EU DAIRY SECTOR: IMPACT OF LUXEMBURG REFORM, EU ENLARGEMENT AND TRADE NEGOTIATIONS

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Abstract

The EU dairy sector is facing a period of significant changes that are due to three major decisions: the EU enlargement, the Luxembourg reform and on-going WTO negotiations. To evaluate the impact of such changes we developed a model of the EU and world dairy industry. The model is composed of two modules that interact: a milk and beef supply module and a dairy industry module. In this paper we present the model and focus on elements that are crucial for a better understanding of the impact of reforms: quota rents in the EU, evolution of production in the new member states and trade policy.

Keywords: agricultural policy, dairy industry, partial equilibrium model
JEL codes: C21, Q13, Q18.

1. Introduction

The EU dairy sector has undergone, and is still facing, a period of significant change. Three major changes are having significant impacts for the entire EU dairy sector: EU enlargement, domestic policy reform and the outcomes of the current round of WTO negotiations. The 2004 enlargement of the EU to include 10 new member states (NMS) has increased both the production capacities and demand for dairy products in the EU. Further enlargements (Romania and Bulgaria) in the coming years will continue this trend. The Luxemburg reform takes place from 2004 until 2007 and will result in a significant decrease in the support prices for butter and skim milk powder (SMP), the introduction of decoupled payments and the maintenance of the milk quota system. On the international scene, the outcome of the ongoing Doha Round of the WTO trade negotiations is likely to follow the direction of the Uruguay Round Agreement on Agriculture. This will imply a reduction in both import barriers and subsidised exports.

Each of these three changes will have significant impacts on the whole EU dairy sector. Previous studies have analysed the impact on the dairy sector of such changes seperately. A lot of work was done at the end of the 90's about the impact of further trade liberalisation (Larivière and Meilke, 1999; Cox *et al.*, 1999; Shaw and Love, 2001; Donnellan and Westhoff, 2002). To prepare for the Luxemburg reform in the dairy sector, an in depth study was developed (INRA-Wageningen Consortium, 2002). Different studies were also developed to analyse the impact of removing quota in the EU (Colman, 2002; INRA-Wageningen Consortium, 2002). The impacts of the reform decided in Luxemburg were analysed by different teams (Binfield *et al.*, 2003; Bouamra-Mechemache and Réquillart, 2003). Finally, a few researchers have also studied the impact of the enlargement for the dairy sector (Banse, 2005).

However none of these studies have *jointly analysed* the impact of the three changes that will shape the EU dairy sector in the future. This is a limitation of these studies since trade policy and domestic policy are obviously not independent. Similarly, the evolution of demand for dairy products and the transition from subsistence to commercial production in the new member states (NMS) are key elements for the entire EU dairy sector.

The heterogeneous nature of the dairy sector in the EU has been further enhanced with enlargement to the new member states. Eight of the ten NMS are Central and Eastern European Countries (CEECs) and jointly produce around 20 per cent of total EU-15 milk production. Poland is the largest producer (55 per cent of total production in the CEECs) followed by the Czech Republic and Hungary. The dairy sector in these eight new member states shows large differences across countries in terms of prices, production methods, milk yields, product quality, farm structures and incomes. The existence of subsistence or semi-subsistence milk production in some of these countries (in particular Poland, Latvia and Lithuania) further adds to the large differences found in the sector across the EU-25 (Jongeneel and Ponsioen, 2005). These differences and the availability of data present significant challenges for modelling the dairy sector in the enlarged EU.

In this paper, we present the tool developed under the EDIM project and focus on key elements that are crucial in the analysis of alternative scenarios of evolution of the EU dairy sector.[i] This model is based on the model developed by the INRA-Wageningen Consortium but includes several important extensions: extension to the new member states, improved modelling of the rest of the world, and improved quota rent estimates.

This paper is structured as follows. In Section 2 we present the model structure and outline the estimation procedures used for the determination of the model parameters. In section 3 we discuss in more detail the issues related to quota rents and milk supply. In section 4, we present some first results of the combined impact of EU enlargement and the Luxembourg reform. This is followed by a discussion of some first results and issues relating to trade policy, in particular an increase in market access. Section 5 concludes.

2. Structure of the model

To analyse these three key developments in the EU dairy sector we develop a model of the dairy industry that is based on two interacting modules. The first module deals with milk and beef supply and the second one with milk processing and demand for dairy products. Each module can be used separately or in combination. When combined, equilibrium prices and quantities for milk and dairy products are endogenous. If used separately, some variables need to be set exogenously.

Milk and beef supply module

The supply module is designed to simulate the impact of dairy and beef policy instruments on milk and beef outputs, feed used as an input into milk and beef production, the stocks of dairy cows and beef (suckler) cows, and the allocation of land to beef and dairy production (forage and grazing). Although the focus is on commercial milk production, within the model a provision is also made for supply by the subsistence sector, which is in particular relevant for some CEEC countries. The model is based on an earlier Wageningen Dairy Model (Burrell and Jongeneel, 2001) and includes a number of extensions. In particular the model is extended to include the 10 new member states following their accession in 2004.

The model is based on a restricted dual profit function framework (e.g. Diewert and Wales, 1987; Chambers, 1988). Related demand and supply equations are recoverable from the profit function and shadow price functions for the quasi-fixed factors can be obtained. A special feature of the model is that the short-run profit function approach with the associated supply and demand functions is enriched by stock adjustment equations.

We assume a normalised quadratic functional form for the normalised restricted profit function:

$$\pi_t = \alpha_0 + \sum_{i=1}^{2}\alpha_i p_{it} + \sum_{k=1}^{4}\beta_k z_{kt} + 0.5\sum_{i=1}^{2}\sum_{j=1}^{2}\alpha_{ij} p_{it} p_{jt} + 0.5\sum_{k=1}^{4}\sum_{l=1}^{4}\beta_{kl} z_{kt} z_{lt} + \sum_{i=1}^{2}\sum_{k=1}^{4}\gamma_{ik} p_{it} z_{kt} + e_0 \quad (1)$$

where p_{it} are expected normalised output prices at time *t* (*1* = milk, *2* = beef and veal), and z_{kt} are quasi-fixed factors of production at time *t* (*1* = number of dairy cows, *2* = number of beef cows, *3* = land and *4* = time trend).

