

An Applied Computable Equilibrium (ACE) Model of the CAP Cereal Policy Reforms: the Case of Ireland

G.E. BOYLE*

Maynooth College, Co. Kildare

Abstract: In this paper an Applied Computable Equilibrium (ACE) model is constructed to examine the economic impact of the CAP (Mac Sharry) cereal policy reforms. The model is applied to Irish data. The reforms comprise three elements: (i) a 29 per cent reduction in "support" prices; (ii) a requirement that producers "set aside" 15 per cent of the land devoted to cereal production, and (iii) compensation for the price reduction and "set aside". The simulations for Ireland suggest that production of cereals could fall by between 14 per cent and 9 per cent. The usage of intermediate inputs (mainly fertilisers) could fall by between 19 per cent and 9 per cent. The outcome for land values is dependent, *inter alia*, on the assumed technology of the production system.

I INTRODUCTION

The agreement reached in May of 1992 on the so-called Mac Sharry CAP reforms (see EU Commission), which came into effect in 1993/94 and are to run until 1995/96 at least, represents a fundamental departure in the nature of EU farm policies. The reforms clearly mark the first serious attempt by the EU to decouple farm supports from the market place. The cereals' policy arguably represents the most fundamental departure with the policies of the past. In particular, the introduction of an acreage control or "set aside" policy probably constitutes the most radical adjustment in Community farm policies since the inauguration of the dairy quota in 1984.

The new cereals' policy comprises three main elements:

*The author would like to acknowledge the excellent research assistance given by David Noonan and the helpful comments of the referees. Any errors in the paper are the author's own.

- (i) a reduction in institutional support prices of 29 per cent (from 155 ECUs to 110 ECUs per tonne),
- (ii) the introduction of a "set aside" requirement for cereal farms in excess of 15 hectares equal to 15 per cent of the base cereal area to be applied at an individual farm level, and
- (iii) compensatory payments to dampen the adverse income effects of the price cuts and "set aside" arrangements. The compensation rate per hectare for the price reduction and area "set aside" is computed by multiplying the compensation per tonne (ranging from 25 to 45 ECUs over the period of implementation) by a reference yield per hectare for each country; for Ireland the national reference yield would be 6.08 tonnes per hectare. "Set aside" is mandatory for larger farms if they wish to avail of compensation but those farms below 15 hectares will receive compensation without any "set aside" obligation.

This paper is concerned with analysing the economic effects of these measures in terms of the impact on production; the effect on agri-chemical and fertiliser consumption and hence on the agri-business sector and on the demand for and returns factor inputs, land, labour and capital and finally on the welfare of producers.

Conceptualising how these reforms will affect rational producer responses is relatively straightforward in the case of the price cut and "set aside" components.¹ The interpretation of how the compensation aspect will affect decision-making is less obvious.

One interpretation would be that the compensation package is production neutral, or, in other words it simply constitutes "lump sum" transfers to essentially low-yielding cereal producers. In the jargon of agricultural policy reform the compensation would thus be considered fully "decoupled".

Another and more reasonable interpretation is suggested by Sheehy (1994). Given that compensation is determined on the basis of a fixed base area and reference yield, the compensation payments provide no incentive to increase production above the base level. However, the disincentive to reduce production because of the price cut will be modulated for individual producers depending on the proximity of their cereal yield levels to the reference yield. The percentage change in revenue — arising solely from the price reduction

1. There is room for debate as to whether the nominal 15 per cent acreage "set aside" will translate, *ceteris paribus*, into an actual level of 15 per cent. The concern is that producers would have an incentive to withdraw their poorest land from production (see Gardner (1994) for instance). However, the "set aside" scheme at present operates on a rotational basis and hence over the life of the programme the impact of the incentive for producers to idle the least productive land in initial years would be nullified.

and compensation — relative to the base (i.e., prior to the introduction of the policy) for individual producer i is given by:

$$EP_x + c \frac{yld_r}{yld_i} \quad (1)$$

where,

EP_x is the percentage reduction in support prices; c is the rate of compensation expressed as a percentage of the base period price (equal to about 29 per cent under the Mac Sharry reforms); yld_r is the EU reference yield and yld_i is the individual farm yield.

