)          QMS_TFD(i,j,r)
 # Quantity of the A quota  # ;
```

```
FORMULA & EQUATION E_QMS_TFD (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)
  QMS_TFD(i,j,r) = VDFM_TRQa(i,j,r) / PM_L(i,r) ;
VARIABLE (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)          QMS_TFDb(i,j,r)
 # Quantity of quota A+B # ;
FORMULA & EQUATION E_QMS_TFDb (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)
  QMS_TFDb(i,j,r) = VDFM_TRQb(i,j,r) / PM_L(i,r) ;
```

The following equation "positions" each member country in the tax-quota position, according to the associated double *(TFDTRQ, QFD_RATIO)*. There are five possible positions, each of which is assigned with one of the five possible integer values (from –1 to 3). The following graph illustrates the determination of the "positioning".

FIGURE 1A. **The extra power of tax relative to the production ratio QFD_RATIO**




```
COEFFICIENT (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)     QPOS(i,j,r)
  # initial position according to (TFDTRQ, QFD_RATIO) # ;

# Set "impossible" value -99 initially #
FORMULA (Always) (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)
  QPOS(i,j,r) = -99 ;
# Set value -1 if below (or on) diagonal line A #
FORMULA (Always) (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG: TFDTRQ(i,j,r) +
QFD_RATIO(i,j,r) <= 2)
  QPOS(i,j,r) = -1 ;
# Set value 0 if between diagonal lines A and B #
```

```
FORMULA (Always) (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG: TFDTRQ(i,j,r) +
QFD_RATIO(i,j,r) > 2   AND  TFDTRQ(i,j,r) + QFD_RATIO(i,j,r) < 1+TFDTRQOVQa(i,j,r))
  QPOS(i,j,r) = 0 ;
# Set value +1 if on B or between diagonal lines B and C #
FORMULA (Always) (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG: TFDTRQ(i,j,r) +
QFD_RATIO(i,j,r) >= 1+TFDTRQOVQa(i,j,r) AND TFDTRQ(i,j,r) + QFD_RATIO(i,j,r) <
Q_AB(i,j,r) +TFDTRQOVQa(i,j,r))
  QPOS(i,j,r) = 1 ;
# Set value +2 if on C or between diagonal lines C and D #
FORMULA (Always) (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG: TFDTRQ(i,j,r) +
QFD_RATIO(i,j,r) >=  Q_AB(i,j,r) +TFDTRQOVQa(i,j,r) AND TFDTRQ(i,j,r) +
QFD_RATIO(i,j,r) <   Q_AB(i,j,r) +TFDTRQOVQb(i,j,r))
  QPOS(i,j,r) = 2 ;
# Set value +3 if above (or on) diagonal line D #
FORMULA (Always) (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG: TFDTRQ(i,j,r) +
QFD_RATIO(i,j,r) >=
Q_AB(i,j,r) +TFDTRQOVQb(i,j,r))
  QPOS(i,j,r) = 3
```

The following equation computes the percentage changes to TFDTRQ according to the applicable QPOS value. Please refer to Elbehri and Pearson (2000) for the computational details of implementing TRQ in GEMPACK, especially the Newton correction terms.

```
EQUATION(Linear) E_TFD (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)

  IF (VDFM(i,j,r) GT SMALL_VDFM and QPOS(i,j,r)   = -1,
# Forces TFDTRQ to be equal to 1 #
    TFDTRQ(i,j,r)*p_TFDTRQ(i,j,r) + 100*[TFDTRQ(i,j,r)-1]*del_Newton) +

IF (VDFM(i,j,r) GT SMALL_VDFM and QPOS(i,j,r)      = 0,
# Forces VDFM to equal VDFM_TRQ the value of A quota.  TFDTRQ between 1 and TFDTRQOVQa #
    VDFM(i,j,r)*qfd(i,j,r) - VDFM_TRQa(i,j,r)*p_QMS_TFD(i,j,r)
    + 100*[VDFM(i,j,r)-VDFM_TRQa(i,j,r)]*del_Newton) +

