Effects of abolition of the EU milk quota system for Dutch agriculture and environment

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Abstract – **Following model calculations presented in this paper he removal of the EU quota system will result in 21% more milk production in the Netherlands. Large dairy farms expand and achieve higher income levels compared to a scenario with quota continuation, as increasing scale of production and decrease of quota costs outweigh price reductions and extra manure disposal costs. Production in the category of relatively small farms, however, declines and farms in this category will leave business. Sector income will only marginally fall while production expansion will remain within the limits of present environmental policies related to manure and nutrient applications.**

Key words - milk quota, mathematical programming models, environment

I. INTRODUCTION

The present EU dairy market regime combines price support, through measures like intervention buying, import tariffs and export subsidies, with milk quotas to limit production levels. The 2003 Luxembourg Agreements on reforms of the Common Agricultural Policy (CAP) retain the quota system at least until 1 April 2015. Further reduction of export support and market protection in the framework of WTO may push EU milk prices further down. From the other hand prices of dairy products have increased due to increased demand on world markets. With this at the background the number of countries in favour of milk quota abolition in 2015 is increasing.

The objective of this paper is to analyse the possible effect of milk quota abolition on milk supply, different types of dairy farms, the agricultural sector as a whole and the environment in the Netherlands. The Netherlands is a country with high livestock densities. National environmental regulations affects agricultural production through high manure disposal costs and other environmental costs initiated by the existing manure and nutrients policies [1]. The question is whether it would be profitable for different types of dairy farms and the Dutch dairy sector as a whole to abolish the milk quota system, given existing environmental policies. To take into account the relationships between policies on the one side and economic sectors and competition for fixed resources on the other side, we use an economic model of the Dutch agricultural sector.

The paper is organized as follows. In section 2 a literature overview is given. The literature overview focuses on the different modeling approaches that are used to analyze effects of milk quota abolition at the farm, agricultural sector or economy wide level and the interactions with environmental policies. Section 3 presents the model that is used to address the question at hand, namely the Dutch Regionalised Agricultural Model (DRAM). The fourth section discusses the scenarios in more detail with special emphasis on the new equilibrium milk price after abolition of the milk quota system. The fifth section presents some basic economic data related to dairy farming in the Netherlands. The sixth section presents the major results with respect of milk supply, number of animals, allocation of land to the crops, income per type of dairy cow and environmental effects in the different scenarios in 2015. The paper finishes with discussion and conclusion.

II. LITERATURE OVERVIEW

Different types of economic models are used to analyse the possible effect of milk quota abolition on different levels of aggregation. The models focus on different aspects of reality like effects of abolition of the milk quota system on allocation of the fixed inputs (labor, capital and land), prices and the environment. In [2] the focus is on milk and beef production on farms, processing of milk into dairy products and their allocation between domestic and foreign markets. Moreover a time path is included to capture autonomous shifts in technology, demand and differences in long and short term supply response. [3] and [4] use a general equilibrium model focussing on the interlinkages between all the industries and markets in an economy. Supply and allocation of fixed inputs (labor, capital and land) over the industries are determined by changes in gross margin per industry. In [5], [6] and [7] a positive mathematical programming (PMP) partial equilibrium approach is used to model the regional, national and European agricultural sector. The latter type of models focus on explicit modelling of the joint use of fixed resources. A wealth of physical data can be included to take into account the interaction between behaviour and physical restrictions. In [8] a linear programming model is used to analyze the effects of quota abolition at farm level in the Netherlands. Here manure and nutrients application limits are taken into account as well. Finally, [9] uses an econometrically estimated farm level simulation model using data from Dutch dairy farms to analyze effects of milk quota abolition. [8] And [9] take into account differences in marginal costs, technologies and restrictions at farm level in great detail. A disadvantage is that effects of changes in aggregated demand and supply on different types of input and output prices are neglected.

III. GENERAL DESCRIPTION OF DRAM[1]

DRAM is a model of the regional agricultural sector in the Netherlands [10]. DRAM consists of the following equations: one objective function maximizing national revenue minus variable costs from agriculture, regional agricultural product balances, regional balances for intra-sectorally produced inputs (animal manure, roughage and young animals), nutrient requirements per crop The model is completed with quotas (milk, starch potatoes and sugar beets), production rights (pigs and poultry) and land balances.

