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Economic and Environmental Impacts of the Post-1992 CAP Reforms on Alentejo Economy of Portugal

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Abstract:

This research develops 'Johansen-type' models of agriculture and constructs Input-Output models for assessing the impact of the post-1992 CAP reforms on incomes, employment and the environment in four Alentejo study areas of Portugal. The effects of agricultural output changes on businesses supplying inputs and processing farm output were also assessed by those empirical models.

Key Words: Common Agricultural Policy, Johansen Model, Input-Output Model, Elasticity , Multiplier and Environmental Indicators

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The EU Council of Ministers agreed a package of reforms to the Common Agricultural Policy (CAP), which affected 75% of the Community's farm output (Commission of European Communities, 1993). The reforms involved immediate price realignments for the main agricultural commodities to be phased in over the period 1992 to 1995, together with the commitment to more radical changes in the period beyond 1996.

The Community committed itself to a fundamental change in the support system, with a switch away from assisting the agricultural industry through guaranteed prices to a system of direct income payments, accompanied by measures designed to influence agricultural production methods (European Commission, 1994). These reforms might have effects on the peripheral areas of the Community traditionally heavily dependent on agriculture.

This research work develops a framework to assess the effects of CAP changes and input/output price changes on the farming community; to examine the effects of the farming change on income and employment; and, to evaluate the environmental benefits/costs associated with farm policy changes on the Alentejo Litoral region, the Alto Alentejo region, the Central Alentejo region and the Baixo Alentejo region of Portugal. This involves the development of models for the agricultural sectors of each region to forecast the impact of policy changes on agricultural output. Farming is a key activity in those regions, so any output changes will have consequences for businesses supplying inputs and processing farm output. To estimate these secondary effects, input-output models are constructed for each region and the resultant multipliers used to estimate the overall income and employment impacts of farm output changes. At the same time, the projected environmental costs and benefits of the agricultural changes are estimated using a set environmental indicators. The projections of the models are partially validate using surveys on each region.

An Economic Model

Estimates of the impact of the recent CAP reforms on income, employment and the environment for each of the study areas are obtained by a three-stage process. First, the impacts of the forecasted price changes on local farm output are projected using a simple econometrically estimated model of regional agriculture. Second, estimates of the local income and employment multipliers are prepared and used to project the global increases in wealth and jobs. Finally, the environment impacts are projected from the reported changes in agricultural output.

Deriving a Regional Model of Agriculture

A regional model of agriculture follows an approach developed by Boyle e O'Neill (1990). The Johansen method is used to model the farm economies in each of the study areas. This approach describes the relationship between inputs and outputs in terms of percentage changes rather than absolute terms. The input-output relationships are expressed by means of a production function of the type presented in equation:

(1) $$Y_i = (\varepsilon_1 X_1 + \varepsilon_2 X_2 + \ldots + \varepsilon_n X_n)$$

where Y_i is the percentage change in output of product i, X_j is the percentage change in input j and ε_j is elasticity of output with respect to input X_j. Assuming that agricultural output and input prices are given and that farmers maximise short-run profits, then

Hotelling's Lemma permits the derivation of a set of profit maximising supply and demand relationships for outputs and inputs in terms of product prices, input costs and the levels of quasi-fixed factors, such as capital and labour (Varian, 1984).

The Johansen approach solves this system of equations by linearising in terms of percentage changes. The solution of the equation system is obtained by matrix inversion:

(2) $Y = -A_1^{-1} A_2 X$

If the profit-maximising levels of output are the dependent variables, then A_1 consists of a unit matrix, while A_2 is a matrix of the price and quasi-fixed factor elasticities. If the quantities of inputs and outputs are treated as endogenous variables and the market prices as exogenous, then the model can be used to evaluate the consequences of a price change on both the patterns of production and inputs.

