# Dairy reform scenarios with CAPSIM acknowledging quota rent uncertainty

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*Abstract*— **The study provides an agricultural multi commodity analysis able to focus and investigate the ongoing EU milk reform. The analysis is carried with the Common Agricultural Policy SIMulation (CAPSIM) model which is a comparative-static, partial equilibrium modelling tool covering the whole of agriculture of EU member states. The model provides a *reference run* which is a "baseline scenario" where the 2003 CAP Reform is projected into the future. This scenario is compared to a "quota expiry" scenario where milk quotas are abolished by 2015, a "soft landing" scenario where further quota expansions are envisaged and an "early quota expiry" by 2009. Sensitivity analysis is done for different set of quota rent assumptions and export refund abolition. Key results, under a "quota expiry scenario" are that milk production would increase by 2.8% in EU27 whereas milk prices would drop by 7.5%.**

*Keywords*— **EU milk reform, CAPSIM, quota rent.**

## I. INTRODUCTION

The European Commission (EC) is preparing the so-called "Health Check" (HC) on the Common Agricultural Policy (CAP). The objective of the HC is to ensure that the CAP is meeting its objectives effectively and efficiently in an enlarged European Union (EU) and in the foreseeable international setting. Milk quotas are one of the policy instruments to be reassessed in occasion of the HC. They have become a remnant of an older CAP since the 2003 CAP reform introduced decoupled payments and increased the degree of market orientation in general.

The aim of this study is to provide a multi commodity analysis able to focus and investigate EU milk reform options in relation to the ongoing CAP HC. Particular attention is given to detailed country level impacts relying on a detailed representation of dairy policies. Inter linkages with other relevant sectors to milk production are also considered.

The analysis is carried with the Common Agricultural Policy SIMulation (CAPSIM) model (described in more detail in [1]) which is a comparative-static, partial equilibrium modelling tool covering the whole of agriculture of EU member states (MS) with a high level of disaggregation, both in the list of covered items as well as in the policy instruments represented. The database provides a detailed coverage of dairy commodities for EU-27 with cow milk and nine dairy processed products: butter, skimmed milk powder, cheese, fresh milk products, cream, concentrated milk, whole milk powder, whey powder, casein. The model provides a *reference run* which is a "baseline scenario" where the 2003 CAP Reform is projected into the future (i.e. 2014-20). Particular attention is given to the uncertainty inherent to milk quota rent estimates in a corresponding sensitivity analyses. In another sensitivity analysis it is investigated whether the presence or absence of export refunds matters for milk quota expiry scenarios.

This paper is structured as follows. In Section II we present the structure, assumptions of the model, describe the functional forms used for both supply and demand. In the same Section market clearing and price determination, and the behaviour of dairies are illustrated. In Section III the database structure and scenarios are described by making reference to the: main characteristics and sources of the database, *reference run*, dairy reform scenarios and dairy reform sensitivity analyses. In Section IV, scenario results are discussed, including sensitivity analyses on quota rent estimates and export refunds policy. Section V concludes.

## II. STRUCTURE OF THE MODEL

### *A. Basic structure and assumptions*

Key characteristics of CAPSIM can be summarised as follows. It is a *partial equilibrium* model relying on exogenous inputs of macroeconomic variables. It is *comparative static*, but may be used for any sequence of projection years provided that exogenous variables have been forecasted for these years and parameters are adjusted according to the length of the run. In terms of empirical specification, it relies on *calibration* techniques and a *rigorous microeconomic framework* for behavioural functions rather than on a full econometric estimation. Several *hard technological relationships* have been incorporated to support the microeconomic framework. Examples are balances of male and female calves, land, feed energy and protein, milk fat and protein. For these constraints, it is useful that CAPSIM covers the complete agricultural sector. It is a *deterministic* model trying to capture the mean result from a set of exogenous variables, so far starting from a three-year average base year to eliminate as far as possible the influence of yield fluctuations and short-run price fluctuations. *Market clearing* differs depending on the products. For most products it explicitly distinguishes gross imports and exports, while for others it only gives net trade and for non-tradable items[1] net trade is nearly fixed through the chosen price transmission equation. Within the EU, a pooled (non-spatial) market is assumed and bilateral trade flows are not modelled. Nonetheless the intra EU price transmission allows for non-proportional changes in EU MS. Major *policy instruments* include various premiums for activities with associated ceilings, set-aside, intervention prices, quotas, domestic subsidies, border measures (tariffs, flexible levies/export refunds), and World Trade Organisation (WTO) limits are included as indicators on non viable scenarios. The main *simulation outputs* of CAPSIM are market balances, agricultural production and income, changes in processing industry income, consumer welfare and taxpayer impacts deriving from European Agricultural Guarantee and Guidance Fund (EAGGF) expenditure and agricultural tariff revenues. Altogether these give a conventional measure of welfare change. In CAPSIM two modes can be run: the *reference run* mode and the *policy simulation* mode. The *reference run* mode is used to calibrate the unknown time-dependent parameters (shifters) in model equations, building on exogenous forecasts and ex post observations for the related variables (i.e. the activity levels). For this calibration of time-dependent parameters, the functional forms of the behavioural functions are chosen so that neither symmetry, homogeneity nor curvature are affected by these shifters, provided the other parameters linked to price responsiveness are held constant. In *policy simulation mode* all parameters are given and exogenous inputs, for example yields, final consumption expenditure, and the inflation rate, are usually taken over from the *reference run*.

