Responsiveness of Compound Feed Prices in the European Community to Changes in Feed Input Prices

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Abstract

This paper investigates the effects of feed input prices on manufactured compound feed costs and prices in the EC. The analysis is based on a simulation of the cost-minimizing behavior of "typical" feed compounders in the individual EC member countries. The procedure adopted involves three steps. First, country-specific linear programming (LP) feedmix models for various types of livestock are solved repeatedly for different sets of relative feed input prices. Second, summary functions are fitted to the LP solutions. Third, compound feed cost elasticities with respect to feed input prices are computed. Estimation results are presented at the national and the community (EC-9) level.

Introduction

Market demand for feedstuffs in the European Community (EC) is largely determined by the behavior and conditions of the compound feed industry in the various EC member countries. Compound feeds account for a steadily increasing share in total feed costs of EC livestock production. In 1984, concentrate feeds accounted for 72 percent of total feed costs in the EC. The situation is different for the various livestock products, however. It is estimated that concentrate feeds account for about 70 percent of total energy requirements in the poultry sector, 50 percent in the pork sector, and only 17 percent in the beef/dairy sector (EEC, 1988, p.8/8).

The purpose of this study is to quantify the effects of changes in feed input prices on compound feed ration costs and prices in the EC. More specifically, the issue addressed in this study is: How do compound feed ration costs—in terms of input costs—in the various EC member countries and in the EC-9 as a whole respond to feed input price changes? To what extent are these effects transmitted to the selling prices of the compound feed rations?

The present analysis is based on a simulation of the cost-minimizing behavior of "typical" feed compounders in the EC member countries by repeatedly solving country-specific linear programming (LP) feed ration models for various types of livestock. The LP solutions are then approximated by continuous "summary functions", from which compound feed ration cost elasticities with respect to feed ingredient prices can be derived.

LP models

Country-specific LP feed ration models for four types of livestock are involved in the analysis. The four types of feed are a standard dairy cow ration, a ration for fattening pigs, a ration for layers, and a broiler ration. The data on the feedmix models, the nutritional composition of the feed ingredients, and the prices of the feed ingredients (for the marketing year 1984/85) were available from the

Institute for Agricultural Economics in the Netherlands (see Appendix Tables A.1 and A.2). The prices reflect variations in Monetary Compensatory Amounts (MCAs) and intra-EC transportation costs. The feedmix models take into account various nutritional and technical restrictions, as well as some "behavioral" restrictions (i.e., observed ingredient usage patterns).

The LP models were used to produce a sample of ration costs for a wide range of different feed input prices. The procedure begins with solving a series of minimal-unit-cost LP models:

$$\text{Min } c_{ij} = (p^0 + \alpha_{ij}.d_i)^T.x,$$

subject to

$$A.x \leq b,$$
$$x \geq 0,$$

where p^0 is the vector of base price values, x is the vector of input demand quantities, d_i ($i = 1,\ldots,I$) is the vector of the directions of change for the various feed prices, and α_{ij} is the price variation for the ij-th data point. Sets of LP observations are generated for each country by choosing several ("orthogonal") directions, d_i, and several values for the spacing parameter, α_{ij} (see Figure 1).

In the present analysis, the prices of nine individual feed ingredients and three groups of feed ingredients[1] were <u>independently</u> varied by taking various multiples (over a range of 50 to 200 percent) of their 1984/85 base values, while holding all other prices constant.[2] The prices of the feed ingredients belonging to one group were varied simultaneously. This method, which is known as the <u>pseudo-data</u> method, was introduced by Griffin (1977, 1978) and used by McKinzie et al. (1986).[3]

Single-equation summarizations

The following step is to fit summary functions to the LP solutions. The <u>translog</u> functional form is used as a local, second-

order approximation to the concave and piece-wise linear response surface generated by the LP models. The translog cost function (with m feed ingredients) is as follows:

$$(1)\quad \ln[c^*(p)] = a_0 + \sum_{k=1}^{m} a_k \cdot \ln(p_k) + \tfrac{1}{2} \sum_{k=1}^{m} \sum_{h=1}^{m} b_{kh} \cdot \ln(p_k) \cdot \ln(p_h) + \sum_{k=1}^{m} \ln(p_k) \cdot \epsilon_k,$$

with the usual restrictions on the coefficients:

$$(2)\quad \sum_{k=1}^{m} a_k = 1; \quad b_{kh} = b_{hk}; \quad \sum_{h=1}^{m} b_{kh} = 0.$$

Under the stated restrictions the translog cost function is linearly homogeneous in input prices; only changes in relative prices will affect the derived demand for any input. The disturbances (ϵ_k) are introduced to reflect the approximation errors due to the omission of higher-degree price terms (Maddala and Roberts, 1980). Equation (1) implicitly reflects constant returns to size (that is, there are no cost advantages or disadvantages to larger sized operations). As a result,

$$(3)\quad \underset{\text{(marg.cost)}}{MC} = \underset{\text{(avg.cost)}}{AC} = \underset{\text{(unit cost)}}{c},$$

or

$$(4)\quad C(p,q) = q \cdot C(p,1) = q \cdot c(p),$$

where the marginal feed cost, MC, is defined as $\partial C(p,q)/\partial q$, with q denoting the level of output, and C denoting total variable feed cost. Consequently, changes in feed input prices induce parallel, horizontal shifts in the marginal cost curves. In addition, marginal feed costs are homogeneous of degree zero in the output.

Cost elasticities

By using Shephard's lemma, the systems of (marginal) cost share equations were estimated rather than the translog functions themselves. The cost shares of the various feed inputs are the logarithmic derivatives of equation (1):

$$(5) \qquad s_k = \frac{\partial \ln(c^*)}{\partial \ln(p_k)} = a_k + \Sigma_h \, b_{kh} \cdot \ln(p_h).$$

The cost share of any feed input expresses the percentage change in unit cost of the compound feed ration in response to a 1 percent change in price of the feed input, other factors held constant. The coefficients of the cost share equations were obtained by using a least-squares (Zellner) estimation procedure. In illustration, the estimation results for Belgium/Luxembourg are given in Appendix Table A.3.