To overcome problems associated between the exogenous variables and the error term, the elasticities are estimated from the profit function, which can be shown under certain conditions (Lau, 1978). In using the profit function to model production possibilities, there were two requirements: i) farmers had to behave as profit maximisers; and, (ii) the market for outputs and inputs had to be assumed to be competitive. Accepting these restrictions, then profits (H) could be defined as a function of the process for output and the variable inputs (P_j) and the level of quasi-fixed factors (Z). The profit function is then the dual of the production function if it is satisfied a number of so-called 'regularity' conditions (Lau, 1978). By differentiating the profit function with respect to input and output prices, input demand and output supply functions are obtained (Varian, 1984).

The precise specification of the profit function is governed by the need to satisfy as many of the 'regularity' conditions as possible and to impose as few as possible arbitrary restrictions on the parameters which describe the production technology. The translog function is considered to meet these requirements:

$$(3) \qquad \ln H(P,Z) = a_0 + \sum_{i=1}^{n} a_i \ln P_i + 0.5 \sum_{i=1}^{n} \sum_{j=1}^{n} a_{ij} (\ln P_i)(\ln P_j) + \sum_{k=1}^{m} b_k \ln Z_k$$

$$+ \sum_{i=1}^{n} \sum_{k=1}^{m} b_{ik} (\ln P_i)(\ln Z_k) + 0.5 \sum_{h=1}^{m} \sum_{k=1}^{m} c_{hk} (\ln Z_h)(\ln Z_k)$$

where a_0, a_i, a_{ij}, b_k, b_{ik} e c_{hk} are parameters, n denotes the total number of inputs and outputs and m equals the total number of quasi-fixed factors. For the profit function to be the dual of the production, it must be linearly homogeneous in input and output prices and the cross-price coefficients (a_{ij}) must satisfy the symmetry conditions (Lau, 1978). Differentiating the equation (3) with respect to input and output prices yields a set of output supply and input demand equations of the following type:

$$(4) \qquad S_i = \left(\frac{\partial \ln H}{\partial \ln P_i}\right) = \left(\frac{\partial H}{\partial P_i}\right)\left(\frac{P_i}{H}\right) = a_i + \sum_{j=1}^{n} a_{ij} (\ln P_j) + \sum_{k=1}^{m} b_{ik} (\ln Z_k)$$

where S_i is the share of the input or output i in total profits. The elasticities required for the Johansen-type model can then be obtained from equation (4) as outlined by Sidhu and Bannante (1981). Strictly, the elasticity estimates are short-run in nature, because they are derived assuming that some of the inputs (Z_K) are fixed. The predicted price responses do not take into account the ability of farms to adjust the fixed inputs in the long-run. However, while Lau (1976) and Hertel (1987) have derived methods for estimating long-run elasticities, they are either i) only applicable where there is one quasi-fixed factor or ii) to functional forms other than the translog.

The elasticities are estimated using individual farm business data. The sample comprises both cross-sectional and time-series data, it is necessary to modify the functional form of the translog function used, to avoid confusing changes in factor shares due to price changes with those due to changes in the sample of farms. One of the simplest procedures for doing this is to assume that differences in behaviour between individual farms could be captured by a variable intercept term, while responses to price and costs changes are presumed to be constant across all farms of the sample type. For a situation involving f farms, n outputs and inputs and m quasi-fixed factors, a translog profit function, seven output share equations, three input share equations and two quasi-fixed share equations are estimated simultaneously using Seemingly Unrelated Regression Method, with the share of revenue from 'other crops', being estimated residually. In practice, it is impossible to fit a single equation through all the data, so instead the farms in the sample are split into one of four types and separate functions fitted for each farm type group in each of the study areas. In general, the fitted equations satisfy the conditions on '

(Higgins, 1981) and 'convexity' (Lau, 1976), but the proportion of variance explained is disappointingly low. Nevertheless, the magnitude and sign of the elasticities are generally as expected. To derive a set of workable elasticities, which could be used to predict the effect of policy changes on agricultural output in each of the study areas, it is necessary to obtained 'pooled' estimates by weighting the individual farm-type elasticities by the proportion of farms of each type in a given study area. In each case the elasticities were estimated for the 1993 data point. As the distribution of farm types differed among study areas, these consequent ‘pooled’ elasticities also differ among the four study areas.