DRAM aggregates agricultural activities from the individual farm level to the regional level. The version of DRAM that is used in this paper distinguishes between twelve regions. These are the twelve provinces in the Netherlands. Regional differentiation is important because of heterogeneity of soil types per region and because of regional concentration of agricultural production.

In DRAM agricultural outputs are produced by agricultural activities. The selection of agricultural activities, outputs and inputs is determined by economic importance and possible environmental effects. Within each of the twelve provinces in DRAM, sixteen arable crop activities, three fodder crop activities (grass, maize and other), seven intensive livestock activities (beef cattle, fattening calves, sows, fattening pigs, laying hens, meat poultry and mother animals of meat poultry) and eight types of dairy cow activities are distinguished (see below).

Technical input coefficients concerning the total use of nutrients N and P (either from animal manure or mineral fertilizer), young animals and roughage (grass and maize) differ per activity per region and are treated as exogenous variables. Yield per activity is exogenous as well. Purchased variable input costs (concentrates, pesticides and other variable inputs) per activity are modeled using a quadratic variable cost function. The approach of Positive Mathematical Programming (PMP) is used to calculate the parameters of the cost functions in such a way that the observed activity level is almost exactly reproduced [12]. To overcome the problem of degrees of freedom in the standard PMP approach, prior information about the supply elasticities are used to calculate the parameters of the regional and activity specific cost functions [10,13].

Prices of marketable outputs and purchased inputs are treated as exogenous variables in DRAM. Internal inputs in DRAM are different qualities of roughage, young animals and manure. Internal inputs are produced and consumed within agriculture. Prices of the internal inputs are partly endogenous within DRAM. Animal manure can be traded between regions and internationally [14]. Young animals and roughage are not traded between regions, but they can be traded ‘internationally’[2]. Fixed inputs in the model

[1] A more detailed description can be found in [10] and [11]. The latter publication is available from the first author upon request.

[2] International trade include the use and produce of internal deliveries by activities not included in the model e.g. horses and sheep.

are land and quotas. Capital is assumed not to be restrictive in quantity and price in agriculture at the sector level.

Because of its economic and environmental importance for Dutch agriculture and because of its large share in total agricultural land use, milk production in the Netherlands is modelled in more detail in DRAM. Alternative milk production systems (technologies) are included as different types of dairy cows in DRAM. The model includes eight types of dairy cows by grouping dairy cows in the Netherlands by farm size, intensity of farming and milk production per dairy cow. This is presented in table 1. Farmers' behaviour might be different on small and large farms due to differences in marginal costs. Costs structures are also very different at intensive and extensive farms and farms with high and low milk production per dairy cow. Every type of dairy cow contains fixed coefficients with respect of feeding rations (grass, fodder maize and concentrates), own roughage supply, fertilizer inputs, other variable costs, land inputs, young animals and manure and nutrients excretion. These figures can also be different per region.

Table 1 Description type of dairy cows in DRAM

Dairy activity type	Milk production (kg per dairy cow)	Dairy cows (heads per hectare)	Dairy cows (heads per farm)
dairy 1	< 7450	< 1.6	< 60
dairy 2	< 7450	< 1.6	> 60
dairy 3	< 7450	> 1.6	< 60
dairy 4	< 7450	> 1.6	> 60
dairy 5	> 7450	< 1.6	< 60
dairy 6	> 7450	< 1.6	> 60
dairy 7	> 7450	> 1.6	< 60
dairy 8	> 7450	> 1.6	> 60

IV. SCENARIOS

A reference scenario with continuation of the milk quota until 2015 is compared with a counterfactual scenario wherein the milk quota system is abolished in 2009. In both scenarios manure policies in the Netherlands to comply with the EU Nitrate Directive are the same: 250 kg N from animal manure is allowed at dairy cow grassland and fodder maize activities, while 170 kg N from animal manure is allowed at arable crops and the grassland and fodder maize activities at other farm types than dairy farms. Arable crops, including fodder maize, also face application limits for P_2O_5 from animal manure, namely 85 kg P_2O_5 per hectare. The producer price of milk is exogenous in DRAM. It is assumed that (in real prices of 2002) this price decreases form about € 25 per 100 kg of milk in 2015 in the reference to about € 21.75 per 100 kg of milk in 2015 in the scenario with milk quota abolition. This price effect is about the 'middle of the road' of the results found in the literature [2,3,4,15]. Figure 2 summarizes the most important scenario assumptions.