The supply equations, which are actually estimated, are obtained by differentiating the profit function with respect to the normalised output prices (Hotelling's Lemma)

$$q_{it} = \alpha_i + \sum_{j=1}^{2}\alpha_{ij} p_{jt} + \sum_{k=1}^{4}\gamma_{ik} z_{kt} + e_i\,,\ i = 1,2 \quad (2)$$

The demand equation for the numeraire variable input (animal feed) can be recovered from the linear homogeneity in prices of the profit function. Milk output supply is a function of current milk price, current beef and feed prices and current levels of quasi-fixed factors. Beef and veal output supply is a function of current beef and feed prices, current levels of quasi-fixed factors and milk output. Implicit in the short-run model are the shadow price relationships for the quasi-fixed factors (see for example, Moschini, 1988, 320). These relationships are obtained by partially differentiating the profit function with respect to the quasi-fixed factor (showing the amount by which profit would change following a one-unit change in the level of the fixed factor). This defines (minus) the shadow price of the quasi-fixed factor. The (conditional) shadow price functions for the quasi-fixed factors are given by

$$\frac{\partial \pi}{\partial z_h} = -p_h^s \,,\; h = 1,\, 2,\, 3 \tag{3}$$

Rearranging these functions yields the equations for the optimal level of each of the quasi-fixed factors:

$$z_h^* = \frac{1}{\beta_{hh}}\left(p_h^s - \beta_h - \sum_{k \neq h}^{4} \beta_{kh} z_{kt} - \sum_{i=1}^{2} \gamma_{ih} p_{it} \right),\; h = 1,\, 2,\, 3 \tag{4}$$

We assume that these quasi-fixed factors need more than one period to adjust to price and policy changes and, following Burrell and Jongeneel (2001), the adjustment of the quasi-fixed factors is modelled according to the following partial adjustment equation:

$$z_{k,t} = \lambda_k z_{k,t-1}^* + (1 - \lambda_k) z_{k,t-1} \;,\; h = 1,\, 2,\, 3 \tag{5}$$

By assuming that quasi-fixed factors adjust to their optimal levels following the partial adjustment mechanism, the following stock adjustment equations for dairy cows, beef cows and land are obtained

$$z_h = \frac{\lambda_h}{\beta_{hh}}\left(p_h^s - \beta_h - \sum_{k \neq h}^{4} \beta_{kh} z_k - \sum_{i=1}^{2} \gamma_{ih} p_i \right) + (1 - \lambda_h) z_{h,t-1} + e_i \,,\; h = 1,2,3 \tag{6}$$

Other dynamics in the model come from the inclusion of a technological change trend variable (z_4 = trend) and an exogenous milk yield growth rate.

In the case where no quota restrictions are imposed, milk supply follows the variable output supply function in (2). This is relevant for the CEEC countries, which prior to 2004 were not subject to a milk quota restriction. In the case where countries face a milk quota regime, such as all EU-15 member states since 1984, the imposition of a milk quota can be treated as analogous to the constrained quasi-fixed factors (Moschini, 1988) by introducing an additional quasi-fixed factor, z_5 = milk output. When quota are binding, milk output is equal to the quota level and $z_5 = z_5^{quota}$. The relevant behavioural relationship is than a quasi-fixed factor relationship, or the milk shadow price (p_1^s) function given by:

$$z_5 = \frac{1}{\beta_{55}}\left(p_1^s - \beta_5 - \sum_{k=1}^{4} \beta_{k5} z_{kt} - \gamma_{25} p_{2t} \right) \tag{7}$$

From this the milk shadow price (p_1^s) can be solved as

$$\Rightarrow p_1^s = \beta_5 + \gamma_{25} p_{2t} + \sum_{k=1}^{4} \beta_{k5} z_{kt} + \beta_{55} z_5^{quota} \tag{7'}$$

If milk quotas are in place, the dairy stock adjustment equation follows a simpler path. With milk output constrained by quota and a fairly inflexible relationship between milk output and dairy cows, farmers have little room to manoeuvre in adjusting their dairy stock.

Spatial equilibrium model of the European and world dairy markets

A spatial equilibrium model of the world dairy industry model is developed. It is a hedonic (milk characteristics), spatial equilibrium model which integrates an agricultural product (cow milk), 2 milk components (fat and protein), and 14 final dairy products (butter, skim milk powder, whole milk powder, condensed milk, casein, liquid milk, cream, fresh products and five categories of cheese: fresh, semi hard, hard, processed, blue and soft cheese).

This model extends on Bouamra *et al*. (2002) in two directions. First, it is enlarged to the 10 NMS, which gives a complete picture of the EU-25 dairy sector. We distinguish the three main producers (Poland, Hungary and Czech Republic) and consider the seven other countries as an aggregate. All of the 25 European Union regions are considered both as a supplier of milk and dairy products and as a demand region for dairy commodities. They can trade between each other or with the rest of the world. Second, to better evaluate the impact of trade liberalisation, the rest of the world is modelled in more detail. We consider that the 25 European Union countries compete on international markets with another exporting region, Oceania. It produces milk and processes it into dairy commodities that are then exported on world markets. On the import side, we distinguish four importing regions that are the main importers of EU-25 products, rest of Europe, Asia, Africa and Middle East countries, and America. For each importer, we model import demand functions based on "average" import demand elasticities that have been estimated using Comtrade trade statistics. Figure 1 illustrates the main trade flows that are taken into account in the model. Assumptions on production, consumption and trade for each region considered in the model are summarised in Table 1 below.

