Demand for dairy products in the EU

Zohra Bouamra-Mechemache (1), Vincent Réquillart (2), Claudio Soregaroli (3) and Audrey Trévisiol (4)

(1) Toulouse School of Economics (GREMAQ - INRA)

(2) Toulouse School of Economics (GREMAQ - INRA & IDEI)

(3) Università Cattolica del Sacro Cuore (Piacenza)

(4) APCEDE (Poitiers)

November 2007

Abstract: *In the EU dairy sector, given the remaining high protective tariffs and the quota system, the main factor that drives dairy product market prices is the demand. This paper evaluates the development of demand in the EU and presents estimates of consumption trends and forecasts for the future as well as estimates of elasticity with respect to prices and income in two major EU consumer countries: France and Italy. We use two methods to estimate the development of demand for dairy products, one based on a multi-stage demand system and another based on a single trend equation. The two methods generally lead to the same qualitative results but trend projections are larger using the demand system approach which is based on a shorter data period. This difference is thus partly explained by the fact that high trend projections are not sustainable over a long period. The results show a decreasing consumption of butter and fluid milk and an overall growth in protein and fat consumption. Nevertheless, the increase in fat consumption should be more moderate than the consumption of protein. The results also show that the demand for dairy products is relatively price inelastic but is more sensitive to changes in income (especially for butter and cheese categories). As shown by the use of a partial equilibrium model of dairy markets, the likely impact of the CAP reform strongly depends on the development of demand for dairy products in the EU. More research effort on demand analysis is therefore crucial in order to assess the impact of reforms or trade negotiations more accurately and effectively.*

Keywords: CAP policy, dairy, consumption trend, elasticity

1. Introduction

The EU is a major player in the world dairy sector: it is the main milk producer, one of the two main exporters as well as a major importer of cheese and butter (International Dairy Federation, 2004). The sector is facing three significant changes that could dramatically impact the equilibrium of EU dairy markets. These changes are mainly institutional, namely the Luxemburg reform on the Common Agricultural Policy (CAP), the EU enlargement (10 new Member States in 2004 and 2 additional ones in 2007), and finally World Trade organization (WTO) negotiations. It is clear that the EU dairy sector will be more market oriented in the future. In particular, the outcome of WTO trade negotiations is likely to lower border protection from imports and also reduce the role of subsidized exports. The CAP reform significantly decreases the support price for butter and SMP and is also limiting the role of public intervention. In the longer term, it is likely that the quota system will be reformed.

Actually, although the EU is a major player on the world dairy markets, about 90% of the milk produced in the EU is for domestic consumption of dairy products. Of this percentage about 10% benefits from consumption subsidies and the remaining 80% is consumed at EU support prices.[1] Because dairy products are for human consumption and do not have a lot of substitutes, the aggregate demand for dairy products is commonly considered as price inelastic. Moreover, because the production is regulated by quota (the milk quota system has been prolonged till 2014), any change in the aggregate demand for milk strongly impacts its price as quantity adjustment is restricted by the production quota.[2] On the whole, results from different economic models (EDIM, cf. Consortium INRA-Wageningen, 2002; FAPRI Europe, cf. FAPRI, 2004) suggest that, assuming a perfect transmission of price changes from upstream producers to downstream consumers, a 1% change in the aggregate domestic demand for milk causes a 3 to 4% change in milk price.

Due to the high sensitivity of milk price to the demand, farmers' revenues strongly depend on the increase of aggregate demand for milk. For example, the INRA-Wageningen Consortium Study (2002) on dairy policy scenarios has shown that if the demand growth rate is 0.5% a year rather than 0.75% a year (as has been observed in the past), ten years later, the farm milk price is 5 to 7% lower and the producer surplus is decreased by 2 billion €.

If demand for dairy products is relatively inelastic at the aggregate level, this is not true at the product level because dairy products may compete among themselves. In addition, the changes in demand for the different dairy products are heterogeneous. While the demand for cheese and fresh dairy products is growing, the demand for liquid milk or butter is stagnant or decreasing. Thus, the aggregate demand for milk fat is increasing less than the aggregate demand for milk protein.

An understanding of dairy market adjustments requires knowledge of demand price elasticity (own and cross price) and income elasticity for the various dairy products as well as information about structural changes in consumption. Obviously the market price and quantity equilibrium for the different final dairy products will strongly depend on the characteristics of demand for each product.

It is thus very important to have an accurate analysis of the development of the EU demand for dairy products in the future and to have good estimates of how this demand reacts to economic and market changes. In this paper, we address this issue using two methods commonly applied to estimate demand parameters: an analytical approach based on the estimation of a demand system and a single equation approach based on a projection of the EU demand trends in dairy markets. While the first method is a more systematic approach that can take direct and cross-price effects into account, trend equations are more useful when the necessary data are particularly aggregated and limited information is available on prices.

We use a country by country methodology to take into account the heterogeneity of EU member countries due to differences in preferences as well as economic development. We thus highlight the implications of both methods, and the related data sources for the evaluation of the development of EU dairy demand. Finally, using a model of the EU dairy industry, we analyse the impact of policy reforms on dairy market for alternative estimates of demand.

The paper is organized as follows: section 2 provides a review of the literature on dairy product demand estimates in Europe; section 3 presents the two methods of estimate; these methods will be applied using data described in section 4 and results are presented in section 5 with a focus on the comparison between the two methods and on the sensitivity of market equilibrium to changes in the demand; section 6 concludes.

2. Review of existing studies

2.1. Price and income elasticity

Previous studies have addressed the sensitivity of demand for dairy products with respect to prices and income in EU countries. Estimates of demand elasticity are often calculated using either the Almost Ideal (AI) demand system (Deaton and Muellbauer, 1980) or extensions of its linearised version such as the Quadratic Almost Ideal demand system (Banks *et al.*, 1997). Table 1 presents a synthesis of the elasticities estimated in the reviewed studies, while Tables 2 and 3 present more detailed information on the estimates of price elasticity and income elasticity for each study.

As a general rule, the demand for dairy products is rather inelastic as most of the studies report price elasticity lower than 1 (in absolute term). According to these results, the demand for butter is the least elastic and the demand for fresh dairy products and cheese are the most elastic among dairy products. However, results vary significantly from one study to another and it is difficult to define the source of variation with any precision (methodology, period, type of data and type of elasticity that is computed). Certainly, there are also country differences. It is interesting to note that in the case of France, for which 6 studies are available, the results are relatively homogeneous (particularly for fresh dairy products and cheese estimates).

Fresh dairy products and cheese exhibit higher income (or expenditure) elasticity than butter and drinking milk. To a greater extent than for price elasticity, results on income elasticity are very heterogeneous among studies. For example, estimates of income elasticity for drinking milk vary from -0.04 to 1.30, for fresh products from 0.22 to 2.50, for butter from -0.80 to 1.88 and for cheese from 0.02 to 3.22. However, the largest values for income elasticity correspond to "conditional" elasticity. Their "unconditional" counterparts would certainly be lower (because in these countries it is likely that an increase in income contributes more to non-food expenditure than to food expenditure).[3]

INSERT TABLES 1, 2 and 3

2.2. Consumption trends

Only a few studies are devoted to the analysis of consumption trends. The DG Agriculture of the European Commission, the OECD and FAPRI periodically publish analyses of market changes. However their projections frequently integrate price effects due to changes in agricultural policy. It is thus difficult to compare the results as the implicit assumptions are not always identical. Moreover, the results integrate two effects: the effect of changes in price on consumption and the effect of changes in consumption patterns for a variety of reasons, including changes in income. This is particularly the case for industrial products whose prices and consumption greatly depend on policy parameters, since a large share of SMP and butter consumption benefits from consumption subsidies. Moreover, because projections include the reaction to prices, they cannot be directly included in policy analysis models (both sectoral and CGE models) that analyse policy reforms.

Nevertheless, in table 4 we provide a synthesis of recent publications. They indicate either no growth or a decrease in the demand for butter and SMP, limited growth in the demand for fluid milk and a larger growth in the demand for cheese. For WMP, the results are more contrasting. However, domestic consumption represents roughly 50% of the production as a significant part is exported. Because fluid milk and cheese represent a large share of the milk used in the EU (43% in fat content and 66% in protein content) changes in demand for these two product categories have a strong impact on the aggregate demand for milk.

INSERT Table 4

3. Models

This section describes the two methods used to estimate demand parameters in this study: the estimation of a demand system and the estimation of trend equations. The first method is certainly a more systematic approach that can take direct and cross-price effects into account; the second, based on simple econometric techniques, has the advantage of using more aggregate data that are often of interest for policy purposes.

