Is there Market Power in the French Comte Cheese Market?

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Is There Market Power in the French Comté Cheese Market?

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Abstract— **An NEIO approach is used to measure seller market power in the French Comté cheese market, characterised by government-approved supply control. The estimation is performed on quarterly data at the wholesale stage over the period 1985-2005. Three different elasticity shifters are included in the demand specification, and the supply equation accounts for the existence of the European dairy quota policy. The market power estimate is small and statistically insignificant. Monopoly is rejected, as well as weak forms of Cournot oligopoly. Results appear to be robust to the choice of functional form, and suggest little effect of the supply control scheme on consumer prices.**

Keywords— **Supply control, NEIO, protected designation of origin.**

I. INTRODUCTION

Comté is one of the most popular cheeses in France, with an annual production of about 50,000 metric tons, making the Comté industry the largest cheese industry benefiting from a protected designation of origin (PDO) in the country. (Most of the production is consumed nationally.) Production has been increasing steadily since the early 1990s. The industry is characterised by the existence of industry-wide contracts between upstream producers (dairy cooperatives) and downstream processors (ripening facilities), as well as government-approved supply control.

A New Empirical Industrial Organization (NEIO) approach is used to assess the degree of seller market power exercised in the Comté cheese market. The question has policy relevance given the importance of the industry and the controversial nature of the supply control scheme. In 1998, the producer association, the Comité interprofessionnel du gruyère de Comté (CIGC), was fined by the French antitrust authority for implementing a production plan without government support. (The plan consisted of charging penalties to individual producers for production in excess of a predetermined quota. A similar plan was approved by public authorities immediately afterwards, and such production plans are still in place today.) The Court's 1998 ruling stated:

[...] it remains undisputed that, on the first hand, the [supply control] measure targeted all Comté-producing firms and, on the other hand, [...] the criticized measure had a deterring effect which limited the price decrease and made Comté production less attractive for Emmental producers wishing to shift to Comté production; [...] finally, that several firms were indeed charged with a penalty for producing above their allocated quota, for a total amount of 1,156,509 French Francs; that, as a result, the measure had a significant effect on the market in question [...].

In a 2000 report, the Organization for Economic Cooperation and Development expressed concerns regarding the existence of market power associated with certain European PDOs, explicitly referring to specialty cheese markets [1]. In addition, approval of the Comté production plan by public authorities, in particular the French Ministry of Consumer Affairs, has traditionally been difficult to obtain.

Yet, the empirical importance of the existing distortion remains unknown. An empirical analysis that estimates the extent of market power being exercised in the Comté market is thus of interest to policymakers, and potentially to antitrust authorities. More generally, economists have been prompt in describing European PDOs as cartelised markets, and this argument may be used to oppose the recognition of PDOs at the international level. (For an overview of the debate over geographical indications between the EU and the US, see for instance [2].) Although focused on a particular commodity, this study sheds doubt on the ability of collective marketing arrangements such as those observed in certain PDO markets to sustain monopoly prices.

Traditionally, the NEIO technique has been used to measure the effects of industry concentration on buyer or seller competition and the efficiency of markets. It has also been used, in agricultural applications, to test whether marketing institutions such as producer cooperatives or marketing orders benefiting from antitrust exemptions have been successful in extracting oligopoly rents [3,4]. The present paper belongs to this latter branch of literature.

The article addresses the concern that the NEIO methodology has often been implemented on overly aggregated industries [5]. By focusing on one cheese

variety, without ignoring the possibility of substitution with other cheeses, the study narrowly defines the imperfectly competitive industry and tailors the estimation procedure to a close observation of policy, technology and demand conditions. The existence of a preexisting distortion due to the European dairy quota policy is taken into consideration by specifying cost as the opportunity cost of not producing a substitute cheese. This constitutes an interesting adaptation of the standard NEIO model.

The estimation leads to the conclusion that if market power has been exerted by the Comté industry, it is hard to detect econometrically and likely very small. This finding suggests that consumers have not been hurt by supply control and that the social cost of the policy has been negligible.

II. THE FRENCH COMTÉ CHEESE MARKET

Comté is a pressed, cooked cheese made out of raw cow's milk, aged for at least 4 months, that comes in large wheels weighing between 66 and 106 lbs. The specificity of Comté cheese was recognised by a Court decision in 1952, and its production was first codified in 1958. Comté was introduced in the European register of protected designations of origin in 1996, the date the register was created. Production is currently regulated by a 2007 governmental decree. The decree contains provisions such as the delimitation of the area of production, the physical characteristics of the cheese, and restrictions on the production methods to be used at each stage of fabrication, including the farm level. Notable production constraints include restrictions on cow breeds, on feed, limits on the stocking rate, and limits on the distance travelled for collecting milk.