CAPSIM explicitly distinguishes the following agents: agricultural producers, processing industry, food industry, land supply, labour and capital, final consumers and policy. Agricultural producers are profit maximisers with a pragmatic treatment of subsistence production and demand and agricultural labour use. The processing industry (oilseeds, dairy) also follows profit maximisation. The food industry and compound feed industry apply a fixed margin between producer and consumer prices. Total land supply is exogenous, but land may turn fallow if land prices drop strongly. The profit function calibration assumes for labour and capital that 50% are perfectly variable with the factor price approximated by the general price index. The other 50% are assumed fixed and receive agricultural profit as residual income. Final consumers maximise utility. Policy is exogenous but export refunds and import levies are linked to the difference of administrative and market prices. Export demand (import supply) from the rest of the world is described by an ad hoc behavioural function dependent on a single variable, the EU export price (import price) relative to an exogenous world price.

[1] Gross EU extra trade data from the Food and Agriculture Organization (FAO) have been incorporated and merged with Eurostat based market balances for cereals, rice, oilseeds and corresponding cakes and oils, potatoes and vegetables, fruits, sugar, meats, eggs, milk products, olive oil and wine. Net trade modelling with given border prices is currently applied in case of pulses, as well as residual energy rich and protein rich feed items. Non-tradables are calves, fodder items, and cow and sheep raw milk.

*B. Functional forms used for supply and demand*

The behavioural functions for producers are derived from a Normalised Quadratic (NQ) profit function [2] in terms of so called net revenues and net prices. Net revenues of activities are market revenues net of shadow values for land (crops) or feed energy and protein (animals). Net prices of feed items are correspondingly ordinary prices corrected for shadow values of feed energy and protein, see also [1] for details of this approach to include physical balances. The profit function is thus:

$$\pi_{m,t}\left(\mathbf{N}_{m,t}\right) = \alpha_{m,0,0,t} + \sum_j \alpha_{m,j,0,t} N_{m,j,t} + \sum_j \sum_k \alpha_{m,j,k} N_{m,j,t} N_{m,k,t} , \quad (1)$$

where

$$\mathbf{N}_{m,t} = \left(\mathbf{NREV}_{m,t}, \mathbf{NP}_{m,t}\right) / \mathrm{PP}_{m,REST,t} , \quad (2)$$

and

$\pi_{m,t}$ = normalised profit function in MS $m$;

$\mathbf{N}_{m,t}$ = column vector of price variables $s$ normalised by the general price index $\mathrm{PP}_{m,REST,t}$ in MS $m$;

$\mathbf{NREV}_{m,t}$ = column vector of net revenues $\mathbf{NREV}_{m,j}$ for activity $j$, MS $m$, year $t$;

$\mathbf{NP}_{m,t}$ = column vector of net prices $\mathbf{NP}_{m,i}$ of input $i$ in MS $m$, year $t$;

$\alpha_{m,j,k}$ = time invariant parameters of the profit function in MS $m$;

$\alpha_{m,j,0,t}$ = time dependent parameters of the profit function in MS $m$.

This gives behavioural functions of netputs $Y_{m,j,t}$ linear in $\mathbf{N}_{m,t}$. Treating the price responsiveness parameters $\alpha_{m,j,k}$. as time invariant, permits to shift behavioural functions without affecting curvature.

The specification for food demand follows from a Generalized Leontief (GL) type indirect utility form. [3] have shown that theoretically consistent demand systems with linear Engel curves stem from an indirect utility function of the following form:

$$V_m\left(\mathbf{CP}_m, EX_m^{HD}\right) = -G_m / \left(EX_m^{HD} - F_m\right), \quad (3)$$

where

$\mathbf{CP}_m$ = column vector of consumer prices in Member State $m$ ;

$EX_m^{HD}$ = consumer expenditure per head in Member State $m$;

$G_m, F_m$ = linear homogenous functions of consumer prices in Member State $m$;

$V_m$ = indirect utility function in Member State $m$.

Roy's identity gives demand functions of the form:

$$CNS_{m,i}^{HD} = -\frac{\partial V_m}{\partial CP_{m,i}} \Big/ \frac{\partial V_m}{\partial EX_m^{HD}} = \frac{G_{m,i}}{G_m}\left(EX_m^{HD} - F_m\right) + F_{m,i} , \quad (4)$$

where

$CNS_{m,i}^{HD}$ = per capita demand quantity of item $i$ in Member State m;

$G_{m,i}$ = $\partial G_m / \partial CP_{m,i}$ ;

$F_{m,i}$ = $\partial F_m / \partial CP_{m,i}$ ;

where $F_{m,i} = \delta_{m,i,t}$ (time dependent parameter for item i) and function $F_m$ is linear in prices:

$$F_m(\mathbf{CP}_m) = \sum_u \delta_{m,u,t} CP_{m,u} \ . \quad (5)$$

Function $G_m$ is of GL form:

$$G_m(\mathbf{CP}_m) = \sum_u \sum_v \beta_{m,u,v} CP_{m,u}^{0.5} CP_{m,v}^{0.5} \ , \quad (6)$$

and $G_{m,i}$ is its derivative with respect to price *i*:

$$G_{m,i}(\mathbf{CP}_m) = CP_{m,i}^{-0.5} \sum_u \beta_{m,u,i} CP_{m,u}^{0.5} \ , \quad (7)$$

where $\beta_{m,u,i}$ are time invariant price response parameters of the demand system related to items u and *i*. They have been recalibrated for this study to include elasticity information in [4] and [5].