The total change in the cost of the ration with respect to a change in any input price is defined as follows:

$$(6) \qquad d\ln[c^*(p)] = \Sigma_k \left(\frac{\partial \ln(c^*)}{\partial \ln(p_k)}\right) \cdot d\ln(p_k) = \Sigma_k \, s_k \cdot d\ln(p_k).$$

For example, with two feed inputs we have the following:

$$(7) \qquad \hat{c}^*(p) = s_1 \cdot \hat{p}_1 + s_2 \cdot \hat{p}_2,$$

where the circumflex denotes percentage change.

Estimation results

We turn now to the cost elasticities (marginal cost shares) implied by the translog estimates. These cost elasticities are "partial" in the sense that only one price is changed at the time. The results for the various rations for both the individual EC member countries and the EC-9 are reported in Table 1 and Table 2,

respectively.[4] The elasticities evaluated at the 1984/85 base price sample point are contrasted with the average cost elasticities over the entire sample range $[0.5p^0\text{-}2p^0]$. The elasticities in Table 2 for the EC-9 are weighted averages based on 1985 compound feed production for each livestock category in the EC member countries. The aggregate elasticity for the poultry subsector in each EC member country takes into account the 1985 number of livestock units for layers and broilers, respectively (see Appendix Tables A.4 and A.5).

The numerical results show that corn is the largest single feed ingredient for poultry production, while wheat and barley are more important for pork and beef/dairy. Soymeal is most important in poultry production (broilers); corn gluten feed is most important in dairy; manioc is most important in pork production. Other energy-rich items ("cereal substitutes" in the narrow sense) are used heavily in dairy; large amounts of other protein-rich items (oilseed meals) are used in dairy (for increasing milk yields) and pork production. However, the evidence at the national level suggests that there are substantial differences in feed composition among the EC member countries. These differences can be attributed to the existing differences in relative prices (caused by the application of MCAs and transportation costs). In general, relatively inexpensive feedstuffs exhibit a higher percentage share in the rations.

The estimation results further suggest an observation which is important from a theoretical and methodological point of view. In some instances, the cost shares at the base point are negative, which indicates that the translog approximation is not entirely satisfactory at this particular point. One of the neoclassical properties is that the cost function should be nondecreasing in the input price vector; this implies that the input shares must be nonnegative at each observation point. However, as the price of a particular feed input is increased, at some reservation price, its share in the total ration may become zero. Consequently, the actual production relationship becomes discontinuous at the reservation price, implying a zero cost share for any price above the reservation price. For example, an LP cost range analysis showed that the share of corn in the dairy ration in Belgium/Luxembourg is zero over the price range $[0.82p^0_{corn}\text{-}2p^0_{corn}]$.

The problem is that the translog function cannot model these corner solutions, and negative cost shares may be observed. As a result of the linear homogeneity restrictions which have been imposed on the coefficients of the translog function, the cost shares must sum to 1. Therefore, if the negative cost shares would be set equal to zero they are no longer consistent with the other cost shares. However, in most cases the absolute values of the observed negative shares are rather low. Furthermore, it can be seen that with respect to the average cost elasticities over the entire price range $[0.5p^0\text{-}2p^0]$, no negative cost shares or cost elasticities emerge.

How will selling prices of compound feed rations be affected? Assuming that the behavior of the compound feed firms in the EC is consistent with profit-maximization, the marginal cost of producing each compound feed is set equal to its corresponding price. This implies the following:

$$P = c^*(p) + g, \tag{8}$$

where P is the unit price of the finished ration (output price), and g is the nonfeed cost per unit of output (which, for simplicity, is assumed to be positive and constant). The percentage change in the price of the finished ration is defined as follows:

$$\hat{P} = \mu \cdot \hat{c^*} = (0.8)\hat{c^*}, \tag{9}$$

where μ is the feed cost share in total production cost which in a typical EC compound firm is fairly constant and gravitates around 80 percent (see also Surry, 1987, p.50).

Conclusions

The above analysis is characterized by some inevitable shortcomings and limitations (see, for instance, Maddala and Roberts, 1980; Maddala, 1982). The translog function represents a local approximation and is only valid in some neighborhood around the point of

expansion (that is, the vector of 1984/85 base prices). In this neighborhood, the second-order approximation will be satisfactory and third- and higher-order effects, which may be present (globally) in the piece-wise linear cost function, will not be significant. But as the range of price variation is increased, third- or higher-order price effects will become significant. As is shown for Belgium/Luxembourg in Table 3—where the translog estimates are contrasted with LP arc elasticities—the (point) elasticity performance is decidedly weaker for large price changes (for example, ±25 percent). This makes the estimation results less useful for policy analysis with large (and simultaneous) price changes.

We think, however, that the observed violations of the regularity conditions for the cost shares at particular sample points are sufficiently small and exceptional not to justify a rejection of the estimates; they will not significantly bias the other cost elasticities.

In view of the problems of inflexible prices and multi-collinearity, the approach described in this paper provides an appealing avenue for estimating the relationships between compound feed prices and major feed ingredients in the EC (for example, cereals, soymeal, etc.). The approach permits the explanation of compound feed price changes within a theoretically consistent derived-demand framework.

Furthermore, the information from this study can easily be used for policy applications with integrated feed-livestock models of the EC, both at the national and the community level.

Notes

1. The individual feed ingredients are: corn, sorghum, soft wheat, barley, oats, rye, soymeal, corn gluten feed (CGF), and manioc; the broad groups of feed ingredients are: energy-rich items, protein-rich items, and additives (minerals, vitamins, etc.).
2. Orthogonality implies that the i-th element of the d_i vectors (for i=1,...,m) is equal to 1, and the other elements are equal to zero.
3. For a general description of the pseudo-data sampling method, see Griffin (1982), and Preckel and Hertel (1988).
4. For more detailed results, the reader is referred to Peeters (1989).