The production process unfolds in three stages: milk production, cheese fabrication and cheese ripening. All stages must take place within a delimited geographical area covering several districts of the Franche-Comté region. The geographical constraint is not binding. Between 60 and 70% of the milk produced in the eligible region is transformed into Comté cheese. In January of 2005, there were about 3,300 milk producers, 190 cheese factories and 20 ripening facilities involved in Comté cheese production. Notably, 85% of the cheese factories were owned by milk producers through cooperatives.

Milk producers, dairy cooperatives and ripening facilities are represented by a producer association, CIGC, whose stated missions are to guarantee the specificity of Comté cheese and help producers maintain a sustainable activity in the region. CIGC fulfills its first mission by controlling producers at various stages of the production process, filing lawsuits against imitators, and participating in the development of standards.

The second mission is fulfilled through technical assistance to producers, generic advertising and the promotion of Comté cheese in export markets. CIGC also makes a yearly production plan to limit the quantity of Comté cheese produced, paired with model contracts designed to redistribute wealth between milk producers and ripening facilities.

The production plan is enforced through the delivery of certification marks necessary to authenticate cheese wheels. Marks are purchased from CIGC by cheese factories and applied onto unripe cheese wheels. Each factory is allocated a quota and charged a premium for each mark purchased beyond that quota. The penalty is adjusted to account for any modification in the average weight of wheels. The production plan is subject to yearly approval by the government.

The main purpose of the model contracts, to be adopted by ripening facilities and the cheese factories supplying them, is to set the price of unripe cheese. The contract also compels the ripening facility to purchase all the cheese produced by its suppliers.

Therefore, the Comté production sector can be modeled as a vertically integrated entity, with CIGC choosing the total quantity to be produced and reallocating rents through the contractual price of unripe cheese. These rents include the quota rent from the European dairy quota program, as well as any additional rent generated by the supply control scheme at the expense of buyers of ripened cheese. In what follows, we refer to the vertically integrated Comté production sector as "the Comté industry".

III. ESTIMATION STRATEGY

While the NEIO approach need not be explained in detail here, some features of the methodology deserve attention. (See [6] and [7] for a presentation of the NEIO technique.)

We assume a market equilibrium of the form:

$$P_C\left(1+\frac{\theta}{\eta_{CC}}\right)=c\,, \qquad (1)$$

where P_C is the price of Comté cheese, c the marginal cost, η_{CC} the own-price demand elasticity and θ is a market-level parameter that is simply interpreted as a degree of competitiveness, as suggested in [5]. It is equal to zero if the industry is competitive, and to 1 if the industry behaves as a monopolist. In a symmetric Cournot oligopoly with n firms, θ would take on the value $1/n$. The parameter θ, later referred to as the market power or conduct parameter, is directly related to the Lernex index L of imperfect competition for the industry: $\theta = L|\eta_{CC}|$. Here, imperfect competition is assumed to originate in the production limitations imposed on individual producers by CIGC. Using time-series data on price and quantity, we estimate equation (1), together with a demand equation, in order to jointly determine the demand elasticity, the marginal cost and the conduct parameter. Identification of θ relies on temporal variation in η_{CC}, so we need to introduce demand shifters that also shift the demand elasticity.

Three elasticity shifters are included in the demand specification: the price of a substitute cheese (Emmental cheese), income, and quarterly dummies. Emmental is the main type of pressed, cooked cheese manufactured in France, with an annual production of about 250,000 metric tons. By "elasticity shifters", we mean variables that interact with the price of Comté cheese on the right-hand side of the demand equation (quantity being the dependent variable), and therefore allow the calculated demand elasticity to vary across the period. To the extent of our knowledge, this is the first NEIO study to incorporate three different elasticity shifters in the demand equation. Typically, shifters are included either as interaction terms with price ("slope shifters") or as additive terms ("intercept shifters"). This imposes unduly restrictions on demand and could lead to spurious effects of the slope shifters on the calculated elasticity. Therefore, in our demand equation, each shifter is introduced both as a slope shifter and an intercept shifter. (See [4] for a discussion on the choice of demand shifters in existing NEIO studies.) Following the NEIO practice, we conduct sensitivity analysis by testing two alternative functional form specifications for demand.

