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by

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and

Mitchell Auerbach

Introduction

In 1983, the Commission of the European Community (EC) set out a number of proposals for reform of the Common Agricultural Policy (CAP). Pressures for changes in EC agricultural policy have been building for many years due primarily to the increasing cost of the CAP. The financial burden of the policy is expected to increase with the projected membership of Spain and Portugal in 1986 unless substantial modifications are initiated. Some of the Commission's 1983 proposals have been adopted and further changes are likely. EC policy-makers are attacking the budgetary problems through modifications of the traditional policy mechanisms (e.g., the institution of a marketing quota for milk production) and through reductions in the levels of price supports. These changes will affect production and consumption in the EC, and, consequently, will have an impact on international agricultural trade and U.S. agriculture.

The EC constitutes an important market for U.S. agricultural exports, particularly feedgrains and oilseeds. Other than recommending reductions in price supports for cereals, EC policy-makers have done little to resolve the problems of surplus wheat and barley production. Reform of the cereal policies is frequently linked to progress in limiting imports of feedstuffs considered to be substitutes for EC cereals. The EC has reached an agreement with Thailand to limit imports of manioc and recently voted to establish an import quota on corn gluten feed, supplied mainly by the United States. It is hoped that these measures will lead to increased use of feedgrains and oilseeds produced within the EC.

Most of the trade restrictions included in the CAP are designed to protect commodities produced within the Community. Products such as manioc, gluten feeds and soybeans are not extensively produced in Western Europe. The institution of barriers to these imports represents an extension of the concept of protection to include imports that may compete with entirely different products that are produced internally. This development is a natural consequence of EC policies. By supporting internal feedgrain prices at high levels, compound feed producers have an incentive to purchase cheaper substitutes on the world market. In late 1984, cif Rotterdam prices for corn gluten feed, corn gluten cake and citrus pellets were all lower than the EC intervention price for barley (Agra Europe, Jan. 25, 1985).

Soybeans and soybean meal are not seen as cereal substitutes by EC policy-makers. Nevertheless, there is interest among farmers and other groups in the EC in restricting imports of soybeans and soybean products. There are three reasons for this interest. First, products such as manioc must be supplemented in animal rations with high-protein feedstuffs. Inexpensive soybeans make it advantageous to mix manioc and soybean meal, a combination which may substitute for feedgrains. Second, a generous support program for rapeseed in the EC has resulted in increased production of this oilseed which is priced too high to be competitive with soybeans. Finally, it has been argued in the EC that raising the price of feed would contribute to a reduction of surplus livestock production, particularly in the dairy sector.

So far, EC policy-makers have not recommended trade restrictions on soybeans or soybean meal. One reason for this may be that negotiations with the U.S. in the framework of the General Agreement on Tariffs and Trade (GATT) resulted in an agreement by the EC not to place duties or other restrictions on imports of these products. Import quotas on corn gluten products would also be in violation of earlier GATT agreements but the EC seems to be willing to bear the cost of the compensation which would be required in this case. The volume of soybean imports is much greater than that of corn gluten, however, and the potential compensation costs could be correspondingly much more burdensome. In addition, U.S. policy-makers have reacted vigorously to any suggestion that trade barriers might be considered for soybeans and soybean products. The threat of U.S. retaliation is another reason why the EC might be hesitant to implement measures of this nature.

The purpose of this paper is to examine the consequences of restrictions by the EC on imports of soybeans and soybean products. The EC imports soybean meal, used almost exclusively for livestock feed, and soybeans which are crushed within the EC. Since the EC is largely self-sufficient in vegetable oils, much of the soybean oil produced as a by-product of the crushing process is exported. In 1984, the ten EC countries imported about 9.6 million metric tons of soybeans of which 9.4 million were crushed to produce 1.6 million metric tons of soybean oil and 7.4 million metric tons of soybean meal. Almost 11.3 million metric tons of soybean meal were imported and 876,000 metric tons of soybean oil were exported. Oilseed statistics also show the EC importing soybean oil and exporting soybean meal but these trade flows consist primarily of exchanges among the ten member countries of the EC (USDA/FAS, Oilseeds). Although soybean oil is used within the EC, it is assumed for the purposes of this study that soybeans are imported mainly as a source of protein meal for livestock rations. Thus, the focus of the research reported here is on the effects of higher soybean meal prices, induced by hypothetical trade barriers, on feed use and livestock production.