  IF (VDFM(i,j,r) GT SMALL_VDFM and QPOS(i,j,r)     = 1,
# Forces TFDTRQ to be equal to TFDTRQOVQa #
    TFDTRQ(i,j,r)*p_TFDTRQ(i,j,r) - TFDTRQOVQa(i,j,r)*p_TFDTRQOVQa(i,j,r)
    + 100*[TFDTRQ(i,j,r)-TFDTRQOVQa(i,j,r)]*del_Newton) +

  IF (VDFM(i,j,r) GT SMALL_VDFM and QPOS(i,j,r)    = 2,
# Forces VDFM to equal VDFM_TRQb the value of A + B quota. TFDTRQ between TFDTRQOVQa and
  TFDTRQOVQb # VDFM(i,j,r)*qfd(i,j,r) - VDFM_TRQb(i,j,r)*p_QMS_TFDb(i,j,r)
    + 100*[VDFM(i,j,r)-VDFM_TRQb(i,j,r)]*del_Newton) +

   IF (VDFM(i,j,r) GT SMALL_VDFM and QPOS(i,j,r)  = 3,
# Forces TFDTRQ to be equal to TFDTRQOVQb #
```

```
  TFDTRQ(i,j,r)*p_TFDTRQ(i,j,r) - TFDTRQOVQb(i,j,r)*p_TFDTRQOVQb(i,j,r)
  + 100*[TFDTRQ(i,j,r)-TFDTRQOVQb(i,j,r)]*del_Newton)
  +    TFD_slack(i,j,r) = 0 ;
```

The following two equations are needed for accurate sims - introduced in case TFDTRQOVQa or TFDTRQOVQb is shocked. See Elbehri and Pearson for details.

```
VARIABLE (Change)
  (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)                TFDTRQBELOVa(i,j,r)
    # TFDTRQOVQa minus TFDTRQ # ;
FORMULA              &              EQUATION              E_TFDTRQBELOVQa
  (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)
    TFDTRQBELOVa(i,j,r) = TFDTRQOVQa(i,j,r) - TFDTRQ(i,j,r) ;

VARIABLE (Change)
  (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)      TFDTRQBELOVb(i,j,r)
    # TFDTRQOVQb minus TFDTRQ # ;
FORMULA & EQUATION E_TFDTRQBELOVQb
  (all,i,C_B_COMM)(all,j,PSGR_COMM)(all,r,EU_REG)
    TFDTRQBELOVb(i,j,r) = TFDTRQOVQb(i,j,r) - TFDTRQ(i,j,r) ;
```

2 A, B and C sugar production

Next the percentage change in the quantity of A, B and C sugar produced in the EU is calculated. First of all the coefficients for the quantity of sugar produced in each country are defined and the initial values are read in.

```
VARIABLE(all,i,C_B_COMM)(all,r,EU_REG)                qa(i,r);
# percentage change in quantity of A sugar beet produced in country r # ;

COEFFICIENT(all,i,C_B_COMM)(all,r,EU_REG)             QOA(i,r);
# quantity of A sugar beet production; note this is the "level" of qa # ;
READ(all,i,C_B_COMM)(all,r,EU_REG) QOA(i,r)      FROM FILE GTAPDATA HEADER
"QOA" ;
UPDATE (all,i,C_B_COMM)(all,r,EU_REG)    QOA(i,r) = qa(i,r) ;

VARIABLE(all,i,C_B_COMM)(all,r,EU_REG)                qb(i,r);
# percentage change in quantity of B sugar beet produced in country r # ;

COEFFICIENT(all,i,C_B_COMM)(all,r,EU_REG)             QOB(i,r);
# quantity of B sugar beet production; note this is the "level" of qb # ;
READ(all,i,C_B_COMM)(all,r,EU_REG) QOB(i,r)    FROM FILE GTAPDATA HEADER "QOB" ;
UPDATE (all,i,C_B_COMM)(all,r,EU_REG)    QOB(i,r) = qb(i,r) ;
```