Table 1. Assumptions on variables used in the processing model

	SUP	*FLM*	*FRP*	*BUT*	*CRE*	*SMP*	*WMP*	*COM*	*CAS*	*SHC*	*PRC*	*OTC**
Production												
EU25	EN	EN	EN	EN	EN	EN	EN	EN	EN	EN	EN	EN
Oceania	EN	EN	-	EN	-	EN	EN	-	EN	EN	EN	-
Consumption												
EU25	-	EN	EN	EN	EN	EN	EN	EN	EN	EN	EN	EN
Oceania	-	EX	-	EX	-	EX	EX	-	EX	EX	EX	-
Rest of the world[1]	-	-	-	EN	-	EN	EN	EN	EN	EN	EN	EX
Exports												
EU25[2]	-	EX	EX	EN	EX	EN	EN	EN	EN	EN	EN	EX
Oceania	-	-	-	EN	-	EN	EN	-	EN	EN	EN	-
Imports												
EU25[3]	-	EX	EX	EN	EX	EN	EN	EX	EN	EN	EN	EX
Rest of the world[4]	-	-	-	EN	-	EN	EN	EN	EN	EN	EN	EX

EN: endogenous variable ; EX: exogenous variable ; - : absence of variable

* : OTC : other categories of cheese including blue, fresh, soft and hard cheese

1: Consumption is equal to imports from EU and Oceania; 2: Exports to rest of the world importing regions, additional exports are fixed.; 3: Imports from Oceania, additional imports from the rest of the world are fixed.
4: Imports from EU25 and Oceania, additional imports from the rest of the world are fixed.

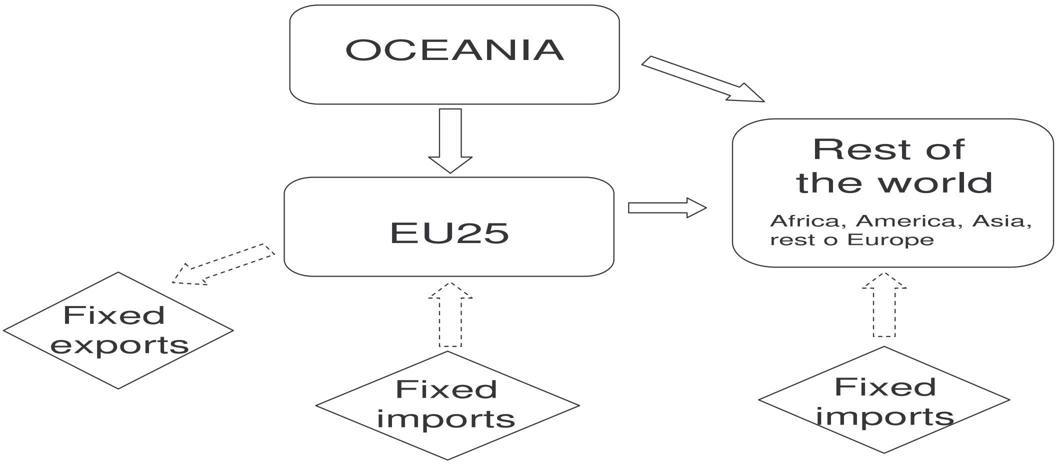

Figure 1. Regions and trade flows considered in the dairy industry model.

We denote I_1 the subset of producing and exporting regions (EU, Oceania) and I_2 the subset of importing regions. The inverse supply function for milk in region *i* ($i \in I_1$) is denoted $S_i(X_i)$ with X_i the quantity of milk collected. Because milk is a bulk product, we do not allow trade of raw milk between regions. We denote $Y_{i,k}$ the production of the processed commodity *k* in region *i*. Production of commodity *k* involves two basic components (fat and protein) that are an integral part of raw milk and that are "rearranged" and allocated among processed commodities. We denote $\alpha_{i,s}$ the quantity of the s^{th} component per unit of raw milk produced in region *i* and $\gamma_{k,s}$ the quantity of the s^{th} component per unit of processed commodity *k*. Under a Leontief technology, the transformation of the raw milk into processed commodities must satisfy:

$$\sum_k Y_{i,k}\gamma_{k,s} \le X_i\alpha_{i,s} \qquad \forall i \in I_1, s \tag{8}$$

Equation (8) ensures the balance in the allocation of component *s* in each producing region *i*. In addition to milk components, the production of commodity *k* also involves labour and capital inputs, which are provided at a constant marginal cost c_k. We assume that processing costs are identical among regions.

The inverse demand function for each final commodity *k* in region *i* is denoted by $D_{i,k}(Z_{i,k})$ where $Z_{i,k}$ denotes the consumption of commodity *k* in region *i*.

Trade across regions involves transportation cost. We assume a constant marginal cost for transportation of commodity *k* from region *i* to region *j* and denote it $t_{i,j,k}$. Trade flows, denoted by $XD_{i,j,k,ex,imp}$, represent the quantity of commodity *k* that is transported from region *i* to region *j* under the export regime *ex* (of region *i*) and under the import regime *imp* (of region *j*). We distinguish subsidized exports (*ex* = "*sub*") from non subsidized exports (ex = "*nsub*"). The per-unit export subsidy for commodity *k* is denoted by $ES_{k,ex}$. Obviously, $ES_{k,\text{"nsub"}} = 0, \forall k$. On the import side we consider import tariffs and tariff rate quota (TRQ). TRQs are modelled as an import quota associated with a low tariff (*imp*="*min*") and over quota imports associated with a higher tariff (*imp*="*ovq*"). We also consider the case where no tariff prevails (*imp*="*no*"). The per-unit import tariff for commodity *k* is denoted by $IT_{k,imp}$. Obviously, $IT_{k,\text{"no"}} = 0, \forall k$. Finally, note that $XD_{i,i,k,\text{"nsub"},\text{"no"}}$ is the quantity of commodity *k* that is both produced and consumed in the same region *i*. The trade flow constraints across regions are:

$$\sum_{j,ex,imp} XD_{i,j,k,ex,imp} \le Y_{i,k} \qquad \forall i \in I_1, \forall k \tag{9}$$

$$Z_{i,k} \leq \sum_{j,ex,imp} XD_{j,i,k,ex,imp} \qquad \forall i,k \tag{10}$$

In any region, these equations guarantee that exports plus domestic use cannot be larger than domestic production (equation 9), and that domestic consumption cannot exceed domestic production plus imports (equation 10).