3.1. Demand systems

The demand system estimation is based on the AI demand system (Deaton and Muellbauer, 1980). This model and its extensions have been extensively used in the empirical literature, as the previous section confirms for the dairy demand studies. We estimate the linear approximation of the AI model (LA-AI) in differences as:

$$\Delta w_{it} = \alpha_i + \sum_j \gamma_{ij} \Delta \log(p_{jt}) + \beta_i \Delta \log(\frac{Y_t}{P_t^S}) + \varepsilon_{it} \qquad j=1,...,n,\ i=1,...,n-1 \qquad (1)$$

where w_{it} is the budget share of product *i*, p_{jt} is the price of product *j*, Y_t is the total expenditure, P_t^S is the 'corrected' Stone index as in Moschini (1995)[4], and ε_{it} is the error term. The constant term α_i plays the role of a trend effect and picks up changes in consumer preferences, population, and the other elements that are not specified in the standard model. Add-up, homogeneity, and symmetry conditions are

a) $\sum_i \alpha_i = 0, \sum_i \beta_i = 0, \sum_i \gamma_{ij} = 0$; b) $\sum_j \gamma_{ij} = 0$; c) $\gamma_{ij} = \gamma_{ji}$.

We apply this model to a multi-stage budgeting allocation. As is well known, multi-stage budgeting implies weak separability of consumer preferences (see Deaton and Muellbauer, 1980, and Moschini *et al.*, 1994).

The LA-AI demand models are estimated with maximum likelihood while dropping one equation from the system according to the adding-up conditions. The model uses first, second, or twelfth differences depending on the annual, bi-annual, or monthly nature of the data. Theoretical homogeneity and symmetry restrictions are tested using the log-likelihood ratio test: over the ten estimated models, homogeneity is rejected in only two cases and symmetry in one case (see table A3 in the appendix)[5]. Therefore, homogeneity and symmetry are imposed. Concavity is also locally imposed using the semi flexible approach of the Cholesky decomposition as suggested by Moschini (1998). Results of the parameter estimates are reported in tables A4 and A5 of the appendix.

Given the multi-stage budgeting allocation, the elasticities computed from the demand systems is conditional on the budgeting level. However, for the purposes of this study, which presents policy objectives, unconditional elasticities are more relevant since they better measure the detailed reaction of dairy consumption to a change in macroeconomic variables such as GDP and policy measures. Therefore, the unconditional values are calculated from the conditional counterpart using the method suggested by Carpentier and Guyomard (2001) extended to 3rd and 4th stage levels (see Appendix).

We estimate LA-AI models for France and Italy. For both countries, we define a multi-stage budget allocation that differs in the two cases because of the different nature of the data sources (Table 5). In the first stage, consumers choose between food and non-food expenditure. Then, in the second stage, consumers choose among the main food product categories. At this stage, the product categories defined for France and Italy differ slightly. For France, aggregates are: meat, fat (including cream and butter), cheese, 'fresh dairy products', and other food products. For Italy, the second stage includes all of the main food categories with dairy products grouped in a single aggregate; only in the third stage do consumers choose among the different products that make up the dairy aggregate.

INSERT Table 5

3.2. Trend equations

Trend equations find their application when the available data are particularly aggregated and limited information is available on prices. This is often the case for policy modelling purposes where the objective is to collect the same type of data for different countries at the aggregate level and where apparent consumption levels are measured. The next paragraphs briefly discuss this issue in relation to the data used in this study.

The general form of the estimated trend equation models is given by:

$$C_i = f(GDP, POP, t, D) \tag{2}$$

with C_i being the consumption of good *i*, GDP the Gross Domestic Product, POP the population, D dummy variables (mainly used to indicate structural change in data), and *t* the time index for the year.

In order to estimate an autonomous change in consumption (i.e. the trend effect) the price effect needs to be taken into account. When possible, consumption is computed at constant price using the following expression:

$$C_{tc} = C_t \left[1 + \varepsilon_D \frac{P_{ref} - P_t}{P_t} \right] \tag{3}$$

with C_{tc} being the adjusted consumption, C_t the observed consumption, P_t the price, P_{ref} the reference price chosen, ε_D the price elasticity of demand.[6] Of course, this method provides only a rough model as it does not take into account cross-price effects. Moreover, estimates for own-price elasticities are not always available so assumptions about their value must be made.

Several forms of models are estimated for the single equations:

- linear regression using variables or the logarithm of variables, including or not including quadratic terms for the independent variables;
- linear regression using Box-Cox transformations of the dependent variable;
- linear regression using variables in differences.

The validity of the estimated models is judged by checking residual properties: the normality of the distribution of the errors when ordinary least squares are used (Skewness and Kurtosis test), the independence of errors (Durbin-Watson test), the significance of the model (Fisher test) and of explanatory variables (Student test). When autocorrelation is detected, it is corrected by the Prais-Winsten or Cochrane-Orcutt transformations. The choice of the valid models is based on two main selection criteria: the adjusted R^2 and the mean squared error of the predictor.

We estimate consumption trends for each of the four main consuming countries in the European Union which represents around ¾ of the total consumption in the EU: France, Germany, Italy, the United Kingdom

(UK) and an aggregate of the other EU member states (named EU-11). Consumption trends have been estimated for eight dairy products: butter, whole milk powder (WMP), fluid milk, cream, fresh dairy products, condensed milk, cheese (excluding processed cheese)[7] and processed cheese.[8]

4. Data

The demand system approach. For France, we use annual data covering the period 1960-2003 (INSEE) (for the 1st and 2nd stages and at the 3rd level only for fat products) and data covering a four-week period from a consumer panel (SECODIP) for the period 1994-2004 (for the other categories of the 3rd stage). For Italy, we use data from the National Accounting Statistics of ISTAT (for the 1st and 2nd stages) and retail data from NIELSEN (for the 3rd and 4th stages). Data cover the periods 1952-2002 (annual data) and 1991-2003 (by semester) respectively. Descriptive statistics of the above data are reported in Tables A1 and A2 of the Appendix.

The single equation approach. We use annual data from different sources and countries concerning consumption, Gross Domestic Product (GDP), population and prices. The data sources are: Eurostat, CNIEL (Centre National Interprofessionnel de l'Economie Laitière, France), ZMP (Zentrale Markt- und Preisberichtstelle, Germany), UNEP (United Nations Environnemental Program), European Council, INSEE (Institut National de la Statistique et des Etudes Economiques, France), ISTAT (Italian National Institute of Statistics), Municipality of Milan (Statistical Office), Milk Development Council (UK), Tiffin, R. and Tiffin, A. (1999), and the Office for National Statistics of UK. When available, data cover the period 1960-2002.

5. Results

5.1. Elasticity of demand for dairy products in France and in Italy

In this section, we provide the values of the computed, uncompensated and unconditional elasticities and estimated trends. Since the multi-stage demand system approach uses retail level data from consumer panels, the estimation will provide information on household direct consumption. The estimation results will thus exclude the indirect demand from households which corresponds to the demand for dairy products from the agro food sector (this mainly concerns butter, powders and some categories of cheese) as well as the catering demand (mainly for cheese and fresh dairy products). Moreover, the data do not cover the demand for non human use.

Up to now, it has not been possible to include the analysis of these specific uses as time series did not exist until recently. Tables 6 and 7 report the elasticities for each dairy product computed, extending the method suggested by Carpentier and Guyomard (2001) to a three-stage and a four –stage budgeting system.

In France (Table 6), the demand for fluid milk as well as yogurt and other fresh products is inelastic to prices and expenditure. The change in demand is mainly due to a trend effect that is large and negative for fluid milk and large and positive for yogurt and other fresh products. This could be due to a very different innovation policy for these two products. While a significant number of new products are developed by the fresh products industry, it is not the case in the fluid milk industry.

The demand for cream is more price sensitive than the demand for butter and the substitutability between the two products is significant. The demand for butter is affected by income changes as expenditure elasticity is significant and close to 1. Interestingly, the demand for butter and cream is not significantly affected by prices of vegetable oils. Finally, there is a large trend effect. It is negative for butter, certainly related to health issues. By contrast, cream experienced a high increase in autonomous trend. This could be related to the development of low fat cream which may be considered by consumers as a healthy product.

The price elasticity of demand for the different cheese categories varies between -0.27 (processed cheese) to -1.22 (semi-hard cheese). The presence of heavily advertised brands in the processed cheese industry could explain their relative price insensitivity. Own-price sensitivity of cheese categories could be explained by the existence of close substitutes: significant positive cross-price elasticities are for soft cheese and semi-hard cheese, fresh cheese and hard cheese, processed cheese and blue cheese. Finally, the demand for cheese is significantly affected by a change in income as expenditure elasticity varies between 0.528 to more than 1 depending on the products[9]. Finally, it should be noted that the autonomous change in the demand is significant for some cheese categories. It is positive for fresh and processed cheese while it is negative for soft and blue cheese.

In Italy (Table 7), with respect to fresh dairy products and butter, we find significant price elasticities less frequently compared to the French case. This would suggest that for these products the demand is not significantly influenced by price. As with the French results, the demand for fresh dairy products is rather price inelastic, since unconditional elasticities are very low and not significantly different from zero[10]. Changes in consumption are determined by variation in total expenditure even though, unlike France, trend effects are not significant. In the case of butter, price does not seem to play a role in determining consumption, which is driven by a positive effect of total expenditure and a negative one given by trend. The significant negative trend for butter, as highlighted for France, reflects the change in preferences; in Italy the magnitude is even greater, probably driven by the shift in preferences towards olive oil.

