Econometric models of beef producing sectors in main EU member states : Agenda 2000 and Beyond: Impact of reforrms of the Common Market Organisation for beef

Yves Le Roux

9 - ECONOMETRIC MODELS OF BEEF PRODUCING SECTORS IN MAIN EU MEMBER STATES

Agenda 2000 and Beyond: Impact of reforms of the Common Market Organisation for beef

Yves Le Roux

Partner 1: INRA-ESR, Rennes

9.1. Introduction

The objective of this part of the project (i.e., subtask 2.3) was to develop a tool for simulating policy reform in the beef and veal sectors of the European Union. In order to provide an assessment of the impact of such policy reforms, at the national level and at the European level, sectoral econometric models have been developed. Changes in these beef and veal sectors are induced by the market conditions, and by policies. These policies may apply directly on these sectors, or they may affect related sectors. A fair representation of the beef and veal sectors must include these main determinants, and simultaneously the dynamic interactions among categories of animals, that is the demographic structure of the cattle and the associated biological constraints.

National models are developed for the main European beef and veal producers, i.e., France, Germany, United-Kingdom and Italy. These models are founded on a generic approach which aims to a good coverage of relevant variables and which specifies stock and flow variables with an explicit account for biological limits.

The objective is to account for the demographic structure of bovine production and for the impacts of economic variables (mainly prices) and agricultural policy variables (intervention price, headage premiums, milk quotas) on production. In other words, beef supply steadily depends on the bovine demographic characteristics: one of the concerns is here to take into account how economic or policy changes affect this (dynamic) link. The approach can be summarised as an inventory approach to model the livestock sector, which accounts for behavioural relationships to finally determine meat supply and trade. The model is made of a set of behavioural and biological relationships.

This approach requires a disaggregation of the livestock into categories of animals (calves for slaughtering, calves for breeding, adult male/female animals over 1 year, over 2 years, etc.) and a disaggregation of the net production (slaughterings of calves, bulls, steers, heifers, cows).

For each national model, parameters which link the variables of interest (calf crop, livestock addition, slaughtering rate, etc.) are assumed to be dependent on economic or policy variables (which will be the control variables of the model during the simulation step). But these parameters must also enforce biological constraints, which first implies to build a dynamic set of relationships between these variables. In that prospect, a particular attention is paid to the specification of the various variable rates. Most of them are specified as logistic functions. All the parameters of the model (except the biological upper limits which are fixed according to empirical observations and to common knowledge) are estimated using econometric techniques applied to time series data.

Models can be used to simulate a baseline scenario (including the "Agenda 2000" reform measures) and scenarios of decrease in the number and/or the level of premiums.

More generally, the dynamic characteristics of each model allows for computing dynamic elasticities of main endogenous variables with respect to control variables, such as policy variables. An illustration may be completed through the assessment of the effect of the number of beef premiums granted on net production.

In the following section, a brief presentation of the methodology used and the data set built is given. In section 3, the main quantitative results, among the main countries which have been modelled, are presented. Section 4 reports and discusses simulation results. Finally, section 5 concludes.

9.2. National models of beef and veal sectors: Structure and main characteristics

For each main producing EU Member State (France, Germany, United-Kingdom, Italy) a complete model of the bovine sector is specified and estimated. Each national model simultaneously accounts for the demographic structure of bovine production and for the impacts of economic variables (mainly prices) and agricultural policy variables (intervention price, headage premiums, milk quotas) on production. The whole system is perfectly balanced over time, that is, the herd of one category of animals at the beginning of one period is necessarily equal to the sum of all possible utilisations during the period (slaughtering, net export, or herd replacement). This explicit intertemporal balance is at the core of the model functionning. [134]

Three subsets of relationships are defined for calves, female animals aged one year and over, and male animals aged one year and over. For each category, the herd at the beginning of one period is intended to be slaughtered, bred, or (net) exported during the period. These arbitrations apply to sub-categories

[134] This is not always the case in models of animal markets. See, for example, Lianos and Katrinidis (1993) where the link between inventories and slaughterings do not insure the dynamic balance between supply and utilisations.

such as heifers, suckler cows and dairy cows for female animals, and bulls and steers for male animals. For each of these sub-categories, net production is determined at each period with respect to biological possibilities, which leads to the total net production.

The complete structure of the model is provided in appendix 1.

9.2.1. Demographic structure: An illustration

As an illustration, calves born during year t ($BICA_t$) are a proportion cc_t of the female herd at the end of the year $t-1$, ($FEHE_{t-1}$) where cc_t is the calf crop: $BICA_t = cc_t \,.\, FEHE_{t-1}$

These born calves are then allocated into calves for slaughtering, calves for breeding and net exports of lives calves (the latter can be derived from the former). Thus:

$CASL_t = csl_t \,.\, BICA_t$ where $CASL_t$ are calves for slaughtering and $SLCA_t = slr_t \,.\, CASL_t$ where $SLCA_t$ are the slaughterings of calves (net production of veal is derived through the average slaughter weight).

$CABR_t = cbr_t \,.\, BICA_t$ where $CABR_t$ is the herd of calves for breeding, which itself is allocated into males and females, through the relationships $MCAH_t = mal_t \,.\, CABR_t$ and $FCAH_t = (1 - mal_t) \,.\, CABR_t$, where $MCAH_t$ and $FCAH_t$ are respectively the herds of male and female calves for breeding.

These herds determine the herds of adult male and female animals the year after, and consequently slaughtering of each kind of animal through similar arbitration rates. For example, the herd of adult males is defined as:

$MAHE_t = \gamma_t \; MCAH_{t-1} + mrr_t \,(MAHE_{t-1} - XLMA_t + MLMA_t)$ where $XLMA_t$ and $MLMA_t$ are exports and imports of live adult male animals, respectively. γ_t is the share of the male adult cattle which comes from the herd of calves for breeding and mrr_t is the rate of replacement of the male adult cattle. Slaughterings and net production can be easily derived, and allocated into bulls and steers.

A similar process is written for adult female animals, which leads to net productions of heifers and cows, and then to the total net production of beef.

9.2.2. Impacts of economic and policy variables

It is assumed that each arbitration is a function of economic and policy variables. Hence, all the various rates (cc_t, csl_t, slr_t, cbr_t, mal_t, γ_t, mrr_t, etc.) which link the different variables are specified as functions of economic and policy variables. To ensure that these rates do not exceed realistic limits which are imposed by biological constraints, they are modelled as logistic functions of explanatory variables (for a similar way to deal with biological limits, see Fabiosa and Qi, 1998). Such a specification allows for setting an upper limit to each of these rates.

For any variable rate y_t, the specification is: $y_t = \frac{y^+}{1+e^{-X_t\beta}} + \varepsilon_t$ where: y^+ is the upper limit chosen for y_t. X_t is a vector of explanatory variables, β is a vector of parameters, and ε_t is an error term. The upper limit is fixed before estimation, and its value is determined according to empirical observations on the concerned rate over the sample, and according to common knowledge.

The effect on y_t of one variable of X_t is of the sign of the corresponding parameter of β. The elasticity of y_t with respect to a variable x_{it} of X_t (which is assumed to be affected by a parameter β_i) is given by: $\varepsilon_{y_t/x_{it}} = \beta_i \, x_{it} \, (1-\frac{y_t}{y^+})$. This elasticity can be computed for any sample point, or generally for the sample mean point. Note that this elasticity only measures the instantaneous effect of x_{it} on y_t, *ceteris paribus*. Actually, it does not take into account the simultaneous characteristic of the model: for example, x_{it} may appear as an explanatory variable in another relationship which explains a variable which explains y_t too. Moreover, this kind of direct or indirect effect may occur at time t, or between two consecutive periods. The previous elasticity only offers partial information, limited to the comparison among effects inside only one relationship. Therefore it is necessary to compute dynamic multipliers which take into account both direct and indirect effects of each exogenous variable on one endogenous variable. Due to the expression of the key rates which link these variables in terms of logistic functions, the complete model is highly nonlinear, and a linear approximation would be hardly tractable. Thus, these dynamic multipliers and the associated elasticities must be approximated through simulation methods.

Estimation of relationships where these variable rates appear finally lead to the slaughterings expressed in heads for each category of animals (calves, heifers, cows, bulls and steers). Relationships which define the average slaughter weights are then estimated in the same manner (the average slaughter weight for each kind of animal is modelled as a logistic function of explanatory variables, such as the lagged weight reflecting biological constraint, and the price of animal feedingstuffs). Finally, the net productions expressed in carcass weight equivalent are obtained as the product of slaughterings by the average slaughter weight.

Producer prices are endogenous in the model, and they are the only variables which are expressed in linear form. Prices for calves and for adult cattle are taken into consideration. The real producer price indexes are expressed as a function of the real intervention price and of the excess supply. For both categories, the excess supply is defined as the difference between net production and domestic consumption, which is assumed to be exogenous.

For the other relationships, the main explicative variables are these real price indexes and the agricultural policy variables, which are exogenous. These are essentially: the total amount of male premiums granted, differentiated whether it is the first or the second payment, and accordingly to bulls and steers, the total amount of suckler cow premiums granted, and the national milk quota level. Exogenous variables also include imports of live animals for calves, heifers, cows and steers.