Regarding the supply relationship, we do not rely on factor prices to specify the marginal cost curve, thereby departing from the standard NEIO model. Instead, we use the lagged price of a close substitute in production, Emmental cheese, assumed to be fixed exogenously, together with terms aimed at capturing the production cost difference between Comté and Emmental. The choice of the lag is justified by differences in the ripening time of the two varieties, Comté cheese being ripened for a longer period. In doing this, we explicitly recognise the fact that there exist alternative uses for the European milk quota in the region, mainly the production of Emmental cheese. The share of Comté and Emmental among the four main cheeses produced in Franche-Comté (Comté, Emmental, Morbier and Raclette) was 96.5% at the beginning of the study period and decreased to 83.9% in 2005. Over the period, the mean was about 89.8%. (These shares are rough estimates computed by comparing the quantities of each cheese variety, and do not account for differences in their milk content. It is expected that the milk content of Comté and Emmental is higher than that of the other two cheeses, which are not cooked.) Notably, the vast majority of new entrants in the Comté industry over the period of investigation have originated in cheese factories previously specialised in Emmental production. Introducing the lagged price of the main substitute in production in the cost specification amounts to using the *opportunity cost* of producing Comté cheese, that is, the difference in the marginal price-cost margin between the two cheese varieties.

Another reason for including the lagged price of Emmental in the cost specification is that it includes any dairy quota rent accruing to the dairy production sector, and is therefore a better indication of the true cost of producing Comté than a sum of physical input costs. In fact, ignoring the possibility that the dairy quota has been binding over the period of interest could lead the analyst to spuriously attribute significant price-cost margins to the presence of market power at the level of the Comté industry, while they are in fact due to the dairy quota and exist as well in other dairy markets. (Evidence suggests that the European dairy quota has been binding in the Comté region, meaning that the average price of dairy products has exceeded the marginal cost of producing milk in this region.) By specifying marginal cost as the opportunity cost of not producing Emmental, we thus seek to detect any *additional* markup beyond that originating in the European dairy quota. Section IV develops a theoretical model of imperfect competition that accommodates the preexisting dairy quota distortion and the existence of alternative milk uses, and is consistent with the traditional market-level NEIO equilibrium.

The contemporaneous and lagged prices of Emmental cheese are used as instruments in the empirical estimation. The assumption that these prices are exogenous to the demand and the supply relation is justified by the fact that entry is free in the Emmental market. Notably, there are no specific restrictions regarding the quality of milk used for Emmental production, and Emmental cheese can be produced anywhere. (Today, more than 70% of the total production of Emmental in France occurs outside of the traditional area of production.) Therefore, the Emmental market is assumed to be competitive. In addition, if generic milk is transformed into Emmental cheese according to a fixed-proportion, constant-returns-to-scale technology, which we will assume, then the exogeneity of the Emmental price will be satisfied as soon as random shocks to the demand for Comté cheese and to its supply relation are uncorrelated with the equilibrium price of generic milk, which under the dairy quota system is determined by the available quota and the total demand for milk. These random shocks in the Comté market may potentially affect the equilibrium price of generic milk in two ways: by shifting the total supply of generic milk or the demand for dairy products other than Comté cheese. We argue that both effects should be negligible, given that the milk market can be considered European-wide. First, even though random shocks to the demand for Comté or its supply relation affect the quantity of milk quotas used for Comté production, and therefore that available to produce generic milk, this is unlikely to affect the total milk supply, since Comté represents less than 5% of the total milk collected in France. Second, random shocks to the price of Comté may shift the demand for substitutes of Comté, but again this is unlikely to affect the derived demand for milk, given the small share of the total European milk supply transformed into cheeses that can be considered close substitutes to Comté cheese.

Finally, let us consider the choice of the frequency of data. Most of the variables needed, except income and population, are available at a monthly frequency. Since the production plan sets production caps for a 1-year period, it seems to call for the use of yearly data. Besides considerably reducing the sample size, such an approach would ignore specific provisions of the production plan, however. During the year, CIGC can adopt exceptional compulsory or voluntary measures, such as withdrawals of eligible milk or unripe cheese wheels, whenever the market situation is deemed unfavorable. While compulsory withdrawals have been exceptional, voluntary (but financially encouraged) withdrawals have been used more frequently. The possibility of adjustments to the production plan during the year may therefore partly justify the use of less aggregated data.