```
VARIABLE(all,i,C_B_COMM)(all,r,EU_REG)                    qc(i,r);
# percentage change in quantity of C sugar beet produced in country r # ;

COEFFICIENT(all,i,C_B_COMM)(all,r,EU_REG)                 QOC(i,r);
# quantity of C sugar beet production; note this is the "level" of qc # ;
READ(all,i,C_B_COMM)(all,r,EU_REG) QOC(i,r)   FROM FILE GTAPDATA HEADER "QOC" ;
UPDATE (all,i,C_B_COMM)(all,r,EU_REG)   QOC(i,r) = qc(i,r) ;

COEFFICIENT(all,i,C_B_COMM)(all,r,EU_REG)                 QOT(i,r);
# quantity of A quota measured in the same units as QOA, QOB, QOC # ;
READ(all,i,C_B_COMM)(all,r,EU_REG) QOT(i,r)   FROM FILE GTAPDATA HEADER "QOT" ;
UPDATE (all,i,C_B_COMM)(all,r,EU_REG)   QOT(i,r) = p_QMS_TFD(i,"SGR",r) ;
```

The following equations calculate the percentage change in the quantity of A, B and C production.

```
EQUATION QA_pChange (all,i,C_B_COMM)(all,r,EU_REG)
#percentage change of qa #
IF(QFD_RATIO("c_b","sgr",r) > 1,
  QOT(i,r)*p_QMS_TFD("c_b","sgr",r) - QOA(i,r)*qa(i,r)) +

IF(QFD_RATIO("c_b","sgr",r) = 1,
  QOT(i,r)*p_QMS_TFD("c_b","sgr",r) - QOA(i,r)*qa(i,r)  ) +

IF(QFD_RATIO("c_b","sgr",r) < 1,
  QFD_RATIO("c_b","sgr",r)*QOT(i,r)*p_QMS_TFD("c_b","sgr",r)  +
  QOT(i,r)*QFD_RATIO("c_b","sgr",r)*p_QFD_RATIO("c_b","sgr",r) –
  QOA(i,r)*qa(i,r)  )

 = 0;

EQUATION QB_pChange (all,i,C_B_COMM)(all,r,EU_REG)
#Percentage change in qb
IF(QFD_RATIO("c_b","sgr",r) <= 1,
  QOB(i,r)*qb(i,r)  ) +

IF(QFD_RATIO("c_b","sgr",r) >  1  AND  QFD_RATIO("c_b","sgr",r) <=  Q_AB(i,"sgr",r),
  QFD_RATIO("c_b","sgr",r)*QOT(i,r)*p_QMS_TFD("c_b","sgr",r)  +
  QOT(i,r)*QFD_RATIO("c_b","sgr",r)*p_QFD_RATIO("c_b","sgr",r) –
  QOA(i,r)*qa(i,r)- QOB(i,r)*qb(i,r)  ) +

IF(QFD_RATIO("c_b","sgr",r) > Q_AB(i,"sgr",r),
  QFD_RATIO("c_b","sgr",r)*QOT(i,r)*p_QMS_TFD("c_b","sgr",r)  +
  QOT(i,r)*QFD_RATIO("c_b","sgr",r)*p_QFD_RATIO("c_b","sgr",r)  -
  QOA(i,r)*qa(i,r)- QOB(i,r)*qb(i,r) - QOC(i,r)*qc(i,r) )
= 0;
```

```
EQUATION QC_pChange (all,i,C_B_COMM)(all,r,EU_REG)
# Percentage change in qc #
IF(QFD_RATIO("c_b","sgr",r) <= Q_AB(i,"sgr",r)  ,
  QOC(i,r)*qc(i,r) ) +
IF(QFD_RATIO("c_b","sgr",r) > Q_AB(i,"sgr",r) ,
  QFD_RATIO("c_b","sgr",r)*QOT(i,r)*p_QMS_TFD("c_b","sgr",r)  +
  QOT(i,r)*QFD_RATIO("c_b","sgr",r)*p_QFD_RATIO("c_b","sgr",r) –
 [Q_AB("c_b","sgr",r)*QOT(i,r)*p_QMS_TFD("c_b","sgr",r)  +
  QOT(i,r)*Q_AB("c_b","sgr",r)*p_Q_AB("c_b","sgr",r)]  -
  QOC(i,r)*qc(i,r) )
= 0;
```

3 B sugar exports

First calculate the percentage change in the quantity of B sugar being exported.