Note the similarity to the well known Linear Expenditure System (LES), the only difference being that the marginal budget shares of the GL system $\left(\partial(CP_{m,i}CNS_{m,i}^{HD}) / \partial EX_m^{HD} = CP_{m,i}G_{m,i} / G_m\right)$ are functions of all prices. As in the LES function, $F_m$ may be interpreted as the value of committed income, given exogenous (committed) consumption quantities $\delta_{m,i,t}$. The expression in brackets in equation (4) corresponds to 'uncommitted income' which is allocated according to the marginal budget shares.

*C. Market clearing and price determination*

The approach to market clearing applied to most tradable products including those in the dairy sector starts from the aggregate difference of supply and demand functions of all agents and MS giving EU net trade. This ultimately depends on the EU market price to which national prices are linked. This aggregate net trade equals the difference of gross exports and imports:

$$NET_{i,t}(PE_{i,t}) = X_{i,t}(PX_{i,t}) - M_{i,t}(PM_{i,t}), \quad (8)$$

where

$NET_{i,t}(PE_{i,t})$ = EU net trade of item *i* as a function of EU market price $PE_{i,t}$;

$X_{i,t}(PX_{i,t}))$ = EU gross exports of item *i* as a function of EU export price $PX_{i,t}$;

$M_{i,t}(PM_{i,t})$ = EU gross imports of item *i* as a function of EU import price $PM_{i,t}$

EU export prices differ from market prices if export refunds are used (and import prices differ in a similar way from EU market prices in case of tariffs):

$$PX_{i,t} = PE_{i,t} - ESUT_{i,t}(PE_{i,t}), \quad (9)$$

where

$ESUT_{i,t}(PE_{i,t})$ = Average EU export refund of item *i* as a function of EU market price.

If there are administrative prices (effective intervention prices for butter and skimmed milk powder) export refunds may be endogenously increased to ensure that the ratio of EU market prices to the administrative price does not fall significantly below the base year value, but the export refund may also drop to zero if market prices strongly increase relative to administrative prices, see [1]. If there is no administrative price, say for poultry, per unit export refunds are exogenous.

Intra EU price transmission from EU to MS market prices occurs through a scaling factor which is a decreasing function of MS net trade.

$$PP_{m,i,t} = PE_{i,t} \cdot \phi_{m,i}(NET_{m,i,t}), \quad (10)$$

where

$\phi_{m,i}$ = endogenous scaling factor in MS *m* for item *i*

$NET_{m,i,t}$ = MS net trade of item *i*;

$PP_{m,i,t}$ = Producer price of item *i* in MS *m*.

The earlier specification in CAPSIM and several other models has been to treat **φ** as an exogenous parameter. In a quota expiry study with strongly differing quota rents among MS it may be expected that production from more competitive regions is partly replacing domestic supply in less competitive regions. Prices in the former are likely to decline stronger whereas less competitive regions would benefit from some natural protection through transaction costs. For tradable products the maximum variation of producer prices through changes in MS net trade is around 20% (specified according to differences in export and import unit values in FAO data) but for non-tradable items, including raw milk, the price transmission function (10) has been specified such that any change in MS net trade would quickly imply strong price changes, ensuring that net trade of non tradable items is almost fixed.

*D. Behaviour of dairies*

It has been mentioned that the CAPSIM database has been disaggregated and extended to include additional dairy products. The current dairy products treated in CAPSIM are: butter, skimmed milk powder, cheese, fresh milk products, cream, concentrated milk, whole milk powder, whey powder, casein. They are linked to each other and to supply of raw milk through balances on milk fat and protein:

$$\sum_{s \in SEMLK} \gamma_{m,s,c} PRD_{m,s,t} = \sum_{r \in RAWMLK} \gamma_{m,r,c} PRC_{m,r,t} \ , \qquad (11)$$

where

$PRD_{m,s,t}$ = production in MS $m$ of secondary milk product $s$, year $t$;

$\gamma_{m,s,c}$ = content in MS $m$ of secondary product $s$ in terms of c ∈ {milk fat, milk protein};

$PRC_{m,r,t}$ = processing in MS $m$ of raw milk type $r$ ∈ {cow milk, sheep milk}, year $t$;

$\gamma_{m,r,c}$ = content in MS $m$ of raw milk type r in terms of $c$ ∈ {milk fat, milk protein}.

Similar balances are included in many large scale partial agricultural simulation models whereas CGE models usually do not allow for this level of technical detail. What partly differs among the models are the equations steering supply of dairy products and demand for raw milk which are in CAPSIM:

$$PRX_{m,i,t} = \theta_{m,i,0} + \sum_j \theta_{m,i,j} \ PM_{m,i,t} / PP_{m,rest,t} \ , (12)$$

where

$PRX_{m,i,t}$ = processing demand $PRC_{m,i,t}$ for $i$∈RAWMLK or supply of secondary milk product $PRD_{m,i,t}$ for $i$∈SECMLK;

$\theta_{m,i,j}$ = parameters of behavioural functions in MS $m$;

$PM_{m,i,t}$ = net margin in MS $m$ in processing of raw milk type $i$ or production of secondary $i$ (normalised with the general price index),

and

$$PM_{m,i,t} = PP_{m,i,t} - \sum_c \gamma_{m,i,c} PS_{m,c,t} \ , \qquad (13)$$

where

$PP_{m,i,t}$ = producer price in MS $m$ of (milk) product $i$, year $t$;

$PS_{m,c,t}$ = shadow price in MS $m$ of content $c$, year $t$.

