Endogenous adjusted Output Quotas – The Abolishment of the Raw Milk Quota in the European Union

Markus Lips
e-mail: markus.lips@iaw.agrl.ethz.ch

Peter Rieder

Paper prepared for presentation at the Xth EAAE Congress
'Exploring Diversity in the European Agri-Food System',
Zaragoza (Spain), 28-31 August 2002

Endogenous adjusted Output Quotas – The Abolishment of the Raw Milk Quota in the European Union

Markus Lips[1] and Peter Rieder

Suggested paper for the Xth EAAE Congress in Zaragoza Spain, August 28-31 2002

[1] corresponding author:
Department of Agricultural Economics
Swiss Federal Institute of Technology
SOL E4
ETH-Zentrum
8092 Zurich
Switzerland
markus.lips@iaw.agrl.ethz.ch

Endogenous adjusted Output Quotas – The Abolishment of the Raw Milk Quota in the European Union

Abstract

This paper discusses an approach to implement output quotas in the GTAP model which permits an endogenous adjustment of both the supplied quantity and the quota rent. Since the quota rent is interpreted as additional earnings of the factors used no change of the worldwide GTAP data base is required. Several modifications of the GTAP model and two exogenous coefficients are necessary. Considering uncertain values of one of the coefficients, systematic sensitivity analysis is applied.

The abolishment of the raw milk quota in the European Union would lead to a remarkable decrease in raw milk prices in most member countries. The raw milk production increases in Denmark, Ireland, Luxembourg and the Netherlands while it declines in Greece and Portugal. In the other member countries the raw milk production changes slightly.

Key words: general equilibrium model, GTAP, output quota, raw milk production, sensitivity analysis

---

We would like to thank Ken Pearson for assistance with new Gempack software as well as Martina Brockmeier and Jürg Friedli for helpful comments.

1 Introduction

In the European Union (EU) the raw milk production is limited by an output quota. During the negotiations of the Agenda 2000 four member countries wanted to terminate the quota system (Kleinhanss, Manegold et al. p. 1). Although it was decided to continue the quota system until 2008, it will come up in 2003 for a review on the basis of a report from the Commission with a view to discontinuing (European Commission, p. 4).

It is advisable to analyze the impact of an abolishment of the raw milk quota for all member countries of the EU. One possibility of doing this is the application of the multi-regional general equilibrium model of the **G**lobal **T**rade **A**nalysis **P**roject (GTAP, Hertel and Tsigas). The corresponding worldwide GTAP data base (version 5, Dimaranan and McDougall) includes all member countries of the EU.

A currently used approach to depict output quotas in the GTAP model is to fix the supplied quantity exogenously. The corresponding quota rent can adjust endogenously (Nielsen, p. 2; Bach, Frandsen et al., p. 167; van Meijl and van Tongeren, p. 13). This approach can not be applied for analyzing the impact of abolishment of the raw milk quota, since the change of the output quantity is an important result we are looking for.

Based on the GTAP Technical Paper number 4 (Bach and Pearson) we suggest an approach which enables the endogenous adjustment of both the produced quantity and the quota rent. This approach was successfully used in analyzing the impact of the upcoming negotiation round of the world trade organization on Switzerland (Lips). The approach requires no change of the GTAP data base since the quota rent is understood as an additional factor payment, which is still in the GTAP data base.

The remaining sections of this paper are organized as follows: Section two includes the basic idea of the modeling of output quotas in the GTAP model. In the third section the necessary adjustments to the GTAP model are presented. The aggregation used of the GTAP data base and the necessary coefficients are discussed in the fourth section. All results are in section five, while section six contains the conclusions.