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Figure 1

The optimal LP response to prices

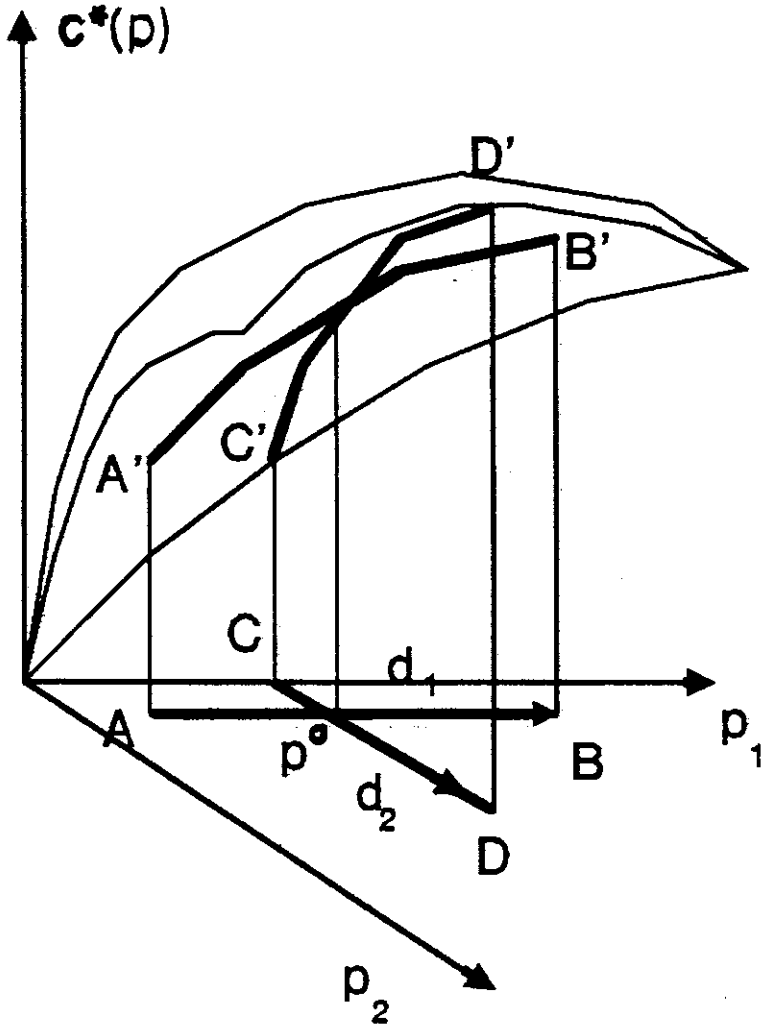

Table 1: Estimated "partial" ration cost elasticities in the EC member countries

West-Germany

	Dairy		Pigs		Layers		Broilers	
	At base prices	Average	At base prices	Average	At base prices	Average	At base prices	Average
Corn	-0.017	0.009	-0.060	0.029	0.359	0.389	0.323	0.333
Sorghum	-0.012	0.007	-0.021	0.005	-0.012	0.005	-0.006	0.028
Wheat	0.131	0.069	0.257	0.225	0.022	0.021	0.009	0.017
Barley	0.059	0.021	0.025	0.032	0.074	0.065	--	--
Oats	0.013	0.003	0.005	0.001	--	--	0.003	0.000
Rye	0.016	0.007	0.007	0.002	--	--	0.005	0.001
Soymeal	-0.029	0.011	0.145	0.135	0.071	0.086	0.257	0.253
CGF	0.139	0.114	0.003	0.001	0.034	0.018	--	--
Manioc	0.098	0.076	0.304	0.272	0.085	0.085	0.071	0.070
Energy	0.301	0.331	0.078	0.069	0.100	0.082	0.130	0.122
Protein	0.298	0.344	0.216	0.203	0.217	0.217	0.105	0.099
Addit.	0.004	0.010	0.040	0.028	0.049	0.031	0.105	0.077

France

	Dairy		Pigs		Layers		Broilers	
	At base prices	Average	At base prices	Average	At base prices	Average	At base prices	Average
Corn	-0.005	0.011	-0.041	0.067	0.525	0.581	0.337	0.367
Sorghum	-0.007	0.008	-0.002	0.008	-0.003	0.008	-0.023	0.028
Wheat	0.426	0.355	0.269	0.238	0.024	0.020	0.009	0.011
Barley	0.187	0.155	0.271	0.211	0.017	0.007	--	--
Oats	0.144	0.117	0.007	0.001	--	--	0.003	0.001
Rye	-0.006	0.012	0.010	0.002	--	--	0.003	0.001
Soymeal	0.100	0.169	0.102	0.083	0.086	0.093	0.277	0.276
CGF	0.048	0.017	0.002	0.000	0.007	0.002	--	--
Manioc	0.006	0.002	-0.008	0.006	0.001	0.001	-0.001	0.004
Energy	-0.022	0.045	0.135	0.122	0.029	0.021	0.136	0.117
Protein	0.118	0.101	0.213	0.229	0.241	0.227	0.123	0.103
Addit.	0.012	0.008	0.043	0.033	0.071	0.041	0.136	0.093

Italy

	Dairy		Pigs		Layers		Broilers	
	At base prices	Average	At base prices	Average	At base prices	Average	At base prices	Average
Corn	0.009	0.023	0.296	0.394	0.565	0.601	0.336	0.369
Sorghum	0.003	0.011	0.015	0.021	0.004	0.017	0.003	0.029
Wheat	0.271	0.212	0.019	0.010	0.004	0.004	-0.004	0.005
Barley	0.128	0.035	0.029	0.009	0.007	0.002	--	--
Oats	0.015	0.003	0.002	0.002	--	--	0.002	0.000
Rye	0.010	0.007	0.003	0.002	--	--	0.002	0.001
Soymeal	-0.078	0.137	0.158	0.122	0.079	0.088	0.285	0.298
CGF	0.172	0.150	0.005	0.002	0.022	0.005	--	--
Manioc	-0.006	0.010	0.160	0.112	0.007	0.009	0.010	0.006
Energy	0.219	0.289	0.078	0.072	0.033	0.022	0.144	0.130
Protein	0.124	0.113	0.176	0.222	0.209	0.211	0.097	0.080
Addit.	0.010	0.009	0.059	0.033	0.070	0.040	0.125	0.082

The Netherlands

	Dairy		Pigs		Layers		Broilers	
	At base prices	Average	At base prices	Average	At base prices	Average	At base prices	Average
Corn	-0.012	0.005	-0.063	0.016	0.363	0.395	0.403	0.418
Sorghum	-0.015	0.005	-0.022	0.005	-0.017	0.005	-0.005	0.012
Wheat	0.047	0.008	0.133	0.118	-0.002	0.009	0.003	0.001
Barley	0.047	0.008	0.019	0.023	0.005	0.012	--	--
Oats	0.020	0.004	0.003	0.001	--	--	0.000	0.000
Rye	0.015	0.004	0.002	0.002	--	--	0.001	0.000
Soymeal	-0.002	0.009	0.138	0.116	0.080	0.092	0.171	0.181
CGF	0.141	0.138	0.008	0.002	0.044	0.024	--	--
Manioc	0.063	0.014	0.308	0.273	0.148	0.126	0.025	0.020
Energy	0.390	0.449	0.141	0.121	0.107	0.082	0.125	0.118
Protein	0.291	0.347	0.285	0.291	0.218	0.223	0.158	0.167
Addit.	0.015	0.008	0.047	0.031	0.054	0.033	0.118	0.080