To represent the EU dairy policy that influences world dairy markets equilibrium, we introduce the milk quota constraint as well as a constraint on the volume of subsidized exports.[ii] We write:

$$X_{"EU"} \leq \overline{X}_{"EU"} \quad . \tag{11}$$

$$\sum_{j \neq "EU",imp} XD_{"EU",j,k,"sub",imp} \leq \overline{XE}_{"EU",k} \qquad \forall k \tag{12}$$

On the import side, the TRQ is written as:

$$\sum_{i \neq j,ex} XD_{i,j,k,ex,"min"} \leq \overline{XI}_{j,k} \qquad \forall j,k \tag{13}$$

As a basis for representing resource allocation, we consider the following optimization problem:

$$\begin{aligned} & Max_{X_i,Y_{i,k},Z_{i,k},XD_{i,j,k,ex,imp}} QW(X_i, Y_{i,k}, Z_{i,k}, XD_{i,j,k,ex,imp}) = \\ & \sum_{i,k} \int_0^{Z_{i,k}} D_{i,k}(u)du - \sum_{i} \int_0^{X_i} S_i(u)du - \sum_{i,k} c_k Y_{i,k} - \\ & \sum_{i,j,k,ex,imp} (t_{i,j,k} - ES_{k,ex} + IT_{k,imp}) XD_{i,j,k,ex,imp} \end{aligned} \tag{14}$$

Subject to (8)-(13), $X_i \geq 0, Y_{i,k} \geq 0, Z_{i,k} \geq 0, XD_{i,j,k,ex,imp} \geq 0$.

The solution to (14) can be shown to generate a competitive resource allocation (see Chavas *et al.*, 1998). We derive the equilibrium on:

- the milk market in producing and exporting regions: production, price (country level);
- the intermediate products markets: fat and protein prices (country level);
- the dairy products markets: production, price, subsidized and unsubsidized consumption (country level);
- trade: imports, subsidised exports, unsubsidised exports (EU level).

We integrate the EU dairy policy instruments that include milk production quota, domestic subsidies for industrial uses of butter and SMP, a production subsidy for casein, export subsidies and import tariff rate quotas for each final dairy product as well as direct decoupled payments (June 2003 Luxemburg agreement). Domestic and export subsidies are endogenously determined in the model. They are adjusted in order to get SMP and butter prices as close as possible to the corresponding intervention price. Trade policies are also explicitly taken into account (EU export commitments, TRQ, in and over quotas tariffs).

Dynamics in the model relate to changes in demand functions and in supply. Annual shifts in demand functions for each dairy commodity have been estimated for EU-15 countries as well as for NMS and the rest of the world importing regions. These shifts in demand functions (an autonomous trend effect) are explained by the increase in population and in income as well as changes in taste of consumers.

Estimation of model parameters

The parameters for the system of equations in the supply model (output supply equations and quasi-fixed factor adjustment equations) are separately estimated for the EU-15 member states and the NMS. Parameters were separately estimated because two different estimation methods were required to address the differences in data availability for the original EU-15 member states and the 10 NMS.[iii] Both estimation methods make use of prior or non-sample information (NSI). For both estimation methods NSI consisted of non-stochastic theoretical constraints (e.g. symmetry) and stochastic constraints representing prior information from previous economic research (e.g. own price elasticity estimates for milk) and agronomic characteristics (e.g. genetic progress in annual milk yields). The usual regularity conditions were imposed during estimation.

Modelling the dairy sector of the new member states required a number of adjustments to the original model: firstly due to a lack of data a different estimation technique was required for the parameter estimation, secondly because no quota existed in the CEECs in the base year (2000) the supply functions (including the one for milk) could be directly estimated and the shadow function approach was not used.

Model parameters were already estimated for the EU-15 in the original Wageningen Dairy Model (Burrell and Jongeneel, 2001) and the current research directly incorporates these estimates. For the NMS, model parameters are estimated using a restricted generalised maximum entropy estimator (R-GME). The estimation procedure is briefly outlined here.

Estimation for the NMS is similar to that for the EU-15 member states in including NSI, but uses a restricted generalised maximum entropy estimator (R – GME). A classical econometric approach was not feasible since the system of equations for the NMS was ill-conditioned (insufficient number of observations) due to a lack of useable data for the NMS. The time series covers the period 1991-2002. GME is more efficient and robust than traditional econometric approaches when samples are small for three main reasons: firstly, it considers all information in the data constraint for each observation rather than rely only on sample moment conditions; secondly, the implicit weighting in the objective function between prediction and precision means that outlying observations have less impact on the estimations and thirdly, by including NSI it can be used to obtain reliable estimates in ill-conditioned problems. The entropy criterion consists of a dual-loss objective function in which equal weight is given to precision and prediction. In order to specify the entropy measure, all the coefficients and error terms in the system of equations represented in (2) and (6) must be reparameterised in terms of parameter supports and proper probabilities. The parameter support space is defined as $z_{ij} = \lfloor z_{ij1}, z_{ij2}, ..., z_{ijM} \rfloor$ and is an M x 1 vector of parameter supports such that $z_{ij1} < z_{ij2} < ... < z_{ijM}$ and M is a fixed integer M>2. The parameter support space spans up a uniform discrete space centred at zero which contains the expected parameter realisation. The corresponding convex weights associated with the parameter support space, p_{ij}, is a M x 1 vector of unknown probabilities such that

$$p_{ij} \in [0,1], \quad \sum_m p_{ijm} = 1 \quad and \quad \sum_m z_{ijm} p_{ijm} = parm_{ij} \quad \forall i, j \qquad (15)$$

where $parm_{ij}$ is a short-cut notation to represent all the α, β and γ parameters as given in equations (2) and (6). The error terms in equations (2) and (6) are also treated as unknown parameters to be estimated and therefore also requires an error support space v_i with associated probabilities w_i. Parameterization is similar to that of the model parameters.