This leads to a set of endogenous variables and equations, among which some are identities (see the list in Table 9.1, which corresponds to the French model).

Table 9.1. The set of endogenous variables (example of the French beef model)

Dependent variable		**Identities**
	Calves	
$BICA_t$	Births of calves	
$CAHE_t$	Total herd of calves at the end of year *t*	∈
$CASL_t$	Herd of calves for slaughtering	
$SLCA_t$	Number of calves slaughtered	
$CABR_t$	Herd of calves for breeding	
$MCAH_t$	Herd of male calves for breeding	
$FCAH_t$	Herd of female calves for breeding	∈
$CASA_t$	Herd of calves for slaughtering still alive at the end of the year *t*	∈
$XLCA_t$	Exports of live calves	∈
$CASW_t$	Calf average slaughter weight	
$NPVE_t$	Net production of veal	
$IPCA_t$	Index of producer price of calves	
	Female animals older than one year	
$HEHE_t$	Herd of heifers	
$XLHE_t$	Exports of heifers	
$XNLHE_t$	Net exports of heifers	∈
$SLHE_t$	Number of heifers slaughtered	
$HASW_t$	Heifer average slaughter weight	
$NPHE_t$	Net production of heifers	
$DAHE_t$	Herd of dairy cows	
$SUHE_t$	Herd of suckler cows	
$SLCO_t$	Number of cows slaughtered	
$COASW_t$	Cow average slaughter weight	
$NPCO_t$	Net production of cows	
	Male animals older than one year	
$MAHE_t$	Herd of male adult animals (over than 1 year)	
$SLMA_t$	Number of male adult animals slaughtered	
$SLXMBU_t$	Number of male adult animals slaughtered and net exported	
$SLST_t$	Number of steers slaughtered	
$XNLMAC_t$	Net exports of male adult animals	∈
$SLBU_t$	Number of bulls slaughtered	∈
$BUASW_t$	Bull average slaughter weight	
$STASW_t$	Steer average slaughter weight	
$NPBU_t$	Net production of bulls	
$NPST_t$	Net production of steers	
$NPAC_t$	Net production of adult cattle	∈
$IPCT_t$	Index of producer price of adult cattle	

9.2.3. The data used

All equations of the four national models are estimated econometrically. Required data are national times series data for all endogenous and exogenous variables of the model (mainly, herds, slaughterings, net productions, trade, prices, policy instruments, etc.... for each category of animals). The completed database is made up of aggregate annual data mainly issued from the NewCronos-Eurostat database, from 1973 to 1998.

9.3. Estimation results

Direct estimation results, that is equation by equation, are presented first. Then, the main dynamic multipliers that can be computed are commented.

9.3.1. Direct estimation results

Detailed estimation results are reported in appendix 3 for each country and for each category of animals. This paragraph summarises the main findings.

9.3.1.1. Calf crop models

In all countries, the calf crop depends significantly on the expected real producer price of calves. But, as indicated by Table 9.2, the magnitude of obtained elasticities (calculated at the sample mean) differs across countries.

Table 9.2. Elasticities of the calf crop with respect to the real price of calves

France	Germany	Italy	United-Kingdom
0.38	0.21	0.94	0.08

The allocation of calves born during year *t* among slaughtering and breeding herds is (nearly) always significantly dependent on the total amount of first payments of male premiums. This variable has a negative effect on the choice in favour of slaughtering but a positive one in favour of breeding. However elasticities (only evaluated here at the concerned equation level) reflect different sensitivities across countries.

Table 9.3. Elasticities of allocation in favour of slaughtering or breeding relative to the total amount of first payments of male premiums

	France	Germany	Italy	United-Kingdom
Slaughtering herd	-0.11	-0.20	-0.06	-1.05
Breeding herd	0.10	0.03	-	0.05

The various values of these elasticities do not seem to be related to the national orientation of calf production, which is balanced between slaughtering and breeding in France and in Italy, but which is mainly in favour of breeding in Germany, and especially in the UK.

The rate of slaughtering determines which proportion of the herd of calves devoted to slaughtering is effectively slaughtered during the year *t*. Due to the biological seasonality of births of calves, this rate is nearly the same for each country, about 75%. The expected real price of calves has generally a negative effect on this rate (elasticity of –0.34 for France and –0.22 for the UK), reflecting the expectation of a continuation of a price change: for example, an increase in the calf price will encourage delaying slaughtering. But an inverse effect is observed in Italy: the elasticity of the slaughtering rate to the calf price is 0.77, showing the interest to immediately benefit of an increase in this price.

The calf average slaughter weight is also different among countries, according to their main orientations of production. This average slaughter weight is very low (about 40kg cwe[135]) in the UK, but this country does not breed calves to be slaughtered as calves, but for breeding. This average weight is higher for the other countries: about 110 to 115kg cwe in France and in Germany, and nearly 140kg in Italy. The elasticity of the slaughter rate to the real price of animal feed is also quite different among countries: this elasticity is –0.25 in France and –0.16 in Italy, but about –0.08 in Germany.

Finally, the net production of calves is indirectly dependent on all these variables, through the rate of slaughtering and the average slaughter weight. The total effects will be analysed further.

9.3.1.2. Models of female animals older than one year

Rates of replacement and rates of slaughtering of adult animals are also significantly dependent on price effects, but not always with the same sign (see appendix 3). For example the average elasticity of the rate of replacement of the heifer herd (that is the proportion of heifers which remain heifers the following year) with respect to the expected real price of adult cattle is –0.1 in Germany, showing the interest not to delay slaughtering of heifers in case of an increase in price, but this elasticity is equal to 0.1 for Italy and 0.4 for the UK, showing the reverse effect.

Similar apparent contradictions can be observed for some other rates, for which interpretation of direct elasticities must be made cautiously (in the sense that they are evaluated within only one estimated equation, without taking into account possible indirect effects through other variables). These opposite

---

[135] cwe = carcass weight equivalent.

effects may be only apparent, and only the further computation of total effects are conclusive in some cases.

For the cow herd, it is generally found that the milk quota has a positive effect on the dairy herd, that the suckler cow premium has sometimes a positive effect on the suckler herd, and that there is a substitution effect between dairy and suckler herds.

Effects on cow slaughterings are just derived from effects on cow herds, due to the low importance of trade for these categories of animals, for all countries.

9.3.1.3. Models of male animals older than one year

Effects of prices and policy variables on endogenous variables are more homogenous across countries in the case of adult male animals than for adult female animals. For example, the herd of adult male animals is assumed to be made up of: a proportion γ_t of the herd of male calves for breeding, and a proportion mrr_t of the adult male animals which were yet present the previous year. The rate γ_t is always positively dependent on: the total amount of the first payments of male premium (tap_spma1_t), and/or the expected real producer price of adult cattle ($(\frac{ipct}{ipgdp})_{t-1}$). On the other hand, the rate of adult male replacement mrr_t is always positively dependent on: the total amount of the second payments of male premium (tap_spma2_t), and/or the expected real producer price of adult cattle (see Table 9.4).

Table 9.4. Effects of prices and policy variables on adult cattle

Effects on	γ_t		mrr_t	
of	tap_spma1_t	$(\frac{ipct}{ipgdp})_{t-1}$	tap_spma2_t	$(\frac{ipct}{ipgdp})_{t-1}$
France	+	+	+	+
Germany	+		+	+
Italy	+		+	+
United-Kingdom		+		+

Effects on the total slaughterings of male adult cattle are derived from effects on inventories. Specific effects on bull and steer slaughterings, respectively, may be influenced by premiums granted to these categories of animals. The effect of the total premiums granted either to bulls or to steers on the rate of slaughtering is always negative (see Table 9.5). That reflects the opportunity of capitalising rather than slaughtering the cattle in case of an increase in the total amount of these premiums (which can be due to an increase in the number of premiums, or in the unitary level). Note that this effect is always very small for bulls, but more important for steers.

Table 9.5. Elasticities of the rate of slaughtering of bulls and steers with respect to the total amount of premiums granted to these animals

	bulls	steers
France	-0.01	-0.46
Germany	-0.02	-0.60
Italy	-0.01	-
United-Kingdom	-	-1.18

Generally, the average slaughter weights of all animals are significantly affected by a positive time trend effect (through a positive effect of the lagged slaughter weight) and by a negative effect of the price of animal feed. However, elasticities of the slaughter weights to this price are not very large (see Table 9.6).

Table 9.6. Short-run elasticities of average slaughter weights with respect to the real price of animal feed

	Heifers	Cows	Bulls	Steers
France	-0.08	-	-0.11	-0.10
Germany	-0.08	-0.06	-0.06	-0.10
Italy	-0.09	-0.04	-0.12	-0.01
United-Kingdom	-0.05	-0.05	-0.06	-

Real indexes of producer prices are modelled as linear functions of the real intervention price, expressed in national currency, and of the excess supply. These indexes are positively correlated with the intervention price, and negatively dependent on the excess supply (calculated as the difference between the net production and the domestic consumption). Elasticities of producer prices to the intervention price, in real terms, are reported in Table 9.7.