Table 1 (cont'd)

Belgium/Luxembourg

	Dairy		Pigs		Layers		Broilers	
	At base prices	Average	At base prices	Average	At base prices	Average	At base prices	Average
Corn	-0.002	0.006	-0.052	0.010	0.365	0.398	0.304	0.319
Sorghum	-0.007	0.006	-0.029	0.005	-0.012	0.004	-0.014	0.029
Wheat	0.134	0.038	0.230	0.220	0.064	0.061	0.056	0.059
Barley	0.068	0.012	0.036	0.035	0.071	0.064	--	--
Oats	0.015	0.004	0.005	0.001	--	--	0.002	0.000
Rye	0.028	0.007	0.007	0.003	--	--	0.005	0.001
Soymeal	-0.043	0.011	0.074	0.068	0.065	0.080	0.245	0.241
CGF	0.192	0.128	0.003	0.001	0.026	0.011	--	--
Manioc	0.016	0.004	0.276	0.242	0.057	0.060	0.047	0.048
Energy	0.283	0.444	0.126	0.110	0.093	0.076	0.130	0.120
Protein	0.317	0.340	0.281	0.274	0.211	0.212	0.106	0.099
Addit.	-0.001	0.001	0.043	0.031	0.059	0.034	0.119	0.084

United Kingdom

	Dairy		Pigs		Layers		Broilers	
	At base prices	Average	At base prices	Average	At base prices	Average	At base prices	Average
Corn	-0.011	0.007	-0.088	0.031	0.646	0.673	0.253	0.280
Sorghum	-0.016	0.007	-0.023	0.005	0.001	0.004	-0.016	0.026
Wheat	0.384	0.323	0.307	0.259	0.001	0.000	0.141	0.129
Barley	0.222	0.155	0.339	0.262	0.001	0.000	--	--
Oats	0.025	0.006	0.007	0.001	--	--	0.003	0.000
Rye	0.014	0.003	0.006	0.001	--	--	0.004	0.001
Soymeal	-0.004	0.024	0.041	0.034	0.069	0.062	0.237	0.240
CGF	0.038	0.025	0.004	0.001	0.005	0.002	--	--
Manioc	0.010	0.004	0.022	0.040	--	--	-0.000	0.006
Energy	-0.035	0.057	0.084	0.072	0.008	0.006	0.138	0.126
Protein	0.361	0.358	0.259	0.266	0.211	0.216	0.113	0.107
Addit.	0.012	0.032	0.043	0.028	0.059	0.037	0.126	0.085

Ireland

	Dairy		Pigs		Layers		Broilers	
	At base prices	Average	At base prices	Average	At base prices	Average	At base prices	Average
Corn	-0.003	0.007	-0.073	0.030	0.633	0.668	0.252	0.281
Sorghum	-0.005	0.007	-0.027	0.005	0.001	0.006	-0.020	0.026
Wheat	0.293	0.245	0.302	0.251	0.000	0.001	0.131	0.123
Barley	0.322	0.278	0.319	0.259	0.001	0.004	--	--
Oats	0.025	0.037	0.005	0.001	--	--	0.003	0.001
Rye	-0.001	0.013	0.092	0.065	--	--	0.005	0.001
Soymeal	0.066	0.078	0.121	0.123	0.084	0.075	0.238	0.240
CGF	0.203	0.139	0.002	0.000	0.005	0.002	--	--
Manioc	0.007	0.002	-0.012	0.033	0.000	0.000	-0.001	0.006
Energy	-0.023	0.054	0.080	0.069	0.008	0.006	0.136	0.125
Protein	0.113	0.117	0.148	0.137	0.201	0.200	0.113	0.106
Addit.	0.003	0.023	0.043	0.027	0.067	0.038	0.142	0.091

Denmark

	Dairy		Pigs		Layers		Broilers	
	At base prices	Average	At base prices	Average	At base prices	Average	At base prices	Average
Corn	-0.008	0.007	-0.074	0.027	0.653	0.680	0.269	0.296
Sorghum	-0.012	0.007	-0.030	0.005	0.002	0.006	-0.022	0.025
Wheat	0.368	0.300	0.315	0.254	0.000	0.000	0.135	0.120
Barley	0.288	0.225	0.304	0.247	0.002	0.003	--	--
Oats	0.023	0.012	0.005	0.001	--	--	0.001	0.001
Rye	0.019	0.014	0.094	0.068	--	--	0.003	0.001
Soymeal	0.041	0.042	0.086	0.100	0.088	0.081	0.234	0.241
CGF	0.096	0.110	0.002	0.000	0.031	0.033	--	--
Manioc	0.010	0.004	-0.002	0.037	0.000	0.000	-0.002	0.004
Energy	-0.012	0.066	0.081	0.069	0.008	0.006	0.138	0.124
Protein	0.181	0.192	0.180	0.166	0.142	0.144	0.115	0.103
Addit.	0.004	0.023	0.039	0.026	0.073	0.045	0.128	0.085

Table 2: Estimated "partial" ration cost elasticities in the EC-9

EC-9

	-----Cattle-----		------Pigs------		-----Poultry----	
	At base prices	Average	At base prices	Average	At base prices	Average
Corn	-0.0084	0.0097	-0.0288	0.0624	0.4011	0.4323
Sorghum	-0.0101	0.0072	-0.0167	0.0069	-0.0089	0.0166
Wheat	0.2292	0.1698	0.2121	0.1851	0.0238	0.0246
Barley	0.1316	0.0797	0.1160	0.0954	0.0124	0.0105
Oats	0.0336	0.0194	0.0047	0.0010	0.0012	0.0003
Rye	0.0121	0.0070	0.0136	0.0079	0.0015	0.0004
Soymeal	-0.0033	0.0531	0.1173	0.1030	0.1665	0.1725
CGF	0.1195	0.0993	0.0043	0.0011	0.0115	0.0055
Manioc	0.0395	0.0241	0.1879	0.1716	0.0319	0.0306
Energy	0.1833	0.2495	0.1091	0.0956	0.0980	0.0846
Protein	0.2480	0.2683	0.2358	0.2399	0.1672	0.1610
Addit.	0.0089	0.0135	0.0445	0.0302	0.0936	0.0611