RESEARCH APPROACH

If the EC were to impose trade barriers on soybeans, it would be necessary to place similar restrictions on imports of soybean products so as not to undermine domestic crushing industries. The effect of such a policy change would be to raise the price of soybean meal and oil. The type of trade restriction imposed is not important for this study since any restriction, tariff or import quota, will result in increased soybean meal prices. Higher meal prices would affect demand in three ways. First, since soybean meal is used primarily as a source of protein in livestock feed, higher prices will lead to changes in the composition of compound feeds. Second, since the adjustment of the ingredient combination in livestock feed will result in higher prices for the final product, livestock producers may substitute other inputs, such as pasture, for compound feed. Third, the higher feed prices will also lead to adjustment in livestock output. The overall decline in demand for soybean meal followng a price increase, thus, depends on the way in which compound feed producers change the composition of livestock rations and the importance of the output and substitution effects as livestock producers adjust to the increased prices for compound feed.

A common approach to analyzing the impact of price changes on soybean demand is to estimate a price elasticity of demand. Knipscheer and Hill recently estimated the price elasticity of demand for soybean meal in the EC as -0.165. Other researchers have reported much larger estimates for the price elasticity of foreign demand for U.S. soybeans (Vandenborre; Meyers and Hacklander; Houck, Ryan and Subotnick). The implications of an estimate such as that of Knipscheer and Hill is that raising the price of soybean meal in the EC would have little impact on demand. This is a reasonable result since alternative protein sources are either relatively expensive (fish meal) or imperfect substitutes for soybean meal (rapeseed and sunflower seed meals).

However, estimated elasticities are likely to be accurate only for small price changes. It is not clear that an estimate such as that of Knipscheer and Hill is a reliable guide to the change in demand if prices are raised substantially. Small changes in soybean meal prices may not lead to much adjustment in the composition of livestock rations and little change in input use or livestock output since feed prices may change by an imperceptable amount. Large increases in soybean meal prices, however, might make it profitable to significantly reduce the amount of soybean meal in livestock rations, relying on other protein sources to maintain the nutritional value of the feed. The substitutions of other ingredients for soybean meal could also affect the price of compound feeds and lead to adjustments in EC livestock industries. The total fall in demand could be under-estimated by the simple application of an estimated elasticity to a large change in prices.

To explore the likely consequences of restrictions on imports of soybeans and products by the EC, a two-part model is developed. Since European feed compounders use linear programming models to determine least-cost feed rations, the same method is used to analyze the adjustment in the composition of livestock rations following increases in the price of soybean meal. Linear programming models indicate not only the least-cost combination of ingredients but also the price of the final product. The second part of the model is a set of compound feed demand equations from which estimates of the price elasticities of feed demand can be obtained for the various livestock sectors.

Applying these elasticities to the change in feed prices indicated by the programming models provides an estimate of the change in feed use. The total change in soybean meal demand can then be determined by combining the two effects, that due to adjustment of the ration composition and that resulting from changes in feed use.

The use of compound feed in livestock production has increased through time. Surry and Meilke describe this process of technological change for swine production in France. They suggest that the use of formula feed can be expected to follow a normal diffusion process as an increasing share of producers adopt the technical innovation. Since the increase in use of compound feed through this process of innovation is likely to dominate the effects of prices on feed use, it is necessary to control for technological change in estimating the input demand equations. A simple way to represent the evolution of compound feed use through time is to estimate equations of the following form:

(1) $\log QD_i = a_i + d_i T + e_i \log T$

Where QD is the quantity of feed demanded, T is a time trend and i is an index for the different livestock industries being modeled.

Demand for compound feed depends on livestock output and relative prices. The input demand equations estimated include these variables as well as the variables for time.

(2) $\log QD_{it} = a_i + b_i \log P_{it} + c_i \log \left(\frac{OP}{FP}\right)_{it} + d_i T + e_i \log T + u_{it}$

P is production, OP is the price for the livestock product, FP is the price of compound feed and u is the error term. An estimate of the price elasticity of feed demand is given by the negative of the coefficient c_i. Since these equations include the output variable, the elasticities are valid only if output is held constant. To allow for variation in output, output equations for each industry are estimated.

(3) $\log P_{it} = g_i + h_i \log (\frac{OP}{FP})_{it} + k_i \log (\frac{OP}{W})_{it} + v_{it}$

W is a proxy for agricultural wages and v is the error term. Assuming constant returns to scale and constant output prices, substitution of equations (3) into equations (2) allows the feed demand elasticities to be adjusted for output changes. The variable output elasticities are computed as: $-c_i - h_i b_i$.

This model can be used to simulate the effects of successively higher levels of protection. In addition to measuring the likely fall in demand, the programming models indicate which ingredients will be used to replace soybean meal in the rations. This information is useful in assessing the validity of the contention that restrictions on soybean and meal imports will result in increased use of EC feedgrains and oilseeds. Finally, the model can be used to shed light on the potential impact of higher feed prices on livestock production. To fully understand this aspect of the problem, a complete model of the livestock sectors would be required. However, an approximation of the effects can be obtained by assuming constant feed conversion ratios and estimating the production likely to result from the reduced use of compound feed. The assumption of constant feed conversion ratios is reasonable since the programming models impose a constant nutritional value on the feeds produced.