Aspect	Reference	Quota abolished in 2009
Milk price (€ per 100 kg)[a)]	24.9	21.75
Milk quota system	Continued until 2015, abolished afterwards	Abolished in 2009
Environmental policy (kg N from animal manure per hectare)	170 kg N/ 250 kg N; 85 kg P_2O_5 for arable crops, including fodder maize	170 kg N / 250 kg N; 85 kg P_2O_5 for arable crops, including fodder maize

a)Prices of 2002.

Fig. 2 Scenario assumptions

V. ECONOMIC/ENVIRONMENTAL DATA AND AUTONOMOUS DEVELOPMENTS

In DRAM milk production marginal costs include all purchased variable costs (excluding purchased animal manure), net sales from intra-sectorally produced inputs (young animals, roughage and manure (the manure disposal costs)), opportunity costs of land, opportunity costs for labor and a PMP term. Due to a lack of data it is assumed that labour (opportunity) costs per farm are equal per unit of labour per farm. The PMP term covers the so-called unobserved costs [12]. Milk prices, milk production marginal costs and unit quota rents in 2002 and in 2015 per type of dairy cow activity are presented in table 2. In table 2 the different types of dairy cow activities are grouped to more conveniently present the data.

Table 2 Milk price, milk production marginal costs and unit quota rents in 2002 (€ per 100 kg) and in 2015 in the reference scenario (percentage difference compared to 2002)

Type	2002 Milk price	Marginal costs	Unit quota rents	2015 Milk price	Marginal costs	Unit quota rents
Large & low costs	31.7	14.0	17.7	-21	-11	-29
Large & high costs	32.2	14.9	17.3	-21	-15	-26
Small & low costs	31.5	19.3	12.2	-21	-17	-27
Small & high costs	31.8	22.4	9.4	-21	-9	-50
National average	31.8	16.8	15.0	-21	-18	-24

First, dairy cow activity are grouped by representing large and small dairy farms (see Table 2). Next, large and small dairy farms are further sub-divided by high and low variable costs plus (opportunity) labor costs per kilogram milk. So, basically the category 'Large & high costs (per kilogram milk)' are the farms with relatively less milk production per farm in the category large farms. Table 2 shows that quota rents decrease over time especially for the category small dairy farms with high costs. This decrease is explained by a large decrease in the milk price which is only partly offset by the decrease in marginal costs of milk production (including the opportunity costs of labor). It is important to note that data of the national average in 2015 is highly influenced by changes in the shares of the different groups in total milk production.

Milk supply elasticities effectively used range from about 0.85 for dairy 1 and dairy 3, to about 0.7 for dairy 5 and dairy 7 and to about 0.6 for dairy 2, dairy 4, dairy 6 and dairy 8. A price elasticity of milk supply was econometrically estimated by [9]. Estimating a short term model, they found elasticities of 0.26 and 0.43 depending on the functional forms respectively symmetric normalized quadratic or normalized quadratic [9]. Higher elasticities in this paper are justified as they are based on medium to long run milk production marginal costs.

VI. Results

The model results show that quota abolition in 2009 would result into almost 30% increase of milk production in the category dairy cows representing larger dairy farms with low costs (Table 3). At the same time, total milk production in the category dairy cows representing small farms with high cost declines by 13% as compared to the reference in 2015. Total milk supply in the Netherlands is projected to increase 21%.

The increase in milk production increases the number of dairy cows to about 1.43 million heads. This is about the same number of dairy cows as in 2002. The increase in total milk production and the number of dairy cows go together with a decline in production in the arable and other livestock sectors, except fattening calves. Possible dampening effects through e.g. changes in market prices of young animals are not taken into account.