Table 3: Test of large simultaneous price changes in Belgium/Luxembourg ("global performance test")

(a) PCORN -10%; PSOYMEAL +10%

Change in cost of ration	LP solution	Translog estimates At base prices	Translog estimates At average prices	LP arc elasticities 0.9p-1.1p	LP arc elasticities 0.8p-1.25p
Dairy	0.00	0.00	0.05	0.01	-0.03
Pigs	0.12	0.74	0.58	0.57	-0.44
Layers	-3.58	-3.00	-3.18	-3.22	-3.90
Broilers	-0.89	-0.59	-0.78	-0.58	0.12

(b) PCORN -25%; PSOYMEAL +25%

Change in cost of ration	LP solution	Translog estimates At base prices	Translog estimates At average prices	LP arc elasticities 0.9p-1.1p	LP arc elasticities 0.8p-1.25p
Dairy	-0.78	0.00	0.12	0.02	-0.08
Pigs	-3.83	1.85	1.45	1.42	-1.10
Layers	-9.43	-7.50	-7.95	-8.05	-9.75
Broilers	-2.38	-1.48	-2.62	-1.45	0.30

Note: The LP arc elasticities are defined as

$$\epsilon = \left(\frac{c_2 - c_1}{c_2 + c_1}\right) \cdot \left(\frac{p_2 + p_1}{p_2 - p_1}\right)$$

where $p_1 = 0.9p^0$, $c_1 = c(0.9p^0)$, etc.

Appendix

Table A.1: Approximative base prices of compound feed ingredients, 1984/85 (national currency/ton)

	Code	NL	BLEU	F	D	I	UK	IRL	DK
---Major grains---									
Corn	x1	612.1	9703.1	1300.0	549.3	288.7	135.3	142.3	1773.6
Sorghum	x2	620.5	9837.5	1320.1	556.6	288.7	135.3	142.9	1791.3
Wheat	x3	503.7	8011.5	1101.2	451.8	253.6	106.1	114.8	1405.3
Barley	x4	502.7	7999.6	1101.2	451.8	240.8	106.1	113.7	1405.3
Oats	x5	495.5	8070.7	1156.8	447.7	262.3	109.0	118.1	1485.2
Rye	x6	516.5	8134.0	1153.3	456.3	264.2	114.4	123.5	1419.4
---Major substitutes---									
Soymeal 44%	x9	619.0	10610.0	1694.0	587.3	315.0	153.6	167.0	2010.0
Corn gluten feed	x10	481.0	8320.0	1351.8	463.8	253.5	122.4	133.0	1590.0
Manioc	x11	424.0	7370.0	1210.3	412.3	227.5	109.4	119.0	1420.0
---Energy products---									
Beet pulp	x12	427.0	7420.0	1138.3	403.8	229.0	104.8	112.0	1360.0
Citrus pulp	x13	439.0	7610.0	1246.5	425.5	234.5	113.0	122.0	1460.0
Middlings of corn	x22	548.8	9512.5	1558.1	531.9	293.1	141.3	152.5	1825.0
Corn oilcakes	x27	711.8	12201.5	1948.1	675.3	362.3	176.6	192.0	2311.5
Palmkernels	x29	1097.5	19025.0	3116.3	1063.8	586.3	282.5	305.0	3650.0
Linseed	x30	658.5	11415.0	1869.8	638.3	351.8	169.5	183.0	2190.0
Beet molasses	x34	462.4	7359.6	1013.1	415.6	233.2	97.6	104.6	1292.9
Cane molasses	x35	427.3	6799.6	936.0	384.0	215.5	90.2	96.6	1194.5
Lactoserum	x38	680.9	11671.0	1863.4	646.0	346.5	169.0	183.7	2211.0
Animal oils and fats	x42	1272.0	22110.0	3630.8	1236.8	682.5	328.2	357.0	4260.0
>Average<		672.5	11512.4	1832.0	642.1	353.5	167.3	180.8	2175.5
---Protein products---									
Soybeans	x7	804.7	13793.0	2202.2	763.4	409.5	199.7	217.1	2613.0
Toasted soybeans	x8	835.7	14323.5	2286.9	792.8	425.3	207.4	225.5	2713.5
Copra expeller	x14	529.1	9152.0	1486.9	510.1	278.9	134.6	146.3	1749.0
Palmkernel expeller	x15	457.0	7904.0	1284.2	440.6	240.8	116.3	126.4	1510.5
Linseed expeller	x16	529.1	9152.0	1486.9	510.1	278.9	134.6	146.3	1749.0
Cottonseed expeller	x17	360.8	6240.0	1013.8	347.8	190.1	91.8	99.8	1192.5
Rapeseed expeller	x18	384.8	6656.0	1081.4	371.0	202.8	97.9	106.4	1272.0
Groundnut expeller	x19	529.1	9152.0	1486.9	510.1	278.9	134.6	146.3	1749.0
Sunflower expeller	x20	340.5	5835.5	931.7	323.0	173.3	84.5	91.9	1105.5
Middlings of wheat	x21	414.0	6920.0	1028.3	411.3	215.5	99.6	105.0	1270.0
Middlings of rice	x23	439.0	7610.0	1246.5	425.5	234.5	113.0	122.0	1460.0
Dry fodder peas	x24	502.7	7999.6	1101.2	451.8	253.5	106.1	113.7	1405.3
Broad beans	x25	502.7	7999.6	1101.2	451.8	253.5	106.1	113.7	1405.3
Other beans	x26	502.7	7999.6	1101.2	451.8	253.5	106.1	113.7	1405.3
Babassus expeller	x28	482.9	8371.0	1371.2	468.1	258.0	124.3	134.2	1606.0
Sesam expeller	x31	577.2	9984.0	1622.1	556.5	304.2	146.9	159.6	1908.0
Potato pulp	x32	481.0	8320.0	1351.8	463.8	253.5	122.4	133.0	1590.0
Lucerne meal	x33	336.7	5824.0	946.2	324.6	177.5	85.7	93.1	1113.0
Vinasse	x36	408.8	7072.0	1149.0	394.2	215.5	104.0	113.1	1351.5
Skimmed milk powder	x37	680.9	11671.0	1863.4	646.0	346.5	169.0	183.7	2211.0
Feathermeal	x39	1176.1	20159.0	3218.6	1115.8	598.5	291.8	317.3	3819.0
Animal meal	x40	866.6	14854.0	2371.6	822.2	441.0	215.0	233.8	2814.0
Fish meal	x41	1238.0	21220.0	3388.0	1174.5	630.0	307.2	334.0	4020.0
>Average<		581.7	9922.2	1570.5	553.3	300.6	143.4	155.5	1871.0
---Additives---									
1	x43	373.8	6645.0	1017.4	331.8	212.1	90.2	107.4	1204.8
2	x44	1255.3	22314.8	3416.5	1114.1	712.2	302.8	360.7	4045.9
3	x45	3185.1	56617.5	8668.5	2826.8	1806.9	768.3	915.1	10265.4
4	x46	1939.8	34482.4	5279.4	1721.7	1100.5	467.9	557.3	6252.1
5	x47	1174.5	20878.0	3196.5	1042.4	666.3	283.3	337.4	3785.4
6	x48	1894.4	33674.2	5155.7	1681.3	1074.7	457.0	544.2	6105.5
7	x49	378.9	6734.8	1031.1	336.3	214.9	91.4	108.8	1221.1
8	x50	805.7	14322.7	2192.9	715.1	457.1	194.4	231.5	2596.9
9	x51	1889.3	33584.4	5142.0	1676.8	1071.8	455.8	542.8	6089.2
10 (Chalk)	x52	35.4	628.6	96.2	31.4	20.1	8.5	10.2	114.0
11	x53	687.0	12212.5	1869.8	609.8	389.8	165.7	197.4	2214.3
12 (Salt)	x54	133.9	2379.6	364.3	118.8	75.9	32.3	38.5	431.5
13	x55	351.1	6240.9	955.5	311.6	199.2	84.7	100.9	1131.6
>Average<		1084.9	19285.8	2952.8	962.9	615.5	261.7	311.7	3496.7