Table 9.7. Elasticities of real producer prices to the real intervention price

	Calves	Adult cattle
France	1.12	0.59
Germany	1.09	0.85
Italy	0.73	1.47
United-Kingdom	0.97	1.29

9.3.2. Dynamic elasticities

Contrary to previous direct elasticities which are calculated *ceteris paribus*, multipliers and dynamic elasticities take into account all direct and indirect simultaneous and over time effects, within the whole model, of a given exogenous variable on a given endogenous variable. Therefore, their interpretation is more explicit. It is theoretically possible to compute dynamic elasticities of key variables of the model (such as cattle or net productions) to any exogenous variable of the model (such as the number of premiums granted, the unitary level of one premium, the milk quota, the intervention price, etc.). When the model is linear of the form: $Y_t = AY_{t-1} + \Gamma_0 X_t + \Gamma_1 X_{t-1}$, where Y_t is the vector of endogenous variables and X_t the vector of exogenous variables, then the matrix of impact multipliers is Γ_0. The effect at $t+n$ of an exogenous shock in t is measured by the matrix of interim multipliers of order n: $INTER_n = A\,INTER_{n-1} = A^{n-1}(\Gamma_1 + A\Gamma_0)$, while the matrix of total multipliers (i.e., $INTER_n$ with $n \to \infty$) is TOTAL = $(I-A)^{-1}(\Gamma_0 + \Gamma_1)$. Matrices of dynamic elasticities can then be derived from these multipliers (whether impact, interim or total) by multiplying each term (g,k) of any matrix by $\frac{X_{kt}}{Y_{g,t+s}}$, where $s = 0,1, \ldots\infty$ (elasticities are generally computed at the sample mean point).

Here, the model is not linear, because of the logistic specification of numerous relationships, but also because of the fact that net production variables are the product of two other endogenous variables, the average slaughter weight and the slaughterings expressed in number of heads. Due to these nonlinearities, an analytic determination of these dynamic elasticities is not easily tractable. Thus, a simulation method was preferred. The adopted method may be described as follows.

First a reference baseline projection is simulated on the period 2000-2010. The values of (exogenous) policy variables (unitary premiums, intervention price, milk quota) are those decided within the Agenda 2000 final decisions until 2002 (2005/2006 for the milk quota). [136] They are assumed to remain unchanged after this date. Nevertheless, the numbers of premiums (i.e., the number of first and second payments for the male premium and the number of suckler cow premiums) are known only until 1999. Thus, they are assumed to remain at their observed 1999 level over the whole projection period. Changes in beef and veal consumption in the four considered countries are based on the assumption that per capita consumption goes on decreasing according to past observed trends. This assumption results in the per capita consumption levels reported in Table 9.8 for 2000 and 2010. To

---

[136] Note that new policy instruments (such as the implementation of an aid scheme for private storage from 2002 on, which will take over from intervention, or the introduction of a slaughter premium), or instruments which are not introduced in the model (such as the extensification premium), are not taken into account in neither the baseline projection, nor the scenario of changes in the number of premiums. This *ceteris paribus* condition makes the computation of the dynamic elasticities reliable.

approximate the total consumption, the population is assumed to keep on increasing in France and in the United-Kingdom, but decreasing in Germany and Italy (FAO assumptions).

Table 9.8. Beef and veal assumed per capita consumption levels (Kg/head)

	Beef		Veal	
	2000	*2010*	*2000*	*2010*
France	22.4	20.9	4.8	4.2
Germany	13.8	10.3	1.2	1.2
Italy	20.4	18.5	3.8	3.5
United-Kingdom	15.3	11.0	0.1	0.1

Other exogenous variables (price of animal feed, price index of gross domestic product, and imports of live animals except bulls) are assumed to remain stable relative to the recent period.

The second step consists of making a variantial scenario involving a shock on one chosen exogenous variable in the first year of the simulation period (all other exogenous variables remaining unchanged relatively to the baseline scenario). A shock of 1% is applied to this variable in the first year, and this number recovers its initial level the following years. [137] Then, year after year, changes in every endogenous variable can be compared to baseline scenario levels, and can be expressed in terms of elasticities.

This exercise is carried out for the following key exogenous variables:

- the number of male premiums,
- the number of suckler cow premiums
- the level of the intervention price.

Effects are mainly observed on cattle (for the various categories), net productions, and prices.

9.3.2.1. Elasticities to the number of male premiums

In all countries, the instantaneous effect (measured by the short-run or impact elasticity) of the number of male premiums is positive on net production of veal and negative, but nearly nil, on net production

[137] The purpose here is not to assess the effect of a sustained change in an exogenous variable, such as the number of premiums for example, which would actually be the real consequence of a policy reform, but to compute **elasticities** of key variables to the number of premiums. In this aim, it is necessary that the number of premiums recovers its previous level, after the shock.

of beef (cf. Table 9.9). [138] The long-run (or cumulative) elasticities remain negative for the net production of veal in all countries except France, where the long-run effect is zero. More importantly, the long-run elasticity of the net production of beef to the number of male premiums is positive and about 0.4 for France and Germany, but nearly zero for Italy and the United-Kingdom. This suggest that in the four countries, the number of male premiums has relatively low effects on the net production of beef.

Table 9.9. Elasticities of the net production of beef and veal with respect to the number of male premiums

	Veal		Beef	
	Impact	Long-run	*Impact*	Long-run
France	*-0.25*	0.00	*-0.03*	0.40
Germany	*-0.41*	-0.19	*0.05*	0.45
Italy	*-0.19*	-0.35	*-0.02*	-0.08
United-Kingdom	*-1.68*	-1.66	*-0.00*	0.06

In all countries, the instantaneous effect of the number of male premiums on cattle is zero for both calves and adult cattle (cf. Table 9.10). The long-run elasticity of calf herd is positive in all countries but Italy. The long-run elasticities of adult cattle are logically of the same sign than the long-run elasticities of the net production of beef. The value is exactly the same for France (0.40), but lower in Germany (0.23 as compared to 0.45 for the long-run elasticity of beef net production).

Table 9.10. Elasticities of herds with respect to the number of male premiums

	Calves		Adult cattle	
	Impact	Long-run	*Impact*	Long-run
France	*0.05*	0.45	*0.02*	0.40
Germany	*0.03*	0.25	*0.01*	0.23
Italy	*-0.03*	-0.18	*0.02*	-0.16
United-Kingdom	*0.01*	0.07	*0.00*	0.06

The elasticities of producer prices to the number of male premiums generally reflect the effects of these premiums on net productions. For example, in France and Germany, the impact elasticities of the net production of veal with respect to the number of male premiums are negative. Meanwhile, the

[138] As regards to net production of veal, the elasticities estimated for UK must be considered with caution due to the very low production of veal in this country.

corresponding elasticities for the producer prices of veal are positive. One notes the same converse relationship for long-run elasticities, still for France and Germany. They are positive for net production of beef and negative for the beef producer prices. Table 9.11 shows that the long-run elasticities of the producer prices of both veal and beef are nearly nil for Italy and the UK. These results suggest that, for example, a decrease in the number of male premiums will induce a slight increase in the producer prices of beef and veal in France and Germany, but will have nearly no effect on these prices in Italy and the UK.

Table 9.11. Elasticities of the producer prices of beef and veal with respect to the number of male premiums

	Veal		Beef	
	Impact	Long-run	*Impact*	Long-run
France	*0.35*	-0.03	*0.03*	-0.46
Germany	*0.17*	0.09	*-0.03*	-0.25
Italy	*0.00*	0.00	*0.01*	0.07
United-Kingdom	*0.03*	0.03	*0.00*	-0.06

These global effects may recover contrasted, and sometimes opposite effects, according to the categories of animals. For example, In France, the long-run elasticity of the net production of beef to the number of male premiums is 0.4. In fact, this elasticity is 0.71 for net production of bull meat, 0.66 for heifers, 0.35 for cows, but the effect is negative on steer production, with an elasticity of –1.0.

9.3.2.2. Elasticities to the number of suckler cow premiums

A shock applied to the number of suckler cow premiums has effects on productions, prices, and herds, but only some years after this shock has been implemented. Instantaneous effects are always nearly zero. The long-run elasticities of net production are positive for both veal and beef (cf. Table 9.12). In turn, the corresponding elasticities of producer prices are negative. However, effects on prices are rather low, and sometimes nearly zero (cf. Table 9.14).

Long-run elasticities of calf herd and adult cattle to the number of suckler cow premiums are generally very close to those relative to net production of veal and beef. Globally, elasticities of net production of veal and beef and of cattle are not very large, except in Germany. Note that the direct elasticity of suckler herds to the number of suckler cow premiums is about 1.5 in Italy (but the suckler herd accounts for only 20% of the total cow herd in Italy), 0.7 in Germany, only 0.3 in France and zero in the UK.