Table 3 Milk production per category and total in the Netherlands in 2015 in different scenarios

Category	Reference 1000 ton	Quota abolished in 2009 % change relative to reference scenario
Large & low costs	4,983	28
Large & high costs	3,421	27
Small & low costs	1,751	8
Small & high costs	869	-13
Total	11024	21

Increases in milk production and number of dairy cows require extra grass and fodder maize to feed the extra number of dairy cows. Total acreage of grassland and fodder maize increases with 2.7%. The acreage of land allocated to arable crops decreases with about

6%. Within the group of arable crops the share of potatoes, sugar beets and vegetables in the total acreage of arable crops increases, while the share of cereals and other arable crops decreases. Manure disposal costs of dairy cow manure in the east of the Netherlands increase from about €4.0 per m^3 in the reference to about €6.40 per m^3 in the quota abolition scenario.

Table 4 Total income per dairy cow category in 2015 in different scenarios

	Reference Mio €	Quota abolished in 2009 % change relative to reference scenario
Large & low costs	1,010	-1.1
Large & high costs	633	3.3
Small & low costs	309	-2.2
Small & high costs	167	-21.7
Total	2,109	-1.1

Table 4 shows the effect on sector income per dairy cow category. Sector income is defined as revenues minus variable costs minus extra milk quota costs[3]. Table 4 shows that in the scenario with quota abolishment in 2009, sector income decreases compared to the reference. Yet, some types of dairy cows achieve a higher income level than in the reference scenario with quota continuation, as in their case production expansion (increasing scale of production) and decrease of milk quota costs outweighs price reductions and extra manure disposal costs. Clearly, losers of early abolishment are the types of dairy cows that represent smaller farms, especially the category with high milk production marginal costs per kg milk.

Finally table 5 shows the effect of abolition of the milk quota system on the national N balance. Total N production from animal manure and application of N from animal manure to the crops increases. Due to increased production and application of N from animal manure, the emission of N as ammonia increases at average with 9%. Table 4 shows that the national average increase in the N surplus at the soil level equals 14%. Emission of nitrogen as ammonia increases with 9%.

Table 5 Nitrogen (N) balance over all activities and regions in DRAM in 2015 in reference and early quota abolition scenario

Component	Reference Kg N per ha	Quota abolished in 2009 % change relative to reference scenario
Nitrogen (N) production from animal manure	218	11
Nitrogen from mineral fertilizer applied to the crops	123	-3
Nitrogen (N) application from animal manure applied to the crops	187	9
Nitrogen (N) uptake with harvested crops	202	0
Emission of nitrogen (N) as ammonia	81	9
Nitrogen (N) surplus at soil level	75	14

VII. discussion and conclusion

Model results presented in this study shows that removal of the EU quota system will result in 21% more milk production in the Netherlands. [9] found a smaller milk production increase (15.7% instead of 21%). This is largely due to the fact that the model applied by [9] can be characterised as a short-term model with production factors such as land and capital fixed at the farm level. [8] Simulated a two-price system by means of a mathematical programming farm model and found an increase in milk production at the farm level between 2.7% and 25.1%, depending on the environmental policies implemented. [8] assumes that extra land to produce extra grass and fodder maize is fully available. In this study this assumption is relaxed by including land balances at regional level. Another feature of this study is that

[3] The extra costs of land and labor are not included in the income variable. Extra milk quota costs in the reference scenario and the milk quota abolition scenario in 2015 is a function of the depreciation period, the interest rate and the value of the milk quota purchases over the period d 2002 to 2015.

manure balances are included to explicitly model substitution possibilities between different types of animal manure. This allows the dairy cow activities to increase their share on the manure markets at the expense of other manure types.

European wide studies differ with respect of milk supply effects per country after abolition of the milk quota system. [2] Predicts that milk supply in the Netherlands will increase less than the EU average. From the other hand [4] predict that milk supply in the Netherlands will increase more than the EU average. The latter authors apply the GTAP model and predict an increase in milk output in the Netherlands of 14.4%.

In DRAM individual dairy farms are aggregated to different types of dairy farms and further calculations are based on group averages. The disadvantage of this more aggregated approach is that differences at the level of individual farms are not fully accounted for. As a result real effects of abolition of the milk quota might be underestimated. The aggregation error can be improved upon by including more types of dairy cow activities.

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