EMPIRICAL RESULTS

Least-Cost Feed Rations

The model described in the preceding section was used to analyze the impact of hypothetical EC trade restrictions on the use of soybean meal in France. The four principal livestock sectors in France are broilers, laying hens, hogs and cattle. For each sector, the least-cost combination of feed ingredients was estimated on the basis of average 1982 prices. The feed

Table 1. Composition of Initial Feed Rations

Ingredients	Broiler	Layer	Hog	Dairy
	% of Ration			
Oats				
Barley			16.61	16.96
Corn	57.06	65.22	36.82	9.66
Wheat			20.00	19.67
Cassava			1.65	
Citrus Pellets				
Alfalfa Pellêts				20.58
Fish Meal				
Animal Meal	9.22	10.00	2.64	5.47
Rapeseed Meal				
Sunflower Seed Meal				
Soybean Meal	29.09	14.06	20.38	24.53
Other*	4.63	10.72	1.90	3.13

*includes animal fats, vitamins, salt, artificial methionine and lime

Source: Auerbach

Table 2: Compound Feed Prices (French francs per 100 kilograms)

Type of Feed	Source		
	Eurostat (1982)	FAO (1981-82)	Models
Fattening for hogs	165.78		154.65
Complete broiler feed	208.59	176.71	187.06
Complete layer feed	169.73	183.75	172.42
Complementary dairy cow feed	153.62	177.90	159.00

Source: Auerbach

rations for each sector are approximations to a typical compound feed and represent an "average" ration. For example, the layer ration reported is for producing hens 8 to 22 weeks old and since it is based on average annual prices is only an approximation of the actual rations used in France. The four typical rations estimated account for about 62% of all compound feed produced in France, the rest being made up of milk replacers, feeds for young animals (piglets and chicks), and feeds for sheep, goats, turkeys, rabbits and other animals (SCEES, 1981).[1]

The typical rations for the four sectors are reported in Table 1. These feed rations were determined using the actual 1982 average prices. Since no examples of actual rations used in France were available, other types of information were used to make a sbjective assessment concerning the reasonableness of these rations. A comparison of the feed prices generated by the programming models with similar prices from other sources is shown in Table 2. The fact that the prices from the models are within the range of prices reported in other sources is one bit of evidence that the rations are reasonable approximations. Some further evidence is provided by examining rations in other countries. A comparison of actual Dutch and U.S. broiler rations with the one generated by the model suggests that the different ration compositions are consistent with observed relative prices. The ratio of soybean to corn prices in 1982 was 1.08 in the Netherlands, 1.52 in France and 2.2 in the

[1]A complete description of the programming models can be found in Auerbach. Where possible, the technical coefficients and nutritional requirments were taken from French sources (AEC). Price data were found mainly in publications from the European Statistical Office (Eurostat) and Toepfer International. Time-series data for the estimation of the input demand and output equations are from French statistical publications (SCEES, Surry) and Eurostat.

United States (Auerbach). Soybean meal constituted 38.4% of the observed Dutch broiler ration and 21.98% of the U.S. ration. The corresponding figure for the estimated Franch ration was 29.09% which stands in approximately the same relation to the other two rations as the soybean-to-corn price ratios for the three countries. Finally, the implied total use of soybean meal computed from production figures for the four types of feed constituted 56% of total soybean meal disappearance. Total production of the four feeds accounted for about 62% of total compound feed production. Since other types of feed (e.g., milk replacers) may require a greater protein content, the estimated models appear to be consistent with the reported information on feed production and soybean meal disappearance (Auerbach).

The estimated rations for broilers and hogs are based on the technical requirements for the grow-out or fattening stages of production. The layer ration is an approximation to the feed requirements of 8 to 22 week old hens. The dairy ration represents a supplementary feed for lactating cows during the Fall and Winter months. These types of compound feed represent the largest categories of feed produced. It is assumed that adjustments in the composition of the minor categories of compound feed, such as those for piglets, sows, baby chicks and other animals, are similar to the adjustments of these major feeds allowing general conclusions for the compound feed sector as a whole.

The soybean meal price used in the initial models was 216.78 French francs (FF) per 100 kg. This price was varied to chart the effects of higher soybean meal prices on the amount used in the four rations. The results of this exercise are shown in Table 3. At a price of 740 FF/100 kg. no soybean meal is used in any of the rations. Soybean meal is forced out of the dairy