Demand for cheeses shows significant own price elasticity only for soft and semi hard cheeses. These two categories are also substitutes.[11] Total expenditure drives consumption choices for all of the products, with hard cheeses showing the highest sensitivity. Trends in consumption are significant and positive only for soft cheeses: this category includes products such as gorgonzola, fontina and taleggio whose consumption might be favoured by the aging population. Comparison with the negative trend registered in France for soft cheeses is hardly feasible given the different product types that characterise the aggregate in the two countries.

According to our results, the demand for dairy products in France and Italy follows patterns that are similar for some products (butter) and differs significantly for other categories (cheeses). Thus, extrapolating results obtained in one EU country to other EU countries can only be tentative.

INSERT TABLES 6 and 7

5.2. Consumption trends in the European Union

In this section, we present the main results of the estimation of consumption trends in the different EU-15 countries (Table 8 as well as Table A5 in annex). Contrary to the previous case, the trend single equation estimation uses apparent consumption data and thus includes the catering demand and the demand from the agro food industry.

INSERT TABLE 8

Only two dairy products, butter and fluid milk, show a negative trend in consumption while all other products experience a growth in demand, with the largest increase being for fresh dairy products and cheese. One might wonder, however, if such an increase, more than 2% a year for cheese and fresh products consumption, is sustainable over a long period. However, the countries that experience the largest consumption trends are those for which the present levels of consumption are the lowest. This suggests some convergence among countries.

At the aggregate level, taking into account the different compositions in fat and protein of the dairy products, we find that the annual demand for protein will increase by 1% while the demand for fat will increase by 0.4%.

A tendency that is not covered by our analysis is the change in the composition of dairy products. Some analysts (ONILAIT, 2004, Richarts, 2004) argue that the demand for the fat component will not increase because of the change in products' composition. They argue that in a given product category, products that exhibit the largest increase in sales are those which have the lowest fat content in their category. However, their projections are based on crude assumptions about the changes in product contents. In order to evaluate the likely effect of this tendency on fat demand, we provide in the following paragraph an example based on the analysis of the market for cream in France.[12]

Thus, we consider the development of consumption for two categories of cream: a) "low-fat" cream (less than 29% fat); and b) "non low-fat" cream (more than 29% fat). To convert cream consumption into fat units we use technical data about the average fat content of each category of cream (Ireland J. et al., 2002 ; SCEES, 2001). As explained above, we observed two different phenomena: the market share of low fat cream increases while the share of high fat cream decreases. We perform two estimates of consumption trend using either the volume of total cream or the volume of cream in fat equivalent. We find that the demand for fat increases by 2.15% if we assume a constant composition of cream while it increases by 1.71% if we take into account the change in the composition of cream.

Thus, when the actual change in fat content in the product is taken into account, it leads to a lower increase in demand. However, in the above example, the trend remains significantly positive. The change in composition lowers the increase of fat demand by 0.4%. This result is based on the analysis of one product in one country. It is thus difficult to extrapolate to the whole market for dairy fat. The analysis should be extended to the other dairy commodities and for the other countries to better assess the real changes in aggregated fat demand.

5.3. Comparison of consumption trends estimates

Assuming that prices are constant, in Tables 9 and 10 we compare the one year consumption projection for France and Italy computed from the parameters obtained from the two models, that is from the model of demand and the simple trend equation model. Macroeconomic variables such as GDP or population differ in the two countries and it is assumed that the total expenditure change is equivalent to the GDP variation[13].

For France, the projected variations in consumption go in the same direction for all of the considered products except blue cheese. Differences are in magnitude, with the estimates from the demand system being of higher value for several product categories. These differences could originate from various sources. Firstly, the data used for demand systems only cover home direct consumption of dairy products by households while data used for trend estimates cover the apparent consumption of dairy products. Secondly, the period of analysis is very different: the last 10 years for the demand system while it is the last 40 years for the trend equations. This could explain part of the differences in magnitudes. Over a long period it is difficult to sustain a growth rate as high as 5% (cream).

The results for Italy are difficult to compare, especially for cheeses, since aggregates vary in the two models. Liquid milk excludes fresh milk in the LA-AI model and has a positive projection, while in the trend estimates the change is negative. This last result seems consistent with the trends shown by fresh milk in Italy. More contrasting are the results for butter since trend equations show a positive value while the demand system approach show a strong negative trend. This difference might be explained by the data type: the demand system is based on retail data and concerns final butter consumption while trend estimates also include the product's industrial use. Finally, projections for cheeses are all positive, even if the magnitudes from the demand system approach are smaller.

INSERT TABLES 9 and 10

5.4. Demand trend and market equilibrium

The impact of policy reforms on dairy markets will be highly dependent on demand characteristics and more particularly on the changes in EU demand for dairy commodities. Therefore, the trend estimates play a key role in market equilibrium and the distribution of surplus. Thus we analyse the impact of the Common Agricultural Policy (CAP) reform decided in Luxembourg in 2003 on dairy market equilibrium when considering different assumptions on the development of the EU demand for dairy products. First, we derive market equilibrium without trend in EU25 (No Trend). Then, we investigate how equilibrium changes when we introduce (1) a trend in the new member state only (Trend EU10), (2) a trend in EU15 member states only (Trend EU15) and finally (3) a trend in all EU member states (Trend EU25).

The impact of the CAP reform on dairy markets is derived from the model developed by Bouamra et al. (2002).[14] As the model is designed for the EU at the country level, we used the trends estimated by the single equation approach. This approach provides results for the main EU15 consuming countries as well as the aggregate of the other EU15 countries while the demand system only gives results for France and Italy. With respect to EU10 countries, we have formulated assumptions as we do not have estimates.[15]

The CAP reform for the milk sector includes a gradual decrease in the intervention prices of butter and SMP by 25% and 15%, a gradual increase in the quotas (1.5% in three steps) and introduces decoupled payments to compensate for the price decrease. As shown on Table 11, prices are significantly affected by the assumptions about demand trends.

If the demand for dairy products remains stable (No Trend scenario), the CAP reform has a strong negative impact (-11% between 2004-05 and 2011-12) on the EU25 milk price. The increase in production and the decrease in intervention prices (and therefore in subsidies used to sustain domestic prices) explain the decrease in both farm milk price and dairy product prices. These decreases in prices generate an increase in domestic consumption as well as an increase in exports as the EU becomes more competitive on world markets (except for butter). Note that the increase in domestic consumption is relatively small as demand is rather inelastic. The total consumption of SMP decreases as a significant part of the SMP consumption was subsidised. Subsidies which are given to SMP decrease more than the unsubsidized price. The result is that for subsidized utilisation, the reform induces a price increase and thus a decrease in consumption. Due to the increase in the milk quota, milk production increases as well as the production of all dairy products (except butter).

Assuming a positive trend in demand significantly affects market equilibrium. In the following we compare results taking into account the trend in EU 25 (last column Table 11) to results with no trend. First, the farm milk price is significantly higher by about 10%. Due to the existence of the quota, the impact on milk production is very small. The aggregate production increases by only 0.5%. This is because in a lot of countries even with a 'low' price the quota is binding. Second, the production of the different dairy products is also affected. As compared to the no trend case, the production of industrial products decreases while the production of final consumption products increases (except fluid milk). Exports are reduced as the domestic demand increases while the production is not significantly affected due to the existence of the milk production quota. The change in demand affects fat products and protein products differently. Thus butter price is negatively affected while SMP price is significantly higher. World market prices are also affected. If the demand in the EU increases then the EU exports decrease (due to the milk production quota) generating an increase in world prices. This is not true for butter as the EU would import less which causes a decrease in the world price of butter. The impact on producers' surplus is significant as the increase in the aggregate demand for milk induces an increase in their income by about €4.3 billion.

The positive effect of the development of demand on milk and dairy prices mainly comes from the increase in demand from EU15 countries which generates an increase of 9.4% in milk price. The increase in demand in EU10 new member countries has a much lower impact on milk price and dairy markets. It only generates a 1.9% additional increase in milk price and accounts for 17% of the total increase in milk price generated by an increase in the global EU25 demand. Even though the demand for dairy products in EU10 might grow at a faster rate than in EU15, the initial level of consumption and the population are significantly lower (EU10 population is less than 20% of the total EU25 population). Thus, in absolute terms, the major changes in consumption come from EU15 countries.

From these simulations we can draw at least two policy implications:

- The fact that the demand for protein increases at a higher rate than demand for fat is consistent with the new dairy policy that chooses to lower the intervention price for butter by a larger proportion than for SMP. As milk fat and milk protein are strictly joint products (the ability of price to influence the ratio between fat and protein in milk remains low), the market equilibrium for these two products will be reached by a decrease in the relative price of fat products to protein products. Currently, in 2005 and 2006 the EU price of SMP is significantly higher than the intervention price while the EU price of butter is roughly identical to the intervention price.[16]

- The impact of a change in trade policy (e.g. removing export subsidies) in the context of the Luxemburg policy will depend on the development of demand in the EU. In the context of the Luxemburg policy, with no change in the domestic demand, the EU will significantly use export subsidies to reach equilibrium in dairy markets in the future while, in the presence of a positive trend in demand, the EU will not use export subsidies for this purpose. Removing export subsidies for agricultural products will thus have different consequences depending on the trend in domestic demand.