Source: Agricultural Economics Institute, The Hague (NL); Own calculations.

Table A.2: Approximative base price indices of compound feed ingredients, 1984/85 (price of barley = 100)

	Code	NL	BLEU	F	D	I	UK	IRL	DK
---Major grains---									
Corn	x1	121.8	121.3	118.1	121.6	119.9	127.6	125.2	126.2
Sorghum	x2	123.4	123.0	119.9	123.2	119.9	127.6	125.7	127.5
Wheat	x3	100.2	100.1	100.0	100.0	105.3	100.0	101.0	100.0
Barley	x4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Oats	x5	98.6	100.9	105.1	99.1	108.9	102.8	103.9	105.7
Rye	x6	102.8	101.7	104.7	101.0	109.7	107.9	108.6	101.0
---Major substitutes---									
Soymeal 44%	x9	123.1	132.6	153.8	130.0	130.8	144.8	146.9	143.0
Corn gluten feed	x10	95.7	104.0	122.8	102.6	105.3	115.4	117.0	113.1
Manioc	x11	84.4	92.1	109.9	91.2	94.5	103.1	104.7	101.0
---Energy products---									
Beet pulp	x12	84.9	92.8	103.4	89.4	95.1	98.8	98.5	96.8
Citrus pulp	x13	87.3	95.1	113.2	94.2	97.4	106.5	107.3	103.9
Middlings of corn	x22	109.2	118.9	141.5	117.7	121.7	133.2	134.1	129.9
Corn oilcakes	x27	141.6	152.5	176.9	149.5	150.4	166.5	168.9	164.5
Palmkernels	x29	218.3	237.8	283.0	235.5	243.5	266.4	268.3	259.7
Linseed	x30	131.0	142.7	169.8	141.3	146.1	159.8	161.0	155.8
Beet molasses	x34	92.0	92.0	92.0	92.0	96.8	92.0	92.0	92.0
Cane molasses	x35	85.0	85.0	85.0	85.0	89.5	85.0	85.0	85.0
Lactoserum	x38	135.5	145.9	169.2	143.0	143.9	159.3	161.6	157.3
Animal oils and fats	x42	253.1	276.4	329.7	273.7	283.4	309.4	314.0	303.1
>Average<		133.8	143.9	166.4	142.1	146.8	157.7	159.1	154.8
---Protein products---									
Soybeans	x7	160.1	172.4	200.0	169.0	170.1	188.3	191.0	185.9
Toasted soybeans	x8	166.2	179.1	207.7	175.5	176.6	195.5	198.3	193.1
Copra expeller	x14	105.3	114.4	135.0	112.9	115.8	126.9	128.7	124.5
Palmkernel expeller	x15	90.9	98.8	116.6	97.5	100.0	109.6	111.1	107.5
Linseed expeller	x16	105.3	114.4	135.0	112.9	115.8	126.9	128.7	124.5
Cottonseed expeller	x17	71.8	78.0	92.1	77.0	79.0	86.6	87.7	84.9
Rapeseed expeller	x18	76.6	83.2	98.2	82.1	84.2	92.3	93.6	90.5
Groundnut expeller	x19	105.3	114.4	135.0	112.9	115.8	126.9	128.7	124.5
Sunflower expeller	x20	67.7	72.9	84.6	71.5	71.9	79.7	80.8	78.7
Middlings of wheat	x21	82.4	86.5	93.4	91.0	89.5	93.9	92.4	90.4
Middlings of rice	x23	87.3	95.1	113.2	94.2	97.4	106.5	107.3	103.9
Dry fodder peas	x24	100.0	100.0	100.0	100.0	105.3	100.0	100.0	100.0
Broad beans	x25	100.0	100.0	100.0	100.0	105.3	100.0	100.0	100.0
Other beans	x26	100.0	100.0	100.0	100.0	105.3	100.0	100.0	100.0
Babassus expeller	x28	96.1	104.6	124.5	103.6	107.1	117.2	118.0	114.3
Sesam expeller	x31	114.8	124.8	147.3	123.2	126.3	138.5	140.4	135.8
Potato pulp	x32	95.7	104.0	122.8	102.6	105.3	115.4	117.0	113.1
Lucerne meal	x33	67.0	72.8	85.9	71.9	73.7	80.8	81.9	79.2
Vinasse	x36	81.3	88.4	104.3	87.2	89.5	98.1	99.4	96.2
Skimmed milk powder	x37	135.5	145.9	169.2	143.0	143.9	159.3	161.6	157.3
Feathermeal	x39	234.0	252.0	292.3	247.0	248.5	275.2	279.1	271.8
Animal meal	x40	172.4	185.7	215.4	182.0	183.1	202.8	205.6	200.2
Fish meal	x41	246.3	265.3	307.7	260.0	261.6	289.6	293.8	286.1
>Average<		115.7	124.0	142.6	122.5	124.8	135.2	136.7	133.1
---Additives---									
1	x43	74.4	83.1	92.4	73.4	88.1	85.0	94.5	85.7
2	x44	249.7	278.9	310.3	246.6	295.7	285.5	317.2	287.9
3	x45	633.7	707.8	787.2	625.7	750.4	724.4	804.9	730.5
4	x46	385.9	431.1	479.4	381.1	457.0	441.2	490.2	444.9
5	x47	233.7	261.0	290.3	230.7	276.7	267.1	296.8	269.4
6	x48	376.9	420.9	468.2	372.1	446.3	430.9	478.7	434.5
7	x49	75.4	84.2	93.6	74.4	89.3	86.2	95.7	86.9
8	x50	160.3	179.0	199.1	158.3	189.8	183.3	203.6	184.8
9	x51	375.9	419.8	467.0	371.2	445.1	429.7	477.4	433.3
10 (Chalk)	x52	7.0	7.9	8.7	6.9	8.3	8.0	8.9	8.1
11	x53	136.7	152.7	169.8	135.0	161.9	156.3	173.6	157.6
12 (Salt)	x54	26.6	29.7	33.1	26.3	31.5	30.4	33.8	30.7
13	x55	69.8	78.0	86.8	69.0	82.7	79.9	88.7	80.5
>Average<		215.8	241.1	268.2	213.1	255.6	246.8	274.2	248.8