```
 VARIABLE(all,i,SGR_COMM)                                        qdEU(i);
# aggregate domestic consumption of sugar in EU # ;

COEFFICIENT(all,i,SGR_COMM)                                      QOD(i);
# quantity of domestic sugar consumption in EU # ;
READ(all,i,SGR_COMM)  QOD(i)         FROM FILE GTAPDATA HEADER "QOD" ;
UPDATE (all,i,SGR_COMM)       QOD(i) = qdEU(i) ;

EQUATION QDDEU (all,i,SGR_COMM)
# aggregate consumption of sugar in EU # ;
   [SUM(r,EU_REG,  VDM(i,r) + sum(s,reg,VIMS(i,s,r)))]*qdEU(i) =
                              SUM(r,EU_REG,VDM(i,r)*qds(i,r) + sum(s,reg,VIMS(i,s,r)*qxs(i,s,r)));

 VARIABLE (all,i,sgr_COMM)                                       qxbb(i);
# aggregated B sugar export from EU # ;

COEFFICIENT(all,i,SGR_COMM)                                      QOXB(i);
# aggregate quantity of EU B sugar export; level # ;
READ(all,i,SGR_COMM) QOXB(i)   FROM FILE GTAPDATA HEADER "QOXB" ;
UPDATE (all,i,SGR_COMM)    QOXB(i) = qxbb(i) ;

EQUATION QXBBR (all,i,SGR_COMM)
# percentage change in aggregate quantity of EU B sugar export # ;
   QOXB(i)*qxbb(i)  = sum(r,EU_REG,QOA("c_b",r)*qa("c_b",r) + QOB("c_b",r)*qb("c_b",r)) -
QOD(i)*qdEU(i) ;
```

Hereafter follows the change in the in the value of B export subsidy payments

```
VARIABLE (all,i,TRAD_COMM)                                       pmEU(i)
# percentage change in aggregate EU market price # ;
EQUATION PRICEEU (all,i,TRAD_COMM)
  (sum(r,EU_REG, VOM(i,r)))*pmEU(i) = sum(r,EU_REG,VOM(i,r)*pm(i,r)) ;
```

```
VARIABLE(all,i,SGR_COMM)                                    pxwsgr(i);
# average world price of sugar #
EQUATION PXWSGRR (all,i,SGR_COMM)
  SUM(r,NEU_REG,SUM(s,REG, VXWD(i,r,s)))*pxwsgr(i)  =
                                  SUM(r,NEU_REG,SUM(s,REG, VXWD(i,r,s)*pfob(i,r,s)));

COEFFICIENT(all,i,C_B_COMM)                                 VSXi(i);
# value of aggregate EU B sugar export at EU market price #  ;
READ(all,i,C_B_COMM)     VSXi(i)         FROM FILE GTAPDATA HEADER "VSXi" ;
UPDATE (all,i,C_B_COMM)          VSXi(i) = pmeu("sgr")*qxbb("sgr") ;


COEFFICIENT(all,i,C_B_COMM)                                 VSXw(i);
# value of aggregate EU B sugar export at world market price #  ;
READ(all,i,C_B_COMM)      VSXw(i)         FROM FILE GTAPDATA HEADER "VSXw" ;
UPDATE (all,i,C_B_COMM)     VSXw(i) = pxwsgr("sgr")*qxbb("sgr") ;