INSERT TABLE 11

6. Conclusion

The EU is a major player in the world dairy sector. With WTO trade negotiations and CAP reform, the dairy sector will be more market oriented in the future. In the European Union, because the production of dairy products is regulated by quota, the main factor that drives the market price equilibrium is the demand. Therefore it is very important to have an accurate analysis of the development of the EU demand for dairy products in the future and to have good estimates of how this demand reacts to prices and income.

Two methodologies have been used to estimate demand trends: 1) the demand system approach which is based on a shorter time series including only retail consumption data; 2) the single equation approach that uses a longer time series including both retail demand and the demand from the agro food industry. These two approaches can be used in a complementary way depending on the evaluated demand level. Qualitatively equivalent trend projections were derived from the two methods. However, when comparable, trend level results are higher with the demand system approach. The single equation approach is more appropriate for analysing the overall demand for dairy products but is limited because, unlike the demand system estimation, it does not take into consideration the interaction between products.

In this study, we have presented estimates of consumption trends and forecasts for dairy products in the EU of fifteen members as well as estimates of elasticity of demand with respect to prices and income in two major consuming countries in the EU: France and Italy.

According to our results, consumption of butter and fluid milk should decrease while consumption of other dairy products should increase. Overall milk protein and fat consumption should both increase. Nevertheless, the aggregate increase in fat equivalent should be more moderate than the increase in protein equivalent. Moreover, the fat content in dairy products should decrease in the future and this may have an additional effect on the demand trend for fat.

As shown by the use of a partial equilibrium model of dairy markets, the likely impact of the CAP reform strongly depends on the development of demand for dairy products in the EU. More research effort on demand analysis is therefore crucial in order to assess the impact of reforms or trade negotiations more accurately and effectively.

References

Alston, J. M., Foster, K.A. and Green, R. D. 1994. Estimating Elasticities with the Linear Approximate Almost Ideal Demand System: Some Monte Carlo Results. Review of Economics and Statistics, 76(2), 351-56.

Banks, J., R. Blundell, A. Lewbel. 1997. Quadratic Engel Curves and Consumer Demand. The Review of Economics and Statistics,Vol. LXXIX, N°4.

Bouamra-Mechemache Z., J.P. Chavas, T. Cox, V. Réquillart. 2002. EU dairy policy reform and future WTO negotiations: a spatial equilibrium analysis. Journal of Agricultural Economics. 53(2), 4-29.

Bouamra-Mechemache Z., and V. Réquillart. 2006. Report on dairy policy simulation. EDIM Deliverable 8.5, Project funded by the European Commission, 01-04-2004/31-12-2005.

Brosig s; and T. Ratinger. 1999. Shifts in Food Demand of Czech Households During Transition. IX European Congress of Agricultural Economists, European Agriculture Facing the 21st Century in a Global Context, Watsaw, Poland.

Burrell, A. , R. Jongeneel. 1999. Demand for Dairy Products: A Case Study for the Netherlands- A report on work in progress for FAIR5-PL97-3481, Novembre 3, 1999- University of Wageningen.

Carpentier, A. 1991. Etude de la demande des produits laitiers. Mémoire de fin d'études, ENSAR Rennes.

Carpentier, A., H. Guyomard. 2001. Unconditional Elasticities in Two-Stage Demand Systems: An Approximate Solution. American Journal of Agricultural Economics 83(1), 222-229.

Cathagne A., H. Guyomard and F. Levert. 2006. Milk quotas in the European Union: Distribution of Marginal Costs and Quotas Rents. EDIM Working paper 01/2006. http://edim.vitamib.com/

Combris, P., V. Nichèle, J.-M. Robin and, V. Ximènes. 1998. Consommation et demande de produits laitiers en France. Working Paper. INRA ESR Ivry.

Conforti, P., P. Pierani, P. L. Rizzi. 2000. Food and Nutrient Demands in Italy. Actual Behaviour and Forecast Through a Multistage Quadratic System with Heterogeneous Preferences. WP 303, Universita degli Studi di Siena. Dipartimento Di Economia Politica.

Consortium INRA-Wageningen. 2002. Study on the impact of future options for the milk quota system and the common market organisation for milk and milk products. European Commission, DG Agri. Summary report. http://europa.eu.int/comm/agriculture/publi/reports/milkquota/index_en.htm

Deaton, A., J. Muellbauer. 1980. Economics and Consumer Behavior. Cambridge University Press.

Edgerton, David L. Weak Separability and the Estimation of Elasticities in Multistage Demand Systems. *American Journal of Agricultural Economics*, 1997, *79*(1) 62-79.

European Commission, 2007. “Prospects for agricultural markets and income in the EU 2007-2014; Directorate-General for Agriculture and Rural Development. Brussels, available at http://ec.europa.eu/agriculture/publi/caprep/prospects2007a/Fullrep.pdf.

Food and Agricultural Policy Research Institute (FAPRI). 2006. FAPRI Agricultural Outlook. Center for Agricultural and Rural Development, Iowa State University. Available at: http://www.fapri.org/outlook2006/text/outlookPub2006.pdf

Frohberg, K. and E. Winter, 2001. Functional Forms in Complete Demand Systems – Do they Matter for Policy Analysis? In Analysis of Food Consumption in Central and Eastern Europe: Relevance and Empirical Methods, Institute of Agricultural Development in Central and Eastern Europe, IAMO, S. Brosig and M. Hartmann edition.

Fulponi, L..1989. The Almost Ideal Demand System: An Application to Food and Meat Groups for France. Journal of Agricultural Economics Vol. 40(1) 82-92.

Green, R. D. and Alston, J. M. 1990. Elasticities in Aids Models. American Journal of Agricultural Economics, 72(2), 442-45.

Grings, M.. 2001. Structural Changes in Eastern German Food Consumption: Quantitative Analysis and Some Conclusions for Research on Food Consumption in Transition Countries. In: Analysis of Food Consumption in Central and Eastern Europe: Relevance and Empirical Methods” (2001), edited by S. Brosig and M. Hartmann –Studies on the Agricultural and Food Sector in Central and Eastern Europe. IAMO.

Hossain, F, H. H. Jensen and R. Snuka. 2001. Food demand Pattern in Latvia: Evidence from Household Budget Survey In Analysis of Food Consumption in Central and Eastern Europe: Relevance and Empirical Methods, Institute of Agricultural Development in Central and Eastern Europe, IAMO, S. Brosig and M. Hartmann edition.

International Dairy Federation, 2004. The IDF World Dairy Situation 2004, Bulletin - 391/2004.

Ireland J., J.C. Favier and M. Feinberg. 2002. Répertoire général des aliments Tome 2. Ciqual, Lavoisier, collection Tech&Doc, Paris.

Lavergne, P., V. Réquillart and M. Simioni. 2001. Welfare Losses Due to Market Power: Hicksian versus Marshallian Measuremen. American Journal of Agricultural Economics 83(1):157-165.

Moro D., M. Nardella and P. Sckokai. 2005. Regional Distribution of short-run, medium-run and long-run Quotas Rents across EU-15 milk producers. EDIM Working paper 03/2005. http://edim.vitamib.com/ .

Moschini, G.. 1995. Units of Measurement and the ‘Stone Index’ in Demand System Estimation. American Journal of Agricultural Economics, 77: 63-68.

Moschini, G..1998. “The semiflexible almost ideal demand system”. European Economic Review, 42: 349-364.

Moschini, G., Moro, D. and R. Green. 1994. Maintaining and Testing Separability in Demand Systems. American Journal of Agricultural Economics, 76:61-73.

Nichèle, V..2003. Health Information and Food Demand in France. In: Health, Nutrition and Food Demand, edited by W.S. Chern, and K. Rickertsen, CAB International, Wallingford, Oxon UK.

OECD-FA0, 2007. Agricultural Outlook: 2007-2016.

ONILAIT. 2004. Perspectives d’équilibre du marché de la matière grasse dans l’UE à l’horizon 2010. , Commission permanente des marchés, Paris.

Pierani, P., P. L. Rizzi. 1991. An Econometric Analysis of the Olive Oil Market in Italy. European Review of Agricultural Economics, 18-1, 37-60.

Richarts, E.. 2004. Butter Market Forecast, Projection Results. Transbeurop Meeting, Brüssel, 10 November 2004.

SCEES (Service Central des Enquêtes et Etudes Statistiques), 2001. Chiffres et données Agroalimentaire : lait et produits laitiers en 2000. Agreste, n° 103.

Tiffin, A. and R. Tiffin. 1999. Estimates of Food Demand Elasticities for Great Britain: 1972-1994. Journal of Agricultural Economics, 50-1,140-147.