Source: Agricultural Economics Institute, The Hague (NL); Own calculations.

Belgium/Luxembourg

Base prices 1984/85	9703.1	9837.5	8011.5	7999.6	8070.7	8134.0	10610.0	8320.0	7370.0	11512.4	9922.2	19285.8
Index (barley=100)	121.3	123.0	100.1	100.0	100.9	101.7	132.6	104.0	92.1	143.9	124.0	241.1

DAIRY	Const.	Corn	Sorghum	Wheat	Barley	Oats	Rye	Soymeal	CGF	Manioc	Energy	Protein	Addit.
Corn	0.0058	-0.2339	0.0345	0.0117	0.0326	0.0069	0.0256	0.0329	0.0156	0.0114	0.0509	0.0130	-0.0012
Sorghum	0.0058	0.0345	-0.2334	0.0120	0.0345	0.0096	0.0246	0.0339	0.0101	0.0131	0.0493	0.0134	-0.0015
Wheat	0.0380	0.0117	0.0120	-0.3788	0.0110	0.0062	0.0008	0.0305	0.1128	0.0012	0.2463	-0.0544	0.0007
Barley	0.0121	0.0326	0.0345	0.0110	-0.2530	0.0178	0.0200	0.0442	-0.0227	0.0163	0.0689	0.0309	-0.0004
Oats	0.0036	0.0069	0.0096	0.0062	0.0178	-0.0934	0.0065	0.0100	-0.0096	0.0191	0.0082	0.0169	0.0019
Rye	0.0070	0.0256	0.0246	0.0008	0.0200	0.0065	-0.1288	0.0201	-0.0035	0.0141	0.0279	-0.0081	0.0008
Soymeal	0.0115	0.0329	0.0339	0.0305	0.0442	0.0100	0.0201	-0.2476	0.0291	0.0069	-0.0661	0.1030	0.0031
CGF	0.1277	0.0156	0.0101	0.1128	-0.0227	-0.0096	-0.0035	0.0291	-0.3787	-0.0138	0.0447	0.2138	0.0022
Manioc	0.0035	0.0114	0.0131	0.0012	0.0163	0.0191	0.0141	0.0069	-0.0138	-0.0680	0.0090	-0.0085	-0.0009
Energy	0.4437	0.0509	0.0493	0.2463	0.0689	0.0082	0.0279	-0.0661	0.0447	0.0090	-0.3936	-0.0290	-0.0164
Protein	0.3397	0.0130	0.0134	-0.0544	0.0309	0.0169	-0.0081	0.1030	0.2138	-0.0085	-0.0290	-0.3019	0.0111
Addit.	0.0015	-0.0012	-0.0015	0.0007	-0.0004	0.0019	0.0008	0.0031	0.0022	-0.0009	-0.0164	0.0111	0.0005

PIGS	Const.	Corn	Sorghum	Wheat	Barley	Oats	Rye	Soymeal	CGF	Manioc	Energy	Protein	Addit.
Corn	0.0097	-0.3065	0.0591	0.0748	0.0220	0.0034	0.0098	-0.0232	0.0014	0.1299	0.0220	0.0181	-0.0106
Sorghum	0.0054	0.0591	-0.1335	0.0417	0.0201	0.0019	0.0122	-0.0229	0.0018	0.0434	-0.0036	-0.0159	-0.0042
Wheat	0.2196	0.0748	0.0417	-0.2903	0.1814	0.0034	0.0062	-0.0114	0.0017	0.0189	-0.0130	-0.0130	-0.0004
Barley	0.0352	0.0220	0.0201	0.1814	-0.3352	0.0032	0.0066	0.0128	0.0022	0.0838	-0.0113	0.0209	-0.0064
Oats	0.0009	0.0034	0.0019	0.0034	0.0032	-0.0349	0.0026	0.0037	0.0015	0.0057	0.0026	0.0068	0.0003
Rye	0.0031	0.0098	0.0122	0.0062	-0.0066	0.0026	-0.0574	0.0075	0.0020	0.0110	0.0013	-0.0007	-0.0010
Soymeal	0.0679	-0.0232	-0.0229	-0.0114	0.0128	0.0037	0.0075	-0.1345	0.0023	-0.0274	0.0007	0.1789	0.0135
CGF	0.0006	0.0014	0.0018	0.0017	0.0022	0.0015	0.0020	0.0023	-0.0201	0.0027	0.0019	0.0012	0.0015
Manioc	0.2420	0.1299	0.0434	0.0189	0.0838	0.0057	0.0110	-0.0274	0.0027	-0.2539	-0.0183	0.0158	-0.0114
Energy	0.1105	0.0220	-0.0036	-0.0130	-0.0113	0.0026	0.0013	0.0007	0.0019	-0.0183	0.0403	-0.0226	-0.0001
Protein	0.2740	0.0181	-0.0159	-0.0130	0.0209	0.0068	-0.0007	0.1789	0.0012	0.0158	-0.0226	-0.1988	0.0095
Addit.	0.0311	-0.0106	-0.0042	-0.0004	-0.0064	0.0003	-0.0010	0.0135	0.0015	-0.0114	-0.0001	0.0095	0.0094