Another consideration that should come to play when deciding upon data frequency is the observed differences in the ripening time of Comté cheese. Aging varies from 4 to 24 or even 30 months. In addition, cheese wheels can be stored at low temperatures to suspend the ripening process, which further increases firms' ability to delay the marketing of cheese. Therefore, one cannot completely rule out the endogeneity of the ripening time. Yet, by using a static model of imperfect competition and assuming that the industry is vertically integrated, we overlook the strategic decisions of ripening facilities with respect to ripening and storage. The error associated with using a static framework will be greater if we use high-frequency data, while it would theoretically disappear if the frequency were low enough to assume that all cheese wheels are ripened within one period.

Taking all these considerations into account, we choose to use quarterly data, which represents the lowest frequency allowing us to obtain acceptable estimates. (Using yearly data would result in a sample size of only 21.) While this does not totally solve the issue of endogenous ripening, it should be less critical than with monthly data, especially since the bulk of the production is sold between 6 and 8 months of age, with a tendency towards longer ripening times at the end of the period of investigation.

Estimation of the system of simultaneous equations is done using the iterated non linear optimal generalized method of moments [8]. The *J*-test of overidentifying restrictions fails to reject the model specification or the stochastic assumptions used for identification, giving empirical credence to the assumption that the contemporaneous and lagged prices of Emmental cheese can be considered exogenous to the demand and supply of Comté.

IV. Theoretical model

Assume that producers in the Comté region can produce 2 goods, Comté cheese and Emmental cheese, according to the aggregate cost function $C(Q_C, Q_{E,-2})$, where Q_C and $Q_{E,-2}$ denote the quantities of Comté and Emmental produced. (This cost does not include

the dairy quota rent.) The function C is assumed to have all desirable properties, i.e., it is nondecreasing in its arguments and convex. Producers are endowed with ω milk quotas, and the dairy quota is binding. While producers located in the Comté region have exclusivity over the production of Comté cheese, they only produce a small share of the total milk supply, and therefore we assume that they cannot influence the price of Emmental. (Entry is free in the Emmental market.) Let us call k_C the coefficient of conversion of milk into Comté cheese, and k_E the coefficient of conversion of milk into Emmental cheese, both assumed to be fixed. That is, 1 unit of dairy quota can be used to produce k_C units of Comté cheese or k_E units of Emmental cheese. The inverse demand function for Comté cheese is denoted $P(.)$, and $P_{E,-2}$ denotes the price of Emmental, supposed to be fixed. (The twice-lagged variables $Q_{E,-2}$ and $P_{E,-2}$ take into account the fact that Comté cheese is ripened for a longer period than Emmental cheese. Over the period, Comté cheese was ripened about 5.5 months longer than Emmental.)

Let us first assume that CIGC acts as a joint profit-maximizing cartel, subject to the quota constraint. CIGC's problem can thus be written as:

$$\max_{Q_C} \quad P(Q_C)Q_C + P_{E,-2}k_E\left(\omega - \frac{Q_C}{k_C}\right) - C\left(Q_C, k_E\left(\omega - \frac{Q_C}{k_C}\right)\right). \tag{2}$$

The first-order condition is:

$$P(Q_C) + P'(Q_C)Q_C - \frac{k_E}{k_C}P_{E,-2} - C_1 + \frac{k_E}{k_C}C_2 = 0, \tag{3}$$

where C_i denotes the first derivative of C with respect to its *i*th argument. This optimization condition can be rewritten:

$$MR(Q_C) = \frac{k_E}{k_C}P_{E,-2} + \phi(Q_C), \tag{3'}$$

where $MR(.)$ denotes the marginal revenue function and

$$\phi(Q_C) = C_1\left(Q_C, k_E\left(\omega - \frac{Q_C}{k_C}\right)\right) - \frac{k_E}{k_C}C_2\left(Q_C, k_E\left(\omega - \frac{Q_C}{k_C}\right)\right). \tag{4}$$

Let us now prove that ϕ is a nondecreasing function of Q_C. We have:

$$\phi'(Q_C) = C_{11} - \frac{k_E}{k_C}C_{12} - \frac{k_E}{k_C}C_{21} + \left(\frac{k_E}{k_C}\right)^2 C_{22} = \begin{pmatrix} 1 \\ -\frac{k_E}{k_C} \end{pmatrix}' \begin{pmatrix} C_{11} & C_{12} \\ C_{21} & C_{22} \end{pmatrix} \begin{pmatrix} 1 \\ -\frac{k_E}{k_C} \end{pmatrix} \geq 0, \tag{5}$$

where the inequality follows from the convexity of C.