The NSI or prior information was introduced as information on short run milk supply (NSI1), medium run milk supply (NSI2), autonomous annual milk increase (NSI3) and medium run response of cow milk to a change in dairy cow stock (NSI4). Prior information is imposed on each observation rather than on a particular observation or sample average. Therefore, to each stochastic restriction a stochastic component is attached to account for the variation in the data (e_{NSI}^{D}), whereas a second stochastic component is added, which expresses the uncertainty around the prior belief on the NSI introduced during the estimation (e_{NSI}^{U}). There are therefore eight stochastic error terms associated with the introduction of the NSI.

The final restricted GME criterion maximises the cumulative joint entropy representing the parameters, stochastic error terms and in addition the stochastic error terms associated with the NSI, (e_{NSI}^{D}) and (e_{NSI}^{U}). Using **p** as the compact vector notation for the vector of proper probabilities associated to each parameter, **w** as the vector of proper probabilities associated with the error terms associated with the sample data constraints, and denoting the vector of error terms associated with the non-sample information as $\mathbf{w}_{\text{NSI}}$, the GME objective criterion is given by

$$\max_{p,w} H(p,w) = -p' \ln p - w' \ln w - w'_{NSI} \ln w_{NSI} \tag{16}$$

subject to the data consistency constraints represented by equations (2) and (6), the regularity constraints on the probabilities (probabilities for each parameter must sum to one), the required theoretical constraints and the prior information NSI constraints. The primal solution to the R-GME problem obtained by solving for the first order conditions of the Lagrange problem yields the optimal values for the proper probabilities. From the estimated proper probabilities and parameter supports all parameter estimates and (estimated) error terms are recovered. The consistency and asymptotic normality of the (R-)GME estimator are proved under mild assumptions in Golan *et al*. (1996, 104-106).

A Normalised Entropy Index is used to measure the information content for the whole system including the stochastic NSI introduced during estimation. This index is then used to select the NSI used in the final model. For further details of the estimation method and results see Jongeneel and Tonini (2005).

3. Quota rents, quota and milk supply

Estimated marginal costs and milk supply elasticities

When a quota regime is in place, output is determined by the quota limit and price is given independently. Once quotas have been in place for some years, as is the case in the EU-15 member states, it is impossible to estimate directly from observed price and quantity outcomes either the slope or the height of the shadow milk supply function. The method used here for deriving the shadow milk supply function from the profit function gives reliable information about the slope of the function but is less reliable in fixing the height of the function at the quota level. The difference between the market price and the shadow price (equivalent to marginal costs) at quota level is known as the quota rent. Information on quota rents (or marginal costs) is therefore necessary to fix the height of the shadow price function. This information is important for quantifying the impacts of policy scenarios in simulation models, particularly in the case of quota removal scenarios.

Estimates of quota rents are taken from a complementary study in the EDIM project (Moro *et al*., 2005). Quota rents are estimated using a cost minimisation approach and a flexible functional form (hybrid-translog cost function). Data used in the estimations is unbalanced panel data from FADN for the period 1996 to 2001[iv].

Two lines of arguments can be made regarding the definition of appropriate quota rents. According to the first line, the appropriate quota rents are short-run rents since the shadow milk supply function used in the supply model is a short-run function (long-run adjustments in the model are provided by separately estimated quasi-fixed factor adjustment equations). According to the second line of reasoning, the decision-making horizon that farmers face when buying (or selling) quota should be taken into account. It seems plausible to assume that farmers take into account not only short-run variable costs (feed costs, etc.) but also costs associated with adjusting the dairy cow (capital) stock. In that case it is 'intermediate marginal' costs rather than short-run marginal costs that are relevant. Two additional arguments in favour of the latter line of reasoning are: 1) the quota rents obtained in this way seem to fit in with the lease prices for those countries where a quota market exists; and 2) the medium run marginal costs come rather close to the short-run average variable costs[v]. In this paper, we use medium-run marginal cost.

Marginal costs differ across producers and can differ significantly if one considers a marginal producer, an average producer or a particularly efficient producer. In order to accurately fix the height of the shadow milk supply function at the quota level, quota rents for the marginal (and not average) producers are needed. However, assume that the farm milk price drops below the marginal cost of the marginal producer. The producer stops producing and this quota becomes available for other producers. Are the other producers able to expand their production? This will depend on the existing allocation of quotas. If quotas are allocated according to efficiency (that is, if there is a market for quota that efficiently works and thus all producers have the same marginal costs), the other producers have no interest in expanding production and aggregate production will decrease. However, if quotas are not efficiently allocated (for example, because there is no market for quota, which is the case in some EU countries such as France), then other producers will wish to increase their production and thus aggregate production will not drop. In this paper, we use the estimate of the average marginal costs rather than the marginal cost of the marginal producer to take into account the possibility of reallocation of production among producers.

Table 2 shows the short-run and medium-run (accounting for adjustment in dairy cow stock) marginal costs for an average farm, the average variable costs (that include also costs for non-milk production) and the short-run and medium-run shadow prices (marginal costs) as a percentage of the milk price facing the average farm. On average the medium-run marginal costs were 73 per cent of the milk price. (Short-run marginal costs are on average about 42 per cent of the milk price and only 55 per cent of the average variable costs). Quota rents as a percentage of the milk price are equal to one minus the shadow/milk price ratios. In the analysis the medium-run marginal cost estimates is used.