The “effective” price reduction faced by individual producers can thus range from a minimum of zero, (where, $yld_r = yld_i$), to a maximum determined by the ratio of (yld_r/yld_i), (where $yld_i > yld_r$). Thus for producers whose yields are, say, twice the level of the reference yield, they face an “effective” price cut of about 15 per cent.

The general relationship between the percentage price decline, the percentage compensation rate and yield is shown in Figure 1.

Interpreted in the above way we can say that the compensation payments are only partially “decoupled”. It should be noted that for those producers whose yields are below the reference yield, the level of compensation received

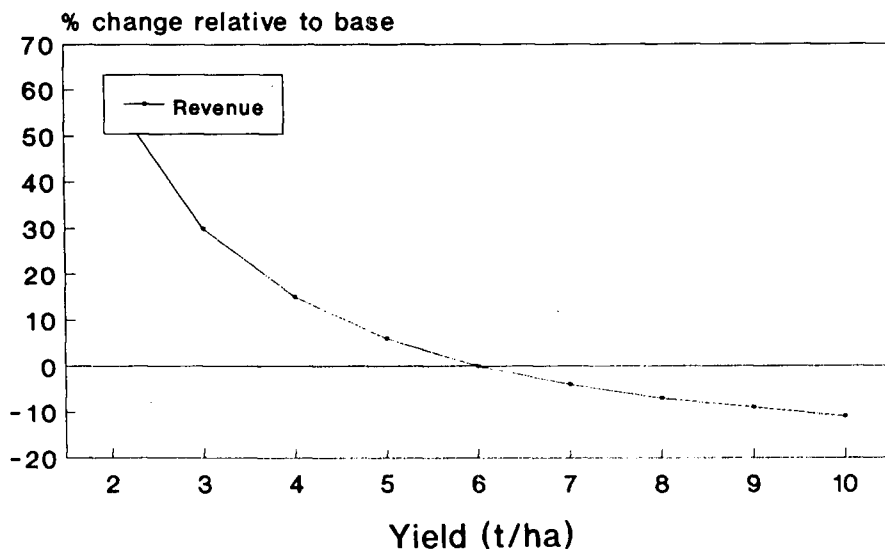


Figure 1: Cereal Policy Reforms (% Change in Revenue by Yield)

partly offsets the impact of price decline and hence affects production and input-use decisions, and partly constitutes a "lump sum" transfer.

Any analysis of the impact of the reform measures on the Irish cereals sector must thus take cognisance of the circumstances of individual producers because different producers will face different policy impacts. Table 1 sets out the main policy impacts on producers and their estimated incidence in terms of the numbers of producers and their share of cereal production.

Table 1: *Policy Impact of the Cereal Reforms and Estimated Incidence*

<i>Policy Impact</i>	<i>% of Producers*</i>	<i>% of Production*</i>
A. "Price" Cut Only	15	9
B. "Set Aside" Only	7	16
C. "Price" Cut and "Set Aside"	13	59
D. No "Price" Cut or "Set Aside"	64	16

*These estimates are based on data supplied by Mr K. Reidy, TEAGASC, personal communication.

Notes:

- A: "Small scale" producers where $yld_i > yld_r$. These producers will face an "effective" cut of between 29 per cent and 0 per cent.
- B: "Large scale" producers where $yld_i < yld_r$. These producers will face an "effective" price cut of zero.
- C: "Large scale" producers where $yld_i > yld_r$. These producers will face an "effective" cut of between 29 per cent and 0 per cent.
- D: "Small scale" producers where $yld_i < yld_r$. These producers will face an "effective" price cut of zero.

This typology of policy impacts does not do full justice to the complexity of the reform measures. As noted above the extent of "effective" price cut faced by individuals who fall into categories A and C will depend on the ratio of the reference yield to their actual yield. To avoid making our analysis hopelessly complicated we propose to model the effects of these policy impacts for representative producers in these categories. Based on the data underlying that given in Table 1, the "effective" price cuts faced by representative producers in categories A and C are 4.4 per cent and 7.12 per cent respectively.^{2, 3}

2. The larger price decline for producers in category C is because the larger-scale producers also tend to produce larger yields.