The natural generalization of equation (3') to the NEIO market-level equilibrium described in (1) is thus:

$$PMR(Q_C) = \frac{k_E}{k_C}P_{E,-2} + \phi(Q_C), \tag{6}$$

with

$$PMR(Q_C) = (1-\theta)P(Q_C) + \theta MR(Q_C) = P_C\left(1 + \frac{\theta}{\eta_{CC}}\right)$$

denoting the perceived marginal revenue curve and θ the conduct or market power intensity. The coefficient k_E/k_C on the lagged price of Emmental reflects the difference in milk content between the two cheese varieties.

The idea behind the cost specification on the RHS of equation (6) is that by producing one unit of Comté cheese, the industry forfeits the rent that it would earn if it produced and sold the quantity of Emmental cheese corresponding to the amount of EU dairy quota utilised to produce this unit. Therefore, in equilibrium, the industry equates the perceived marginal revenue from producing an additional unit of Comté cheese to the marginal opportunity cost of doing so, which is equal to the marginal revenue forfeited from potential sales of Emmental cheese minus the difference in marginal costs $\phi(Q_C)$. This opportunity cost specification assumes that the milk content of both cheese varieties is fixed and does not depend on the quantities produced, an assumption parallel to the traditional fixed-proportions hypothesis ubiquitous in the NEIO literature. Given that more milk is used to produce 1 kg of Emmental than 1 kg of Comté, the coefficient k_E/k_C should be close to but less than 1. More precisely, the productivity of milk in Comté is about 10% (i.e., 10 kg of Comté can be made from 100 kg of milk), while that of Emmental ranges between 8 and 9%. Thus, k_E/k_C is expected to be between 0.8 and 0.9.

V. EMPIRICAL MODEL

The demand for Comté cheese is specified as follows:

$$\begin{aligned}\ln q_C &= \alpha_0 + \alpha_{Sp} + \alpha_{Su} + \alpha_{Fa} + \beta_C \ln P_C \\ &+ \beta_{Sp} \ln P_C Sp + \beta_{Su} \ln P_C Su + \beta_{Fa} \ln P_C Fa \\ &+ \gamma_E \ln P_E + \beta_E \ln P_C \ln P_E \\ &+ \gamma_I \ln I + \beta_I \ln P_C I + e_d\end{aligned}, \quad (7)$$

where q_C denotes the per capita quantity of Comté cheese sold, Sp, Su and Fa are seasonal dummy variables, P_C and P_E represent the wholesale prices of Comté and Emmental, respectively, and I denotes the per capita net disposable income. Prices and income are deflated using the general CPI.

This demand specification has the desirable property of allowing each of the three shifters (price of Emmental, income and season) to increase demand proportionately *and* rotate the demand elasticity. This flexibility is necessary to avoid spurious effects of those shifters on the demand elasticity estimates.

To assess the importance of functional form assumptions, we estimate an alternate model based on a linear version of equation (6):

$$\begin{aligned}q_C &= \alpha_0 + \alpha_{Sp} + \alpha_{Su} + \alpha_{Fa} + \beta_C P_C \\ &+ \beta_{Sp} P_C Sp + \beta_{Su} P_C Su + \beta_{Fa} P_C Fa \\ &+ \gamma_E P_E + \beta_E P_C P_E \\ &+ \gamma_I I + \beta_I P_C I + e_d\end{aligned}. \quad (7')$$

The supply relationship is derived from the theoretical model exposed in section IV. In addition, we assume that the cost difference $\phi(Q_C)$ is an affine function of Q_C, the total quantity of Comté. The resulting equation is:

$$P_C\left(1+\frac{\theta}{\eta_{CC}}\right) = c_0 + c_1 P_{E,-2} + c_2 Q_C + e_s, \quad (8)$$

where the demand elasticity η_{CC} is a function of the demand parameters β_C, β_{Sp}, β_{Su}, β_{Fa}, β_E and β_I, and c_0, c_1 and c_2 are cost parameters to be estimated.

Note that because P_C and $P_{E,-2}$ are both divided by the price index, our specification implicitly assumes that the cost difference between Comté and Emmental, keeping Q_C constant, has risen proportionately to the price index. The presence of the term $c_2 Q_C$ allows us to test for scale in the conversion from Emmental production to Comté production. In particular, if farms are heterogeneous in their ability to shift from Emmental to Comté production, we would expect the coefficient c_2 to be positive. As argued in section IV, the coefficient c_1 should reflect the difference in milk content between Comté and Emmental and is expected to range between 0.8 and 0.9.

VI. DATA DESCRIPTION

The data covers the period from January 1985 to December 2005. The starting date was chosen as 1985 because the EU dairy quota program, assumed to have influenced the supply of milk, was introduced in 1984. Industry data on the wholesale price and marketed quantity of Comté cheese comes from CIGC. It is not possible to distinguish between domestic and export sales. However, given the very small share of exports (about 5%), total quantity should constitute a reasonable proxy.