VARIABLE(CHANGE)(all,i,C_B_COMM)                            del_EXPSUB(i);
# Change in export subsidy to support EU B sugar export # ;
EQUATION DELXSUB   (all,i,C_B_COMM)
  100*del_EXPSUB(i)    =  VSXi(i)*[qxBb("sgr")+ pmeu("sgr")]   -
                          VSXw(i)*[qxBb("sgr")+ pxwsgr("sgr")]  ;
```

4 Financing of B sugar export (tax on A and B sugar)

Calculate changes to the price of A and B quota sugar relative the base price

```
VARIABLE(all,i,C_B_COMM)(all,r,EU_REG)                      pa(i,r);
 # price of A sugar beet in EU countries # ;

VARIABLE(all,i,C_B_COMM)(all,r,EU_REG)                      pb(i,r);
 # price of B sugar beet in EU countries # ;

VARIABLE(all,i,C_B_COMM)(all,r,EU_REG)                      pbase(i,r);
# base price for sugar beet in EU countries # ;

EQUATION pbaseflex (all,i,C_B_COMM)(all,j,sgr_comm)(all,r,EU_REG)
# percentage change in the base price for sugar beets is equal to the percentage change in pfd, the
   demand price of sugar beets for sugar refineries in the EU countries declared in the standard model #
   pbase(i,r) =  pfd(i,j,r);

VARIABLE (all,i,c_b_COMM)                                   paEU(i);
# average price of A sugar beet in EU # ;

COEFFICIENT(all,i,C_B_COMM)(all,r,EU_REG)                   VSAbase(i,r);
# A sugar beet production valued at base price # ;
```

```
READ(all,i,C_B_COMM)(all,r,EU_REG) VSAbase(i,r)  FROM FILE GTAPDATA HEADER
"VSAi" ;
UPDATE (all,i,C_B_COMM)(all,r,EU_REG)    VSAbase(i,r) = pbase(i,r)*qa(i,r) ;


COEFFICIENT(all,i,C_B_COMM)(all,r,EU_REG)                    VSBbase(i,r);
# B sugar beet production valued at base price # ;
READ(all,i,C_B_COMM)(all,r,EU_REG) VSBbase(i,r)  FROM FILE GTAPDATA HEADER
"VSBi" ;
UPDATE (all,i,C_B_COMM)(all,r,EU_REG)     VSBbase(i,r) = pbase(i,r)*qb(i,r) ;

COEFFICIENT(all,i,C_B_COMM)(all,r,EU_REG)                    VSAp(i,r);
# A sugar beet production valued at price Pa # ;
READ(all,i,C_B_COMM)(all,r,EU_REG) VSAp(i,r)     FROM FILE GTAPDATA HEADER
"VSAp" ;
UPDATE (all,i,C_B_COMM)(all,r,EU_REG)     VSAp(i,r) = pa(i,r)*qa(i,r) ;

COEFFICIENT(all,i,C_B_COMM)(all,r,EU_REG)                    VSBp(i,r);
# B sugar beet production valued at price Pb # ;
READ(all,i,C_B_COMM)(all,r,EU_REG) VSBp(i,r)      FROM FILE GTAPDATA HEADER
"VSBp" ;
UPDATE (all,i,C_B_COMM)(all,r,EU_REG)     VSBp(i,r) = pb(i,r)*qb(i,r) ;


 COEFFICIENT (all,i,C_B_COMM)(all,r,EU_REG)                    VSA(i,r);
# value of A sugar beet production in EU countries # ;
READ(all,i,C_B_COMM)(all,r,EU_REG) VSA(i,r)       FROM FILE GTAPDATA HEADER "VSA"
;
UPDATE (all,i,C_B_COMM)(all,r,EU_REG)     VSA(i,r) = paEU(i)*qa(i,r) ;