3. Producers in categories B and D will also receive additional "lump sum" transfers. The level of these transfers will depend on individual producer yields in relation to the reference yield, but for representative producers in these categories, we estimate, based also on the data underlying Table 1, that these transfers could amount to about 5 per cent of and 13 per cent of base period revenue for producer categories B and D respectively. The larger transfers to producers in D arise because their yields are significantly lower than the yields of producers in B.

These policies raise fundamental questions about, first, their effectiveness in reducing the level of cereals' production which was the primary motivation of the EU Commission in bringing forward the reform measures, and second, the impact of the proposals in terms of the responses of producers and the consequences for resource prices.

The purpose of our paper is to attempt to address these issues. We do so by constructing an applied computable equilibrium or ACE model of the Irish cereals sector and we use this model to simulate the likely impact of the reform measures. Section II of the paper sets up the model. Section III parameterises the model and conducts the simulations while Section IV concludes the paper.

II AN ACE MODEL OF THE CEREALS SECTOR

In developing our model we extend the basic approach of Floyd (1965) and Gardner (1990). These authors set out a single-output two-input model whereas we consider a single-output four-input model. The key assumptions of the model are that producers maximise profits subject to a linearly homogeneous technology and that markets are assumed to be competitive with all firms in the industry presumed identical. With these basic assumptions one can proceed to build a model of the sector in two ways. First, by specifying a specific functional form for the technology (for example, a Cobb-Douglas or CES function) one could solve the model in "levels" form. Alternatively, one could solve the model in terms of percentage changes. The latter approach is sometimes termed the Johansen procedure, of which the best-known application is the so-called ORANI project of the Australian Industries Commission (see Dixon *et al.* (1992)). We have chosen this route for a number of reasons (see Boyle and O'Neill (1990), Munk (1985), Mahe and Munk (1988)). First, we believe it lends transparency to the model and the results are readily communicable to a non-technical audience which usually will be the primary users of policy analyses. Second, the solution of the model is relatively easy compared with its "levels" counterpart. Third, the Johansen approach does not limit modelling of the supply or demand side to "simple" functional forms such as the Cobb-Douglas or CES functions and can maximise the use of the existing literature in parameterising the model.⁴ Fourth, model closure (that is, the choice of endogenous and exogenous variables) is more easily facilitated compared to the "levels" version. The main drawback of the Johansen approach is that the analysis will only be accurate for "small" changes in exogenous variables. However, this "approximate"

4. The linearisation error will, however, increase from zero as one moves from the Cobb-Douglas function (Gardner (1990)).

mation error" seems a reasonable tradeoff for the greater flexibility which the approach allows. Moreover, it is apparently possible to employ an iterative solution procedure which can significantly diminish the extent of the "approximation error" (Dixon *et al.* (1992) and Hertel *et al.* (1992)).

Equations of the Model

The model consists of 11 equations: a production function, 4 factor demand and supply equations (land, labour, capital and materials), a product demand equation and an identity. These equations are specified respectively as:

$$Ex = s_l El + s_n En + s_k Ek + s_m Em \quad (2)$$

$$El = g_{ll} Ep_l + g_{ln} Ep_n + g_{lk} Ep_k + g_{lm} Ep_m \quad (3)$$

$$En = g_{nl} Ep_l + g_{nn} Ep_n + g_{nk} Ep_k + g_{nm} Ep_m \quad (4)$$

$$Ek = g_{kl} Ep_l + g_{kn} Ep_n + g_{kk} Ep_k + g_{km} Ep_m \quad (5)$$

$$Em = \gamma_{ml} Ep_l + \gamma_{mn} Ep_n + \gamma_{mk} Ep_k + \gamma_{mm} Ep_m \quad (6)$$

$$El = e_l Ep_l \quad (7)$$

$$En = \varepsilon_n Ep_n \quad (8)$$

$$Ek = e_k Ep_k \quad (9)$$

$$Em = \varepsilon_m Ep_m \quad (10)$$

$$Ey = h Ep_x \quad (11)$$

$$Ey = Ex \quad (12)$$

where,

the prefix E(-) denotes a percentage change; x is product supply and y product demand; l,n,k and m are the factors of land, labour, capital and materials (mainly fertilisers and agri-chemicals) respectively; s(-) denotes the value share of the factor of production in the value of output; p_x is the price of cereals and p_i ($i=l,n,k,m$) are the prices of the factors of production; γ_{ii} ($i=l,n,k,m$) are the Marshallian own-factor demand elasticities and γ_{ij} denotes the Marshallian cross-price elasticities; ε_i ($i=l,n,k,m$) are the input supply elasticities and η denotes the product demand elasticity.