Table 9.12. Elasticities of the net production of beef and veal to the number of suckler cow premiums

	Veal		Beef	
	Impact	Long-run	*Impact*	Long-run
France	*0.00*	0.17	*-0.07*	0.12
Germany	*0.00*	0.50	*-0.00*	0.35
Italy	*0.00*	0.29	*-0.03*	0.09
United-Kingdom	*0.00*	0.11	*0.00*	0.07

Table 9.13. Elasticities of herds to the number of sucler cow premiums

	Calves		Adult cattle	
	Impact	Long-run	*Impact*	Long-run
France	*0.00*	0.13	*0.02*	0.22
Germany	*0.00*	0.50	*0.00*	0.52
Italy	*0.00*	0.25	*0.02*	0.27
United-Kingdom	*0.00*	0.17	*0.00*	0.16

Table 9.14. Elasticities of producer prices of beef and veal with respect to the number of suckler cow premiums

	Veal		Beef	
	Impact	Long-run	*Impact*	Long-run
France	*0.00*	-0.25	*0.07*	-0.16
Germany	*0.00*	-0.17	*0.00*	-0.17
Italy	*0.00*	-0.00	*0.02*	-0.08
United-Kingdom	*0.00*	-0.00	*0.00*	-0.14

9.3.2.3. Elasticities to the intervention price

Instantaneous elasticities of the producer prices of beef and veal to the intervention price (expressed in national currencies) are naturally close to those which are directly derived from the estimated beef and veal price equations (due to the linear form of these equations, and because the intervention price appears only in these price equations). They indicate that generally a shock in the intervention price is nearly entirely transmitted to the producer prices of veal and beef at the same period (cf. Table 9.15). Due to lagged effects on production, the corresponding long-run elasticities are lower. Furthermore, in the case of France, the long-run elasticity of the beef price to the intervention price is negative: the effect is positive in the first year, but this positive effect is compensated by negative effects in the following years. This is due to the fact that the expected producer price has negative effects on adult male slaughterings, which are higher in France than in other countries. These negative effects overcompensate the positive effects induced by the cattle increase. Finally, the total compensation of the instantaneous positive effect occurs after about ten years. Moreover the computation of cumulative effects on a longer period leads to a negative long-run elasticity.

Table 9.15. Elasticities of the producer prices of beef and veal with respect to the intervention price

	Veal		Beef	
	Impact	Long-run	*Impact*	Long-run
France	*0.96*	0.11	*0.61*	-0.16
Germany	*1.00*	0.70	*0.95*	0.42
Italy	*0.68*	0.68	*0.82*	0.64
United-Kingdom	*1.08*	1.07	*1.79*	1.48

A change in the intervention price affects the net production of beef and veal and cattle only during the years following the shock. The main reason is that the intervention price first affects the producer prices, which, in turn, modify all producers' decisions with a time lag. In all countries, the long-run elasticities of the net production of veal with respect to the intervention price are positive (cf. Table 9.16). They are close to one in Germany, Italy and the UK, but only 0.6 for France. The long-run elasticities of the net production of beef are positive in all countries too. They are higher in France (0.7) and Germany (1.0) than in Italy and the U.K. (0.2 to 0.3). Similar effects on calf and adult cattle are observed, but elasticities are more homogeneous across countries: except for the UK, the elasticities of calf herds are about 0.6 to 0.8 in all countries, while elasticities of adult cattle are about 0.7 (cf. Table 9.17).

Table 9.16. Elasticities of the net production of beef and veal with respect to the intervention price

	Veal		Beef	
	Impact	Long-run	*Impact*	Long-run
France	*0.00*	0.58	*0.00*	0.67
Germany	*0.00*	0.83	*0.00*	1.00
Italy	*0.00*	0.81	*0.00*	0.20
United-Kingdom	*0.00*	1.10	*0.00*	0.30

Table 9.17. Elasticities of herds to the intervention price

	Calves		Adult cattle	
	Impact	Long-run	*Impact*	Long-run
France	*0.00*	0.69	*0.00*	0.65
Germany	*0.00*	0.83	*0.00*	0.73
Italy	*0.00*	0.55	*0.00*	0.75
United-Kingdom	*0.00*	0.35	*0.00*	0.34

Finally, it appears that the intervention price has more significant effects on the various endogenous variables than the number of premiums granted. For example in France, the long-run elasticity of the net production of beef to the intervention price is 0.65, while the long-run elasticities of this variable with respect to the number of male premiums and to the number of suckler cow premiums are, respectively, only 0.4 and 0.12. Similar conclusions can be made for the other countries, even if in some cases the respective elasticities have very low values.

9.4. Policy simulations

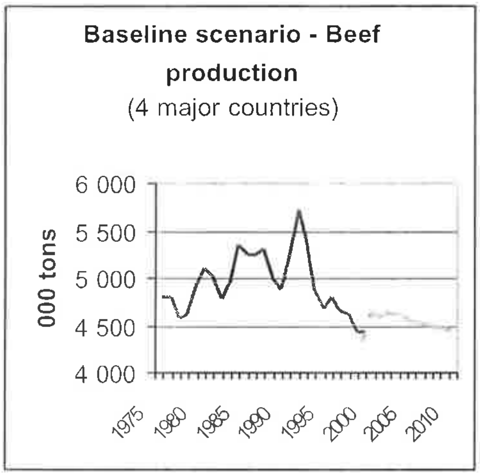
The national models have been used to simulate two basic policy scenarios. The first one is the baseline scenario. As this baseline scenario includes the policy changes adopted within the Agenda 2000 reform, it allows to analyse the impacts of this reform on the considered national beef and veal sectors. The second scenario focuses on one key instrument of the beef and veal CMO: the headage payment system. In order to shed some light on the potential impacts of restricting the current premium scheme (through a decrease in the various ceilings currently in force, such as the number of eligible animals or the intensity ceiling for example), this second scenario assumes a –20% decrease in the number of premiums granted to farmers.

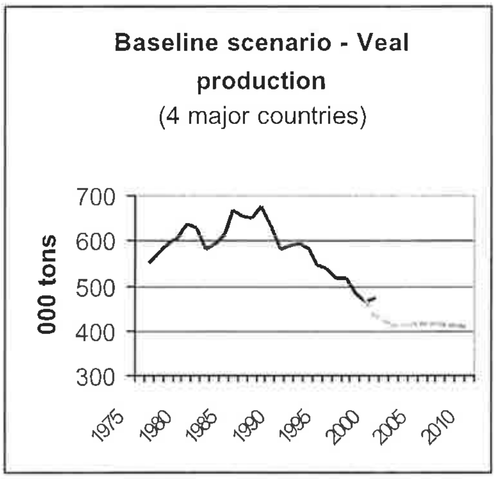
9.4.1. The baseline scenario: The impacts of the Agenda 2000 reform

The baseline scenario relies on the same hypotheses than the one adopted for computing the dynamic elasticities. Hence, globally, this scenario consists in the application of the Agenda 2000 final decisions from 2000 to 2002 and a continuation of this policy afterwards (i.e., untill 2010). For example, the levels of the unitary premiums decided in the Agenda 2000 reform are applied from 2000 to 2010 since they are assumed unchanged after the reform is implemented. A similar assumption is adopted regarding the number of premiums granted. For each country and each category of animals, they are assumed to remain at their 1999 until the end of the projection period (i.e., 2010).

For the aggregated four countries (which account for about 60 to 65% of the EU15 beef and veal production), this baseline scenario induces first a significant increase in the beef production until 2003, then a decrease until 2010 (-3.9%). These converse movements result in a slight increase over the 10 years projection horizon (+2.4%). For veal production, the baseline scenario leads to a significant decrease until 2003 (-9.9%), and then a relative stability resulting in a -10.7% decrease over the whole period.

Figure 9.1. The impacts of the baseline scenario on beef and veal production at the four countries aggregated level





The baseline scenario induces differentiated changes in the four considered countries. For beef, France and UK experience an increase in production over the projection period. This increase is about +4% in France and +43% in the UK (but it concerns a less important quantity). These increases are roughly compensated by an important decrease in Germany (-19.8%). The adjustment of veal production over the projection period is negative for all countries, but with different magnitudes: -9.6% in France, -27.5% and Germany, and -5.1% in Italy (net production of veal is nearly zero in the UK).

9.4.2. The restrictive premium scheme scenario: The impacts of a –20% decrease in the number of premiums granted

The restrictive premium scheme scenario rely on the same assumptions than the baseline scenario except the one relating to the number of premiums granted. In the baseline scenario, the numbers of the various premiums granted to farmers are assumed to remain unchanged with respect to their 1999 observed levels, over the whole projection period. This concerns the number of first and second payments of the male premium and the number of annual payments of the suckler cow premium. The restrictive premium scheme scenario assumes a -20% decrease in the total number of premiums granted (the number of first and second payments for male animals, and the number of suckler cow premiums) during the first year of the simulation period. Note that in this scenario the change in the number of premiums is maintained all over the simulation period. National models provide the effects of this policy change on all endogenous variables (cattle, net production, prices). In this paragraph, we report and discuss the simulated effects on net productions only because they give a synthetic picture of the overall induced adjustments within the national supplying beef and veal sectors

Computed dynamic elasticities, particularly of net productions with respect to the number of premiums granted, already suggested that this policy instrument has a low impact on beef and veal supply in the four considered countries. The simulation results of the restrictive premium scheme scenario confirms this conclusion. The effects of this scenario on net production of beef and veal, relative to the baseline scenario, are reported in table 9.18.