EQUATION LLTAX  (all,i,C_B_COMM)
# calculate average percentage change in paEU relative to the change in del_EXPSUB . The database is calibrated so
that there is a homogeneous tax on A sugar production  (1-VSA(i,r)/VSBbase(i,r) = 0.02) # ;
  100*del_EXPSUB(i) = SUM[ r, EU_REG,VSAbase(i,r)*[ qa(i,r)+ pbase(i,r)] - VSA(i,r)  *[ qa(i,r)+
paEU(i) ] +
                                                VSBbase(i,r)*[ qb(i,r)+ pbase(i,r)] - VSBp(i,r)*[ qb(i,r)+
pb(i,r) ]];


VARIABLE(CHANGE)(all,i,C_B_COMM)                                 del_TAX_A(i);
# calculate the change in the power of the tax on A quota sugar due to changes in the value of B sugar export subsidies
   using paEU  #
EQUATION delTAXA  (all,i,C_B_COMM)
      sum(r,EU_REG,VSAbase(i,r))*100*del_TAX_A(i) =
      sum(r,EU_REG,  VSA(i,r)*[qa(i,r)+ paEU(i)] - VSAp(i,r)*[qa(i,r)+ pbase(i,r)]  );
```

```
COEFFICIENT (PARAMETER)(all,i,C_B_COMM) (all,r,EU_REG)        BRATE(i,r)
 # initial rate of tax levied on B sugar # ;
FORMULA (INITIAL) (all,i,C_B_COMM) (all,r,EU_REG)  BRATE(i,r) = 1- VSBp(i,r)/VSBbase(i,r) ;

VARIABLE(CHANGE)(all,i,C_B_COMM)(all,r,EU_REG)                    del_TAX_B(i,r);
# changes in rate of tax levied on B sugar beet production; linked to the endogenously determined A sugar tax rate by en-
forcing the initial ratio of B tax rate over A tax rate # ;
EQUATION delTBB (all,i,C_B_COMM)(all,r,EU_REG)
  del_TAX_B(i,r) =    BRATE(i,r)/0.02* del_TAX_A(i);

EQUATION delTB (all,i,C_B_COMM)(all,r,EU_REG)
# compute pb using del_TAX_B # ;
  VSBbase(i,r)*100*del_TAX_B(i,r)  =  VSBp(i,r)*[qb(i,r)+ pb(i,r)] - VSBp(i,r)*[qb(i,r)+ pbase(i,r)];

EQUATION delTA
# compute pa using del_TAX_A # ;
(all,i,C_B_COMM)(all,r,EU_REG)
   VSAbase(i,r)*100*del_TAX_A(i)  =   VSAP(i,r)*[qa(i,r)+ pa(i,r)]  -  VSAP(i,r)*[qa(i,r)+ pbase(i,r)] ;

VARIABLE(CHANGE)(all,i,sgr_COMM)(all,r,EU_REG)                del_EXPEU(i,r);
# EU members' contribution to support EU B sugar export. EXPSUB(i) = sum(r, EU_REG, EXPEU(i,r)) # ;

EQUATION Del_TAX (all,i,C_B_COMM)(all,r,EU_REG)
  100*del_EXPEU("sgr",r) = VSAbase(i,r)*[qa(i,r)+ pbase(i,r)]  - VSAp(i,r) *[ qa(i,r)+ pa(i,r)]        +
                           VSBbase(i,r)*[ qb(i,r)+ pbase(i,r)] - VSBp(i,r)*[qb(i,r)+ pb(i,r)] ;
```

The following three equations decide, respectively, percentage changes in the three tax wedges (τ_a, τ_b and τ_w).