Making use of Allen's (1968) result that:

$$\gamma_{ij} = s_i (\sigma_{ij} - \eta); \quad i, j = l, n, k, m \quad (13)$$

where,

σ_{ij} denotes the Allen Elasticity of Substitution (AES) and s_i are the factor cost shares, we can write the factor demand equations in a form which will be more convenient for parameterisation.⁵

$$E_i = \sum_j s_j \sigma_{ij} E p_j - \eta \sum_i s_i E p_i; \quad i, j = l, n, k, m \quad (14)$$

Producer welfare is captured by the percentage change in short-run restricted profits ($E\pi$ or the net returns to the relatively fixed factors of production, land, labour and capital):

$$E\pi = \frac{1}{1-s_m} \left(E p_x - s_m E p_m + E x - s_m m + c \frac{yld_r}{yld_i} \right) \quad (15)$$

where,

s_m is the share of materials in the value of output.

III PARAMETERISATION AND SIMULATION OF THE MODEL

To parameterise the model we need 16 Allen elasticities of substitution but given linear homogeneity in factor prices and symmetry we only require 6 independent coefficients. We also require 4 factor share estimates, 4 factor supply elasticities and a product demand elasticity.

Information on Allen substitution elasticities is extremely sparse, especially at an individual product level and most of the published studies concern the aggregate sector. The available studies are also widely diverse in terms of country coverage, the number of inputs included in the production system, functional form and estimation method and hence it is very difficult to draw strong conclusions about elasticity magnitudes from the published literature. None the less, an examination of this literature allows us to infer broadly typical elasticity values for our 6 AES parameters which will at least provide a reasonable set of baseline assumptions.⁶

Most studies report an AES value for capital/labour of around unity. While fewer papers include land as an input, those that do, most frequently produce an AES of about zero for the capital/land and labour/land pairings. Of all the input combinations, least agreement is apparent for the AES between capital and materials and labour and materials. A number of studies imply

5. Competitive pricing is implied by Equations (11) through (14).

6. We base our initial set of AES values on the following studies: Adamowitz (1986); Boinnieux (1989); Binswanger (1974); Boyle (1981); Chalfant (1984); Chambers (1983); Glass and Mc Gillopp (1990); Hertel (1989); Lopez (1980); Mergos and Yotopoulos (1988), and Ray (1982).

complementarity for both of these input pairings but the vast majority suggest substitutability with an AES of about unity occurring with greater frequency. The final input pairing, land/materials, is a critical parameter in the context of analysing the "set aside" policy since a high degree of substitution between land and materials implies that the introduction of a "set aside" proposal, *ceteris paribus*, will lead to more intensive use of the "set aside" land. If this were to happen, the proportionate fall in production would be much less than the proportionate reduction in "set aside". Gardner (1990) refers to the latter effect as the "slippage" factor possible in an acreage control or "set aside" policy. The empirical AES literature on this particular input combination is particularly thin but the few available studies strongly suggest that this parameter is several times larger than the other input pairings discussed, with values close to three occurring most often.

We can also identify a value for this important parameter by analysing the findings of experimental results which have established the relationship between cereals' yield and the fertiliser input.⁷ A number of such experimental results are available for Ireland. The typical fertiliser response curve, for example wheat, is a quadratic of the form:

$$\left(\frac{q}{l}\right) = a + b\left(\frac{f}{l}\right) + c\left(\frac{f}{l}\right)^2 \quad (16)$$

where,

q is total wheat output; l is the total land area; f is total fertiliser use.