Table 9.18. The effects of a –20% decrease in the number of premiums granted on net production of beef and veal (relative to the baseline scenario)

	Net production of veal		Net production of beef	
	2003	2010	*2003*	2010
France	*+4.3%*	-0.8%	*-1.4%*	-8.3%
Germany	*+10.2%*	+3.0%	*-4.3%*	-9.5%
Italy	*+3.5%*	+1.8%	*+0.4%*	-0.2%
United-Kingdom	*n.s.*	n.s.	*+0.1%*	-1.8%
Total	*+4.4%*	**+0.3%**	*-1.5%*	**-5.3%**

n.s.: no significant

Simulation results show that even a drastic reduction in the number of premiums has nearly no effect on the net production of veal at the aggregate level. The –20% decrease in the number of premiums induces a decrease in the net production of beef, but, at the aggregate level, this decrease remains relatively limited (-1.5% until 2003 and -5.3% over the whole projection period). The decrease observed at the aggregate level results mainly from slightly more important decreases experienced in France and Germany (-8.3% and –9.5%, respectively), Italy and the UK being nearly no affected by the policy change.

The policy change that is simulated in this scenario is a cut-off in the number of all premiums. Effects are differentiated among countries, but also among categories of animals. This last finding indicates that a change in the awarding of premiums may have more significant consequences if it is targeted on specific categories of animals. However, such targeted changes would probably induce cross effects among categories of animals, such that impacts on targeted categories of animal could be partially compensated by effects on other categories of animals.

Finally, one of the main findings of the present study, either through the computation of dynamic elasticities or through the analysis of the impacts of policy reform scenarios, is that direct payment such as the beef premium scheme in force in the CMO for beef and veal are rather decoupled in the sense that they induce relatively low effects on production.

9.5. Conclusion and policy recommendations

A complete model of the beef and veal producing sector has been estimated for the four major producing Member States. Each model focuses on the effects of economic and agricultural policy variables on behavioural and biological relationships. Such models may be used to make simulations of policy changes in the beef sector, that is mainly, of changes in direct aids (both unitary premiums and the number of premiums granted), in milk quotas, or in the intervention price.

To assess the effects of such policy changes, the dynamic elasticities of the main endogenous variables (cattle, production, and prices) with respect to the policy variables are computed through a simulation method. They show, for example, that the number of premiums granted has no sizeable effects on net productions of beef and veal, but that effects of the intervention price are more significant.

Then, an issue which is addressed here is the assessment of a more restrictive awarding of direct aids through a cut-off in the number of premiums granted. Simulation results suggest that a change in the number of premiums granted does not have a sizeable effect on net productions of beef and veal, although impacts on herds and net productions vary across the various categories of animals and among countries. A change in the number of male premiums has an incidence only on beef production, not on veal production, but this effect is relatively limited.

Responses of the main European producing countries to policy changes are not homogenous. But, generally and naturally, effects observed at the aggregate level are close to the ones observed in France, which is the first producing Member State for both veal and beef.

One of the main results that can be drawn on our analysis is that the number of premiums (that is essentially the density ceilings) is not an efficient instrument for regulating the EU supply of beef and veal. Therefore, in order to affect significantly the beef and veal supply, the number of premiums should not be used alone, but in conjunction with other policy instruments.

APPENDIX 1.

Structure of the national models

The structure of the French model is presented. Some slight differences may occur for models of other countries. In this case, they are mentioned in appendix 3 when presenting the estimation results.

Names of endogenous variables are given in Table 9.1.

Calves

$BICA_t = cc_t (HEHE_{t-1} + COHE_{t-1})$

$CASL_t = csl_t . BICA_t$

$CABR_t = cbr_t . BICA_t$

$SLCA_t = slr_t . CASL_t$

$MCAH_t = mal_t . CABR_t$

$FCAH_t = CABR_t - MCAH_t$

$XLCA_t = BICA_t + MLCA_t - CAHE_t - 1.02. SLCA_t + CASA_{t-1}$

$CAHE_t = CABR_t + CASL_t - SLCA_t$

$CASA_t = CASL_t - SLCA_t$

Bovine female animals older than 1 year

$HEHE_t = FCAH_{t-1} + hrr_t . HEHE_{t-1}$

$(SLHE_t + XLHE_t - MLHE_t) = hsx_t . HEHE_{t-1}$

$SLHE_t = hsl_t . (SLHE_t + XLHE_t - MLHE_t)$

$$DAHE_t = (1 - hrr - hsx_t). HEHE_{t-1} . \frac{DAHE_{t-1}}{COHE_{t-1}} + dhrr_t .DAHE_{t-1}$$

$$SUHE_t = (1 - hrr - hsx_t). HEHE_{t-1} . \frac{SUHE_{t-1}}{COHE_{t-1}} + shrr_t .SUHE_{t-1}$$

$SLCO_t = (1 - dhrr_t).DAHE_{t-1} + (1-shrr_t).SUHE_{t-1}$

Bovine male animals older than 1 year

$MAHE_t = \gamma_t .MCAH_{t-1} + mrr_t (MAHE_{t-1} - XNLMA_t)$

$SLMA_t = (1 - \gamma_t).MCAH_{t-1} + (1 - mrr_t).(MAHE_t + MLCA_t - XNLMA_t)$

$SLMA_t = SLBU_t + SLST_t$

$SLBU_t + XNLMA_t = buslx_t . MAHE_{t-1}$

$SLST_t = stsl_t . MAHE_{t-1}$

$SLBU_t = busl_t . (SLBU_t + XNLMA_t)$

Net production of veal and adult cattle

$NPVE_t = casw_t \, . \, SLCA_t$

$NPHE_t = hasw_t . SLHE$

$NPCO_t = coasw_t . SLCO_t$

$NPBU_t = buasw_t . SLBU$

$NPST_t = stasw_t . SLST_t$

$NPAC_t = NPHE_t + NPCO_t + NPBU_t + NPST_t$

Specification of the key variables of the model

The various rates

$$y = \{ cc, csl, cbr, slr, mal, hrr, hsx, hsl, dhrr, shrr, \gamma, mrr, buslx, bosl, busl \}$$

$$y_t = \frac{y^+}{1 + exp(-X_t \beta)} + \varepsilon_t$$

where: y^+ is the upper limit choosen for y_t,

X_t is a vector of explanatory variables

β is a vector of parameters,

ε_t is an error term.

The average slaughter weights

Calves: $$casw_t = \frac{casw^+}{1 + exp(-X_t \beta)} + \varepsilon_t$$

Heifers: $$hasw_t = \frac{hasw^+}{1 + exp(-X_t \beta)} + \varepsilon_t$$

Cows: $$coasw_t = \frac{coasw^+}{1 + exp(-X_t \beta)} + \varepsilon_t$$

Bulls: $$buasw_t = \frac{buasw^+}{1 + exp(-X_t \beta)} + \varepsilon_t$$

Steers: $$stasw_t = \frac{stasw^+}{1 + exp(-X_t \beta)} + \varepsilon_t$$

indexes of producer prices

Calves: $$\left(\frac{ipca}{ipgdp} \right)_t = X_t \; \beta + \varepsilon_t$$

Adult cattle: $$\left(\frac{ipct}{ipgdp} \right)_t = X_t \; \beta + \varepsilon_t$$

APPENDIX 2.

List of the exogenous variables

$ipgdp_t$	Price index of gross domestic product (1990=100)
$ipfeed_t$	Animal feed price index
tap_spma1_t	Total amount of the **first** payment of the special premium for male animals (bulls and steers)
tap_spma2_t	Total amount of the **second** payment of the special premium for male animals (bulls and steers)
tap_bu_t	Total amount of the special premium for bulls
tap_st_t	Total amount of the special premium for steers
tap_scp_t	Total amount of suckler cow premiums
$milk_t$	Milk quota (assumed equal to the milk collected, before 1984)
$intp_t$	Nominal intervention price

Each variable "total amount of premiums" (tap_*_t) is the product of the number of premiums granted by the unitary level of the premium.

APPENDIX 3.