Note that for dairy products equation (12) is a supply function which should respond positively to an increase in the margin whereas for raw milk equation (12) is a derived demand. Both may be obtained from a NQ profit function (compare Equation 112 in [6]).

The common ground between the Common Agricultural Policy Regional Impact Analysis (CAPRI) [6], the Agricultural Member states

MODeling (AGMEMOD) [7] and CAPSIM models is formed by the assumption that production may shift between milk products (in the feasible space defined by balances on milk fat and protein), but with increasing marginal costs for the expansion of particular products, putting some limits on responsiveness. In some earlier applications with given marginal cost (see [5] or [8]), the optimal mix of dairy products at given prices for secondary products as well as a given raw milk price (or quantity) was a linear program. In the meantime EDIM has been extended to include increasing marginal cost in the dairy industry, but without other interdependencies among products than the milk fat and protein balances. On the contrary, equations (12) permit to reflect specific supply side relationships among dairy products such as a complementarity between whey powder and casein or cheese and partly between butter and skimmed milk in the parameters $\theta_{m,i,j}$, beyond the linkages imposed by fat and protein balances. This stylised knowledge has been incorporated in the parameters $\theta_{m,i,j}$.

As stated above farmers are assumed to maximise profits. This is a simplification even in EU15 countries due to labour and capital market imperfections, including imperfect insurance markets such that risk aversion matters as well [9]. In transition countries high transaction costs and quality differences often generate a large difference between purchases and selling prices of non storable goods, for example milk. An appropriate modelling of subsistence requires the application of agricultural household models which is infeasible in the framework of CAPSIM. Instead the trend projections have been used to pragmatically acknowledge the structural shifts in the raw milk balance of certain NMS implying a decline of subsistence production and demand over time and corresponding shifts in behavioural functions (implicitly like [10]).

## III. DATABASE STRUCTURE AND SCENARIOS

### *A. Database characteristics and sources*

In total the revised product list of CAPSIM includes 21 agricultural outputs, 5 inputs (imported energy rich feed (mainly manioc), protein rich feed (mainly corn gluten fodder), a primary factor aggregate, labour, intermediate consumption) and 11 processed products. The largest part of the database is filled from various Eurostat domains and comprises areas, crop and animal production, market balance positions, price data consumer expenditure, and macroeconomic variables. In addition there are a number of supplementary data from various sources:

- Policy variables: Official Journal, DG Agri Website, WTO website, EAGGF reports etc.;
- Supplementary trade data (if market balances are unavailable): FAO;
- Consumer prices: International Labour Organisation (ILO);
- World market projections: The Food and Agricultural Policy Research Institute (FAPRI).

For more details on the underlying techniques and methods developed for data selection and data preparation for the Common Agricultural Policy SIMulation (CAPSIM) model see [11]. It may be noted that national and Eurostat data, but also different Eurostat domains and sometimes even the numbers in a single market balance are not necessarily consistent with each other. For a number of years already the database at the level of EU MS is shared between the CAPRI and CAPSIM modelling systems and teams. The modelling database is established in a routine called Complete and Consistent Data Base (COCO) based on various types of official data (see section 2.3 in [6]). This routine allows for conversion of units, trend based completions, mechanical corrections of presumed data errors while imposing some minimal technical consistency in terms of adding up constraints for areas and so forth. The COCO module is basically divided into two main parts: (1) Include and combine input data according to some overlay hierarchy, (2) calculate complete and consistent time series while remaining close to the raw data..

### *B. Reference Run*

The *reference run*, (thereafter called RE) is prepared for 2014 and 2020 and includes recent CAP reforms[2], and forecasts on policy driven variables such as set aside aligned with those of the European Commission Directorate General for Agriculture and Rural Development (DG Agri). The following aspects of the regulation establishing common rules for direct support schemes [12] are included in CAPSIM:

- Total payment amounts for coupled and decoupled support (Annex VIII);
- Sugar payments (Annex VII);
- Specific support to tobacco, cotton, olives, hops;
- Amounts exempted from modulation due to the franchise.

In terms of future international price evolution, this study relied on FAPRI projections. For dairy products, however these were averaged with projections from [13] which received a doubled weight compared to FAPRI. The standard RE ignores a WTO agreement but in a sensitivity analysis an abolishment of export refunds has been assumed (see for further details Section III *D*).

In addition to the 2003 Luxembourg Reform, 2004 Mediterranean Reform, and the first 2 percent expansion of milk quotas in 2008 it incorporates the recent so-called mini milk reform. The mini milk reform [14] includes the permission to standardise the protein content of skimmed milk powder at 34% (in line with international Codex Alimentarious provisions) whereas the current standard for intervention is 35.6%. It is expected that this would lead to reduced protein contents of powders which is translated into an exogenous decrease in the protein content of powders of 1.6 percentage points, together with the related lowering of the intervention price for SMP by 2,8% effective from September 2008, to pick up the most relevant elements.

Given its comparative-static character and the parameterisation mainly based on calibration to a base period, CAPSIM is not intended to be a stand alone projection tool. Instead it incorporates external projections from specialised agencies which are merged with default trends [15]. For this study the key external source was [13] such that the CAPSIM RE results closely resembles this source in the dairy sector.