Allen (1968) shows that the elasticity of substitution can be defined as

$$\sigma_{lf} = \frac{g_l g_f}{g_{lf} q} \quad (17)$$

where,

g_l, g_f are the marginal products of land and fertiliser respectively and g_{lf} is the derivative of the marginal product of land with respect to fertiliser.

Using the results of Gately (1975) for Irish wheat production we can infer the following substitution elasticities at various levels of fertiliser use:

<i>Experimental Fertiliser Trials and σ_{lf}</i>					
<i>Fertiliser use (kgs/ha)</i>					
	225	200	175	150	125
σ_{lf}	-6.11	-1.10	2.87	5.63	7.09

7. Fertilisers constitute the bulk of materials in the case of cereals' production.

Application rates over 200 kgs/ha and under 150 kgs/ha are in the uneconomic region of production, given known price relativities, so by implication for an application rate of around 175 kgs/ha the Allen substitution elasticity between land and fertiliser is indicated to be in close agreement with the AES econometric literature.

Based on the preceding arguments, the following orders of magnitude for the various Allen elasticities of our model are employed as baseline assumptions:

Baseline AES assumptions

σ_{kn}	σ_{kl}	σ_{km}	σ_{nl}	σ_{nm}	σ_{lm}
1	0	1	0	1	3

Given the uncertainty which surrounds specifying these parameters it will be prudent to conduct sensitivity tests on the model outcomes. An issue of some concern, which has also been noted by Abler and Shortle (1992) and a further argument for conducting such tests, is that these AES values imply a supply elasticity which appears excessively "high".⁸

The specification of the remaining elasticity parameters is no less difficult. It is reasonable to suppose that the supply elasticity of materials would be quite large and an assumption of an infinite elasticity is standard in most empirical analyses of firm behaviour. In the short-term, the supply elasticity of labour is probably close to zero. There are many non-pecuniary benefits associated with agricultural employment which keep labour in the sector even when returns are poor. Also in the short-term, conditions in the general economy may not be conducive to encouraging outmigration. In the long-run, however, the supply of labour could be quite elastic.

Floyd (1965) for instance, cites an argument due to Johnson (1960) to the effect that if the ratio of agricultural to non-agricultural wage rates is roughly constant (but not necessarily equal to unity) over the long run, then labour supply is infinitely elastic. A recent article by Barkley (1990) suggests a migration elasticity for US agriculture of 4.5.⁹ This relatively large migration elasticity implies a fairly modest labour supply elasticity. Recent work by Boyle (1992) for the Northern-Ireland agricultural sector suggests that the migration elasticity and by implication the labour supply elasticity, depends negatively on the economy's unemployment rate. With relatively high unemployment, labour supply is virtually inelastic whereas with relatively low

8. In our case the supply elasticity will be substantially influenced by the assumed high value for σ_{lm} in our baseline assumptions. This result can be shown analytically in the two-input production system (see Gardner (1990)).

9. Barkley (1990) defines the migration elasticity as the percentage change in the migration rate in response to a 1 per cent change in relative agricultural/non-agricultural earnings.

unemployment we get a much larger but still absolutely low elasticity coefficient.

Greater difficulties surround any attempts at specifying elasticity magnitudes for land and capital given the absence of any published econometric evidence. Unlike other farm products, there is a strong tradition in Ireland of renting land for cereal production which suggests that land used in this sector might be relatively elastic. However, in the absence of any firm evidence on this issue, we assume these parameters are similar in magnitude to the labour supply elasticity. Thus in our model simulations we employ the following elasticity magnitudes:

Baseline supply elasticity assumptions

ϵ_l	ϵ_n	ϵ_k	ϵ_m
0.20	0.20	0.20	20

For our cost share estimates we draw on a study of Boyle *et al.* (1992). For the case of specialist cereal production this study produced the following share estimates for 1989:

Cost share assumptions (per cent)

s_l	s_n	s_k	s_m
25	8	14	53

Given the intervention system of the CAP, the product demand elasticity can be specified to be infinitely large. This implies that product prices are exogenous and thus determined by policy.