Deriving Regional and Employment Multipliers

To forecast the impact of any changes in agricultural output on total income and employment in the study areas, economic multipliers for agriculture are estimated from the I-O tables constructed for each study area. Provided a number of restrictive assumptions are accepted (Midmore, 1990), this approach has the advantage of being conceptually simple. To construct the I-O matrices for each of the study areas, the sector-by-sector table for Portugal has first to be aggregated into sectors for which reliable regional employment data may be obtained. This involves amalgamating the 49 original industrial sectors contained in the 1990 Portuguese I-O tables into the twelve principal digits SIC (Standard Industrial Classification) sectors, together with a single sector to represent ‘households’. The twelve I-O table for Portugal is then converted to a regional matrix, using a technique developed by Jensen et al. (1979), refined by Johns and Leat (1986) and based on relative employment levels.

Conventially, the national I-O table treats agriculture as a single industry in agricultural output due to expanded milk production must be presumed to have the same impact on the demand for inputs from other industrial sectors as an equivalent increase due to cereal production. This is clearly not tenable. Accordingly, the decision was taken to disaggregate the agriculture sector within the I-O tables into eight enterprises, namely beef rearing, dairying, sheep production, hogs production, wheat production, corn production, rice production and miscellaneous output. The latter includes agro-environment payments. An earlier method put forward by Errington (1989) for estimating I-O coefficients for individual farm enterprises from regional data was felt to impose too many prior restrictions on the production relationship. Instead a system of input demands and output supplies was directly derived form a ‘dual cost function’ (Varian, 1984). Since the technical coefficients in the I-O model describe the average factor cost, and since they are used to predict the total demand for a particular input and total output, the cost function may be used to derive the I-O coefficients for a particular enterprise. Considering a methodology derived by Lager and Schöpp (1985), a translog cost function is fitted to the original sample of farms and I-O coefficients are estimated for each of the eight farms enterprises independently for each study area. These coefficients are used to derive regional income and employment multipliers for the four study areas as outlined by Jensen et al. (1979). They are termed the ‘type 2’ multipliers, which take account not only of the direct and indirect effects of output changes, but also the effects induced by secondary changes in income and employment in the region caused by the initial output changes. The income multipliers show the projected increase in regional income due to a one dollar rise in output of a particular sector. The employment multipliers show the total jobs created within the locality per additional job generated in that sector.

Forecasting the Environmental Consequences of Agricultural Changes

To forecast the environmental consequences of the CAP reform changes, a set of environmental indicators is devised, based on proposals by Parris (1995) and Winpenney and Mills (1995). These indicators are presented in table 1.

The indicators are used to assess whether the predicted in changes in stock numbers, stocking densities, crop areas and input usage will be expected to bring about an environmental improvement or deterioration.

Table 1. Proposed Environmental Indicators

Indicator	Environmental Benefits
Fertiliser usage	Decrease in fertiliser usage is anticipated to increase biodiversity and reduce leaching and pollution.
Pesticides & herbicide usage	Decrease in chemical use will reduce detrimental effects on natural flora and fauna.
Energy usage	Decrease in energy use will reduce atmospheric pollution, as well as rate of depletion of natural resources.
Stocking density	Decrease in stocking rates will reduce grazing pressures, with positive for biodiversity.
Afforestation	Increase in woodland area may increase visual amenity and habitat diversity.
Crop Production	A reduction in the intensity of production is generally associated with an increase in biodiversity.
Crop-Permanent Grassland ratio	An increase in the ratio of grassland to crops is generally expected to reduce the potential for soil erosion from bare land.

Source: Model Results

Results

The impact of the CAP reforms on agricultural production over the period 1992 to 1995 (scenario 1) differs between study areas, as shown in Table 2.

The effects of reform, when there are no supply constraints on agricultural production (scenario 1A), reveale that production declines in all the study areas (Table 2). The impact of scenario 1B, which assumes that milk production is constrained and that the quotas has not changed over the period 1992 to 1995, leads to moderate declines in agricultural production in all the study areas as shown in Table 2.