Industry data on the wholesale price of Emmental cheese comes from SIGF (Syndicat interprofessionnel du gruyère français). For both Comté and Emmental, some adjustments to the raw data were necessary to account for changes in the way the industry price was calculated over the period of investigation. Detailed information regarding these adjustments is available upon request.

The net disposable national income for France was obtained from Eurostat, and so was the population variable used to construct the per capita Comté cheese consumption and net disposable income variables.

A general CPI for France was obtained from the OECD database.

Summary statistics are reported in table 1. Prices and income are in constant 2000 euros.

Table 1 Summary statistics

Variable	All	Winter	Spring	Summer	Fall
Total quantity	9.08	8.75	8.56	9.08	9.93
(1000 tons)	(1.49)	(1.36)	(1.36)	(1.37)	(1.59)
Per capita qty	1.52	1.47	1.43	1.52	1.66
(100 g/inh.)	(0.212)	(0.188)	(0.187)	(0.187)	(0.221)
Comté price	5.58	5.59	5.59	5.56	5.57
(€/kg)	(0.378)	(0.417)	(0.403)	(0.360)	(0.356)
Emmental price	4.99	5.03	4.99	4.96	4.96
(€/kg)	(0.367)	(0.409)	(0.364)	(0.340)	(0.375)
Income	4.60	4.57	4.58	4.61	4.64
(1000 €/inh.)	(0.563)	(0.574)	(0.575)	(0.576)	(0.565)
Observations	84	21	21	21	21

VII. ESTIMATION AND RESULTS

The simultaneous equations system consisting of the demand and pricing equations is estimated using the iterated non linear optimal generalized method of moments. The weighting matrix is constructed allowing for heteroskedasticity and autocorrelation up to 3 lags, and assuming that the error terms e_d and e_s are uncorrelated. Instruments for equations (7) or (7'), denoted by the row vector Z_d, include a constant, the logarithms of P_E and I, seasonal dummies, and a series of interaction terms constructed from $P_{E,-2}$ to instrument for each of the endogenous regressors involving the price of Comté. Instruments for equation (8), denoted by the row vector Z_s, include a constant, $P_{E,-2}$, the logarithms of P_E and I, and seasonal dummies.

Denote $e = \begin{pmatrix} e_d \\ e_s \end{pmatrix}$ and $Z = \begin{pmatrix} Z_d & 0 \\ 0 & Z_e \end{pmatrix}$. The moment conditions used for estimation are:

$$E(e \mid Z) = 0. \tag{9}$$

The vector of unknown model parameters is denoted λ, and the sample size is denoted T. Using tildes to denote the sample equivalents of each random variable, the estimates $\hat{\lambda}$ were chosen so as to minimize

$$Q_T = \frac{1}{T} \tilde{e}' \tilde{Z} \tilde{S}^{-1} \tilde{Z}' \tilde{e}, \tag{10}$$

where matrix $\tilde{S}$ was estimated recursively as the HAC Newey-West estimate of $S = \frac{1}{T} \sum_{t=1}^{T} \sum_{s=1}^{T} E\left[Z_t' Z_s e_t e_s \right]$.

The results from estimating parameters $\hat{\lambda}$ using the double-log and linear demand specifications are displayed in table 2. Reported standard errors are heteroskedasticity-robust and corrected for autocorrelation with 3 lags according to the Newey-West procedure [9]. A 3-lag specification is chosen because the production plan is adopted on a yearly basis, and therefore the quantity marketed in each quarter is likely to be correlated with that marketed in the other quarters of the same year. Hansen's *J*-test of overidentifying restrictions fails to reject the model or the set of stochastic assumptions used for identification. In particular, the exogeneity of the contemporaneous and lagged prices of Emmental to demand and the supply relation cannot be empirically rejected.

A. Demand estimates

Demand estimates seem acceptable and robust to the choice of functional form for the demand equation. The implied own-price, cross-price and wealth elasticity averages over the period all have the expected sign and reasonable magnitudes. However, the magnitude of the wealth-elasticity of demand is not consistent with the general belief that Comté cheese is a luxury good. This may be attributable to the parsimony of the demand specification and the use of total income rather than expenditure on a more narrowly defined group. The temporal variation in the own-price elasticity of demand is depicted in figure 1, and is consistent between the two tested models. Own-price elasticity averages over the period are -1.252 for the double-log model and -1.148 for the linear model, which seems reasonable given available elasticity estimates for the entire cheese group in France. For instance, we found an estimate of -0.83 (INRA 1998) and an estimate of -0.70 (CNIEL 2005).