2 Basic idea for modeling output quotas

Figure 1 shows a market with an output quota. Without quota the market equilibrium of sector j in region r would be at the quantity $QM_{j,r}$. Due to the quota quantity $(QUOTA_{j,r})$ the supply function is $S'_{j,r}$ instead of $S_{j,r}$. Accordingly, the supplied quantity $QO_{j,r}$ is equal to $QUOTA_{j,r}$ and the producer resp. farm gate price is $PS_{j,r}$. Since the production costs are only equal to the price $PQ_{j,r}$, a quota rent ($RENT_{j,r}$) exists which belongs to the producers. Consequently, the price $PS_{j,r}$ includes the quota rent. In the GTAP data base the output value at the farm gate price of sector j in region r is denoted as $VOA_{j,r}$, which is the product of price $PS_{j,r}$ and quantity $QO_{j,r}$. We assume that the quota rent is included in $VOA_{j,r}$. There are two reasons for this. Firstly the producers get the quota rent in the form of a higher producer price and not as a transfer payment. Secondly in version 5 of the GTAP data base the quota rent is not included in the sectors output tax.

In the GTAP model $VOA_{j,r}$ is interpreted as the sum of all input costs of sector j in region r. Keeping in mind that $VOA_{j,r}$ also includes the quota rent we assume that factor payments in sectors with output quotas consist of a minimal necessary factor payment and an additional factor payment. The sum of the additional payments of all factors is equivalent to the quota rent. This means that no change of the global GTAP data base is required for analyzing output quotas since the quota rent is still included in the factor costs of the data base. Thus the necessary effort for analyzing output quotas is substantially minimized. Otherwise several changes of the GTAP model are needed, which are described in section three.

Figure 1: Output quota

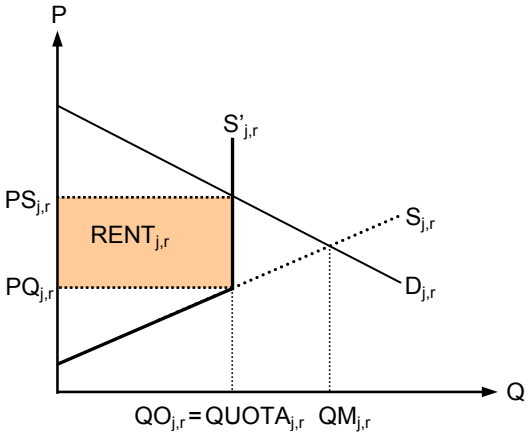

Figure 1 shows that the producers are willing to supply the quota quantity at the price $PQ_{j,r}$ and consequently to renounce the quota rent. Therefore we assume that the producing sector would use the same quantities of factor inputs regardless of whether it receives a quota rent or

not. Consequently, no adjustment of factor markets is required because the quota rent does not generate any change in behavior with regard to factor use.

3 Necessary modification of the GTAP model

Three changes of the GTAP model are needed. Firstly, the output quota is depicted with two coefficients and a maximum condition. Secondly, we have to relocate the zero profit condition. Finally, a modification of the regional income is necessary. All these model adjustments ensure that we attain a general equilibrium.

3.1 Modeling of the quota

Following Bach and Pearson, who introduced import quotas in the GTAP model, we introduce two coefficients, which describe the status of a quota of sector j in region r. $QQ_{j,r}$ shows the relation between the supplied quantity $QO_{j,r}$ and the quota quantity $QUOTA_{j,r}$, while $TQ_{j,r}$ is the relation of the two prices $PQ_{j,r}$ and $PS_{j,r}$:

$$QQ_{j,r} = \frac{QO_{j,r}}{QUOTA_{j,r}}$$

$$TQ_{j,r} = \frac{PQ_{j,r}}{PS_{j,r}} \qquad \text{equation 1}$$

Both coefficients must be given exogenously for the initial equilibrium[1]. The GTAP model is a linearized model[2]. Therefore the linearized form of both coefficients must be added to the model[3].

If a quota is binding, then $QQ_{j,r} = 1$ and $TQ_{j,r} \leq 1$. If it is not binding, then $QQ_{j,r} < 1$ and $TQ_{j,r} = 1$. This leads to a condition which must be fulfilled in every case (Bach and Pearson, p. 16):

$$max\left(QQ_{j,r}, TQ_{j,r}\right) = 1$$

[1] As usual in general equilibrium modeling, the initial equilibrium is represented by the data base. The initial equilibrium is the starting point of a general equilibrium analysis. The model calculates then a new general equilibrium.