Table 2. Agricultural Output and Local Income and Employment under Price Scenario 1

Commodity	Alentejo Litoral			Alto Alentejo			Alentejo Central			Baixo Alentejo		
	1A	1B	1C	1A	1B	1C	1A	1B	1C	1A	1B	1C
Change in agricultural output, million contos	-0.68	-0.52	-0.52	-0.61	-0.07	-0.07	-1.39	-0.10	-0.10	-0.82	-0.51	-0.51
Change in agricultural output as % of 1992 output	-5.92	-4.48	-4.48	-6.48	-0.72	-0.72	-7.26	-0.53	-0.53	-6.83	-4.27	-4.27
Change in overall income, million contos	-1.10	-0.83	-1.43	-0.98	-0.12	-0.21	-2.17	-0.15	-0.23	-1.21	–0.75	-1.16
Change in employment, jobs (1)	-295	-237	-320	-338	-10	-24	-718	-35	-45	-462	-305	-366
Change in employment as of % 1992 labour force	-3.91	-3.15	-4.24	-4.63	-0.14	-0.33	-6.35	-0.31	-0.40	-5.40	-3.58	-4.28
Change in employment, jobs (2)	-912	-676	-758	-589	-78	-91	-1223	-102	-112	-769	-459	-520
Change in employment as of % 1992 labour force	-12.09	-8.96	-10.06	-8.07	-1.06	-1.25	-10.81	-0.90	-0.99	-9.01	-5.38	-6.09

Source: Model Results

Nota (1) – Change in employment was based on separate labour:output ratios for each of the agricultural enterprises

(2) - Change in employment was based on separate labour:output ratio for the agricultural industry as a whole

The first scenario (1C), under constrained agricultural production, leads to declines in output, income and employment in agriculture and their food processing industries for the study areas as shown in Table 2. The results indicate that under a milk quota system there is a negative impact on agriculture and the regional economy in all the study areas. The differences in economic structure are also reflected in the differences between study areas regarding the impact on income and employment which result from changes in the agricultural output. The Alentejo Litoral and the Baixo Alentejo areas are more integrated economies than the other study areas. Therefore, evidently changes in farm output are projected to have a much greater consequence on the regional economy in the Alentejo Litoral area and the Baixo Alentejo economies than on the regional economy in the Alto Alentejo and the Alentejo Central areas. These model results have been compared with rapid audits recorded from farmer groups, farmer associations and governmental agencies. Although there are some differences, these are not sufficiently great to invalidate the results.

The second price scenario (scenario 2) that is investigated is concerned with investigating what will happen if there is a partial convergence between EU and world prices. Three scenarios are run by the model. The scenario 2A represents 25 per cent reduction in the deviation between world price and the EU price. It is assumed that any reduction price support will be compensated by a corresponding increase in the agri-environment payment. The impact of this is simulated by assuming that “Miscellaneous output”, which include items like income from forestry and other agri-environment payments, is increased by an amount equal to the reduction in price support. The scenario 2B considers that the budgets costs released by any reduction in price support could be paid as a social transfer payment to farm households. Farm households will not use the extra income to support the farm business, but they treat as extra consumption income. The scenario 2C assesses the possible consequences for income and employment in processing industries of declining agricultural output, which mirrors Scenario 1C.

Table 3. Agricultural Output and Local Income and Employment under Price Scenario 1