Table 3: Soybean Meal Use at Different Prices

Soybean Meal Price (FF/100 kg)	Broiler	Layer	Swine	Dairy	Implied Total Use (1000 MT)
	----------	% of	Ration	----------	
150.0	31.30	15.96	39.67	24.52	2694.8
156.1			29.69		2359.9
167.9		14.06			2322.0
168.0	29.09				2277.0
182.7			24.52		2103.4
187.9			22.87		2047.9
190.3			20.37		1964.2
218.7			20.13		1955.8
224.0	28.37				1941.2
235.9			19.42		1917.5
241.1		13.93			1914.9
251.0	27.99				1907.1
267.6			12.57		1677.3
278.0				22.52	1644.1
279.5				16.79	1549.1
315.5				16.73	1548.1
423.4				1.31	1487.0
428.7				0.0	1270.6
429.6		2.27			1037.7
433.7		0.0			922.3
439.5	26.11				954.2
458.7	18.67				802.6
460.0	12.19				670.5
470.8	6.27				549.8
503.0			11.23		504.5
510.2			8.54		414.4
634.5			0.0		127.7
672.8	2.07				42.2
740.5	0.0				0.0

Source: Auerbach

and layer rations at around 430 FF/100 kg. but remains in the broiler and swine rations until prices surpass 600 FF/100 kg.

As soybean meal prices are raised, the use of other ingredients in the rations also changes. The changes in the composition of the four compound feeds as soybean meal prices are increased are presented in Tables 4, 5 and 6. Doubling the initial soybean meal price causes rapeseed meal to begin entering the solutions for the poultry rations. Sunflower seed meal only enters the broiler ration when soybean meal has been eliminated. Another protein source, skim milk powder, is also included in the rations if soybean prices are doubled. As the soybean prices are raised, total cereal usage as a percentage of the rations declines slightly. There is some shift from corn to soft wheat which contains a slightly greater percentage of crude protein than corn. The amount of wheat used in all of the rations is constrained to a maximum of 20% due to digestive problems associated with higher levels of use. Likewise, the upper limits on animal meal and fish meal are set at 10% since higher levels lead to unpleasant tasting meat and milk.

In contrast to the poultry rations, rapeseed meal never enters the swine ration. Instead, at very high soybean meal prices some sunflower seed meal and skim milk powder are introduced. The main substitute sources of protein in the swine rations are fish and animal meals. The proportion of the feed made up of cereals is essentially constant as soybean meal prices are raised above the initial price. It is interesting to note the extensive use of cassava at very low soybean meal prices. The combination of large amounts of soybean meal and cassava at these low price levels displaces corn from the ration. As soybean meal prices are raised, a larger proportion of the ration is made up of corn and cassava drops out of the ration. These results are consistent with evidence from the Netherlands. Much of the imported feedgrain

Table 4: Composition of Poultry Rations at Various Soybean Meal Prices (% of Ration)

Soybean Meal Price	Soybean Meal	Rapeseed Meal	Sunflower Meal	Skim Milk Powder	Animal Meal	Corn	Wheat	Total Cereals	Feed Price
(FF/100 kg)									(FF/100 kg)
					Broilers				
150.0	31.30				6.91	56.24		56.24	144.73
168.0	29.09				9.21	57.06		57.06	172.85
224.6	28.37				10.00	56.98		56.98	189.34
251.4	27.99				10.00	36.37	20.00	56.37	196.93
439.5	26.11	3.03			10.00	34.74	20.00	54.74	249.60
458.7	18.67	16.16			9.27	27.78	20.00	47.78	254.61
460.0	12.19	20.25		4.20	8.60	26.62	20.00	46.62	254.85
470.8	6.27	24.80		7.90	8.03	45.70		45.70	256.16
672.8	2.07	20.44		12.31	7.69	43.99		43.99	268.82
740.5	0.0	16.12	10.06	15.36	7.53	43.72		43.72	270.23
					Layers				
150.0	15.96				8.02	64.51		64.51	162.12
167.9	14.06				10.00	65.22		65.22	165.55
241.1	13.93				10.00	58.23	6.79	65.02	175.84
429.6	2.27	18.39			10.00	35.26	20.00	55.26	202.11
433.7	0.0	19.75		1.32	10.00	34.93	20.00	54.93	202.20

Source: Auerbach

Table 5: Composition of Swine Rations at Various Soybean Meal Prices (% of Ration)

Soybean Meal Price (FF/100 kg)	Soybean Meal	Fish Meal	Animal Meal	Skim Milk Powder	Sunflower Meal	Cassava	Barley	Oats	Corn	Wheat	Total Cereals	Feed Price (FF/100 kg)
150.0	39.67					37.75				20.00	20.00	132.56
156.1	29.69					29.66			18.04	20.00	38.04	139.82
182.7	24.52					6.82			40.95	20.00	60.95	147.71
187.9	22.87		1.93			9.37			38.51	20.00	58.51	149.01
190.3	20.38		2.64			1.65	16.61		36.82	20.00	73.43	149.55
218.7	20.13		2.73				17.67		37.59	20.00	75.26	155.35
235.9	19.42	0.51	2.53				17.85		37.85	20.00	75.70	158.80
267.6	12.57	6.76					0.62	9.14	49.40	20.00	79.16	164.94
503.0	11.23	6.98			1.91			6.31	52.16	20.00	78.47	194.55
510.2	8.54	7.26			8.69				57.01	20.00	77.01	195.36
643.5	0	6.66		10.30	8.69				53.37	20.00	73.37	206.74