Table 2. Short and medium run quota rent estimates used in the supply model (€/kg)

	BE	DK	DE	EL	ES	FR	IR
Short-run MC for average farm	0.063	0.125	0.180	0.055	0.126	0.149	0.129
Medium-run MC for average farm	0.174	0.272	0.270	0.306	0.178	0.271	0.171
Average variable costs	0.251	0.224	0.281	0.425	0.219	0.294	0.206
1) % Short-run shadow price/milk price[1]	25.6	43.6	59.3	20.9	64.4	51.9	53.5
2) % Medium-run shadow price/milk price	59.1	81.0	74.0	97.3	62.6	87.5	59.4
	IT	**NL**	**AT**	**PT**	**FI**	**SE**	**UK**
Short-run MC for average farm	0.143	0.134	0.149	0.165	0.161	0.149	0.150
Medium-run MC for average farm	0.257	0.219	0.187	0.247	0.236	0.275	0.179
Average variable costs	0.276	0.194	0.223	0.230	0.273	0.270	0.203
1) % Short-run shadow price/milk price[1]	47.6	54.0	59.3	74.3	57.9	52.1	53.2
2) % Medium-run shadow price/milk price	63.6	67.7	62.0	92.6	70.8	80.3	60.9

[1] Milk price is the average farm price.
Source: Moro *et al.* (2005)

The medium-run elasticities used in the supply model are presented in Table 3. For the NMS, they are based on empirical estimates made for Poland, Hungary and Czech Republic. The elasticities for the other NMS countries are based on a weighted average of the empirical estimates for these three countries, where the weights are the authors' estimates based on a study on similarities between countries in terms of production structure characteristics. Elasticities for the EU-15 are from the earlier model. The results presented for the CEECs (EU-10) and the EU-25 are production-weighted averages.

Table 3. Own-price elasticities of milk supply and MC estimates (for base year 2000)

Country	BE	DK	DE	EL	ES	FR	IR	IT
Medium-run elasticity	0.286	0.315	0.651	0.723	0.280	0.562	0.628	0.284
Country	**NL**	**AT**	**PT**	**FI**	**SE**	**UK**	**CZ**	**HU**
Medium-run elasticity	0.264	0.289	0.291	0.593	0.241	0.321	0.332	0.332
Country	**EE**	**LV**	**LT**	**PL**	**SK**	**SI**	**EU-10**	**EU-25**
Medium-run elasticity	0.280	0.280	0.280	0.183	0.339	0.280	0.253	0.449

Note: estimates for Estonia, Latvia, Lithuania, Slovakia and Slovenia are based on a weighted average of the estimates for Poland, Hungary and Czech Republic.
Source: estimates based on Jongeneel and Tonini (2005) for NMS and Burrell and Jongeneel (2001) for EU-15

Milk production in the NMS: competitiveness and convergence

Poland is by far the largest acceding country in terms of population, area and milk production (11.8 million ton in 2003 or 55 per cent of the total production in the eight CEECs). However, the average milk yield in Poland (4.0 ton/cow in 2002) is about 500 kg below the average in the eight CEECs, and about 65 per cent of the average yield in the EU-15 (6.1 ton/cow in 2003). This relatively low milk yield is probably the result of the large number of very small non-specialized farms in Poland, producing partly for own consumption and using mainly grasslands for feed. The two countries among the eight CEECs with the highest average yields, the Czech Republic and Hungary (about the EU-15 average), are the second and third largest milk producers, respectively, in the group (see Table 4). In these countries there are many large collective and cooperative farms, which use more modern technologies and concentrated feedstuffs as an important part of the feed ration (Tonini and Jongeneel, 2002). According to Agra Europe (2004), 95 per cent of Hungary's milk production meets EU hygiene standards, and similar high levels are reached in the Czech Republic.

The total production of the four main dairy-producing CEECs (Poland, Hungary, Czech Republic and Slovakia) increased during the sixties and seventies and fluctuated at a high level during the eighties. In 1991, there was a large fall in milk prices and production decreased markedly, partly because of decreased yields, but mainly because of a decrease in livestock numbers. Especially for Poland, this was a large shock for dairy production. However, production and yields have been increasing steadily since the mid-1990s (Jongeneel and Tonini, 2005).

Since no effectively binding milk quotas were present in the NMS up until 2004, the marginal costs of their dairy sectors should equal their milk price. The estimated milk prices for 2002 are given in Table 4. On average, the marginal costs estimates for the NMS are 0.21 euro per kilogram whereas those (medium-run) for the EU-15 are about 0.24 euro per kilogram (production weighted average; see Table 2 for marginal costs for individual member states). In terms of competitiveness, the old and new member states seem to be similar, with the new member states being slightly more competitive[vi].

4. First simulation results: Three key changes facing the dairy sector

The impact of EU enlargement and the Luxembourg Agreement

Using the supply module of the dairy model the impact of the Luxembourg agreement and the EU enlargement was simulated. The base year production data and the milk quota allotted to the NMS are given in Table 4. Note that milk quota apply only to milk delivered to dairies and direct sales. Milk used for feed, and more importantly subsistence production, is exempted from the quota restriction. As can be seen from Table 4 feed and subsistence production is about 40 per cent of Poland's total milk supply, and around 20 per cent for Estonia, Latvia, and Lithuania.

Table 4. The impact of EU enlargement and Luxembourg reform on EU-25 dairy sector

	CZ	HU	EE	LV	LT	PL	SK	SI	EU-15
				Base year 2000 data					
Milk price (€/kg)1	0.261	0.297	0.178	0.170	0.155	0.199	0.154	0.290	0.310
Milk production (000 ton)									
Total production	2787	2137	630	823	1713	11889	649	1099	121361
Delivered milk to dairies	2566	1830	409	398	947	6781	451	930	117139
Direct sales	69	165	87	226	390	464	93	22	1092
Feed and subsistence	152	142	133	198	375	4644	105	147	3130
Milk quota[2]	2682^{U}	1947^{U}	624^{U}	695^{U}	1647^{U}	8964^{U}	1013^{U}	560^{U}	118392^{B}
				Simulation results					
Production eligible to quota (000 ton)									
2004	2682^{B}	1947^{B}	594^{U}	623^{U}	1382^{U}	7925^{U}	1013^{B}	595^{U}	118893^{B}
2007	2738^{B}	1990^{B}	646^{B}	667^{U}	1487^{U}	8232^{U}	1041^{B}	574^{B}	120335^{B}
2014	2738^{B}	1990^{B}	646^{B}	729^{B}	1705^{B}	9380^{B}	1041^{B}	574^{B}	122742^{B}

^{B} Quota are binding; ^{U} Quota are not binding

[1] Milk price for EU-15 is the production weighted average milk price.