Estimation results

FRANCE

(t-statistics are provided in parenthesis)

Table 9.19. Estimation results for the calf model

	Calf crop ($cc^{+}=0.7$)	Calves for slaughtering ($csl^{+}=0.75$)	Slaughtering rate ($slr^{+}=0.95$)	Calves for breeding ($cbr^{+}=0.75$)	Male calves for breeding ($mal^{+}=0.50$)	Average slaughter weight ($casw^{+}=130$)
Constant	-2.926 (-2.84)	0.518 (15.5)	1.235 (3.72)	1.039 (20.8)	1.280 (1.04)	0.519 (0.13)
$(\frac{ipca}{ipgdp})_{t-1}$	1.794 (5.39)		-1.594 (-2.14)		-1.083 (-2.84)	
$(\frac{ipct}{ipgdp})_{t-1}$			1.607 (3.60)			
$milk_t$					$0.474.10^{-4}$ (1.18)	
$milk_{t-1}$	$0.102.10^{-3}$ (3.17)					
tap_spmal_t		$-0.334.10^{-6}$ (-5.93)		$0.538.10^{-6}$ (6.41)		
$casw_{t-1}$						0.036 (1.44)
$(\frac{ipfeed}{ipgdp})_{t-1}$						-2.032 (-2.29)
R^2	0.59	0.65	0.61	0.70	0.46	0.87
DW	1.48	0.81	0.91	1.07	1.76	1.15

Table 9.20. Estimation results for heifers for slaughtering and export

X_t	bsx_t ($bsx^{+}=0.3$)
Constant	3.745 (2.80)
$milk_t$	$-0.614.10^{-4}$ (-1.58)
tap_scp_t	$-0.383.10^{-6}$ (-3.61)
$\left(\frac{ipct}{ipgdp}\right)_{t-1}$	-1.268 (-2.81)
	$R^2 = 0.40$ $DW = 1.97$

Table 9.21. Estimation results for the rates of cow replacement

X_t	dairy herd $dhrr_t$ ($dhrr^+$=0.9)	suckler herd $shrr_t$ ($shrr^+$=0.9
Constant	1.745 (25.03)	2.086 (17.02)
$milk_t - milk_{t-1}$	$0.240.10^{-4}$ (1.89)	
$DAHE_t - DAHE_{t-1}$		$-0.123.10^{-2}$ (-2.11)
	$R^2 = 0.14$ $DW = 1.75$	$R^2 = 0.17$ $DW = 2.19$

Table 9.22. Estimation results for the heifer and cow average slaughter weights

X_t	Heifers ($hasw^+$=370)	X_t	Cows ($coasw^+$=350)
Constant	-3.726 (-3.35)	Constant	-8.704 (-19.38)
$hasw_{t-1}$	0.019 (7.24)	$coasw_{t-1}$	0.035 (24.1)
$\left(\frac{ipfeed}{ipgdp}\right)_t$	-0.456 (-1.90)		
	R^2=0.97 DW=0.80		R^2=0.96 DW=1.96

Table 9.23. Estimation results for the herd of adult males

X_t	γ_t $\gamma^+ = 0.55$	mrr_t $mrr^+ = 1.$
Constant	-3.756 (-1.40)	0.060 (0.09)
tap_spma1_t	$0.221.10^{-5}$ (1.73)	
tap_spma2_t		$0.317.10^{-6}$ (0.59)
$\left(\frac{ipct}{ipgdp}\right)_{t-1}$	4.584 (1.99)	0.404 (1.04)
	R^2=0.96 DW=2.14 RMSE=3.23%	

Table 9.24. Estimation results for the rates of slaughtering (plus export for bulls) of adult males

$(XNLMA_t = XLMA_t - MLMA_t)$ (assume $XLST_t = MLST_t = 0 \Rightarrow XNLMA_t = XLBU_t - MLBU_t$)

$(SLXMBU_t = XNLMA_t + SLBU_t)$

$XLBU_t$ and $MLBU_t$ are respectively exports and imports of bulls,
$XLST_t$ and $MLST_t$ are respectively exports and imports of steers

$$SLXMBU_t = buslx_t \,.\, (MCAH_{t-1} + MAHE_{t-1})$$

$$SLST_t = stsl_t \,.\, (MAHE_{t-1})$$

$$SLBU_t = SLMA_t - SLST_t$$

$$XNLMA_t = SLXMBU_t - SLBU_t$$

X_t	Bulls ($buslx^+ = 1.$)	X_t	Steers ($stsl^+ = 0.9$)
Constant	1.033 (2.79)	*Constant*	1.467 (2.01)
tap_bu_t	$-0.199.10^{-7}$ (-0.10)	tap_st_t	$-0.227.10^{-5}$ (-7.87)
$\left(\frac{ipct}{ipgdp}\right)_{t-1}$	-1.429 (-5.19)	$\left(\frac{ipct}{ipgdp}\right)_{t-1}$	-0.715 (-1.94)
		$slbu_{t-1}$	$-0.113.10^{-2}$ (-3.19)
	$R^2=0.82$ $DW=0.90$		$R^2=0.94$ $DW=1.52$

Table 9.25. Estimation results for the bull and steer average slaughter weights

X_t	Bulls ($buasw^+ = 550$)	X_t	Steers ($stasw^+ = 550$)
Constant	-0.687 (-1.74)	Constant	-0.719 (-1.35)
$buasw_{t-1}$	$0.479.10^{-2}$ (5.55)	$stasw_{t-1}$	$0.489.10^{-2}$ (4.27)
$\left(\frac{ipfeed}{ipgdp}\right)_t$	-0.301 (-4.35)		-0.274 (-3.13)
	$R^2=0.96$ $DW=1.33$		$R^2=0.96$ $DW=1.69$

Table 9.26. Estimation results for the real indexes of producer prices (national currencies)

	Calves	Adult cattle
Constant	-0.229 (-0.99)	0.276 (1.62)
Real intervention price expressed in national currency	$0.431.10^{-3}$ (5.22)	$0.245.10^{-3}$ (2.86)
Excess supply	$-0.501.10^{-2}$ (-4.37)	$-0.556.10^{-3}$ (-8.16)
	$R^2 = 0.88$ $DW = 1.56$	$R^2 = 0.98$ $DW = 2.40$

GERMANY

(t-statistics are provided in parenthesis – for nearly all relationships, a dummy variable equal to 1 in 1991 and zero otherwise is introduced to take into account the German reunification, but the corresponding coefficients are not reported here)

Table 9.27. Estimation results for the calf model

	Calf crop ($cc^+=0.85$)	Calves for slaughtering ($csl^+=0.2$)	Slaughtering rate (fixed)	Calves for breeding ($cbr^+=1.$)	Male calves for breeding ($mal^+=0.50$)	Average slaughter weight ($casw^+=130$)
Constant	0.336 (2.44)	1.294 (9.97)	0.75	1.853 (25.0)	3.495 (37.9)	-3.910 (-2.35)
$(\frac{ipca}{ipgdp})_{t-1}$	0.978 (8.48)					
tap_scp_t					$-0.692.10^{-5}$ (-4.58)	
tap_spmal_t		$-0.248.10^{-5}$ (-3.66)		$0.917.10^{-6}$ (2.36)		
$casw_{t-1}$						0.056 (4.95)
$(\frac{ipfeed}{ipgdp})_{t-1}$						-0.194 (-0.57)
R^2	0.91	0.39		0.21	0.63	0.81
DW	1.04	1.14		1.25	0.90	1.54

Table 9.28. Estimation results for heifer cattle (*hehe*$_t$)

$$HEHE_t = rdfc_t \,.\, FCAH_{t-1} + hrr_t \,.\, HEHE_{t-1}$$

X_t	$rdfc_t$ ($rdfc^+=0.98$)	hrr_t ($hrr^+=0.4$)
Constant	2.349 (19.0)	1.173 (10.4)
$\left(\frac{ipca}{ipgdp}\right)_{t-1}$	-0.920 (-8.91)	
$\left(\frac{ipct}{ipgdp}\right)_{t-1}$		-0.267 (-3.25)
	$R^2 = 0.97$ $DW = 1.55$	$R^2 = 0.82$ $DW = 0.85$

Table 9.29. Estimation results for heifers for slaughtering and export

$$SLHE_t + XLHE_t - MLHE_t = bsx_t \,.\, FCAH_{t-1} + \beta_t \,.\, HEHE_{t-1}$$

X_t	bsx_t ($bsx^+=1.3$)	β_t ($\beta^+ = 0.4$)
Constant	-3.955 (-14.8)	0.969 (3.11)
$\left(\frac{ipct}{ipgdp}\right)_{t-1}$	1.405 (7.01)	-1.203 (-5.07)
	$R^2 = 0.92$ $DW = 1.49$	$R^2 = 0.59$ $DW = 1.14$

Table 9.30. Estimation results for heifer slaughtering

$$SLHE_t = hsl_t \,.\, (SLHE_t + XLHE_t - MLHE_t)$$

X_t	hsl_t ($hsl^+=1.$)
Constant	2.233 (3.62)
$\left(\frac{ipct}{ipgdp}\right)_{t-1}$	0.837 (1.54)
	$R^2 = 0.22$ $DW = 0.43$

Table 9.31. Estimation results for the rates of cow replacement

X_t	dairy herd $dhrr_t$ ($dhrr^+=1.$)	suckler herd $shrr_t$ ($shrr^+=1.$)
Constant	0.873 (25.4)	1.006 (6.08)
$milk_t - milk_{t-1}$	$0.230.10^{-3}$ (8.80)	$-0.304.10^{-3}$ (-1.64)
tap_scp_t		$0.381.10^{-6}$ (0.14)
	$R^2 = 0.14$ $DW = 1.75$	$R^2 = 0.24$ $DW = 1.65$