	Alentejo Litoral			Alto Alentejo			Alentejo Central			Baixo Alentejo		
Commodity	2A	2B	2C	2A	2B	2C	2A	2B	2C	2A	2B	2C
Change in agricultural output, million contos	-1.45	-2.22	-2.22	-0.37	-1.03	-1.03	-0.78	-1.89	-1.89	-0.75	-1.54	-1.54
Change in agricultural output as % of 1992 output	-12.63	-19.35	-19.35	-3.86	-10.92	-10.92	-4.07	-9.91	-9.91	-6.31	-12.91	-12.91
Change in overall income, million contos	-2.12	-2.38	-4.80	-0.55	-0.68	-2.04	-1.26	-1.46	-2.94	-0.84	–1.37	-2.63
Change in employment, jobs (1)	-740	-406	-762	-85	240	36	-515	76	-116	-373	-179	-361
Change in employment as of % 1992 labour force	-9.82	-5.38	-10.11	-1.17	3.29	0.49	-4.55	-0.67	-1.02	-4.37	-2.10	-4.23
Change in employment, jobs (2)	-1586	-1252	-1609	-440	-115	-319	-781	-191	-382	-701	-507	-689
Change in employment as of % 1992 labour force	-21.04	-16.60	-21.34	-6.03	-1.57	-4.37	-6.91	-1.69	-3.38	-8.21	-5.94	-8.07

Source: Model Results

Nota (1) – Change in employment was based on separate labour:output ratios for each of the agricultural enterprises

(2) - Change in employment was based on separate labour:output ratio for the agricultural industry as a whole

The effect of scenario 2 in all the study areas is a severe decline in agricultural production and local income and employment, as shown in Table 3.

An investigation is also carried out on how the indicators describe the environmental impacts of CAP reform changes on each of the study areas. Using the environmental indicators outlined in Table 4, an assessment has been made of whether the change may be expected to benefit (+) or harm (-) the environment.

Table 4. Environmental Gains and Losses under the Various Scenarios

	Alentejo Litoral		Alto Alentejo		Alentejo Central		Baixo Alentejo	
Indicadores	**1A**	**2A**	**1A**	**2A**	**1A**	**2A**	**1A**	**2A**
Fertilizer Use								
Wheat	+	+	+	+	+	+	+	+
Com	+	+	+	+	+	+	+	+
Arroz	-	+	-	+	-	+	+	+
Pesticides & herbicides								
Wheat	+	+	+	+	+	+	+	+
Com	+	+	+	+	+	+	+	+
Rice	-	+	-	+	-	+	+	+
Livestock numbers	+	+	+	+	+	+	+	+
Stocking density								
Beef Cattle	+	+	+	+	+	+	+	+
Dairy	+	+	+	+	+	+	+	+
Sheep	+	+	-	+	-	+	+	+
Hogs	+	+	+	+	+	+	+	-
Crop Production								
Wheat	+	+	+	+	+	+	+	+
Com	+	+	+	+	+	+	+	+
Rice	-	+	-	+	-	+	+	+
Crop-permanent grassland ratio (a)	+ /-	+ /-	+ /-	+ /-	+ /-	+ /-	+ /-	+ /-

As the results are similar in respect of each scenario regardless of the assumption, they are only given for Scenarios 1A and 2A. No attempt has been made to weight the indicators. Instead it has been assumed that where the majority of indicators are positive, the environmental effects of the policy changes may be considered to be beneficial and vice -versa. Considering this assumption, the longer term changes (scenario 2) may be expected to be more environmentally positive than the agricultural changes immediately post-92.

Conclusions and Implications

The methodology developed provides some potentially interesting insights regarding the linkages between the agriculture sector and the rest of the economy in rural areas. In particular, changes in agricultural production are likely to have significant effects on overall employment in Alentejo Litoral, Alto Alentejo, Alentejo Central e Baixo Alentejo areas; that is sufficient to be ignored. At the same time, the study suggests that the wider impacts of proposed shifts in public assistance to agriculture, away from support to direct income and agro-environment payments, may be negative at the local level. This indicates a need to review the consequences of such policy shifts more closely before initiating them on a large scale.

The environmental indicators for the study areas indicate a deterioration under scenario 1, while the longer-term projections under scenario 2 are more favourable. In particular, a shift towards supporting farm households through agro-environment and direct income payments is projected to lower the intensity of farming in the study areas, as well as decrease the use of environmentally harmful inputs, such as fertiliser and herbicides.

Finally, the environmental indicators neither capture the size nor quality of the projected environmental improvements. As a result it is difficult to draw specific conclusions apart from endorsing the belief that, in the study areas, the CAP reforms are likely to engineer a move towards more environmentally friendly management systems.

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