```
EQUATION TFDINQQ (all,i,C_B_COMM)(all,r,EU_REG)
  p_TFDINQ(i,"sgr"r) = pbase(i,r) - pa(i,r);

EQUATION TFDTRQOVQQ (all,i,C_B_COMM)(all,r,EU_REG)
  p_TFDOVQ(i,"sgr"r) = pbase(i,r) - pb(i,r);

EQUATION TFDWLD_E  (all,i,C_B_COMM)(all,r,EU_REG)
  p_TFDWLD(i,"sgr"r) = pbase(i,r) - pxwsgr("sgr");
```

5 Quota rent and its allocation

```
COEFFICIENT(all,i,C_B_COMM)(all,r,EU_REG)                    VSAc(i,r);
# A sugar beet production valued at pm the marginal cost of production # ;
READ(all,i,C_B_COMM)(all,r,EU_REG) VSAc(i,r)       FROM FILE GTAPDATA HEADER
"VSAc" ;
UPDATE (all,i,C_ B_COMM)(all,r,EU_REG)     VSAc(i,r) = pm(i,r)*qa(i,r) ;
```

```
COEFFICIENT(all,i,C_B_COMM)(all,r,EU_REG)                    VSBc(i,r);
# B sugar beet production valued at pm the marginal cost of production # ;
READ(all,i,C_B_COMM)(all,r,EU_REG) VSBc(i,r)       FROM FILE GTAPDATA HEADER
"VSBc" ;
UPDATE (all,i,C_B_COMM)(all,r,EU_REG)     VSBc(i,r) = pm(i,r)*qb(i,r) ;

COEFFICIENT(all,i,C_B_COMM)(all,r,EU_REG)                    VSCc(i,r);
# C sugar beet production valued at pm the marginal cost of production # ;
READ(all,i,C_B_COMM)(all,r,EU_REG) VSCc(i,r)       FROM FILE GTAPDATA HEADER
"VSCc" ;
UPDATE (all,i,C_B_COMM)(all,r,EU_REG)     VSCc(i,r) = pm(i,r)*qc(i,r) ;

COEFFICIENT(all,i,C_B_COMM)(all,r,EU_REG)                    VSCp(i,r);
# C sugar beet production valued at pm the marginal cost of production  # ;
READ(all,i,C_B_COMM)(all,r,EU_REG) VSCp(i,r)      FROM FILE GTAPDATA HEADER
"VSCp" ;
UPDATE (all,i,C_B_COMM)(all,r,EU_REG)     VSCp(i,r) = pm(i,r)*qc(i,r) ;


VARIABLE(CHANGE)(all,i,C_B_COMM)(all,r,EU_REG)                del_QUOTA(i,r);
# value of quota rents # ;

EQUATION delQUOTA (all,i,C_B_COMM)(all,r,EU_REG)
  100*del_QUOTA(i,r) = VSAp(i,r)*[qa(i,r)+pa(i,r)]   - VSAc(i,r)*[qa(i,r)+pm(i,r)] +
                       VSBp(i,r)*[qb(i,r)+pb(i,r)]   - VSBc(i,r)*[qb(i,r)+pm(i,r)] +
                       VSCp(i,r)*[qc(i,r)+pm(i,r)]   - VSCc(i,r)*[qc(i,r)+pm(i,r)];