Source: Auerbach

Table 6: Composition of Dairy Ration at Various Soybean Meal Prices (% of Ration)

Soybean Meal Price (FF/100 kg)	Soybean Meal	Fishmeal	Animal Meal	Rapeseed Meal	Alfalfa Pellets	Corn	Barley	Wheat	Total Cereals	Feed Price (FF/100 kg)
150.0	24.52		5.47		20.58	9.66	16.96	19.67	46.29	142.42
278.0	22.52	2.45	4.06		21.26	10.87	15.76	20.00	46.63	174.03
279.5	16.79	9.49			23.18	16.16	11.50	20.00	47.66	174.36
315.5	16.73	9.54			22.97	14.41	13.39	20.00	47.80	180.41
423.4	1.31	9.49		25.55	15.76	23.95		20.00	43.95	198.47
428.7	0.0	9.55		27.66	14.95	24.78		19.03	43.81	198.54

Source: Auerbach

substitues are used in the Netherlands where soybean meal is cheaper relative to feedgrain prices than in other parts of the EC. The French price for corn used in this analysis is 142.22 FF/100 kg. If soybean meal were priced at 150 FF/100 kg, the ratio would be 1.05, much closer to the ratio observed in the Netherlands. The soybean meal to corn price ratio used for the initial rations is 1.53.

As soybean meal is forced out of the dairy ration there is first, an increase in the use of fish meal and, at higher price levels, greater use of rapeseed meal and corn. Sunflower seed meal and skim milk powder never enter this ration and barley is forced out of it as soybean meal prices are raised. The critical soybean meal price level is around 430 FF/100 kg in the dairy and poultry rations. At this level, rapeseed meal begins to enter the least-cost rations to replace the more expensive soybean meal. The swine ration differs in this regard since it is sunflower seed meal rather than rapeseed meal that enters the ration and it does so only when soybean meal prices have been more than doubled. Overall, the results suggest that soybean meal prices would have to be increased at least 100% for French oilmeals to enter livestock rations at signficant levels. Raising soybean meal prices above this critical threshold has the secondary effect of driving barley out of the swine and dairy rations. This may be a high price to pay for encouraging the use of rape and sunflower seed meals.

The use of soybean meal in the four rations can be computed by multiplying the production of each type of feed in 1982 by the soybean meal percentage and summing the resulting quantities. The implied fall in demand as soybean meal prices are increased is shown in the last column of Table 3. The normative demand relationship is not smooth and continuous due to the linearity of the models and the fact that there are fairly abrupt changes in demand as soybean meal is forced out of the various rations. On the basis of these figures, a 10% increase in the actual soybean meal price (216.78 FF/100 kg) would lead to a fall in demand of 2.4%. This result is consistent with the elasticity estimate presented by Knipscheer and Hill. However, increasing the price by 50% results in a decline in soybean meal use of about 24%, about twice what would be expected on the basis of the implied response to the smaller price increase.

Compound Feed Demand

The compound feed demand equations (2) were estimated using annual data over the period 1960-1983. The dependent variable in the equation for cattle feed demand is total production of feed for dairy and beef cattle since separate series are not available for these two enterprises. In the other equations, total production of feed for the different species is used to represent feed demand. Thus, the feed demand variable for hogs, for example, includes compound feed for piglets, sows, rearing and finishing. The data series were found in Surry and updated on the basis of French statistical publications (SCEES).[2]

The four estimated feed demand equations are shown in Table 7. The dummy variable in the equation for broiler feed was included to account for an unexplained outlier in the feed demand series. The poultry and swine equations have been corrected for first-order serial correlation. The standard errors for the price variable are generally large relative to the estimated coefficients. The output variable used in the cattle feed equation is total milk

[2]Richard Henry of the Institut de gestion internationale agroalimentaire (Cergy, France) provided substantial assistance in completing the series and collecting data for some of the variables used.