Torres Ledezma, S., R. Yankam Njonou, and B. Henry de Frahan. 2002. Almost ideal demand system estimates for a highly disaggregated product palette in France. WP 04-02. Catholic University of Louvain.

Turk, J. and E. Erjavec, 2001. Ascertaining Changes in Food Consumption Habits During Transition: The Case of Slovania, Institute of Agricultural Development in Central and Eastern Europe, IAMO, S. Brosig and M. Hartmann edition.

Xepapadeas, A. and H. Habib. 1995. An almost ideal demand system with autoregressive disturbances for dairy products in Greece. Applied Economics Letters, 2, 169-173.

Table1: Synthesis on price and income elasticities of dairy products in the EU member States computed in the reviewed studies.

PRICE ELASTICITIES	Nb. of studies	Average	Std dev	Min	Max
All dairy	5	-0.57	0.44	-1.30	-0.21
Drinking milk	8	-0.53	0.43	-1.07	0.15
Fresh dairy products	4	-0.74	0.25	-0.95	-0.39
Butter	8	-0.47	0.38	-0.99	-0.02

Cheese	10	-0.60	0.36	-1.33	-0.15
Other dairy products	2	-0.18	0.11	-0.26	-0.10
INCOME ELASTICITIES	Nb. of studies	Average	Std dev	Min	Max
All dairy	6	0.86	0.62	0.09	1.89
Drinking milk	8	0.56	0.49	-0.04	1.30
Fresh dairy products	5	0.92	0.91	0.22	2.50
Butter	8	0.60	0.80	-0.80	1.88
Cheese	10	0.78	0.96	0.02	3.22
Other dairy products	2	2.65	2.70	0.74	4.56

Table 2: A synthesis of past studies on demand for dairy products in EU member states: Uncompensated own-price elasticities

Authors	Country	Data	Method	Type of Elasticity	Elasticity					
					All dairy products	Drinking milk	Fresh dairy products	Butter	Cheese	Other dairy products
Grings, 2001	Germany	An., 85-97	2SB-AI	U		-0.239			-0.145	-0.257
Carpentier, 1991	France	An., 70-90	4SB-AI	C		-0.25	-0.79		-0.88	
Combris *et al.*, 1998	France	An., 78-91	3SB-QU-AI	U		NS	-0.95	-0.49	-0.83	
Fulponi, 1989	France	An., 59-85	LA-AI	C	-1.30					
Nichèle, 2003	France	M., 78-91	QU-AI	C		-0.618	-0.853	-0.293	-0.648	
Lavergne *et al.*, 2001	France	An., 70-93	Log Log		-0.21					
Torres Ledezma *et al.*, 2002	France	An., 85-99	3SB-AI	U			NS	-0.061	-0.239	-0.097
Tiffin and Tiffin, 1999	Great Britain	An., 72-94	3SB-AI	C		-0.765			-0.336	
Pierani and Rizzi, 1991	Italy	67-85	AI	C				-0.241		
Conforti *et al.*, 2000	Italy	M., 85-95	QAI	U		-0.42		-0.02	-0.68	
Burrell and Jongeneel, 1999	The Netherlands	An., 73-96	2SB-LinExp	C		0.150	-0.386	-0.700	-1.325	
Xepapadeas and Habib, 1995	Greece	An., 60-91	AI	C		-1.0538		-0.9646	-0.3040	
Hossain et al., 2001	Latvia	M., 96-97	AI	U	-0.34					
Turk and Erjavec, 2001	Slovenia	An., 93	AI	U	-0.68					
Brosig and Ratinger, 1999	Czech Republic	M., 91-96	NQ		-0.32	-1.07		-0.99	-0.62	
Frohberg and Winter, 2001	Lithuania	1995	NQ-QES	U	-0.5 (raw milk)					

Type of Elasticity: Conditional (C) or Unconditional (U) to the budgeting level
Data: An.=annual; M.=monthly
SB stands for stage-budgeting. NQ-QES stands for Normalized Quadratic-Quadratic Expenditure System

Table 3: A synthesis of past studies on demand for dairy products in EU member states: Uncompensated income (or expenditure) elasticities

Authors	Country	Data	Type Elasticity	Elasticity					
				All dairy products	Drinking milk	Fresh dairy products	Butter	Cheese	Other dairy products
Grings, 2001	Germany	An., 85-97	U - Exp		0.664			0.385	0.742
Carpentier, 1991	France	An., 70-90	C - Exp		0.31	2.50	1.34	0.53	
Combris *et al.*, 1998	France	An., 78-91	U - Inc		NS	0.22	0.13	0.23	
Fulponi, 1989	France	An., 59-85	C - Exp	1.89					
Nichèle, 2003	France	M., 78-91	C - Exp		0.710	0.851	0.546	1.056	
Lavergne *et al.*, 2001	France	An., 70-93	- Inc	0.09					
Torres Ledezma *et al.,* 2002	France	An., 85-99	U - Exp			0.480	NS	1.411	4.556
Tiffin and Tiffin, 1999	Great Britain	An., 72-94	C - Exp		1.299			0.020	
Pierani and Rizzi, 1991	Italy	67-85	C - Exp				0.344		
Conforti *et al.*, 2000	Italy	M., 85-95	U - Inc		0.07		0.77	0.02	
Burrell and Jongeneel, 1999	The Netherlands	An., 73-96	C - Exp		-0.042	0.549	1.876	3.222	
Xepapadeas and Habib, 1995	Greece	An., 60-91	C - Exp		1.1724		-0.8036	0.5088	
Brosig and Ratinger, 1999	Czech Republic	M., 91-96	-	0.44	0.31		0.63	0.39	
Hossain et al., 2001	Latvia	M, 96-97	U-Exp	0.76					
Turk and Erjavec, 2001	Slovenia	An. 93	U-Exp	1.17					
Frohberg and Winter, 2001	Lithuania	1995	U-Exp	0.8115					

Type of Elasticity: Conditional (C) or Unconditional (U) to the budgeting level– Income (Inc) or Expenditure (Exp)
Data: An.=annual; M.=monthly

Table 4: Evolution in consumption of dairy products from 2005 to 2013 in EU 25.

	I-W study[(1)]	DG-Agri[(2)]	FAPRI[(3)]	OECD[(4)]
Butter	+1.5%	+0.2%	-2.8%	-2.8%
WMP	-	-	-9.4%	+4.6%
SMP	-1.5%	-4.0%	-3.6%	+3.2%
Cheese	+6.4%	+12.8%	+7.6%	+10.2%
Fluid milk	+2.7%	-	-	-

(1) Computed from the study by a consortium INRA-Wageningen (2002). Results apply for EU15 only.
(2) Computed from DG-Agri study (European Commission, 2007).
(3) Computed from FAPRI 2006 Agricultural Outlook.
(4) Computed from OECD Agricultural Outlook (2007). Results apply to EU-27.

Table 5: Utility tree used to estimate the demand system for dairy products in France and Italy

France					
1st stage	Food				
2nd stage	Cheese	Fat Products	Fresh Dairy products	Meat	Other
3rd stage	Soft	Butter	Fluid milk		
	Hard	Cream	Yogurt and fresh products		
	Semi-hard	Oil and Margarine			
	Blue				
	Fresh				
	Processed				

Italy								
1st stage	Food							
2nd stage	Dairy	Cereals	Meat	Fish	Fat	Fruit&Vegatables	Beverages	Other
3rd stage	Fresh dairy products	Cheese			Butter			
4th stage	UHT milk	Soft						
	Yogurt	Hard						
		Semi-hard						
		Fresh						
		Industrial						

Table 6: Unconditional and uncompensated elasticities of 3rd stage products for France

Categories	ε_{i1}	ε_{i2}	ε_{i3}	ε_{i4}	ε_{i5}	ε_{i6}	E_i	Trend
Fresh dairy products								
Fluid milk	-0.150**	0.094					0.290***	-2.51***
Fresh dairy products	0.062	-0.126*					0.330***	1.67***
Fat products								
Butter	-0.155**	0.015	0.085***				0.704***	-0.87***
Oils&Margarine	0.022	-0.073**	0.015				0.459***	0.04
Cream	0.524***	0.068	-0.606***				0.187*	5.21***
Cheese								
Soft	-0.604***	-0.071	0.434***	0.075	0.017	-0.008	0.719***	-1.47***
Hard	-0.077	-0.450**	0.076	-0.006	0.306***	-0.057	0.947***	-0.31*
Semi-hard	0.653***	0.107	-1.218***	0.100	0.217	-0.063	0.935***	-0.01
Blue	0.321	-0.025	0.285	-1.158***	-0.099	0.446***	1.055***	-0.80**
Fresh	0.019	0.322***	0.162	-0.025	-0.654***	0.031	0.664***	1.81***
Processed	-0.043	-0.285	-0.225	0.556***	0.151	-0.270**	0.528***	1.79***

Note: asterisks denote value significantly different from zero at the *10%, ** 5%, * **1% level.