*C. Dairy reform scenarios*

In the Legal Proposals of the Commission for the HC from May 20, 2008 [16] it is confirmed that the milk quota system should not be continued after the expiry in 2015 and that this step should be prepared through an earlier "soft landing" policy. The dairy reform scenarios performed in this paper are:

- Quota expiry scenario (thereafter called EX, year 2020): the year 2020, 5 years after the scheduled expiry in 2015, corresponds to the magnitude of medium run supply elasticities (about 0.3 for milk).
- A part of the Commission's quota expiry strategy[3] is a soft landing policy involving a series of quota expansion steps. The situation after the last of these steps will be simulated as well (thereafter called EX-SO, year 2014) and may be compared with the RE results given for the same year and the below mentioned scenario on quota expiry in 2009.
- Early quota expiry scenario in 2009 (thereafter called EX-FA, simulation year 2014): to identify the impact of soft landing relative to early full quota expiry we will also simulate quota expiry results for 2014 which would follow from a hypothetical expiry some years earlier (in 2009). This is not politically relevant but may be interesting for a technical analysis and understanding of CAPSIM results.

*D. Dairy reform sensitivity analyses*

For the 2020 simulations two types of sensitivity analyses are carried out.

Sensitivity on different quota rent assumptions:

[2] Except on wine as EU Regulation 479/2008 only dates from 29.06.2008.

[3] It should be noted that the long run results for 2020 from a comparative static model such as CAPSIM would be the same with or without such preparation. The short run effects of soft landing as compared to a 'big bang' quota abolition in 2015 without preparation cannot be analysed with comparative static models.

- RE with increased quota rents[4], export refunds still in place (thereafter called RE-HI);
- Expiry with increased quota rents, export refunds still in place (thereafter called EX-HI).

Sensitivity on export refunds abolition:

- RE with default quota rents, export refunds still in place for meats, eggs, butter, sugar, fruit and vegetables (RE);
- Expiry with default quota rents, export refunds still in place (EX);
- RE with default quota rents, export refunds abolished (thereafter called RE-NS);
- Expiry with default quota rents, export refunds abolished (EX-NS).

For additional clarity the different simulations are summarised in the following table.

Table 1 Overview on CAPSIM simulations

| Acronym | Milk Quotas | Export refunds | Initial rents | 2014 | 2020 |
|---|---|---|---|---|---|
| RE | Status quo | Active | Default | ☒ | ☒ |
| RE-HI | Status quo | Active | High | | ☒ |
| RE-NS | Status quo | Abolished | Default | | ☒ |
| EX | EC proposal | Active | Default | | ☒ |
| EX-NS | EC proposal | Abolished | Default | | ☒ |
| EX-HI | EC proposal | Active | High | | ☒ |
| EX-SO | EC proposal | Active | Default | ☒ | |
| EX-FA | Expired 2009 | Active | Default | ☒ | |

4 According to the rule: Rent(high) = Rent(medium) + min(0.75* Rent(medium), 0.15). The first part of the min operator ensures that zero 'medium' rents remain zero in the sensitivity analysis. The second part is a cut-off point to ensure that even the highest rents, almost 50% in the Netherlands, cannot attain implausible magnitudes.

## IV. SCENARIO RESULTS

### *A. Quota expiry scenario for 2020*

A survey on empirical approaches and results regarding quota rents or marginal costs is given by [17]. This study has adopted the quota rents from [13]. The following figure shows that this choice largely determines the pattern of production impacts of quota expiry scenarios.

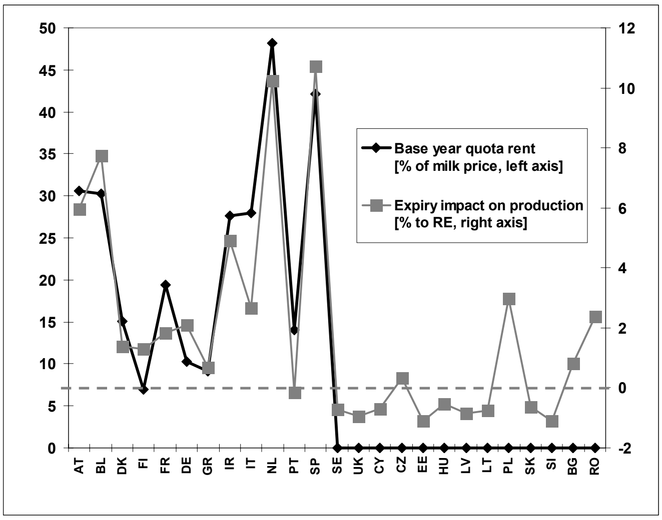


Fig. 1 Initial quota rents and quota expiry impacts in 2020 by MS according to CAPSIM

The following Table 2 shows that strongly increasing milk production is usually depressing producer prices, causing some heterogeneity within the EU. The first column shows that milk prices are expected to decline strongly by 7.5% on average in EU27, with some regional variation. Price impacts are slightly reinforced and production impacts are somewhat more negative if the comparison is made in a CAP environment without export refunds (column EX-NS). Finally the column EX-HI shows that production increases are clearly reinforced with higher initial quota rents and so are the corresponding price impacts.