Table 9.32. Estimation results for the heifer and cow average slaughter weights

X_t	Heifers ($hasw^{+}$=300)	X_t	Cows ($coasw^{+}$=300)
Constant	-0.683 (-0.33)	Constant	-2.383 (-0.62)
$hasw_{t-1}$	0.013 (1.82)	$coasw_{t-1}$	0.022 (1.69)
$\left(\frac{ipfeed}{ipgdp}\right)_t$	-0.541 (-2.87)	$\left(\frac{ipfeed}{ipgdp}\right)_t$	-0.743 (-3.59)
	$R^2=0.84$ $DW=2.01$		$R^2=0.81$ $DW=2.32$

Table 9.33. Estimation results for the herd of adult males

X_t	γ_t $\gamma^{+}=0.8$	mrr_t $mrr^{+}=0.2$
Constant	0.858 (23.8)	-0.178 (-0.80)
tap_spma1_t	$0.467.10^{-6}$ (2.36)	
tap_spma2_t		$0.612.10^{-5}$ (2.73)
$\left(\frac{ipct}{ipgdp}\right)_{t-1}$		0.175 (1.12)
	$R^2=0.78$ $DW=1.21$	$R^2=0.57$ $DW=1.56$

Table 9.34. Estimation results for the rates of slaughtering (plus export for bulls) of adult males

$(XNLMA_t = XLMA_t - MLMA_t)$ (assume $XLST_t = MLST_t = 0 \Rightarrow XNLMA_t = XLBU_t - MLBU_t$)

$(SLXMBU_t = XNLMA_t + SLBU_t)$

$XLBU_t$ and $MLBU_t$ are respectively exports and imports of bulls,

$XLST_t$ and $MLST_t$ are respectively exports and imports of steers

$$SLXMBU_t = buslx_t \,.\, (MCAH_{t-1} + MAHE_{t-1})$$

$$SLST_t = stsl_t \,.\, (MCAH_{t-1} + MAHE_{t-1})$$

$$SLBU_t = SLMA_t - SLST_t$$

$$XNLMA_t = SLXMBU_t - SLMA_t + SLST_t$$

X_t	Bulls ($buslx^+=1.$)	X_t	Steers ($stsl^+=0.9$)
Constant	0.925 (8.22)	*Constant*	4.855 (4.13)
tap_bu_t	$-0.224.10^{-6}$ (-1.17)	tap_st_t	$-0.446.10^{-4}$ (-5.48)
$\left(\frac{ipct}{ipgdp}\right)_{t-1}$	-0.179 (-2.48)		
		$slbu_{t-1}$	$-0.165.10^{-2}$ (-3.41)
	$R^2=0.69$ $DW=1.73$		$R^2=0.64$ $DW=0.71$

Table 9.35. Estimation results for the bull and steer average slaughter weights

X_t	Bulls ($buasw^+=370$)	X_t	Steers ($stasw^+=360$)
Constant	-4.015 (-1.80)	Constant	0.526 (0.25)
$buasw_{t-1}$	0.021 (3.68)	$stasw_{t-1}$	$0.806.10^{-2}$ (1.41)
$\left(\frac{ipfeed}{ipgdp}\right)_t$	-0.469 (-1.80)	$\left(\frac{ipfeed}{ipgdp}\right)_t$	-0.684 (-2.26)
	$R^2=0.92$ $DW=2.06$		$R^2=0.58$ $DW=0.87$

Table 9.36. Estimation results for the real indexes of producer prices (national currencies)

	Calves	Adult cattle
Constant	-0.296 (-1.45)	0.070 (0.38)
Real intervention price expressed in national currency	$0.140.10^{-2}$ (9.36)	$0.110.10^{-2}$ (3.58)
Excess supply	$-0.563.10^{-2}$ (-1.83)	$-0.279.10^{-3}$ (-3.54)
ρ	0.38 (1.47)	0.92 (10.8)
	$R^2=0.92$ $DW=1.71$	$R^2=0.99$ $DW=2.32$

ITALY

(t-statistics are provided in parenthesis)

Table 9.37. Estimation results for the calf model

	Calf crop ($cc^+=0.7$)	Calves for slaughtering ($csl^+=0.7$)	Slaughtering rate ($slr^+=0.95$)	Calves for breeding ($cbr^+=1.$)	Male calves for breeding ($mal^+=0.51$)	Average slaughter weight ($casw^+=150$)
Constant	2.654 (1.70)	1.412 (12.4)	0.486 (0.61)	1.642 (1.18)	2.090 (3.99)	4.186 (6.70)
$(\frac{ipca}{ipgdp})_{t-1}$	3.15 (1.02)		3.250 (2.06)	-5.360 (-1.94)		
$(\frac{ipct}{ipgdp})_{t-1}$	-4.311 (-2.41)		-2.184 (-2.42)	4.973 (3.15)		
tap_spmal_t		$-0.394.10^{-8}$ (-1.87)			$0.151.10^{-7}$ (1.55)	
$(\frac{ipfeed}{ipgdp})_{t-1}$						-1.689 (-2.97)
R^2	0.60	0.37	0.35	0.59	0.18	0.41
DW	1.28	1.03	1.29	1.59	0.79	2.27

Table 9.38. Estimation results for heifer cattle (*hehe$_t$*)

$$HEHE_t = rdfc_t \,.\, FCAH_{t-1} + hrr_t \,.\, HEHE_{t-1}$$

X_t	$rdfc_t$ ($rdfc^+=1$)	hrr_t ($hrr^+=0.5$)
Constant	-1.220 (-0.85)	0.662 (4.38)
$\left(\frac{ipct}{ipgdp}\right)_{t-1}$	3.414 (2.63)	0.213 (0.95)
	$R^2 = 0.37$ $DW = 1.15$	$R^2 = 0.16$ $DW = 2.67$

Table 9.39. Estimation results for heifer slaughtering ($slhe_t$)

$$SLHE_t = (1 - rdfc_t) \, . \, FCAH_{t-1} + \delta_t \, . \, HEHE_{t-1} + MLHE_t$$

(all heifer imports are assumed to be slaughtered the same year, and $XLHE_t = 0$)

X_t	δ_t ($\delta^+=0.5$)
Constant	2.419 (2.83)
tap_scp_t	$-0.200.10^{-7}$ (-4.13)
$\left(\frac{ipct}{ipgdp}\right)_{t-1}$	-1.036 (-2.21)
	$R^2 = 0.58$ $DW = 1.83$

Table 9.40. Estimation results for the rates of cow replacement

$$DAHE_t = (1 - hrr - \delta_t) . \; HEHE_{t-1} . \frac{DAHE_{t-1}}{COHE_{t-1}} + dhrr_t . DAHE_{t-1}$$

$$SUHE_t = (1 - hrr - \delta_t) . \; HEHE_{t-1} . \frac{SUHE_{t-1}}{COHE_{t-1}} + shrr_t . SUHE_{t-1}$$

X_t	dairy herd ($dhrr_t$) ($dhrr^+=0.9$)	suckler herd ($shrr_t$) ($shrr^+=0.9$)
Constant	2.039 (27.8)	1.171 (3.43)
$(\frac{ipca}{ipgdp})_{t-1}$		0.732 (2.75)
$milk_t - milk_{t-1}$	$0.152.10^{-3}$ (0.93)	
$DAHE_t - DAHE_{t-1}$		$-0.205.10^{-2}$ (-2.00)
	$R^2 = 0.12$ $DW = 0.55$	$R^2 = 0.42$ $DW = 1.65$

$$SLCO_t = (1 - dhrr_t).DAHE_{t-1} + (1 - shrr_t).SUHE_{t-1}$$

Table 9.41. Estimation results for the heifer and cow average slaughter weights

X_t	Heifers ($hasw^{+}=270$)	X_t	Cows ($coasw^{+}=270$)
Constant	-1.434 (-1.70)	Constant	1.441 (0.48)
$hasw_{t-1}$	0.018 (5.62)	$coasw_{t-1}$	0.013 (1.28)
		$coasw_{t-2}$	$-0.794.10^{-2}$ (-1.43)
$\left(\frac{ipfeed}{ipgdp}\right)_t$	-0.571 (-5.62)	$\left(\frac{ipfeed}{ipgdp}\right)_t$	-0.312 (-2.27)
	$R^2=0.93$ $DW=1.15$		$R^2=0.46$ $DW=1.61$

Table 9.42. Estimation results for the herd of adult males

$$MAHE_t = vma_t \,.\, (MCAH_{t-1} + MNLBU_t) + mrr_t \,.\, MAHE_{t-1}$$

$(MNLBU_t = MLBU_t - XLBU_t)$ *(assume* $XLBU_t = 0$ *and* $XLST_t = MLST_t = 0$*)*