[2] All values of the initial equilibrium are interpreted as coefficients. The percentage changes of the coefficients are the variables of the model. Accordingly the model consists of linearized equations resp. equations with only percentage change variables.

[3] The linearized changes resp. the percentage changes are denoted by small letters. For instance $qo_{j,r}$ is the percentage change of $QO_{j,r}$. The linearization (total differentiation) of the coefficients yields:

The implementation of this condition in the GTAP model permits an endogenous change from a binding to a non-binding status and vice versa. A new version of the Gempack software (Harrison and Pearson) enables the implementation of this condition by using the order COMPLEMENTARITY.

We use the coefficient $TQ_{j,r}$ for calculating the quota rent ($RENT_{j,r}$), which is needed afterwards:

$$RENT_{j,r} = VOA_{j,r}\left(1 - TQ_{j,r}\right) \qquad \text{equation 2}$$

3.2 New zero profit condition

In the GTAP model the zero profit condition holds at the value $VOA_{j,r}$ resp. the price $PS_{j,r}$. At this level the minimal necessary factor payments as well as the additional factor payments resp. the quota rent are included. Consequently, the zero profit condition has to be changed to the output value without quota rent resp. the price $PQ_{j,r}$.

Since the GTAP model is linearized, the zero profit condition is modeled as change of the output price $PS_{j,r}$. Therefore the changes of all input prices are weighted with their cost shares and added. Relocating the zero profit condition to $PQ_{j,r}$, the cost shares of all inputs must be altered. Since the additional factor payments are no longer considered, cost shares of factors decline while cost shares of intermediate inputs rise. The coefficient $VFA_{i,j,r}$ represents the cost of input i of sector j in region r. $VFA_{i,j,r}$ is used for factors as well as for intermediate inputs. We can distinguish them by the set they belong to. While factors are elements of set ENDW (endowments), intermediate inputs belong to the set TRAD (tradable goods). We introduce the coefficient $CQ_{j,r}$ representing the ratio between the minimal necessary factor payment and the factor costs in the data base:

$$CQ_{j,r} = \frac{\sum_{i \varepsilon ENDW} VFA_{i,j,r} - RENT_{j,r}}{\sum_{i \varepsilon ENDW} VFA_{i,j,r}} \qquad \text{equation 3}$$

$CQ_{j,r}$ refers to all factors used in sector j in region r and enables the modification of the cost shares for all inputs. In the GTAP model the coefficient $STC_{i,j,r}$ denotes the cost share of input i into sector j of region r. Calculating cost shares we have to distinguish between intermediate inputs and factors. The cost share of intermediate input i into sector j in region r is:

$qq_{j,r} = qo_{j,r}$ - $quota_{j,r}$ $\qquad$ $tq_{j,r} = pq_{j,r}$ - $ps_{j,r}$

$$STC_{i,j,r} = \frac{VFA_{i,j,r}}{\sum_{i \varepsilon TRAD} VFA_{i,j,r} + \sum_{i \varepsilon ENDW} CQ_{j,r} * VFA_{i,j,r}}$$

For factors the cost share is calculated in a slightly different way:

$$STC_{i,j,r} = \frac{CQ_{j,r} * VFA_{i,j,r}}{\sum_{i \varepsilon TRAD} VFA_{i,j,r} + \sum_{i \varepsilon ENDW} CQ_{j,r} * VFA_{i,j,r}}$$