All three demand shifters are significant based on the *F*-tests reported in the second part of table 2. Therefore, seasonality, the price of Emmental and the income variable all seem to affect demand. While the separate effects of the Emmental price and income shifters on the intercept and the slope of demand are statistically significant, this is not always the case for the seasonality shifters taken individually. However, when tested for their joint effect on the intercept *and* the slope, all three seasonal effects taken individually are highly significant, particularly the Fall effect (note the singularly high *F*-statistic). Furthermore, the signs of the seasonal effects are consistent across the two tested models. In particular, demand intercepts seem to be larger, and demand slopes steeper, during the Spring, Summer and Fall quarters, compared to the baseline Winter quarter. More interestingly, we confirm statistically that demand for Comté cheese reaches a peak during the Fall season, a trend that is well understood by industry representatives and can be attributed to increased consumption during the Christmas holiday period. This conclusion can be drawn by conducting pairwise tests that compare, for any two seasons, the *combined* effects of the slope and intercept seasonal dummies on demand, the price of Comté being set at its sample mean. For instance, to see whether demand was significantly higher in the Fall than in the Summer, other factors being held constant, we tested the hypothesis: $H_0: \ \alpha_{Fa} + \beta_{Fa} \ln P_C - [\alpha_{Su} + \beta_{Su} \ln P_C] = 0$ against

$H_1: \quad \alpha_{Fa} + \beta_{Fa} \ln P_C - [\alpha_{Su} + \beta_{Su} \ln P_C] > 0$ and were able to reject the null at the 5% level of significance. We conducted similar pairwise tests for other seasons and determined that demand was significantly higher in the Fall than in any other season.

Table 2 Results from the NLOGMM estimation

The asterisk denotes statistical significance at the 5% level. The reported *F*-statistics relate to the joint significance of regressors that include the shifter of interest. The reported *J*-test is for Hansen's test of overidentifying restrictions [8]. The last part of the table reports sample averages of the implied own-price, cross-price and wealth elasticities of demand.

Parameters λ	Double log model	Linear model
β_C	19.161*	2.698*
	(5.203)	(0.774)
β_{Sp}	-0.163*	-0.032
	(0.075)	(0.021)
β_{Su}	-0.245	-0.069*
	(0.128)	(0.033)
β_{Fa}	-0.106	-0.076
	(0.174)	(0.044)
β_E	-5.060*	-0.188*
	(1.432)	(0.059)
β_I	-8.011*	-0.447*
	(2.156)	(0.126)
α_0	-28.904*	-14.599*
	(8.996)	(4.345)
α_{Sp}	0.252	0.142
	(0.129)	(0.118)
α_{Su}	0.448*	0.430*
	(0.223)	(0.187)
α_{Fa}	0.304	0.615*
	(0.298)	(0.245)
γ_E	8.808*	1.084*
	(2.549)	(0.353)
γ_I	14.259*	2.663*
	(3.639)	(0.680)
c_0	0.261	0.031
	(1.122)	(0.911)
c_1	0.915*	0.962*
	(0.167)	(0.138)
c_2	0.070	0.071
	(0.053)	(0.041)
θ	0.007	0.007
	(0.009)	(0.012)
Spring $F(2,152)$	9.988*	7.612*
Summer $F(2,152)$	6.339*	6.824*
Fall $F(2,152)$	54.294*	56.032*
Emmental $F(2,152)$	7.268*	5.385*
Income $F(2,152)$	66.589*	80.674*
J-test $\chi^2(3)$	0.896	1.430
η_{CC}	-1.252	-1.148
η_{CE}	0.121	0.083
η_{CI}	0.506	0.511

Fig. 1 Demand elasticities derived from the double-log (elaslog) and linear (elaslin) models

B. Cost and conduct estimates

Both cost and conduct estimates seem satisfactory in terms of their magnitude and statistical significance. The sensitivity of the cost and conduct parameters to the demand specification is very acceptable.

The coefficient on the lagged price of Emmental cheese, c_1, is highly significant and is slightly smaller than 1 under the alternative demand specifications (estimates are 0.915 for the double-log model and 0.962 for the linear model). The point estimate is slightly higher than anticipated. However, the value of 0.8, which constituted a lower bound in our initial expectation, lies within the 95% confidence interval.