Table 2 Production and producer price impacts in expiry scenarios for raw milk, 2020, EU27

| | RE | EX | EX-NS | EX-HI |
|---|---|---|---|---|
| | €/t \| 1000t | % dif. | % dif. | % dif. |
| Spain | | | | |
| Price | 281 | -20.3 | -20.4 | -25.7 |
| Supply | 6533 | 10.7 | 10.5 | 13.6 |
| United Kingdom | | | | |
| Price | 268 | -2.5 | -2.9 | -3.3 |
| Supply | 15102 | -0.9 | -1.3 | -1.0 |
| 10 New MS | | | | |
| Price | 206 | -7.1 | -7.5 | -7.9 |
| Supply | 21502 | 1.4 | 1.2 | 1.2 |
| Poland | | | | |
| Price | 198 | -10.4 | -10.8 | -11.1 |
| Supply | 11609 | 3.0 | 2.7 | 2.7 |
| Slovenia | | | | |
| Price | 226 | -1.5 | -1.9 | -2.3 |
| Supply | 672 | -1.1 | -1.3 | -1.3 |
| Bulgaria/Romania | | | | |
| Price | 161 | -4.4 | -4.5 | -4.5 |
| Supply | 5933 | 2.1 | 2.0 | 1.7 |
| EU15 | | | | |
| Price | 255 | Price | 255 | Price |
| Supply | 126391 | Supply | 126391 | Supply |
| EU27 | | | | |
| Price | 244 | -7.5 | -8.0 | -9.6 |
| Supply | 153825 | 2.8 | 2.6 | 3.6 |

Table 3 gives a summary on market impacts of quota expiry scenarios for the most important dairy products on the EU27 level. The first two columns apply under status quo policy for export refunds, the last two assume that export refunds are abolished.

An increased milk production of 2.8% (see Table 2, second column at the bottom) will lead to a increase of dairy products supply such that milk fat and protein balances add up to zero. The composition of this increase in production depends on elasticities in the dairy and final demand sectors and potentially on policy. This is indeed important for the butter results: The RE export refund in 2020 would be at 1610 €/t which is endogenously increased to 1720 €/t assuming that EU authorities would try to maintain market prices somewhat above the effective intervention price. This mechanism explained in Section II *C* is also used in EDIM [13] and CAPRI [6], for example. The right column EX-NS shows indeed that butter prices would drop stronger (-3.8% rather than -0.5%) if EU market management could not rely on export refunds. Note also that net trade would become slightly positive (-90 *-0.26 = +24) in the expiry scenario with export refunds. For dairy products other than butter export refunds would not be used such that the differences between columns EX and EX-NS are relatively small, deriving from indirect linkages to butter. It appears that a smaller share of the additional milk fat and protein is directed towards cheese and fresh milk products such that their prices are less affected in the expiry scenarios than those of powders.

Table 3 Market impacts in expiry scenarios for selected dairy products, 2020, EU27

| | RE | EX | RE-NS | EX-NS |
|---|---|---|---|---|
| | €/t \| 1000t | % dif. | €/t \| 1000t | % dif. |
| Butter | | | | |
| Price | 2944 | -0.5 | 2907 | -3.8 |
| Supply | 1910 | 6.0 | 1905 | 4.4 |
| Demand | 2000 | 0.1 | 2008 | 1.2 |
| Net trade | -90 | -126.3 | -103 | -56.7 |
| Skimmed Milk Powder | | | | |
| Price | 2065 | -4.6 | 2065 | -3.6 |
| Supply | 804 | 7.9 | 801 | 6.3 |
| Demand | 892 | 2.3 | 889 | 1.8 |
| Net trade | -88 | -48.8 | -88 | -38.8 |
| Cheese | | | | |
| Price | 4661 | -2.5 | 4655 | -2.4 |
| Supply | 9631 | 2.1 | 9636 | 2.0 |
| Demand | 9164 | 1.1 | 9163 | 1.0 |
| Net trade | 467 | 22.8 | 474 | 21.9 |
| Fresh Products | | | | |
| Price | 699 | -1.6 | 698 | -1.8 |
| Supply | 48482 | 0.8 | 48474 | 0.8 |
| Demand | 48623 | 0.7 | 48612 | 0.7 |
| Net trade | -141 | -19.3 | -137 | -21.4 |
| Whole Milk Powder | | | | |
| Price | 2905 | -4.0 | 2894 | -4.3 |
| Supply | 533 | 3.4 | 534 | 3.6 |
| Demand | 514 | 2.2 | 514 | 2.3 |
| Net trade | 19 | 36.8 | 19 | 38.1 |

Price changes of dairy products differ somewhat by MS, but these differences are less marked than for raw milk, which is taken to be badly tradable (compare Section II *C*).

Dairy products are linked to meat markets on the supply and demand side. Supply side impacts on the beef market are large if the additional supply of calves is not used for fattening of calves or counteracted by a decline in the suckler cow herd. According to the CAPSIM simulations the latter would indeed largely neutralise the impact on beef supply in EU27 (+0.5%) except in countries with a strong expansion of dairy cows and a small initial suckler cow herd like in the Netherlands (+4.2%).

Some decline of meat consumption may be expected on the demand side if dairy consumption increases. This tends to reduce market prices of meats (see Table 4). As was the case for butter we see a slightly stronger decline for beef without subsidies because under status quo market management the average export refund would slightly increase from 133 €/t to 136 €/t in scenario EX vs. RE.