3.3 Modification of the regional income

A modification of the regional income is needed to replace the additional factor payments by the quota rent. In contrast to the additional factor payments the quota rent depends on the coefficient $TQ_{j,r}$. This has to be considered by the change of the regional income.
The quota rent of sector j in region r is the sum of the additional payments of all factors used. Therefore we rearrange equation 3:

$$RENT_{j,r} = \left(1 - CQ_{j,r}\right) \sum_{i \varepsilon ENDW} VFA_{i,j,r}$$

We add up this equation for all sectors of region r resp. all elements of the set TRAD and alter the equation:

$$\sum_{j \varepsilon TRAD} RENT_{j,r} - \sum_{j \varepsilon TRAD} \left(1 - CQ_{j,r}\right) \sum_{i \varepsilon ENDW} VFA_{i,j,r} = 0 \qquad \text{equation 4}$$

The following equation is a simplified depiction of the regional income (Y_r) in the GTAP model:

$$Y_r = R_r + \sum_{j \varepsilon TRAD} \sum_{i \varepsilon ENDW} VFA_{i,j,r} \qquad \text{equation 5}$$

The regional income consists of the payments of all factors i in all sectors j of region r. All others components of regional income like taxes or tariffs are included in R_r. Now we add equation 4 to the right hand side of equation 5 and rearrange it:

$$Y_r = R_r + \sum_{j \varepsilon TRAD} RENT_{j,r} + \sum_{j \varepsilon TRAD} CQ_{j,r} \sum_{i \varepsilon ENDW} VFA_{i,j,r} \qquad \text{equation 6}$$

Since GTAP is a linearized model, equation 6 must be linearized resp. total differentiated. Percentage changes are denoted by small letters. The percentage change of the regional income (y_r) is:

$$y_r = r_r \frac{R_r}{Y_r} + \sum_{j \varepsilon TRAD} rent_{j,r} \frac{RENT_{j,r}}{Y_r} + \sum_{j \varepsilon TRAD} CQ_{j,r} \sum_{i \varepsilon ENDW} \left[pfe_{i,j,r} + qfe_{i,j,r} \right] \frac{VFA_{i,j,r}}{Y_r}$$

The values of factor payments ($VFA_{i,j,r}$) are the products of factor prices ($PFE_{i,j,r}$) and factor quantities ($QFE_{i,j,r}$). The model does not know the percentage change of the quota rent ($rent_{j,r}$). Therefore it has to be derived. Using equation 1 the quota rent ($RENT_{j,r}$) can be formulated with quantities and prices:

$$RENT_{j,r} = QO_{j,r} \left(PS_{j,r} - PQ_{j,r} \right)$$

The linearized form is:

$$rent_{j,r} = qo_{j,r} + \frac{ps_{j,r} * PS_{j,r}}{PS_{j,r} - PQ_{j,r}} - \frac{pq_{j,r} * PQ_{j,r}}{PS_{j,r} - PQ_{j,r}}$$

The usage of coefficient $TQ_{j,r}$ (equation 1) facilitates it:

$$rent_{j,r} = qo_{j,r} + ps_{j,r} \left[\frac{1}{1 - TQ_{j,r}} \right] - pq_{j,r} \left[\frac{TQ_{j,r}}{1 - TQ_{j,r}} \right]$$

If the quota is not binding, $TQ_{j,r}$ is equal to 1. A case differentiation is needed to prevent the denominator being equal to zero.

Since the equation of regional income is changed this also implies the modification of the welfare decomposition provided by Huff and Hertel. It results an additional welfare effect. Yet since the welfare decomposition does not affect the model solution we will neglect this derivation.

4 Aggregation and necessary coefficients

We use the recent version (5) of the GTAP data base, which refers to the year 1997 (Dimaranan and McDougall). For our analysis we aggregate the 66 countries resp. regions and 57 sectors of the GTAP data base to 17 countries resp. regions and seven sectors. Beside the fifteen member countries of the EU the aggregation comprises Switzerland, which also restricts its raw milk production with an output quota, and the rest of the world. The seven sectors are crops (cereals, vegetables, fruit, oil seeds and sugar beet), meat (production of animals for slaughtering), raw milk production, dairy processing, other food processing, industry/ manufacturing and services.