[2] Quota include direct sales but exclude restructuring quota. Quota values for CEECs are for 2004 and for EU-15 for 2000.

Source: own calculations.

The milk price evolution used for this scenario was taken from a previous analysis using the dairy industry module (Bouamra-Mechemache, *et al*., 2003). As compared to a year 2000 baseline, they predicted a 15 per cent milk price decline by 2007, after which the milk price steadily increases with about 1 percentage point per year (price in 2014 is 7.2 per cent below the baseline). Table 4 also shows the convergence of milk production in the NMS for selected years, and whether or not quota are projected to be binding in 2004, 2007 and 2014. In 2004 only 3 out of the 8 NMS face binding quota constraints (34 per cent of NMS production). This is irrespective of the milk price increase generated by accession to the EU dairy support regime. In 2007 this increases to 5 out of 8 countries (40 per cent of NMS production), whereas in 2014 all new member states will face binding quota. Poland is the last country whose quota becomes binding in 2011. The results obtained are conditional on the assumptions that no resources will shift from the subsistence sector into the commercial milk sector. If this would take place, quotas are likely to become sooner binding than is indicated here (cf. Jongeneel and Ponsioen, 2005 for a more detailed discussion).

The impact of international trade policy: Increasing market access

A key issue in the WTO negotiations for the EU dairy industry relates to the agreement on market access. While it seems very likely that export subsidies will be removed during the next 5 to 10 years, what exactly will be decided on market access is more debatable. Here we look at an increase in market access of either an increase in the import quantities of TRQs and/or a decrease in tariffs.

An increase in market access will have both positive and negative effects on the EU dairy sector. The net impact depends thus on the magnitude of these effects. On the one hand, an increase market access will lead to an increase in the world price due to increased demand in importing countries. This will open opportunities for EU exports and will have a positive effect on EU prices. On the other hand, the increase in market access in the EU facilitates EU imports from the rest of the world. Thus, this will have a negative impact on EU prices and increase the supply of dairy products on the EU market. What will be the net impact on EU prices is debatable.

Previous work by Cox *et al*. (1999) and Shaw and Love (2001) predict an overall negative impact for the EU. Cox *et al*. (1999) conclude that the reproduction of a Marrakech agreement will lead to a significant drop in the EU milk price (3.9 per cent). Shaw and Love (2001) conclude that doubling TRQ and halving tariffs will lead to a decrease in EU milk price by 1.8 per cent and to a decrease in prices of EU dairy products by 1 to 3 per cent depending on the products. They also conclude that this increase in market access will generate a significant increase in world prices (from 11.8 per cent for WMP to 18.5 per cent for butter). According to these two studies, the net impact on EU prices is negative; the increase in imports will have a larger impact than the increase in export opportunities. However these studies were conducted for a dairy policy implemented in 1995 or 2000. At that time, the gap between the EU and the world prices was large and any changes in tariffs or TRQ in the EU lead then to significant increases in the EU imports.

In the context of the post Luxembourg reform, the difference between EU and world prices will be reduced. This means that the positive impact (due to increased export opportunities) will be larger for the EU and the negative impact (due to increased imports in the EU) will be smaller. First results from the demand model indicate that, under some circumstances, a decrease in all tariffs and increase in TRQs could have a positive impact on EU prices.

Tables 5 and 6 illustrate some of the ideas discussed above. Under the 2000 conditions (Table 5), the difference between EU and Oceania prices are such that halving tariffs leads to an increase in EU imports because EU domestic prices are greater than Oceania prices plus the over-quota tariffs.

Table 5. Baseline situation: actual 2000 prices, tariffs (Euro/kg) and import quotas (1000 tonnes)

	BUT	SMP	WMP	SHC
EU 15 price	3.17	2.48	2.81	3.60
Oceania price	1.55	1.82	1.90	2.18
EU Tariffs				
Over quota	1.90	1.19	1.32	1.60
Current access	0.87	0.67	-	0.16
Minimum access	0.95	0.48	-	0.21
EU15 import quotas				
Current access	76.7	-	-	18.7
Minimum access	10.0	68.0	-	83.4

In contrast, in the 2007 situation (assuming that EU prices are close to intervention prices and assuming that Oceania prices do not change), import prices are no longer systematically lower than EU prices, depending on products (Table 6). For example, over quota imports will not occur for butter and for SMP even imports within the TRQ would not occur.

Table 6. EU-15 prices following Luxembourg reform and halving of tariffs (Euro/kg)

	BUT	SMP	WMP	SHC
EU 15 price	2.22	1.75	2.0 - 2.2	2.8 – 3.0
EU import price*				
Over quota	2.50	2.42	2.56	2.98
Current access	1.98	-	-	2.26
Minimum access	2.02	2.06	-	2.28

*without taking into account transportation costs from Oceania to EU-15

5. Conclusions

In this paper, we have discussed three major current and future changes in the EU dairy sector; the Luxembourg reform, the recent enlargement of the European Union to the 10 new acceding countries and the current round of WTO negotiations on trade. An overview of the structure of the INRA-Wageningen model, and its extension under the EDIM project, was provided. Highlighted issues are the ways in which the EU dairy sector is integrated in the world market, the empirical estimation procedure to estimate the dairy models for the NMS and the marginal costs (MC) estimates that are used in the supply module. With respect to the latter it is argued that medium-run MC estimates have a preference over short-run ones since they are more consistent with average variable costs figures. Due to differences in the dairy sectors and data availability in the NMS, a non-classical econometric technique was required to estimate model parameters for these countries.

The initial simulations in this paper were run using the stand-alone versions of the two modules. Simulating the impact of the Luxembourg agreement for the enlarged EU, we found that milk quotas will become gradually binding in the NMS. Initially only one third of the NMS' milk production will face binding quota constraints. This is irrespective of the milk price increase faced by the NMS.