Table 7. Estimated Feed Demand Equations and Elasticities Equations (standard errors in parentheses)

Dependent Variables / Independent Variables	Layer Feed	Broiler Feed	Swine Feed	Cattle Feed
Intercept	1.17 (3.34)	2.895 (1.44)	-3.971 (4.21)	6.96 (5.12)
Time	0.037 (0.013)	0.045 (0.012)	0.051 (0.025)	0.099 (0.007)
Log Time	0.173 (0.075)	0.092 (0.068)	0.047 (0.129)	-
Log Output	0.942 (0.592)	0.595 (0.246)	1.579 (0.66)	0.071 (0.483)
Log Price Ratio $(\frac{OP}{FP})$	0.341 (0.145)	0.219 (0.263)	0.127 (0.347)	0.778 (0.466)
Dummy Variable		0.374 (0.051)		
R^2	0.971	0.987	0.905	0.978
Rho	0.568 (0.161)	0.361 (0.199)	0.679 (0.147)	D.W. = 1.975
Degrees of Freedom	20	15	19	21
Elasticities:				
- Constant Output	-0.34	-0.22	-0,13	-0.78
- Variable Output	-0.62	-0.36	-1.03	-0.79

production which may explain the small coefficient since the dependent variable includes both beef and dairy feeds. Although there are certainly errors in the specification of these equations, the estimated feed demand elasticities are consistent with prior expectations. The elasticities from these equations constitute a lower bound on the estimates since output is held constant.

To include the effects of variations in output, four output equations were estimated. The results are shown in Table 8. The poultry and dairy equations have been corrected for first-order serial correlation. The lagged dependent variable is used as an explanatory variable in the pork equation so the Durbin H statistic was computed and the null hypothesis of no serial correlation can not be rejected. The coefficients for the output price/feed price variable are used to compute the variable output elasticities reported in Table 7. As expected, allowing output to vary leads to larger estimates of the feed demand elasticities. The results for the swine sector are not very precise. The large coefficient for the output variable in the feed demand equation leads to a substantial increase in the absolute value of the estimated elasticity. The reverse is true for cattle feed where the coefficient for output in the feed demand equation is very small.

One curious result in the output equations is the negative coefficient for the output price/wage variable in three of the equations. In the fourth, this variable is not significantly different from zero. The wage rate used is the guaranteed hourly minimum wage (SMIC) in France. An agricultural wage series was discontinued and could not be used, but the SMIC is generally considered to be a good proxy for agricultural wages. On the basis of these results, however, it would appear that the SMIC does not fully reflect the

Table 8. Output Equations (standard errors in parentheses)

Independent Variables \ Dependent Variables	Egg Production	Poultry Meat Production	Pork Production	Milk Production
Intercept	7.73 (0.38)	6.164 (1.075)	2.55 (1.39)	11.195 (0.507)
Log $\left(\frac{\text{Output price}}{\text{Feed price}}\right)$	0.302 (0.084)	0.244 (0.192)	0.560 (0.177)	0.125 (0.193)
Log $\left(\frac{\text{Output price}}{\text{Wage}}\right)$	-0.269 (0.040)	0.012 (0.184)	-0.239 (0.086)	-0.254 (0.059)
Time		0.056 (0.015)		
Log Time	0.132 (0.021)			
Pork Production_{t-1}			0.840 (0.150)	
R^2	0.969	0.963	0.954	0.498
Rho	0.350 (0.191)	0.497 (0.205)	Durbin H= -0.066	0.596 (0.167)
Degrees of Freedom	19	13	24	19

cost of labor inputs in the four sectors. In general, the food demand and output equations provide reasonable estimates of the elasticities although their statistical properties are not as robust as one might like. Complete production models of these sectors could overcome some of the imprecision of these results but are difficult to specify and estimate due to the lack of appropriate data series for these sectors in France. The constant output and variable output elasticities are used as lower and upper bounds and it is assumed that the true response lies somewhere in between.

The Effects of Increased Soybean Meal Prices

The model was used to analyze the impact on soybean meal demand of higher prices resulting from hypothetical import duties.. The results are presented in Table 9. The first column shows the estimated reduction in demand due to changes in the composition of the four feed rations in response to increased soymeal prices. These figures are computed by multiplying the percentage of the feed made up of soymeal in each ration by the quantity of that type of feed produced in 1982. These results are then summed and compared with the amount of soybean meal used in the four original rations to determine the percentage change. Estimates of the total change in soybean meal demand are presented in the second and third columns. These figures are obtained using the estimated feed demand elasticities and the change in the price of the rations (as indicated by the programming models) to compute the decline in feed use. This production adjustment effect is added to the effect of the change in ration composition to determine the total fall in demand. The output constant and variable output elasticities are used to provide a range in the estimate of demand charges.

The results presented in Table 9 show that the major source of the fall in demand resulting from increased soymeal prices is the adjustment of the

Table 9: Percentage Changes in Soybean Meal Demand andLivestock Output due to Soybean Meal Price Increases

Percentage Change in Soy Meal Price	Percentage Change in Demand			Percentage Change in Livestock Output			
	Due to Ration Adjustment	Total Change with output constant	Total Change with variable output	Eggs	Broilers	Swine	Dairy
10	- 2.4	- 3.4	- 4.6	- 1.1	- 1.2	- 3.3	- 2.6
20	- 3.1	- 5.1	- 7.3	- 2.2	- 2.4	- 6.7	- 5.3
40	- 21.1	- 24.0	- 26.5	- 4.3	- 4.7	- 9.9	- 9.8
80	- 21.1	- 26.5	- 31.5	- 8.7	- 9.4	- 17.1	- 17.0
100	- 46.4	- 49.6	- 58.4	- 10.9	- 12.8	- 22.7	- 19.7