The coefficients TQ and QQ are needed for the raw milk production of each country or region. Table 1 contains them all. Corresponding to the GTAP data base they should refer to the year 1997.

Table 1: Values of TQ and QQ of raw milk production and important share coefficients for the dairy production

	TQ	QQ	cost share of raw milk in dairy production (in %)	share of exported output of dairy production (in %)
Austria	0.83	1	31	14
Belgium	0.80	1	34	65
Denmark	0.80	1	48	49
Finland	0.80	1	54	8
France	0.80	1	32	20
Germany	0.80	1	26	19
Greece	1	0.93	71	6
Ireland	0.80	1	49	47
Italy	0.80	1	45	7
Luxembourg	0.80	1	58	55
Netherlands	0.80	1	51	54
Portugal	1	0.90	29	10
Spain	0.80	1	53	7
Sweden	0.80	1	50	9
United Kingdom	0.70	1	38	8
Switzerland	0.74	1	51	19
Rest of the world	1	0.10	33	5

Source: Colman; GTAP data base version 5 (Dimaranan and McDougall) and own calculations

In all member countries of the EU as well as in Switzerland the quota regime in raw milk production was applied. Two member countries, Greece and Portugal did not reach their quota quantity. Consequently, there was no quota rent (TQ = 1) and the values of QQs were below 1 (Zentrale Markt- und Preisberichtstelle, p. 69). In all other EU countries and in Switzerland the quota quantity was attained (QQ = 1). The coefficient TQ for raw milk production must be estimated for all countries. For Switzerland we use a study which investigated the behavior of ten representative Swiss farm types with regard to their willingness to produce raw milk under different political conditions (Lehmann, Eggenschwiler et al.). From this investigation which was done by using a linear programming model we derive the TQ value for Switzerland. Colman estimated for the United Kingdom the quota price assuming that farms can expand their production up to 20% (Colman, p. 4). Together with the raw milk price the value for TQ can be calculated. For Austria and Germany we get some estimations from experts for the national milk markets[1]. Kleinhanss,

[1] We would like to thank Petra Salamon and Dirk Manegold from the Federal Agricultural Research Centre in Braunschweig (Germany) as well as Karl Ortner from the Federal Institute of Agricultural Economics in Vienna (Austria).

Manegold et al. estimated the raw milk quota rent in the EU to be 7.9 milliard Euro (Kleinhanss, Manegold et al., p. 36). Subtracting the quota rents of Austria, Germany and the United Kingdom from this value it yields the quota rent of all other EU countries except Greece and Portugal. We divide it by the produced quantity and get a TQ value of 0.8 which is used for all remaining EU countries. In the region rest of the world there is no quota regime applied. Therefore TQ is equal to 1. For the coefficient QQ a small value is used.

Since the values of TQ are estimated, it is advisable to use a random value with associated distribution instead of a single value. The systematic sensitivity analysis based on Gaussian quadrature offers exactly that (Arndt, Arndt and Pearson). For all EU countries except Greece and Portugal, we assume that TQ is distributed within an interval of +/- 10% of the value in table 1. We further assume that the TQs of the single countries vary independently. Using the systematic sensitivity analysis the model solution for every variable is a mean (μ) and a standard deviation (σ). Both of them are reported as percentage changes.

Table 1 also contains the cost shares of raw milk in the dairy production as well as the shares of exported output of dairy production. Both of them are derived from version 5 of the GTAP data base (Dimaranan and McDougall).

In our analysis we abolish the raw milk quota for each country of the EU. Technically speaking we largely expand the quota quantity.

5 Results

Table 2 and 3 contain the changes of prices and quantities respectively. Both of them are indicated as percentage changes referring to the initial equilibrium resp. the data base of 1997. Assuming a normal distribution of results, the means (μ) and standard deviations (σ) allow the calculation of confidence intervals with regard to the varying TQ values. For the 95% confidence interval twice the standard deviation is added and subtracted from the mean. Analyzing the raw milk prices we can be 95 % confident that they are sinking in all regions, since all values in the confidence interval are negative. This is also true for the raw milk quantity changes in Greece, Portugal and the rest of the world. Conversely, we can be sure that Finland, Ireland, Italy, the Netherlands, Spain and the United Kingdom increase their raw milk production. For all other countries the 95% confidence interval includes 0% and therefore an increase as well as a reduction is possible.