Table 7: Unconditional and uncompensated elasticities of 3rd and 4th stage products for Italy

Categories	ε_{i1}	ε_{i2}	ε_{i3}	ε_{i4}	ε_{i5}	E_i	Trend
Dairy							
Fresh dairy	-0.131***	-0.133	-0.040			0.883***	0.95
Cheese	-0.065	-0.186	0.047			0.594***	-0.34
Butter	-0.199	0.322	-0.352			0.663***	-2.98***
Fresh dairy products							
Fluid milk (UHT)	-0.006	-0.093				0.666***	-0.243
Yogurt	-0.137	-0.029				1.122***	0.267
Cheese							
Soft	-0.819***	-0.018	0.845***	-0.157	0.067	0.293***	1.05***
Hard	-0.01	-0.209	0.028	-0.023	-0.029	0.866***	-0.46
Semi-hard	0.689***	0.046	-0.905***	0.014	-0.039	0.694***	-1.17
Fresh	-0.082	-0.022	0.010	-0.196	0.186	0.371***	1.26
Industrial	0.074	-0.064	-0.054	0.397	-0.538	0.658***	-1.24

Note: asterisks denote value significantly different from zero at the *10%, ** 5%, * **1% level.

Table 8: Estimated trends in consumption and per capita consumption (2000) of dairy products in the EU-15 countries. Trends in % and consumption in kg/hab. [(a)]

	Germany	France	Italy	UK	EU-11[(b)]	EU15
Butter	-1.8% (6.5)	-0.4% 8.6)	0.7% (2.7)	-4.5% (2.5)	-2.0% (3.0)	-1.4% (4.5)
Cheese	2.2% (19.5)	1.4% (24.9)	1.2% (20.9)	1.5% (8.5)	3.1% (14.0)	2.0% (17.1)
Processed cheese	0.7% (1.5)	3.2% (1.3)	1.5% (1.3)	2.15% (1.0)	2.8% (1.1)	2.1% (1.2)
Fluid Milk	-1.1% (66.1)		-1.4% (62.5)	-0.7% (119.5)	-0.2% (94.0)	-0.6% (87.1)
Cream	0.1% (7.9)	2.1% (4.1)	3.7% (2.2)		2.9% (4.5)	1.9% (4.8)
Fresh Dairy Pdts	1.0% (26.3)	2.3% (28.0)	3.72% (7.0)	3.2% (8.1)	3.1% (26.7)	2.4% (20.8)

(a) Trends are computed as exponential growth rate; per capita consumption is in brackets.
(b) When trends cannot be estimated for a given country, then the consumption of this country is aggregated with EU-11 and the consumption of this new aggregate is estimated.

Table 9: Estimated % variation in consumption of dairy products in France using parameters from demand system and trend estimates (Time = +1 year, GDP= +0.5%, POP= +0.4%)

	Demand system estimate[1]	Trend single eq. estimate
Fluid milk	-2.37	-0.19
Fresh dairy products	1.84	2.28
Butter	-0.52	-0.39
Cream	5.30	2.15
Soft cheese	-1.11	-0.71
Hard cheese	0.16	0.69
Semi-hard cheese	0.46	0.36
Blue cheese	-0.27	0.15
Fresh cheese	2.14	0.50
Processed cheese	2.06	0.84

[1]Assuming variation in total expenditure = variation of GDP.

Table 10: Estimated % variation in consumption of dairy products in Italy using parameters from demand system and trend estimates (Time = +1 year, GDP= +0,3%)

	Demand system estimate[1]	Trend single eq. estimate
Liquid milk	0.20[a]	-1.37
Fresh dairy	0.34	3.93
Butter	-2.78	0.67
Cream		2.12
Soft cheese	1.14	
Hard cheese	0.26	
Semi-Hard cheese	0.21	
Fresh cheese	0.11	
Industrial cheese	0.20	
Cheese		1.22
Processed Cheese		1.56
Whole milk powder		2.29

[1]Assuming variation in total expenditure = variation of GDP.
[a] Only including UHT milk.

Table 11. Impact of the Luxembourg reform on market equilibrium for milk and dairy products in EU25 for the period 2011-12. Relative results. Index 100=results in 2004-05.

	No Trend	Trend EU10	Trend EU15	Trend EU25
Farm milk				
Price	88.8	90.7	98.2	99.9
Production	101.0	101.1	101.5	101.6
Fluid milk				
Price	93.9	95.2	100.0	101.4
Production*	101.0	100.8	96.7	96.5
Fresh dairy products				
Price	97.1	98.3	101.6	102.7
Production*	100.6	102.6	115.4	117.5
Cream				
Price	94.7	94.4	94.7	94.7
Production*	101.4	101.5	110.1	110.3
Butter				
Price	92.3	91.5	90.3	88.6
Production	100.1	99.1	93.6	92.5
Consumption	100.7	99.3	93.2	92.1
Exports	12.3	12.3	12.3	12.3
World price	104.3	103.0	102.5	102.0
Skim milk powder				
Price	90.2	93.0	103.3	106.2
Production	107.3	103.5	92.6	87.1
Consumption	98.7	97.6	93.3	92.1
Exports	129.4	119.0	92.6	76.6
World price	103.3	106.5	113.6	116.9
Whole milk powder				
Price	89.5	91.1	96.0	97.5
Production	93.9	92.0	76.4	74.9
Consumption	103.4	104.8	109.3	110.8
Exports	215.2	84.2	56.3	52.9
World price	104.5	106.4	112.6	114.5
Semi hard Cheese				
Price	93.0	94.8	101.0	102.8
Production	105.7	108.3	112.2	114.9
Consumption	101.2	106.0	112.6	117.5
Exports	139.8	123.6	104.6	88.4
World price	102.0	104.4	109.5	111.9
Cheese				
Production	102.7	105.1	110.8	113.3
Consumption	100.8	104.0	110.8	113.9
Exports	127.1	118.7	108.2	99.9
Producer surplus**	841	1592	4430	5131

*: Consumption is equal to domestic production as there is virtually no international trade for these products

**: change in surplus between 2004-05 and 2011-12 (in Millions Euros) including direct payments.

In 2004, two changes occurred: the enlargement of EU and the first step of the Luxemburg reform. Both impacts the dairy markets. In order to focus on the impact of trend in demand on dairy markets we choose to start the simulation after the enlargement.

Appendix

A. Calculation of conditional and unconditional elasticities

Denoting by *i* and *j* two commodities belonging to the group of commodities *r*, following Green and Alston (1990) and Alston et al. (1994) the conditional elasticities for good *i* are defined as:

- price elasticity: $e_{(r)ij} = \frac{\gamma_{ij}}{w_i} - \beta_i \frac{w_j}{w_i} - \delta_{ij}$,
- expenditure elasticity: $E_{(r)_i} = 1 + \frac{\beta_i}{w_i}$,

where δ_{ij} is the Kronecker delta ($\delta_{ij} = 1$ for $i = j$; $\delta_{ij} = 0$ for $i \neq j$).

To compute unconditional elasticities we use the method suggested by Carpentier and Guyomard (2001) that corrects Edgerton (1997). Carpentier and Guyomard (2001) provide the expression of price elasticities for a two stage budgeting. In this study we extend this formula up to a four stages case, focusing on Marshallian (uncompensated) elasticities. The following paragraphs illustrate the expressions for the three stage budget allocation.

For a three stage budget allocation, denoting by *i* and *j* two commodities belonging respectively to the sub-groups of commodities *r* and *s* that belong respectively to the groups *a* and *b*, unconditional price elasticities at the third stage are defined as:

$$
\begin{aligned}
e_{ij} &= \delta_{rs} \times e_{(a)(r)ij} + w_{(b)(s)j} \times \left[\frac{\delta_{rs}}{E_{(b)(s)j}} + e_{(r)(s)} \right] \times E_{(a)(r)i} \times E_{(b)(s)j} \\
&+ w_{(b)(s)j} \times w_{(b)s} \times E_{(a)r} \times E_{(a)(r)i} \times (E_{(b)(s)j} - 1) \\
&+ w_{(b)(s)(j)} \times w_{(b)s} \times \left[\frac{\delta_{ab}}{E_{(b)(s)j} \times E_{(b)s}} + e_{(a)(b)} \right] \times E_{(a)(r)i} \times E_{(a)r} \times E_{(b)(s)j} \times E_{(b)s} \\
&+ w_{(b)(s)(j)} \times w_{(b)s} \times w_b \times E_{(a)(r)i} \times E_{(a)r} \times E_a \times (E_{(b)(s)j} \times E_{(b)s} - 1)
\end{aligned}
$$

where:

δ_{rs} is a dummy equal to 1 if $r = s$ and 0 else,
$e_{(a)(r)ij}$ is the conditional price elasticity of good *i* with respect to good *j*,
$w_{(b)(s)j}$ the budget share of good *j* in commodity group *s*,
$E_{(b)(s)j}$ is the conditional expenditure elasticity of good *j* (conditional w.r.t. expenditures of group *s*),

$e_{(r)(s)}$ is the conditional price elasticity of sub-group *r* with respect to sub-group *s*,
$E_{(a)(r)\,i}$ is the conditional expenditure elasticity of good *i* (conditional w.r.t. expenditures of group *r*),
$w_{(b)s}$ is the budget share of sub-group *s* in group *b*,
$E_{(a)r}$ is the conditional expenditure elasticity of sub-group *r* (conditional w.r.t. expenditures of group *a*),
δ_{ab} is a dummy equal to 1 if $a = b$ and 0 else,
$E_{(b)s}$ is the conditional expenditure elasticity of sub-group *s* (conditional w.r.t. expenditures of group *b*),
$e_{(a)(b)}$ is the price elasticity of group *a* w.r.t. group *b*,
w_b is the budget share of group *b*,
E_a is the expenditure elasticity of group *a*.