The estimate of c_2 is small and insignificant. Thus, we fail to reject the hypothesis of constant returns to scale in the conversion from Emmental to Comté. In terms of the function ϕ, this means that we cannot reject the hypothesis that $\frac{d\phi}{dQ_C} = 0$, at least locally. Given that the milk processing and ripening stages for the two cheeses are more likely to involve constant returns to scale than farm operations, this result may be an indication of a certain farm homogeneity among those producers who have shifted from Emmental to Comté over the period of investigation. Said differently, the result could mean that farm heterogeneity is not sufficient, around the observed equilibrium, to link the observed increase in the quantity of Comté cheese to higher production costs.

Finally, and most importantly given the purpose of this study, the market power estimate $\hat{\theta}$ is positive,

small and statistically insignificant in both models. Monopoly is easily rejected, based on the test ($\theta = 1$ vs. $\theta < 1$), at the 5% level of significance. Extremely weak forms of symmetric Cournot oligopoly are also rejected. For instance, we reject a 25-firm symmetric Cournot oligopoly at the 5% level of significance. Market power estimates are well within values traditionally considered to be close enough to perfect competition not to raise economic efficiency concerns [10].

In an unreported regression, we estimated a modified model, allowing the market power intensity to take different values on the two sub-periods 1985q1-1995q3 and 1995q4-2005q4. The choice of sub-periods was motivated by the observation that production caps up to the 1994-1995 campaign had little effect in practice. First, Comté production was not attractive in the late 1980s, so that entry into the industry did not have to be prevented. Second, even though the attractiveness of the Comté sector increased in the early 1990s, the over-quota penalty was too small to discourage entry. The penalty was increased for the 1995-1996 campaign and remained at high levels afterwards. Given the ripening time of Comté cheese, if binding caps took hold in March 1995, the effect should be detectible starting two periods later. The results from estimating this modified model did not support the hypothesis that market power had been more "intense" towards the end of the study period, and did not alter the conclusions of no evident market power in the Comté market. The conduct parameter was small and insignificant for the first period, and small, negative and insignificant for the second period. In addition, the hypothesis that the two conduct parameters are equal could not be rejected. (The associated *P*-value was 0.728.)

VIII. CONCLUSION

In this article, an NEIO technique was used to measure the degree of seller market power in the French Comté cheese industry, characterised by vertical contracts between milk producers and ripening facilities and a government-sanctioned supply control scheme that has drawn particular attention from French antitrust authorities. Identification of the market power parameter was enabled by the inclusion of three different demand shifters in the demand specification, all allowed to change the demand elasticity. One originality of the model lies within the cost specification, which includes the price of Emmental cheese, to take account of the European dairy quota policy and the substitutability of the two cheeses in production. Since the dairy quota policy likely creates a wedge between the marginal cost of milk and its market price, defining the opportunity cost of Comté production in terms of the net revenue forgone from potential sales of Emmental, rather than a sum of input expenses, is critical to avoid attributing any significant price-cost margin solely to market power exercised at the level of the Comté industry.

The hypothesis of perfect competition could not be rejected. In contrast, monopoly was rejected, and so were extremely weak forms of Cournot oligopoly. Cost and market power estimates were robust to the demand specification.

This study sheds serious doubts on the ability of the observed supply control scheme to allow the Comté cheese industry to exert significant market power towards buyers. Small values of the market power parameter imply that the associated deadweight loss has been negligible over the period. This conclusion contrasts with the ruling of the French antitrust authority and provides some reassurance regarding the efficiency of PDO markets that allow collective marketing arrangements.

REFERENCES

1. OECD at http://www.oecd.org
2. Joslin T (2006) The war on *terroir*: geographical indications as a transatlantic trade conflict. J Agr Econ 57:337-363
3. Crespi J, Sexton R (2003) Concurrence, coopératives de producteurs et marketing orders aux États-Unis. Economie Rurale 277-278:135-151
4. Crespi J, Chacón-Cascante A (2004) Do US marketing orders have much market power? An examination of the almond board of California. Agribusiness 20:1-15
5. Kaiser H, Suzuki N (2006) New empirical industrial organization and the food system. Peter Lang, New York
6. Bresnahan T (1982) The oligopoly solution concept is identified. Economic Letters 10:87-92
7. Appelbaum E (1982) The estimation of the degree of oligopoly power. J Econometrics 19:287-299
8. Hansen L (1982) Large sample properties of generalized methods of moments estimators. Econometrica 50:1029-1054
9. Newey W, West K (1987) A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. Econometrica 55:703-708
10. Sexton R, Zhang M (2001) An assessment of the impact of food industry market power on US consumers. Agribusiness 17:59-79

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