We further show in this paper that a further step in the WTO trade liberalisation process may not lead to a decrease in EU prices compared to the post Luxembourg reform situation. The net impact on the EU dairy sector of a WTO agreement on increased market access will depend on the magnitude of two opposing effects. First, as has already been emphasized in the literature, increases in TRQ and reductions in tariffs tend to decrease EU prices. However, at the same time, it increases the demand in the rest of the world, which will tend to increase prices on the world market and in the EU. This impact might even be higher if demand in the rest of the world follows a positive trend. We provide first results that suggest that this positive effect may play a non-negligible role for the EU dairy sector. It is thus important to conduct a deeper analysis of world trade liberalisation. The model presented in this paper will be improved along this line.

The results presented in this paper are first results and as such subject to a number of qualifications. Planned further model improvements include empirical estimation of supply models for at least two additional NMS, and further analysis of the world market relationships and dairy trade liberalisation issues.

References

Agra Europe (2004) Enlargement seen boosting EU milk production by 20%. *Markets* 19, March 2004, p. 11. London: Agra Europe

Banse M. and Grethe, H. (2005) How Will Decreasing Subsistence Production Affect Future Dairy Markets in the Central European Countries?, EAAE Seminar "Modelling Agricultural Policies: State of the Art and New Challenges", 3-5. February 2005, Parma, Italy.

Binfield J., Donnellan, T., Hanrahan, K. and Westhoff, P. (2003) The MTR and the EU Commission Proposal for the WTO: An Analysis of their Combined Effect on the EU and Irish Agricultural Sector, FAPRI-Ireland Partnership.
Bouamra-Mechemache Z., Hadj Ali-Kein, H.and Réquillart, V. (2003) L'impact sur les marchés du lait et des produits laitiers de l'accord de Luxembourg, *INRA, Sciences Sociales*, n°4-5/03.
Burrell, A., and Jongeneel, R. (2001) A Model of the EU's Dairy and Beef Producing Sector. Policy Simulations: Agenda 2000 and Beyond. Impact of Milk Quota Abolition on Milk and Beef Production in the Member States. Final Report of Partner 5 in FAIR Project, May 2001.
Cathagne, A., Guyomard H. and Levert, F. (2005) EDIM Report. March 2005, INRA: Rennes.
Chambers, R.G. (1988) Applied Production Analysis: A Dual Approach. Cambridge: Cambridge University Press.
Colman D. (2002) Phasing Out Milk Quota in the EU. University of Manchester, Center for Agricultural, Food and Resource Economics, School of Economic Studies. Manchester.
Cox T.L., Coleman, J.R., Chavas, J.P. and Zhu, Y. (1999) An economic analysis of the effects on the world dairy sector of extending Uruguay Round Agreement to 2005. *Canadian Journal of Agricultural Economics* 47(5): 169-183.
Diewert, W.E. and Wales, T.J. (1987) Flexible functional forms and global curvature conditions. *Econometrica*, 55(1): 43-68.
Donnellan T. and Westhoff, P. (2002) World dairy trade reform: Perspectives from Europe and the USA. *Bulletin of the International Dairy Federation*, 376: 72-88.
Golan, A., Judge, G. and Miller, D. (1996) Maximum Entropy Econometrics: Robust Estimation with Limited Data. Chichester: Wiley.
INRA-Wageningen Consortium (2002) Study on the Impact of Future Options for the Milk Quota System and the Common Market Organisation for Milk and Milk Products. Summary Report. Brussels: European Commission, DG Agriculture http://europa.eu.int/comm/agriculture/publi/reports/milkquota/index_en.htm.
Jongeneel, R. (2000) The EU's Grains, Oilseeds, Livestock and Feed Related Market Complex: Welfare, Measurement, Modelling and Policy Analysis. Mansholt Institute (PhD Thesis), University of Wageningen.
Jongeneel, R. and Ponsioen, T. (2005) The EU Enlargement and the Dairy Sector: Potential Impacts and Perspectives. Draft EDIM Working Paper 03/05.
Jongeneel, R. and Tonini, A. (2005) Combining Sample and Non-Sample Information in a Restricted Information Thoeretic Generalized Maximum Entropy Approach: Modelling the Primary Dairy Sectors of Hungary and Poland. Paper presented at XI EAAE Conference, Copenhagen, 23-26 August 2005.
Larivière S. and Meilke, K. (1999) An assessment of partial dairy trade liberalization on the US, EU-15 and Canada. *Canadian Journal of Agricultural Economics* 47(5):59-73.
Moro, D., Nardella, M. and Sckokai, P. (2005) Regional Distribution of Short-run and Long-run Quota Rents Across the Major EU-15 Milk Producers. Draft EDIM working paper.
Moschini, G. (1988) A model of production with supply management for the Canadian agricultural sector. *American Journal of Agricultural Economics*, 70: 318-329.
Shaw, I. and Love, G. (2001) Impacts of Liberalising World Trade in Dairy Products. ABARE research report 01.4, Canberra, Australia.

Endnotes

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[i] EDIM: European Dairy Industry Model. This project is funded by the European Commission (DG research) under FP6. http://edim.vitamib.com/

[ii] In this setting, we assume that constraints on subsidized exports apply for each product (as it is the case for butter or SMP). In practice, some constraints apply for a group of products (cheese for example or other dairy products). To take this into account in the empirical model, we define constraints that apply for a group of products rather than individual products.

[iii] The model was ill-conditioned for the NMS due to a very small number of data observations.

[iv] Results for France from another complementary study in the EDIM project (Cathagne *et al.*, 2005) show that quota rents illustrate little trend over the period 1996-2001.

[v] On average the short-run marginal costs were 55 per cent of the average variable costs, whereas the medium-run marginal costs were 92 per cent of the average variable costs. Note that according to economic theory the relevant part of the supply curve for firms that are 'in business' is that part of the MC-curve which lies above the average variable cost curve.

[vi] For international comparison: the weighted average milk price for Oceania, which is often used to reflect international conditions for competitive milk production, was about 0.19 euro per kilogram for 2000-2002, and about 0.16 euro per kilogram for 2002-2004.