Table 4 Market impacts in expiry scenarios for selected meat markets, 2020, EU27

| | RE | EX | RE-NS | EX-NS |
|---|---|---|---|---|
| | €/t \| 1000t | % dif. | €/t \| 1000t | % dif. |
| | | Beef | | |
| Price | 2847 | -0.1 | 2838 | -0.3 |
| Supply | 7583 | 0.5 | 7581 | 0.4 |
| Demand | 8172 | -0.3 | 8173 | -0.2 |
| Net trade | -589 | -9.6 | -592 | -7.6 |
| | | Pork | | |
| Price | 1271 | -0.2 | 1261 | -0.3 |
| Supply | 23710 | -0.1 | 23679 | -0.1 |
| Demand | 21684 | -0.2 | 21696 | -0.2 |
| Net trade | 2026 | 1.3 | 1983 | 1.5 |

Market impacts on the crop sector are quite moderate. The additional milk production would increase feed demand including fodder which would require some area reallocations (e.g. an increase of the area for 'fodder on arable land' by 0.5% in EU27 under EX) and increase prices for feed items in general (prices of 'fodder on arable land' increase by 7% and cereal prices by 0.7% under EX). Overall however these impacts are moderate.

Strongly declining producer prices for milk are reducing income in agriculture therefore, whereas dairies would benefit, because prices of dairy products decline less than raw milk prices under scenario EX. Consumers evidently benefit as well, whereas taxpayers are likely to see an increased burden (Table 5).

Table 5 Welfare impacts in expiry scenarios, 2020, EU27 [m €]

| | EX | EX-NS | EX-HI |
|---|---|---|---|
| Producers | -1767 | -2112 | -2186 |
| Agriculture | -2860 | -3144 | -3617 |
| Dairies | 1083 | 1023 | 1421 |
| Taxpayers | -311 | -150 | -416 |
| EAGGF | 143 | 4 | 213 |
| Butter refunds | 139 | 0 | 206 |
| Tariff revenues | -168 | -146 | -202 |
| Consumers | 1851 | 2219 | 2361 |
| Total welfare | -227 | -42 | -240 |

The total losses to taxpayers under scenario EX are 311 m €. The single largest component is an increase in export refunds whereas other effects on EAGGF are nearly negligible. However, increasing net trade would be associated with reduced imports of dairy products and some meats and thus with declining tariff revenues. The main effects are a reallocation of income from agriculture to dairies and final consumers whereas the overall balance for welfare is small and negative, as in [15].

The latter therefore shows again that a liberalisation in a particular sector may lead to welfare losses in a second best context. Scenario EX-NS (vs. RE-NS) shows that the overall welfare losses are smaller if export refunds had been abolished and second best effects were limited to the tariff revenue side. The rightmost column for scenario EX-HI confirms that all quantitative effects are strongly dependent on the assumed quota rents.

The welfare results in Table 5 are biased downward because CAPSIM is not able to capture the efficiency gains (from an equalisation of quota rents to zero across regions and even within regions). Whereas transaction costs to trade quota rights may be low in some countries (Netherlands, UK) they are certainly high in others (France). Empirical studies have thus shown that a large additional efficiency gains may be reaped from the quota expiry which is not captured in Table 5 [18].

*B. Soft landing and early quota expiry for 2014*

Table 6 gives a summary on impacts of a soft landing policy involving a series of quota expansion steps on markets for the most important dairy products on the EU27 level (scenario EX-SO). In addition a comparison is made between the soft landing hypothesis and a fast, early quota expiry in 2009 (EX-FA) both evaluated for 2014.

Table 6 Market impacts in soft landing scenarios for selected dairy products, 2014, EU27

| | RE | EX-SO | EX-FA |
|---|---|---|---|
| | €/t \| 1000t | % dif. | % dif. |
| | Cow Milk (raw) | | |
| Price | 231 | -3.3 | -4.6 |
| Supply | 154867 | 1.2 | 1.7 |
| | Butter | | |
| Price | 2956 | -0.2 | -0.4 |
| Supply | 1945 | 2.6 | 3.5 |
| Demand | 2042 | 0.0 | 0.0 |
| Net trade | -97 | -53.1 | -69.9 |
| | Skimmed Milk Powder | | |
| Price | 1902 | -2.2 | -2.8 |
| Supply | 865 | 3.5 | 4.7 |
| Demand | 932 | 1.1 | 1.7 |
| Net trade | -67 | -29.6 | -37.7 |
| | Cheese | | |
| Price | 4584 | -1.2 | -1.7 |
| Supply | 9291 | 0.9 | 1.3 |
| Demand | 8889 | 0.4 | 0.6 |
| Net trade | 402 | 11.2 | 15.9 |
| | Fresh Products | | |
| Price | 655 | -0.7 | -1.0 |
| Supply | 49343 | 0.3 | 0.5 |
| Demand | 49411 | 0.3 | 0.4 |
| Net trade | -68 | -18.4 | -27.4 |
| | Whole Milk Powder | | |
| Price | 2558 | -1.8 | -2.5 |
| Supply | 558 | 1.5 | 2.0 |
| Demand | 527 | 0.9 | 1.2 |
| Net trade | 31 | 11.3 | 15.6 |

This assumes that farmers will easily adjust to the gradual (and already announced) increase in quotas under EX-SO and that 5 years after the hypothetical early expiry in 2009 would be sufficient for a complete adjustment.

As may be expected EX-FA is generally having stronger market impacts compared to EX-SO, but the difference is not large. For example the milk price decline would be about 1.3% (= 4.6% - 3.3%) larger under EX-FA compared to EX-SO. This is due to the fact that only Austria, the Netherlands and Spain would be constrained at all by the expanded quotas under EX-SO whereas for all other countries the expansion would render quotas irrelevant.