EQUATION CBQUOTAA (all,j,C_B_COMM) (all,r,EU_REG)
# quota rents allocated as land based subsidies for land used in sugar beet production # ;
  100*del_QUOTA(j,r) = sum(i,hp_land, VFM(i,j,r)*[qfe(i,j,r)+pmes(i,j,r)] -
VFAq(i,j,r)*[qfe(i,j,r)+pfeq(i,j,r)]);
```

Working Papers

Statens Jordbrugs- og Fiskeriøkonomiske Institut

13/01 August 2001	Søren E. Frandsen, Hans G. Jensen, Wusheng Yu and Aage Walter-Jørgensen	Modelling the EU Sugar Policy A study of policy reform scenarios
12/01 August 2001	Poul P. Melgaard	En afviklingsstrategi for den direkte støtte i EU's fælles landbrugspolitik - muligheder og begrænsninger
11/01 Juli 2001	Steffen Møllenberg	EU´s regnskabsstatistik for jordbrug
10/01 Maj 2001	Jørgen Dejgård Jensen, Connie Nielsen og Martin Andersen	ESMERALDA som formodel til makromodellen ADAM Dokumentation og anvendelser
9/01 Maj 2001	Jens Hansen	Overskuds- og indkomstbegreber i regnskabsstatistikken for landbrug
8/01 May 2001	Chantal Pohl Nielsen	Social Accounting Matrices for Vietnam: 1996 and 1997
7/01 May 2001	Aage Walter-Jørgensen and Trine Vig Jensen	EU Trade Developing Countries
6/01 April 2001	Søren Marcus Pedersen og Morten Gylling	Lupinproduktion til fermenteringsindustrien – vurdering af teknologi og økonomi
5/01 April 2001	Mona Kristoffersen, Ole Olsen og Søren S. Thomsen	Driftsgrensøkonomi for økologisk jordbrug 1999
4/01 February 2001	Søren Marcus Pedersen and Morten Gylling	The Economics of producing quality oils, proteins and bioactive products for food and non-food purposes based on biorefining

3/01	Januar 2001	Lars Otto	Metoder til datakonstruktion i Bayesianske netværk – udvikling af beslutningsstøttesystem til sundhedsstyring i svinebesætninger
2/01	January 2001	Søren Marcus Pedersen, Richard B. Ferguson and R. Murray Lark	A Comparison of Producer Adoption of Precision Agricultural Practices in Denmark, the United Kingdom and the United State
1/01	January 2001	Chantal Pohl Nielsen, Karen Thierfelder and Sherman Robinson	Consumer Attitudes Towards Genetically Modified Foods The modelling of preference changes
17/00	December 2000	Hild Rygnestad, Jørgen D. Jensen og Tommy Dalgaard	Målrettede eller generelle politiske virkemidler? Økonomiske analyser i geografisk perspektiv
16/00	December 2000	Stine Hjarnø Jørgensen og Jørgen Dejgaard Jensen	Estimation af priselasticiteter for gødnings- og pesticidkomponenter
15/00	December 2000	Søren E. Frandsen and H.G. Jensen	Economic Impacts of the Enlargement of the European Union. Analysing the importance of direct payments
14/00	December 2000	Jesper Levring Andersen	Beregningsgrundlag for indtjeningen i det danske fiskeri: Arbejdspapir til ”konjunkturrapport” for dansk fiskeri 2000
13/00	December 2000	Jens Hansen	Landbrugets nettokapitalomkostninger fastsat under hensyntagen til inflation og beskatning
12/00	December 2000	Niels Tvedegaard	Omlægning til økologisk slagtekyllingeproduktion – en analyse af de økonomiske konsekvenser på udvalgte bedrifter
11/00	November 2000	Kim Martin Lind	Consumer Demand in a Developing Country with Special Regard to Food – The Case of India

10/00	November 2000	Erik Lindebo	Capacity Development of the EU and Danish Fishing Fleets
9/00	October 2000	Max Nielsen	Calculations of Danish prices of unprocessed seafood
8/00	August 2000	Paul Rye Kledal	Økologisk jordbrug for fremtiden? – en økonomisk analyse af de potentielle økologiske jordbrugere
7/00	Juli 2000	Steffen Møllenberg	Gartnerierhvervets produktivitetsudvikling – samt udviklingen i mængder og priser, herunder bytteforhold, mellem 1980 og 1998/99
6/00	July 2000	Henning Porskrog	Calculation SGM. How we do it in Denmark
5/00	Juli 2000	Arne Lauridsen, Ole Olsen og Svend Sørensen	Driftsgrensøkonomi for økologisk jordbrug 1998/99
4/00	June 2000	Hild Rygnestad	Integrating environmental economics and policy analyses in a geographical information system
3/00	May 2000	Chantal Pohl Nielsen and Kym Anderson	GMOs, Trade Policy, and Welfare in Rich and Poor Countries
2/00	Februar 2000	Niels Tvedegaard	Omlægning til økologisk planteavl – analyse af de økonomiske konsekvenser på udvalgte planteavlsbedrifter
1/00	February 2000	Tove Christensen & Hild Rygnestad	Environmental Cross Compliance: Topics for future research