For the same stage, the unconditional expenditure elasticity for good *i* that belongs to the sub-group *r* that belongs to group *a*, is given by:

$$E_i = E_{(a)(r)i} \times E_{(a)r} \times E_{(a)}$$

where:

$E_{(a)(r)i}$ is the conditional expenditure elasticity of good *i* (conditional w.r.t. expenditures of group *r*),
$E_{(a)(r)}$ is the conditional expenditure elasticity of sub-group *r* (conditional w.r.t. expenditures of group *a*),
and $E_{(a)}$ is the expenditure elasticity of group *a*.

B. Tables

Table A1 – Descriptive statistics of variables used in the demand systems estimation for France

Categories	Price		Units	Expenditure share	
	Mean	St. dev.		Mean	St. dev.
Non-food[(a)]	0.57	0.37	1995 = 1	0.789	0.042
Food[(a)]	0.63	0.36	1995 = 1	0.211	0.042
Food[(a)]					
Cheese	0.64	0.36	1995 = 1	0.058	0.010
Meat	0.65	0.35	1995 = 1	0.283	0.011
Fat products	0.68	0.32	1995 = 1	0.041	0.011
Other	0.61	0.37	1995 = 1	0.581	0.013
Fresh dairy products	0.65	0.36	1995 = 1	0.037	0.006
Cheese[(b)]					
Soft	6.69	0.38	€/Kg	0.255	0.013
Hard	7.16	0.38	€/Kg	0.240	0.008
Semi-hard	8.34	0.55	€/Kg	0.169	0.012
Blue	10.89	0.62	€/Kg	0.059	0.004
Fresh	3.15	0.19	€/Kg	0.229	0.023
Processed	6.88	0.51	€/Kg	0.048	0.004
Fresh dairy products[(c)]					
Yogurt and fresh products	2.03	0.18	€/Kg	0.600	0.036
Fluid milk	0.60	0.05	€/Kg	0.400	0.036
Fat products[(a)]					
Butter	0.71	0.30	1995 = 1	0.530	0.090
Oil & Margarine	0.64	0.35	1995 = 1	0.384	0.050
Cream	0.71	0.34	1995 = 1	0.086	0.049

(a) annual data 1960 – 2003;
(b) monthly data 1996 – 2004;
(c) monthly data 1994 – 2004.

Table A2 – Descriptive statistics of variables used in the demand systems estimation for Italy

Categories	Price		Units	Expenditure share	
	Mean	St. dev.		Mean	St. dev.
Non-food[(a)]	0.39	0.41	1995 = 1	0.689	0.106
Food[(a)]	0.42	0.39	1995 = 1	0.311	0.106
Food[(a)]					
Cereals	0.41	0.39	1995 = 1	0.179	0.039
Meat	0.43	0.39	1995 = 1	0.241	0.044
Fish	0.41	0.42	1995 = 1	0.047	0.014
Dairy	0.41	0.39	1995 = 1	0.128	0.010
Fat	0.45	0.38	1995 = 1	0.071	0.017
Fruit&Vegatables	0.42	0.41	1995 = 1	0.147	0.026
Beverages	0.42	0.40	1995 = 1	0.099	0.011
Other	0.43	0.37	1995 = 1	0.088	0.015
Dairy[(b)]					
Fresh dairy products	1.08	0.05	1991 = 1[(c)]	0.412	0.018
Cheese	1.20	0.09	1991 = 1[(c)]	0.516	0.010
Butter	5.82	0.49	€/Kg	0.072	0.009
Cheese[(b)]					
Soft	1.27	0.13	1991 = 1[(c)]	0.142	0.009
Hard	12.18	1.22	€/Kg	0.285	0.023
Semi-hard	1.25	0.12	1991 = 1[(c)]	0.174	0.005
Fresh	1.18	0.08	1991 = 1[(c)]	0.272	0.020
Industrial	1.10	0.03	1991 = 1[(c)]	0.127	0.008
Fresh dairy products[(b)]					
UHT milk	0.80	0.04	€/Kg	0.524	0.026
Yogurt	3.54	0.16	€/Kg	0.476	0.026

[(a)] annual data 1951 – 2002;
[(b)] by semester data 1991 – 2004;
[(c)] computed trough Divisia indexes from single product categories.

Table A3 – Concentrated log-likelihood values from demand system estimates based on the utility tree of table 5

Stage - Category	Restrictions	Log-likelihood	Number of restrictions
France			
1st - Food/non food			
	Unrestricted	232.66	
	Homogeneity	232.48	1
2nd - Food			
	Unrestricted	949.81	
	Homogeneity	944.09	4
	Homogeneity and symmetry	940.15	6
3rd - Cheese			
	Unrestricted	2221.15	
	Homogeneity	2210.88*	5
	Homogeneity and symmetry	2196.83*	10
3rd - Fresh dairy products			
	Unrestricted	425.47	
	Homogeneity	424.81	1
3rd - Fat products			
	Unrestricted	349.26	
	Homogeneity	348.74	2
	Homogeneity and symmetry	347.47	1
Italy			
1st - Food/non food			
	Unrestricted	220.97	
	Homogeneity	215.60*	1
2nd - Food			
	Unrestricted	1713.46	
	Homogeneity	1708.21	7
	Homogeneity and symmetry	1692.6	21
3rd - Dairy			
	Unrestricted	207.19	
	Homogeneity	206.42	2
	Homogeneity and symmetry	204.96	1
4th - Cheese			
	Unrestricted	442.42	
	Homogeneity	439.81	4
	Homogeneity and symmetry	437.10	6
4th - Fresh dairy products			
	Unrestricted	76.439	
	Homogeneity	76.436	1

* The null hypothesis that the restrictions are correct is rejected at the 5% level of significance.

Table A4 – Conditional parameter estimates for France based on the utility tree of table 5

Categories	γ_{i1} [(a)]	γ_{i2}	γ_{i3}	γ_{i4}	γ_{i5}	γ_{i6}	β_i	Adj. R-square
Non-food	0.116***	-0.116***					-0.112***	0.835
	(0.008)	(0.008)					(0.011)	
Food		0.116***					0.112***	
		(0.008)					(0.011)	
Food								
Cheese	0.048***	-0.022***	-0.002	-0.020**	-0.004		0.042**	0.439
	(0.011)	(0.008)	(0.004)	(0.008)	(0.004)		(0.020)	
Meat		0.137***	-0.011**	-0.094***	-0.011***		0.071*	0.608
		(0.020)	(0.005)	(0.021)	(0.004)		(0.043)	
Fat Products			0.038***	-0.023***	-0.002		0.009	0.821
			(0.003)	(0.006)	(0.002)		(0.011)	
Other				0.153***	-0.016***		-0.109**	0.617
				(0.024)	(0.004)		(0.050)	
Fresh dairy					0.033***		-0.012**	
					(0.003)		(0.006)	
Cheese								
Soft	0.045	-0.068**	0.075**	0.007	-0.046	-0.013	-0.028	0.055
	(0.042)	(0.028)	(0.030)	(0.018)	(0.030)	(0.014)	(0.020)	
Hard		0.088***	-0.013	-0.012	0.028	-0.023*	0.041**	0.136
		(0.029)	(0.023)	(0.019)	(0.025)	(0.014)	(0.018)	
Semi-hard			-0.059**	0.010	0.005	-0.018	0.027	0.071
			(0.029)	(0.014)	(0.029)	(0.013)	(0.025)	
Blue				-0.012	-0.017	0.024***	0.018*	0.073
				(0.016)	(0.013)	(0.009)	(0.010)	
Fresh					0.033	-0.003	-0.041	0.060
					(0.053)	(0.011)	(0.036)	
Processed						0.033***	-0.016**	
						(0.006)	(0.007)	
Fresh dairy products								
Yogurt and fresh products	0.188***	-0.188***					0.031	0.246
	(0.028)	(0.028)					(0.034)	
Fluid milk		0.188***					-0.031	
		(0.028)					(0.034)	
Fat products								
Butter	0.186***	-0.186***	0.000				0.130***	0.885
	(0.016)	(0.010)	(0.013)				(0.034)	
Oil & Margarine		0.213***	-0.027***				-0.072*	0.894
		(0.010)	(0.004)				(0.039)	
Cream			0.027**				-0.058***	
			(0.013)				(0.014)	

[(a)] Asymptotic standard errors are in parenthesis. Note: asterisks denote value significantly different from zero at the *10%, ** 5%, * **1% level.