Table 10: Use of French Feedstuffs as Soybean Meal Prices are Raised (percent of the four major feed rations)

Percentage Increase in Soy Meal Price	Percent of Four Rations Made Up of: Protein Sources*	Corn	Wheat	Barley
0	0	41.3	11.3	9.6
10	0	41.7	11.3	10.0
20	0	35.0	17.8	10.0
40	0	40.2	17.8	2.6
80	0	39.8	17.8	3.0
100	9.4	38.1	19.8	0.2

*Rapeseed meal, sunflower seed meal and skim milk powder rations. Adding the effect of feed use changes in the livestock sectors increases the reduction in demand by relatively small amounts. Due to the linearity of the programming models, the demand changes due to ration adjustment are not smooth. Thus, raising soymeal prices from 40% to 80% above the initial prices does not cause further changes in the composition of the rations. It does, however, increase the price of the ration. Total soybean meal demand falls somewhat over this range purely as a result of the response to the higher feed prices. The simple application of an elasticity of soybean meal demand, such as the one estimated by Knipscheer and Hill, would lead to considerably different results. For the price increases listed in Table 9, the percentage fall in demand implied by their estimate (-0.165) would be -1.65, -3.3, -6.6, -13.2, and -16.5. These figures are much lower than those reported in Table 9 for large price increases.

The implications for livestock output at the higher feed prices are illustrated in the last four columns of Table 9. These figures were obtained by using the variable output elasticities to estimate the reduction in the quantity of feed demanded. Since the programming models impose a constant nutritional value on the rations, the feed conversion ratios should remain the same despite the change in ration composition, assuming no change in the use of other inputs. The feed conversion ratios were obtained by dividing the original amounts of feed used in each sector by the output of that sector. These ratios were then used to estimate the output implied by the reduced level of feed use in response to the higher feed prices. The results of these calculations should be seen as upper bounds to the response since this method does not allow for input substitution in the production process. In the case of cattle, it is likely that the higher compound feed prices would lead to greater reliance on pasture, for example. If this substitution were to take place, the appropriate feed conversion ratio would be smaller than the one used in the calculations and the fall in output would be less pronounced.

The effect of the higher feed prices on broiler and egg output is fairly modest, particularly for soymeal price increases of 40% or less. Since the estimated variable output feed demand elasticity for hogs was large, the implied output response is more dramatic in this sector. France exports poultry meat and eggs but is not self-sufficient in pork. Currently, there does not appear to be a strong desire among policy-makers in France or the EC to reduce output in these industries. The livestock surplus that is of concern in France and the EC is that of the dairy sector. Due to the substitution possibilities, it is likely that the figures in Table 9 are too large. It has been estimated that the EC produces about 122% of its consumption of milk (Agra Europe, May 25, 1984). If France is typical of the EC as a whole and one accepts the figures in Table 9, a very large increase in soymeal prices (on the order of 80% to 100%) would go a long way toward eliminating the surplus. Realistically, however, it is unlikely that a *ceteris paribus* change in soybean meal prices, even of the magnitudes shown in Table 9, would result in such large declines in dairy production.

CONCLUSION

Raising soybean and soymeal prices through the imposition of trade barriers would lead to a fall in French imports of these products. The main source of this decline indicated by the results of this study, is the adjustment of the composition of feed rations. At relatively low increases in meal prices, the total change in demand is moderate. For price increases of 10% or 20%, the reduction in the demand for soybean meal is likely to range from about 3% to 7%. This inelastic response is consistent with econometric estimates of soybean meal demand in the EC (Knipscheer and Hill). If prices are raised by more than 40%, the decline in soybean meal demand is much more important. From 1976 to 1977, the EC's variable levy on corn and wheat frequently reached 100% (Eurostat). In recent years, world prices have been pushed much closer to the EC threshold price by the strength of the dollar and variable levies have shrunk. Nevertheless, if the EC were to institute barriers to soybean and meal imports, the possibility that the prices of these products would be doubled cannot be ruled out on the basis of historical levies. Price increase of this magnitude would significantly reduce French imports of soybeans and meal from the United States and Brazil.

From the French point of view, it is not clear that increasing soymeal prices would result in greater use of domestically produced feedgrains and oilseeds. The percentages shown in Table 10 are the proportion of all four rations made up of various feedstuffs produced in France. The programming analysis indicates that as soymeal prices are raised, the use of corn in the rations changes very little. On the other hand, at higher levels of soymeal prices, soft wheat usage is greater but barley is gradually forced out of the rations. The first column shows the effect of increasing soymeal prices on the use of French-produced protein sources (rapeseed, sunflower and skim milk powder). As soybean meal is forced out of the rations, animal and fish meals, as well as more wheat, are used to insure adequate protein levels. The French protein sources only enter the rations when soybean meal prices are doubled. At this level, however, barley is essentially forced out of the rations.