This seems to be at odds with results for 2020 in Tables 2 and 3 which implied that the quota system is strongly constraining the EU dairy sector. There are two points to resolve this puzzle:

- Some long run trends in favour of increased competitiveness like demand growth and milk productivity growth are gaining strength over time and thus are more influential in 2020 than in 2014.
- Three policy measures tend to reduce dairy prices in the years before 2014. The first is the decline in butter and skimmed milk powder intervention prices, the second is the abolition of subsidies for butter, skimmed milk powder and casein, assumed to be effective from now on. The third is the agreed sequence of quota increases, the last one effective from 2008 onwards.

As a consequence the impacts of the expiry scenario EX-FA are smaller than those expected for EX in 2020 and the differences to EX-SO are quite small. This implies that the soft landing strategy would indeed guide the EU dairy sector into the future without quotas.

In general net trade impacts are stronger than supply and demand impacts, simply because net trade is the difference of two large numbers usually. For raw milk net trade is nearly fixed and supply and demand changes are almost equal (and are thus omitted from Tables 2 and 6). Impacts on net trade are larger for secondary milk products. Among those butter is expected to see the smallest price drop under EX-FA and the largest change in net trade. This rests on our assumptions regarding export refund policies: Under status quo market management EU authorities are expected to prevent a stronger drop in butter prices with an increase in export refunds from 1630 €/t to 1690 €/t, as was the case under scenario EX in 2020. At the same time price stabilisation would give larger butter supply and thus a strong decline in net imports (negative net trade).

## V. CONCLUSION

This study provided an agricultural multi commodity analysis able to focus and investigate the ongoing EU milk reform. The analysis was carried with the Common Agricultural Policy SIMulation (CAPSIM) model which is a comparative-static, partial equilibrium modelling tool covering the whole of agriculture of EU member states.

CAPSIM provided a detailed coverage of dairy commodities for EU-27 with cow milk and nine dairy processed products. Attention was given to the uncertainty inherent to milk quota rent estimates in a corresponding sensitivity analyses. In another sensitivity analysis it was investigated whether the presence or absence of export refunds matters for milk quota expiry scenarios.

Results of milk quota expiry are simulated for 2020 that is some years after the reform, when a comparative static modelling tool may be expected to identify the medium run impacts. Key results are that milk production would increase by 2.8% in EU27 whereas milk prices would drop by 7.5%. These impacts would differ by MS and tend to be stronger where the initial quota rents were estimated to be higher. In fact it turned out that the regional pattern simulated is strongly influenced by the specification of initial quota rents which reflect differences in marginal cost and thus behavioural functions on the supply side.

Market impacts for derived dairy products are usually an increase in supply associated with declining prices, increased demand, and net exports increasing relative to the reference run. The impacts would partly depend on whether market management based on variable export refunds would dampen the price drop or not. In the standard case this market management is still relevant for butter which would limit the price change to 0.5%. In the sensitivity analysis without export subsidies the drop in butter prices would be 3.8 % which is similar to skimmed and whole milk powders. Cheese and fresh milk products would see somewhat smaller price changes (-2.5% and -1.6%).

Declining prices evidently benefit final consumers at the expense of producers. The balance of welfare effects is small and partly dependent on budgetary impacts. The quota expiry would increase butter refunds by about 139 m €. At the same time imports would decline which also holds for other dairy products and could lead to a loss of tariff revenues of about 168 m €. On balance the quota expiry would give small welfare loss of 230 m € for EU27 which declines to 40 m € if export subsidies were abolished (but tariffs still in place). In should be acknowledged that intrasectoral efficiency gains of quota expiry which follow from nonzero transaction cost in quota trade in the reference run are not captured in the CAPSIM analysis. Furthermore structural change over time may increase after the expiry of quotas. On the other hand environmental impacts, positive and negative, are also neglected. The small negative balance from the conventional welfare analysis in CAPSIM should be taken as an inconclusive result therefore.

As may be expected the sensitivity analysis confirms that all impacts are increasing if higher quota rents had been chosen. For this study the quota rents have been taken from the specialised dairy model EDIM [5]. Furthermore supply and final demand elasticities related to the dairy sector relevant have been cross checked with EDIM to ease model comparisons and potentially to provide complementary and matching information from CAPSIM that may supplement the earlier EDIM results. However, it turned out that in spite of sharing key parameters, large scale models are sufficiently complex to permit diverging results in some areas even though some elements have been aligned. For example, even though the signs of many impacts are the same in CAPSIM and EDIM, including the negative welfare balance, magnitudes differ nonetheless. In general EDIM gave a somewhat stronger production growth (+5.2% rather than +3.1%) and raw milk price drop (- 10.7% rather than -7.7%) for EU27. Methodological differences in the description of the dairy industry have been mentioned already and do not seem to be fundamental. The detailed description of the cattle complex including calves and nutrient balances and explicit representation of fodder markets may endogenously dampen supply response in CAPSIM in spite of similar supply elasticities for 'all else equal' changes. These supply side differences could not be completely clarified because the connection of reported elasticities, quota rents, price differences and production impacts in EDIM does not seem to follow from standard calculations. However another methodological difference rests certainly in the representation of external trade. CAPSIM has simple aggregate behavioural functions for exports and imports from the Rest of the World which imply heterogeneity of products whereas EDIM basically follows [19] and thus assumed products are homogeneous at the given level of disaggregation which may have led to stronger price impacts for dairy products.

A methodological challenge for future research would be to further identify which differences in modelling approaches are mainly responsible for quantitative differences mentioned above. It is nonetheless reassuring to note that in qualitative terms and for many quantitative relative indicators the two modelling systems gave quite consistent results.

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