Table 2: Price changes in %

	crop		meat		raw milk		dairy processing		other food processing		industry/ manufacturing		service	
	μ	σ	μ	σ	μ	σ	μ	σ	μ	σ	μ	σ	μ	σ
Austria	0.1	0.0	-0.1	0.0	-16.8	4.7	-6.3	1.7	0.0	0.0	0.1	0.0	0.1	0.0
Belgium	0.2	0.1	-0.8	0.1	-19.7	4.4	-8.1	1.5	-0.1	0.0	0.1	0.0	0.1	0.0
Denmark	0.4	0.2	0.2	0.2	-18.7	4.1	-10.1	2.2	0.2	0.1	0.2	0.1	0.2	0.1
Finland	0.6	0.2	0.1	0.1	-19.0	4.4	-12.5	2.9	-0.1	0.0	0.2	0.1	0.3	0.1
France	0.3	0.1	-2.2	0.5	-20.2	4.7	-6.5	1.5	-0.3	0.0	0.2	0.1	0.2	0.1
Germany	0.1	0.1	-0.8	0.1	-20.2	4.6	-5.7	1.3	-0.1	0.0	0.0	0.0	0.0	0.0
Greece	-0.2	0.0	-0.2	0.0	-0.3	0.0	-0.4	0.0	-0.2	0.0	-0.1	0.0	-0.1	0.0
Ireland	1.7	0.7	-0.7	0.1	-20.9	4.7	-12.5	2.7	-0.3	0.1	0.4	0.1	0.5	0.2
Italy	0.4	0.1	-1.7	0.3	-19.8	4.6	-9.5	2.1	-0.3	0.0	0.2	0.0	0.2	0.1
Luxembourg	0.7	0.3	-0.9	0.1	-18.7	4.1	-11.8	2.4	-0.1	0.0	0.2	0.0	0.2	0.1
Netherlands	0.7	0.3	-0.2	0.1	-19.1	4.3	-10.6	2.3	-0.2	0.0	0.2	0.1	0.2	0.1
Portugal	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.2	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0
Spain	0.3	0.1	-1.6	0.3	-21.0	4.9	-11.0	2.5	-0.2	0.0	0.2	0.1	0.2	0.1
Sweden	0.1	0.0	0.0	0.0	-19.6	4.5	-10.3	2.4	0.0	0.0	0.1	0.0	0.1	0.0
United Kingdom	0.3	0.1	-0.2	0.0	-30.3	4.2	-12.4	1.7	-0.4	0.0	0.2	0.0	0.2	0.0
Switzerland	0.3	0.0	-1.7	0.2	-11.3	1.0	-6.4	0.6	-0.4	0.0	0.1	0.0	0.1	0.0
Rest of the world	-0.1	0.0	-0.1	0.0	-0.2	0.0	-0.2	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0

Looking at the means of the results of the raw milk price changes the abolishment of the quota leads to a remarkable price reduction in most of the EU countries (table 2). The reason for that are the dropped quota rents. Whereas the supplied raw milk quantities change differently (table 3). Two aspects help to explain this. Both of them concern the dairy processing sectors and are presented in table 1. It is therefore important to notice that in all countries of the EU raw milk production and dairy production are linked closely since nearly the entire raw milk quantity is processed in the domestic dairy sector. Firstly, if the cost share of raw milk in the dairy production is high, a price reduction of raw milk also leads to a remarkable price reduction of dairy products. At the same time a high cost share of raw milk stands also for small cost shares of all other inputs especially factors payments. Secondly, the share of dairy production which is exported is important. The substitution and expansion parameters in the GTAP data base of the constant differences of elasticities (CDE) function indicate that the demand for dairy products of private consumption is inelastic in all EU countries. Hence an expansion of dairy and raw milk production can only be achieved with an increase in exports. This is facilitated by a high export share of dairy output.