The effect of a restrictive trade policy on French livestock production is likely to be relatively small. In terms of the dairy sector, the existence of reasonable substitutes for compound feed probably means that higher feed costs would have little impact on the milk surplus. Much more research would be required to fully understand the nature of livestock production in France and the implications of alternative trade and agricultural policies. The direct approach to controlling dairy surpluses recently adopted in the EC (marketing quotas) has the potential for being much more effective than limitations on imported feedstuffs.

In summary, several conclusions follow from the results of this analysis. First, French soybean and meal demand is only likely to be reduced substantially if the trade barriers result in very high prices for soymeal. The effects of this type of trade policy are different from those associated with the current exchange rate situation. As the dollar has strengthened, demand in Europe for U.S. soybeans has declined. In this case, however, the decline is partly due to a shift to imports of Brazilian and Argentine soy products which are less expensive than the U.S. products due to the strength of the dollar. A trade barrier would raise the prices of all imports, removing the incentive to substitute South American for U.S. soybeans and meal. A price increase of the size required to seriously reduce these imports is not inconceivable since Europe has occasionaly applied variable levies well over 100%. Restrictions leading to price increases of this size should be of concern to U.S. policy-makers since they could lead to a substantial reduction in an important market.

On the other hand, EC policy-makers would do well to understand the implications of such a policy. Based on the results of this analysis, it does not appear that limiting imports of soybeans will lead to significant benefits in terms of the use of internally produced feedgrains and oilseeds. In this example, raising soybean meal prices enough to force rapeseed and sunflower meal into the rations has the rather perverse consequence of driving barley out of the rations. While the implications of this policy for surplus dairy production cannot be fully detailed on the basis of this study, there is some evidence that increased soy meal prices would do little to reduce the excess production. On the whole, the analysis leads to the conclusion that the benefits to the EC of adopting restrictive policies on soybean and meal imports may be considerably smaller than anticipated. When the potential reaction of the United States is taken into consideration, such a policy change should lose most of its appeal.

It should be emphasized that these results pertain only to the French feed-livestock complex. The situation in France differs from that in other EC countries in several important respects. As noted earlier, France is more than self-sufficient in corn and the price of this feedstuff is lower relative to other feed inputs than in the other countries. Germany, the United Kingdom, Denmark and the Benelux countries all have important livestock sectors and must import corn from either France or non-EC countries such as the United States. The French compound feed market also differs from those in other EC countries in that there is a somewhat less extensive soybean crushing industry. In 1983/84, France imported 630,000 metric tons of soybeans for crushing and 3.35 million metric tons of soybean meal(USDA/FAS, Oilseeds). Brazil is the major source of French soymeal imports. Since the crushing industry is less important in France, French policy-makers may be less reluctant to see some form of intervention in this market than their counterparts in countries with large crushing industries.

Since France produces many of the commodities used in compound feeds, there is less tendency to use imported feed ingredients such as gluten feed, manioc or citrus pellets. In the Netherlands, these feedstuffs, along with substantial amounts of soybean meal produced by the Dutch crushing industry, are extensively used in feed rations. It is likely that Dutch compound feed producers would be much more sensitive to changes in soybean prices than the French industry. This may also be the case in the other Northern European countries. These factors preclude extending the results of this analysis to the rest of the EC.

Further research on the impacts of higher soybean prices in the EC would be useful in developing quantitative estimates of the implications of various EC policies. Using an econometric model, Leuck obtained results for the EC as a whole that are similar to the results of this study in many respects (Leuck). For a 10% higher soybean meal price his simulations indicated a 1.7% decline in soybean meal use and minor effects on feedgrain demand and livestock production. The substitution effects identified in Leuck's model are similar to those obtained from the programming analysis for France. The value of the approach used in this study is that it provides more reliable information on the impact of large price changes than econometric approaches. It would be interesting to develop similar models for other EC countries and compare the aggregate results with those obtained by Leuck and Knipscheer and Hill.

Further research is needed to improve the estimates of livestock producer response to input price changes. Very large increases in soybean meal prices could lead to large compound feed price changes, reducing the accuracy of estimates based on feed demand elasticities. These elasticities may only be valid for small price chages. More importantly, a more complete model of these industries is needed to take account of the input substitution possibilities. These comments apply to the French sectors examined in this study and should also be kept in mind in applying this modeling approach to other EC countries. Generally, the research approach used in this study appears to be a useful way to explore the implications of EC policy changes for U.S. exports of feed ingredients, including gluten feeds, citrus pellets, corn and other feedstuffs, as well as soybeans.

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