LAYERS	Const.	Corn	Sorghum	Wheat	Barley	Oats	Rye	Soymeal	CGF	Manioc	Energy	Protein	Addit.
Corn	0.3978	-0.0472	0.0199	0.0069	0.0272	--	--	-0.0213	0.0077	0.0577	0.0486	-0.0783	-0.0211
Sorghum	0.0044	0.0199	-0.1345	0.0201	0.0232	--	--	0.0093	0.0065	0.0333	0.0281	-0.0041	-0.0018
Wheat	0.0606	0.0069	0.0201	-0.1994	0.0303	--	--	0.0297	0.0192	0.1014	0.0098	-0.0148	-0.0032
Barley	0.0640	0.0272	0.0232	0.0303	-0.0988	--	--	0.0211	0.0085	0.0130	-0.0126	-0.0094	-0.0022
Oats	0.0000	--	--	--	--	--	--	--	--	--	--	--	--
Rye	0.0000	--	--	--	--	--	--	--	--	--	--	--	--
Soymeal	0.0798	-0.0213	0.0093	0.0297	0.0211	--	--	-0.0573	0.0306	-0.0125	-0.0213	0.0152	0.0065
CGF	0.0106	0.0077	0.0065	0.0192	0.0085	--	--	0.0306	-0.0620	-0.0400	-0.0122	0.0439	-0.0022
Manioc	0.0601	0.0577	0.0333	0.1014	0.0130	--	--	-0.0125	-0.0400	-0.0843	-0.0489	-0.0188	-0.0010
Energy	0.0762	0.0486	0.0281	0.0098	-0.0126	--	--	-0.0213	-0.0122	-0.0489	0.0208	-0.0114	-0.0010
Protein	0.2122	-0.0783	-0.0041	-0.0148	-0.0094	--	--	0.0152	0.0439	-0.0188	-0.0114	0.0854	-0.0077
Addit.	0.0344	-0.0211	-0.0018	-0.0032	-0.0022	--	--	0.0065	-0.0022	-0.0010	-0.0010	-0.0077	0.0337

BROILERS	Const.	Corn	Sorghum	Wheat	Barley	Oats	Rye	Soymeal	CGF	Manioc	Energy	Protein	Addit.
Corn	0.3191	-0.3331	0.4027	0.0343	--	0.0016	0.0025	-0.0515	--	-0.0115	-0.0025	-0.0269	-0.0155
Sorghum	0.0290	0.4027	-0.3666	0.0391	--	0.0017	0.0019	-0.0598	--	0.0185	-0.0247	0.0099	-0.0228
Wheat	0.0587	0.0343	0.0391	-0.1724	--	0.0014	0.0042	0.0353	--	0.0957	-0.0137	-0.0107	-0.0132
Barley	0.0000	--	--	--	--	--	--	--	--	--	--	--	--
Oats	0.0003	0.0016	0.0017	0.0014	--	-0.0127	0.0014	0.0028	--	0.0019	0.0003	0.0017	-0.0001
Rye	0.0009	0.0025	0.0019	0.0042	--	0.0014	-0.0191	0.0007	--	0.0008	-0.0005	0.0055	0.0024
Soymeal	0.2411	-0.0515	-0.0598	0.0353	--	0.0028	0.0007	0.1304	--	-0.0238	-0.0306	-0.0021	-0.0013
CGF	0.0000	--	--	--	--	--	--	--	--	--	--	--	--
Manioc	0.0478	-0.0115	0.0185	0.0957	--	0.0019	0.0008	-0.0238	--	-0.0678	-0.0077	-0.0102	0.0040
Energy	0.1195	-0.0025	-0.0247	-0.0137	--	0.0003	-0.0005	-0.0306	--	-0.0077	0.1050	-0.0124	-0.0133
Protein	0.0991	-0.0269	0.0099	-0.0107	--	0.0017	0.0055	-0.0021	--	-0.0102	-0.0124	0.0385	0.0066
Addit.	0.0844	-0.0155	-0.0228	-0.0132	--	-0.0001	0.0024	-0.0013	--	0.0040	-0.0133	0.0066	0.0531

Table A.3: Estimated coefficients of the cost share equations for Belgium/Luxembourg

Table A.4: Compound feed production in the EC member countries (1985)

	Cattle	Pigs	Poultry	Total
D	7110	5829	3228	16167
F	3519	4326	5534	13379
I	3850	2350	4050	10250
NL	5720	6886	3353	15959
BLEU	1391	2550	937	4878
UK	4549	2144	3231	9924
IRL	1186	443	294	1923
DK	1720	1955	522	4197
EC-9	29045	26483	21149	76677

Source: FEFAC

Table A.5: Number of livestock units for poultry in the EC member countries (1985)

	Layers	Broilers	Total	Layers	Broilers	Total
	(1000 L.U.)			(%)		
D	975	455	1430	68.2	31.8	100.0
F	1155	1614	2769	41.7	58.3	100.0
I	800	1271	2071	38.6	61.4	100.0
NL	806	541	1347	59.8	40.2	100.0
BLEU	224	167	391	57.3	42.7	100.0
UK	986	1116	2102	46.9	53.1	100.0
IRL	47	70	117	40.2	59.8	100.0
DK	102	146	248	41.1	58.9	100.0
EC-9	5095	5380	10475	48.6	51.4	100.0

Source: EUROSTAT; own calculations