Table 3: Quantity changes in %

	crop		meat		raw milk		dairy processing		other food processing		industry/ manufacturing		service	
	μ	σ	μ	σ	μ	σ	μ	σ	μ	σ	μ	σ	μ	σ
Austria	0.1	0.1	-0.2	0.0	0.6	1.5	0.1	2.0	0.0	0.0	-0.1	0.1	0.0	0.0
Belgium	0.1	0.1	0.3	0.2	3.6	4.4	4.4	5.5	0.1	0.1	-0.2	0.1	0.0	0.0
Denmark	-0.1	0.1	-1.1	0.4	12.1	6.4	13.0	6.8	-0.7	0.2	-0.5	0.2	0.0	0.0

Finland	0.4	0.1	0.0	0.0	5.1	2.2	5.3	2.3	0.5	0.1	-0.8	0.2	0.2	0.0
France	0.2	0.0	1.3	0.4	2.0	1.4	1.1	1.9	0.6	0.1	-0.3	0.1	0.1	0.0
Germany	0.2	0.0	0.2	0.1	-0.9	1.2	-1.4	1.4	0.1	0.0	-0.1	0.1	0.0	0.0
Greece	0.0	0.0	-0.2	0.0	-3.0	0.3	-4.7	0.5	-0.1	0.0	0.1	0.0	0.0	0.0
Ireland	-0.4	0.4	1.7	0.1	16.7	8.2	19.9	9.9	1.4	0.2	-1.3	0.5	0.0	0.0
Italy	0.2	0.1	0.8	0.3	3.3	1.6	3.9	1.9	0.4	0.1	-0.3	0.1	0.1	0.0
Luxembourg	-0.9	0.6	0.5	0.1	13.0	7.0	17.4	9.4	0.4	0.0	-0.6	0.2	0.0	0.0
Netherlands	-1.6	0.8	0.4	0.2	14.3	6.9	15.2	7.3	0.8	0.1	-0.6	0.2	0.0	0.0
Portugal	0.0	0.0	-0.3	0.0	-2.2	0.2	-4.8	0.5	-0.2	0.0	0.1	0.0	0.0	0.0
Spain	0.1	0.0	0.6	0.2	3.6	1.7	4.4	2.1	0.4	0.1	-0.3	0.1	0.1	0.0
Sweden	0.1	0.0	0.0	0.1	2.3	1.7	2.2	1.7	0.1	0.1	-0.2	0.1	0.1	0.0
United Kingdom	0.3	0.0	0.5	0.1	3.5	1.0	4.6	1.3	0.6	0.1	-0.5	0.1	0.1	0.0
Switzerland	0.1	0.0	0.9	0.1	0.0	0.0	-0.3	0.0	0.6	0.1	-0.2	0.0	0.1	0.0
Rest of the world	0.0	0.0	-0.1	0.0	-0.7	0.1	-1.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0

For Denmark, Ireland, Luxembourg and the Netherlands the means of quantity changes in raw milk production are greater than 10% (table 2). As presented in table 1 the cost share of raw milk is relatively high in the dairy sector of this countries. Furthermore, the share of exported outputs is large. Countries which have either a small export share of the dairy output (Finland, Italy, Spain, Sweden and the United Kingdom) or a small raw milk cost share in their dairy sector (Austria, Belgium, France and Germany) show a modest increase or a minimal reduction in raw milk production. For Greece and Portugal neither of the shares is important since both countries did not reach the quota quantity in the initial equilibrium. Cheaper dairy imports from other EU countries lead to a decrease in both price and supplied quantity of raw milk production. Finally, Switzerland which is not a member country of the EU is also affected. Furthermore the quota quantity is supplied. Cheaper dairy imports from EU countries cause a reduction in the Swiss raw milk price.