Table A5 – Conditional parameter estimates for Italy based on the utility tree of table 5

Categories	γ_{i1} [a]	γ_{i2}	γ_{i3}	γ_{i4}	γ_{i5}	γ_{i6}	γ_{i7}	γ_{i8}	β_i	Adj. R-square
Non-food	0.161***	-0.161***							0.070***	0.379
	(0.027)	(0.027)							(0.020)	
Food		-0.161***							-0.070***	
		(0.027)							(0.020)	
Food										
Cereals	0.128***	-0.048***	-0.003	-0.023***	-0.010***	-0.025***	-0.005	-0.014***	-0.130***	0.816
	(0.009)	(0.006)	(0.006)	(0.008)	(0.002)	(0.007)	(0.008)	(0.005)	(0.018)	
Meat		0.164***	-0.011	-0.038***	-0.014***	-0.028**	-0.001	-0.024***	0.135***	0.701
		(0.014)	(0.008)	(0.010)	(0.005)	(0.013)	(0.012)	(0.004)	(0.027)	
Fish			0.048***	0.000	-0.003	-0.008**	-0.014***	-0.009***	-0.033***	0.531
			(0.012)	(0.005)	(0.002)	(0.003)	(0.003)	(0.003)	(0.008)	
Dairy				0.090***	-0.007	-0.009	0.006	-0.018***	-0.029*	0.739
				(0.011)	(0.004)	(0.006)	(0.008)	(0.006)	(0.016)	
Fat					0.047	-0.002	-0.007	-0.005***	0.021	0.796
					(0.002)	(0.007)	(0.005)	(0.002)	(0.016)	
Fruit&Vegatables						0.089***	-0.008	-0.008*	0.016	0.608
						(0.010)	(0.007)	(0.005)	(0.027)	
Other							0.033**	-0.005	0.011	0.233
							(0.015)	(0.005)	(0.024)	
Beverages								0.083***	0.009	
								(0.003)	(0.012)	
Dairy										
Fresh dairy	0.240***	-0.203***	-0.037						0.095**	0.301
	(0.014)	(0.037)	(0.023)						(0.040)	
Cheese		0.208***	-0.006						-0.089**	0.254
		(0.071)	(0.035)						(0.039)	
Butter			0.043***						-0.005	
			(0.017)						(0.015)	
Cheese										
Soft	0.010	-0.038***	0.094***	-0.058***	-0.007				-0.071***	0.649
	(0.023)	(0.006)	(0.015)	(0.022)	(0.026)				(0.016)	
Hard		0.173***	-0.028***	-0.072***	-0.035**				0.131***	0.785
		(0.022)	(0.009)	(0.013)	(0.018)				(0.030)	
Semi-hard			-0.003	-0.040	-0.022				0.028***	0.513
			(0.041)	(0.038)	(0.047)				(0.008)	
Fresh				0.150***	0.021				-0.102***	0.690
				(0.034)	(0.038)				(0.021)	
Industrial					0.044				0.015	
					(0.075)				(0.016)	
Fresh dairy prod.										
UHT milk	0.273***	-0.273***							-0.129***	0.301
	(0.084)	(0.084)							(0.047)	
Yogurt		0.273***							0.129***	
		(0.084)							(0.047)	

[a] Asymptotic standard errors are in parenthesis. Note: asterisks denote value significantly different from zero at the *10%, ** 5%, * **1% level.

Table A6. Consumption trends. Models Selected

Product/country	Data	Endogenous	Exogenous	Remarks
Butter				
France	1960-2000	Log C	Pop	
Germany	1970-2002	Cc	Time	
Italy	1974-2000	Cc	Time	
UK	1974-2000	Log C	Time	
Other countries	1960-2000	Cc	Time, $Time^2$	
Cheese				
France	1985-2002	C; log C; ΔC	GDP, GDP^2; ΔGDP	Different models for different types of cheese
Germany	1972-2002	Cc	Time, $time^2$; GDP, GDP^2	Different models for different types of cheese
Italy	1979-2002	Cc	Time	
UK	1974-2000	Cc	Time	
Other countries	1960-1999	Cc	Time, $Time^2$	
Processed cheese				
France	1985-2002	Log C	GDP	
Germany	1976-2002	Cc	GDPc	
Italy	1976-2000	C	Time	
UK	1976-2000	C	Pop	
Other countries	1960-1999	Log Cc	GDPc	
Fluid Milk				
Germany	1977-2002	Cc	Time	
Italy	1977-2002	Cc	Time	
UK	1976-2000	ΔC	ΔPop	Arimax(0,1)
Other countries	1976-1999	Cc	Time	Box-Cox transformation
Cream				
France	1981-2000	C	Pop	Box-Cox transformation
Germany	1970-2000	Cc	Time, $Time^2$	
Italy	1960-2000	Log C	GDP	
Other countries	1960-1999	Log Cc	Log GDPc	
Fresh Products				
France	1980-2002	C	Pop	Box-Cox transformation
Germany	1977-2002	Cc	Pop_c	
Italy	1976-2000	C	Pop, Pop^2	
UK	1977-2000	C	Time	Box-Cox transformation
Other countries	1976-1999	Cc	Log GDPc	

Indice c means per capita.

Endnotes

[1] In the very recent period (June 2007), subsidies were set to 0 for all dairy products. This is the consequence of a global shortage in milk supply in the world (strong increase in demand in importing countries, particularly in Asia; decrease in production in Australia due to drought; quota policy in the EU). This has caused a sharp increase in dairy product prices. The use of subsidies is thus no longer needed to sustain prices in the EU.

[2] As shown by empirical estimates (Moro et al. 2005, Cathagne et al. 2006) milk quota rents are large (36% on average in the EU). This means that the milk supply is fully inelastic at least as long as the quota system remains in place.

[3] As highlighted by Edgerton (1997, p. 78), the same budget level should be used when comparing elasticities from different studies. This is not often the case for the data presented in Tables 2 and 3, given the heterogeneity of the included studies. For purposes of clarity, the type of elasticity computed by the authors is indicated in the tables: the term “conditional elasticity” is used to define elasticity computed at a given stage (starting from the 2nd) in the vertical structure of a multi-stage budgeting process; “unconditional elasticity” refers instead to first stage estimates or to values calculated using methods such as those suggested by Edgerton (1997) or Carpentier and Guyomard (2001).

[4] The Stone index does not satisfy the properties of index numbers since it varies with changes in the unit of measurement of prices. As Moschini (1995) suggests, this problem can be solved by the use of a "corrected" Stone index defined as

$$\log(P^S) = \sum_{k=1}^{n} w_k \log(\frac{p_k}{p^0})$$

where p^0 is a base period value. This approach will be followed in the empirical part.

[5] In a preliminary estimation of the model in levels homogeneity and symmetry were rejected more frequently than when the model was estimated in differences. This result supports the choice of this last model.

[6] An alternative solution would be to estimate both price effect and non price effect by including price as an explanatory variable. However, in numerous cases, price estimates were unsatisfactory. Thus, we choose this method to clear the changes from price effects.

[7] Consumption trends have been estimated by category of cheese when data was available (France and Germany).

[8] We did not estimate a demand trend for skim milk powder (SMP). SMP is not characterised by a time trend but rather by market fluctuations that are due to the fact that SMP is used as a market adjustment product.

[9] At the aggregated level, the demand for cheese is rather inelastic while it is significantly affected by income (we find an own-price elasticity of -0.177 and an expenditure elasticity of 0.808).

[10] Conditional elasticities have higher absolute value and are significantly different from zero. This implies that once the budget is allocated prices matter.

[11] We have estimated a different system where we distinguished between PDO and non-PDO cheeses. Results showed that the demand for cheese is rather price inelastic and in the PDO case expenditure elasticity is high.

[12] It was the only product for which we have sufficient data to distinguish between sub-categories.

[13] Implicitly assuming that marginal propensity to consumption is constant.

[14] Bouamra et al. have developed a spatial (*à la* Takyama and Judge) equilibrium model of the EU dairy sector to perform a quantitative analysis of the impact of different policy scenarios on dairy markets. The whole dairy industry is taken into account: milk supply, milk processing into final dairy products and demand for dairy products. A specific feature of this

model is that the processing stage takes into account the feasibility of the production. Moreover, because the EU is a large exporter on the world market (as well as an importer for some products), the world markets for the main internationally tradable dairy products are represented. Finally, the broad set of policy instruments used in this sector (on the EU domestic market as well as trade instruments) is incorporated.

[15] As we do not have estimates on demand trends for the new EU member states, we assume that they are identical to those estimated in EU15 except for cheese for which they are higher (3%) and for fluid milk for which we assume a stagnation of demand while in EU15 it is in slight decline. Thus, the rate of increase in dairy product demand is higher in EU10 than in EU15. For more details on trend assumptions, please refer to Bouamra-Mechemache and Réquillart (2006).

[16] In 2007, the EU price of butter is larger than the intervention price due to a conjunction of structural events (increase in demand from the rest of the world) and more accidental events (drought in Australia that reduces milk supply).