$XLBU_t$ and $MLBU_t$ are respectively exports and imports of bulls,

$XLST_t$ and $MLST_t$ are respectively exports and imports of steers

X_t	vma_t ($vma^{+}=0.6$)	mrr_t ($mrr^{+}=0.5$)
Constant	0.216 (4.29)	-1.960 (-5.35)
tap_spma1_t	$0.202.10^{-8}$ (1.75)	
$tap\_spma1_t + tap\_spma2_t$		$0.678.10^{-8}$ (2.49)
$\left(\frac{ipct}{ipgdp}\right)_{t-1}$		0.529 (2.45)
	$R^2=0.20$ $DW=0.62$	$R^2=0.26$ $DW=1.15$

Table 9.43. Estimation results for the bull slaughterings *($slbu_t$)*

$$SLBU_t = busl_t \,.\, (MCAH_{t-1} + MAHE_{t-1} + MNLBU_t)$$

X_t	$busl_t$ ($busl^+=0.8$)
Constant	2.186 (39.9)
tap_bu_t	$-0.263.10^{-8}$ (-1.83)
	$R^2=0.29$ $DW=0.98$

$$SLMA_t = (1- vma_t) \,.\, (MCAH_{t-1} + MNLBU_t) + (1 - mrr_t) \,.\, MAHE_{t-1}$$

$$\text{Slaughterings of steers}: SLST_t = SLMA_t - SLBU_t$$

Table 9.44. Estimation results for the bull and steer average slaughter weights

X_t	Bulls ($buasw^+=350$)	X_t	Steers ($stasw^+=350$)
Constant	-0.811 (-0.76)	Constant	0.238 (0.20)
$buasw_{t-1}$	0.011 (3.67)	$stasw_{t-1}$	$0.446.10^{-2}$ (1.12)
$\left(\frac{ipfeed}{ipgdp}\right)_t$	-0.613 (-4.13)	$\left(\frac{ipfeed}{ipgdp}\right)_t$	-0.040 (-0.33)
	$R^2=0.92$ $DW=1.04$		$R^2=0.09$ $DW=1.66$

Table 9.45. Estimation results for the real indexes of producer prices (national currencies)

	Calves	Adult cattle
Constant	0.267 (1.56)	0.043 (0.19)
Real intervention price expressed in national currency	$0.123.10^{-5}$ (4.88)	$0.137.10^{-5}$ (2.85)
Excess supply	$-0.274.10^{-4}$ (-0.03)	$-0.529.10^{-3}$ (-2.56)
ρ	0.09 (0.26)	0.83 (13.0)
	$R^2 = 0.79$ $DW = 1.97$	$R^2 = 0.98$ $DW = 2.28$

UNITED-KINGDOM

(t-statistics are provided in parenthesis)

Table 9.46. Estimation results for the calf model

	Calf crop (cc^+=0.6)	Calves for slaughtering (csl^+=0.15)	Slaughtering rate (slr^+=1.)	Calves for breeding (cbr^+=1)	Male calves for breeding (mal^+=0.51)	Average slaughter weight ($casw^+$=60)
Constant	1.278 (5.72)	-0.667 (-2.91)	-1.751 (-4.53)	2.047 (11.7)	3.141 (23.2)	-4.985 (-2.96)
$(\frac{ipca}{ipgdp})_{t-1}$	0.470 (2.57)		-0.585 (-1.73)			
$(\frac{ipct}{ipgdp})_{t-1}$			2.889 (6.65)			
tap_spmal_t		$-0.195.10^{-4}$ (-4.39)		$0.986.10^{-5}$ (2.81)		
tap_scp_t					$-0.657.10^{-5}$ (-3.49)	
$(\frac{ipfeed}{ipgdp})_{t-1}$						
$casw_{t-1}$						0.058 (4.39)
$milk_t$						$0.232.10^{-3}$ (1.93)
R^2	0.22	0.45	0.73	0.34	0.34	0.60
DW	0.63	0.47	1.17	0.84	0.50	2.06

Table 9.47. Estimation results for heifer cattle ($hehe_t$)

X_t	hrr_t (hrr^+=0.45)
Constant	-0.449 (-1.94)
$\left(\frac{ipct}{ipgdp}\right)_{t-1}$	1.228 (6.34)
	$R^2 = 0.63$ $DW = 1.93$

Table 9.48. Estimation results for heifer slaughtering ($slhe_t$)

$$SLHE_t = \delta_t \,.(\, HEHE_{t-1} + MLHE_t - XLHE_t)$$

X_t	δ_t ($\delta^{+}=0.5$)
Constant	2.862 (8.09)
$milk_t - milk_{t-1}$	$-0.351.10^{-3}$ (-2.22)
$\left(\frac{ipct}{ipgdp}\right)_{t-1}$	-1.446 (-4.95)
	$R^2 = 0.63$ $DW = 1.91$

Table 9.49. Estimation results for the rates of cow replacement

$$DAHE_t = (1 - hrr - \delta_t).\ HEHE_{t-1} \cdot \frac{DAHE_{t-1}}{COHE_{t-1}} + dhrr_t .DAHE_{t-1}$$

$$SUHE_t = (1 - hrr - \delta_t).\ HEHE_{t-1} \cdot \frac{SUHE_{t-1}}{COHE_{t-1}} + shrr_t .SUHE_{t-1}$$

X_t	dairy herd ($dhrr_t$) ($dhrr^{+}=0.9$)	suckler herd ($shrr_t$) ($shrr^{+}=0.9$)
Constant	2.245 (30.7)	2.509 (11.9)
$milk_t - milk_{t-1}$	$0.120.10^{-3}$ (0.70)	
$DAHE_t - DAHE_{t-1}$		$-0.548.10^{-2}$ (-2.37)
	$R^2 = 0.02$ $DW = 2.17$	$R^2 = 0.20$ $DW = 1.37$

$$SLCO_t = (1 - dhrr_t).DAHE_{t-1} + (1 - shrr_t).SUHE_{t-1}$$

Table 9.50. Estimation results for the heifer and cow average slaughter weights

X_t	Heifers ($hasw^{+}$=280)	X_t	Cows ($coasw^{+}$=290)
Constant	-7.289 (-3.47)	Constant	-5.320 (-2.19)
$hasw_{t-1}$	0.041 (5.93)	$coasw_{t-1}$	0.032 (3.77)
$\left(\frac{ipfeed}{ipgdp}\right)_t$	-0.381 (-1.03)	$\left(\frac{ipfeed}{ipgdp}\right)_t$	-0.466 (-1.22)
	R^2=0.91 DW=0.90		R^2=0.51 DW=2.43

Table 9.51. Estimation results for the herd of adult males

$$MAHE_t = \gamma_t \,.\, MCAH_{t-1} + mrr_t \,.(MAHE_{t-1} - XNLMA_t)$$

$$XLMA_t = XLBU_t + XLST_t$$

$$MLMA_t = MLBU_t + MLST_t$$

$(XNLMA_t = XLMA_t - MLMA_t)$ *(assume* $XLBU_t = 0$ *and* $XLST_t = MLST_t = 0 \Rightarrow XNLMA_t = - MLBU_t$*)*

$XLBU_t$ and $MLBU_t$ are respectively exports and imports of bulls,

$XLST_t$ and $MLST_t$ are respectively exports and imports of steers

X_t	γ_t (γ^{+}=0.9)	mrr_t (mrr^{+}=0.4)
Constant	0.346 (1.0)	0.122 (0.63)
$\left(\frac{ipct}{ipgdp}\right)_{t-1}$	0.916 (3.21)	0.366 (2.28)
	R^2=0.46 DW=0.78	R^2=0.20 DW=1.63

Table 9.52. Estimation results for the bull slaughterings *(slst$_t$)*

X_t	$slst_t / (mcah_{t-1} + mahe_{t-1} - xnlma_t)$ $(stsl^+=0.7)$
Constant	0.784 (17.0)
tap_st_t	$-0.929.10^{-5}$ (-5.05)
	$R^2=0.60$ $DW=0.79$

$$SLMA_t = (1- vma_t) \,.\, (MCAH_{t-1} + MNLBU_t) + (1 - mrr_t) \,.\, MAHE_{t-1}$$

$$\Rightarrow \textit{Slaughterings of bulls : } SLBU_t = SLMA_t - SLST_t$$

Table 9.53. Estimation results for the bull and steer average slaughter weights

X_t	Bulls $(buasw^+=350)$	X_t	Steers $(stasw^+=350)$
Constant	-2.778 (-3.20)	Constant	-5.602 (-14.2)
$buasw_{t-1}$	0.016 (5.80)	$stasw_{t-1}$	0.025 (19.1)
$\left(\frac{ipfeed}{ipgdp}\right)_t$	-0.324 (-2.81)		
	$R^2=0.69$ $DW=1.98$		$R^2=0.94$ $DW=1.24$

Table 9.54. Estimation results for the real indexes of producer prices (national currencies)

	Calves	Adult cattle
Constant	-0.015 (-0.04)	-0.369 (-3.07)
Real intervention price expressed in national currency	$0.388.10^{-2}$ (2.84)	$0.520.10^{-2}$ (12.8)
Excess supply	-0.013 (-0.40)	$-0.293.10^{-3}$ (-1.85)
ρ	0.44 (2.28)	0.50 (3.78)
	$R^2 = 0.51$ $DW = 1.28$	$R^2 = 0.96$ $DW = 2.19$