6 Conclusions

In this paper an approach for depicting output quotas in the GTAP model is presented which allows the simultaneous adjustment of both produced quantity and quota rent. Due to uncertain coefficients the systematic sensitivity analysis is applied.

The abolishment of the raw milk quota in the EU would lead to a substantial decrease in raw milk prices in most member countries. The production of raw milk increases in Denmark, Ireland, Luxembourg and the Netherlands. A decrease is expected for Greece and Portugal, while the quantity changes for all other member countries are small. It turns out, that the share of exported outputs and the cost structure of the domestic dairy sector are important for the raw milk production.

Literature

Arndt, C. (1996). An Introduction to Systematic Sensitivity Analysis via Gaussian Quadrature. GTAP Technical Paper No. 2. http://www.agecon.purdue.edu/gtap/

Arndt, C. and K. R. Pearson. (1998). How to carry out Systematic Sensitivity Analysis via Gaussian Quadrature and GEMPACK. GTAP Technical Paper No. 3. http://www.agecon.purdue.edu/gtap/

Bach, C. F. and K. R. Pearson (1996). Implementing Quotas in GTAP Using GEMPACK or How to Linearize an Inequality. GTAP Technical Paper No. 4. http://www.agecon.purdue.edu/gtap/

Bach, C. F., S. E. Frandsen, et al. (2000). Agricultural and Economy-Wide Effects of European Enlargement: Modelling the Common Agricultural Policy. Journal of Agricultural Economics 51 (May): p. 162-180.

Colman, D. (2000). Inefficiencies in the UK milk quota system. Food Policy 25: p. 1-16.

Dimaranan, B. V. and R. A. McDougall. (2001). Global Trade Assistance and Production: The GTAP 5 Data Base. Center for Global Trade Analysis, Purdue University. West Lafayette. USA.

European Commission Directorate-General for Agriculture. (1999). The CAP reform: Milk and milk products. Fact Sheet. Brussels.

Harrison, W. J. and K. R. Pearson (1998). Gempack User Documentation Release 6.0 GPD-1 An Introduction to Gempack, Centre of Policy Studies and Impact Project, Monash University. Melbourne. Australia.

Hertel, T. W. and M. E. Tsigas. (1997). Structure of GTAP. In T. W. Hertel (Editor). Global Trade Analysis Modeling and Applications: 13-73. Cambridge University Press. New York.

Huff, K. and T. W. Hertel (1996). Decomposing Welfare Changes in GTAP. GTAP Technical Paper No. 5. http://www.agecon.purdue.edu/gtap/

Kleinhanss, W., D. Manegold, et al. (2001). Mögliche Auswirkungen eines Ausstiegs aus der Milchquotenregelung für die deutsche Landwirtschaft. Arbeitsbericht 5/2001 Bundesforschungsanstalt für Landwirtschaft. Braunschweig. Germany.

Lehmann, B., C. Eggenschwiler, et al. (2000). Evaluation der Milchkontingentierung, Institut für Agrarwirtschaft. Zürich. Switzerland.

Lips, M. (2002). Die Auswirkungen der Neuen Agrarhandelsrunde der Welthandelsorganisation auf die Schweiz. ETH-Dissertation Nr. 14'496. Zürich. Switzerland.

Nielsen, C. M. (1999). EU Enlargement and the Common Agricultural Policy: Modeling Issues. Second Annual Global Conference on Global Economic Analysis. June 20-22, 1999. Denmark.

van Meijl, H. and F. van Tongeren (2000). The Agenda 2000 CAP Reform, World Prices and URAA GATT-WTO Export Constraints. Third Annual Conference on Global Economic Analysis. June 27-30, 2000. Melbourne. Australia.

Zentrale Markt- und Preisberichtstelle. (2000). Agrarmärkte in Zahlen. Europäische Union 2000 Tier- und Pflanzenproduktion. Bonn. Germany.