Model Simulations

As outlined in Table 1, the policy impact of the cereals' reform package comprises four main dimensions (denoted A to D) depending on the circumstances of producers in terms of scale of activity and yield levels. Only dimensions A to C are of economic interest since producers who fall into category D face neither "effective" price cuts or "set aside" obligations relative to the pre-reform situation. The impact on their economic welfare can be inferred directly from Equation (1) once their yield levels are known.

Model simulations are thus conducted for policy impacts A to C. Product prices and the land input are determined exogenously under impacts B and C, while the only exogenous variable in category A is cereal prices since producers in this category do not face a "set aside" obligation. The land input is set to fall exogenously by 15 per cent for impacts B and C. The exogenous

price changes are 0 per cent for B and -4.4 per cent and -7.12 per cent for A and C respectively. As noted above these are the "effective" price reductions and are estimated representative values for producers in these categories.

Given the uncertainty which surrounds the parameterisation of the model it is important that the sensitivity of model outcomes to parameter assumptions be assessed. It would, however, be impractical to subject the entire 16 parameters to sensitivity analysis. To make the analysis manageable therefore, we propose to conduct sensitivity analysis only for the AES parameters. We consider four possible sets of AES values in each policy impact simulation.

These are labelled as:

- I Baseline AES assumptions.
- II Leontief technology, i.e., all $\sigma_{ij}=0$, ($i, j=l, n, k, m$).
- III Cobb-Douglas technology, i.e., all $\sigma_{ij}=1$.
- IV $\sigma_{kn}=\sigma_{km}=\sigma_{nm}=0.33$; $\sigma_{kl}=\sigma_{nl}=0$; $\sigma_{lm}=1$.

The results of the simulation of the policy impacts are given in Tables 2 to 4. In Table 2 we consider producers who exclusively face price cuts in the wake of the reforms. A number of findings are of interest. For instance, while the

Table 2: Policy Impact A^a — Price Cuts Only

	I	II	III	IV
Ex	-8	-2	-6	-4
Ep _x	(-4.40)	(-4.40)	(-4.40)	(-4.40)
El	-1	-2	-2	-1
En	-2	-2	-2	-2
Ek	-2	-2	-2	-2
Em	-14	-2	-10	-7
Ep _l	-5	-9	-9	-6
Ep _n	-12	-9	-9	-12
Ep _k	-12	-9	-9	-12
Ep _m	-1	-0	-1	-0
E π	-8	-9	-8	-8

Notes:

a: See Table 1 for a description of this producer category.

(-): Denotes an exogenously controlled variable.

Key: I Baseline assumptions.

II Leontief technology, i.e., all $\sigma_{ij}=0$, ($i, j=l, n, k, m$).

III Cobb-Douglas technology, i.e., all $\sigma_{ij}=1$.

IV $\sigma_{kn}=\sigma_{km}=\sigma_{nm}=0.33$; $\sigma_{kl}=\sigma_{nl}=0$; $\sigma_{lm}=1$.

welfare effects are independent of the assumed AES values, this is not the case for the remaining responses. The critical AES assumption is the land and materials (mainly fertilisers) pair because of the dominance of this input in production costs. The lowest response is naturally observed for the Leontief set. The highest set of responses occur for the AES values labelled I but the basic Cobb-Douglas parameters yield not too dissimilar results. Returns to labour and capital suffer significant declines in all simulations — a result driven by the assumptions of inelastic supply in each case. The decline in the returns to land is nearly half as great as for these aforementioned inputs for assumptions I and IV because of the high degree of substitution postulated between land and materials. Given our assumption of a virtually perfect elastic materials supply, the price of this input is seen to only marginally respond to the product price cut.

The results thus show that for a range of plausible AES values, a price-reduction policy route is capable of achieving the desired effect.¹⁰ In particular output falls in all cases and, with the exception of the trivial Leontief case, taking the output responses in conjunction with the land-use response we see that yields are likely to fall appreciably.

Table 3 reports the simulation results for producers who only face a “set aside” impact. This is an interesting experiment not least because of past US experience with acreage control where a substantial “slippage” factor was observed in the wake of the policy.¹¹ The particular dimension of “slippage” which interests us here is that which occurs because of substitutability between land and materials. Our findings suggest that except for the Leontief case, “slippage” is substantial, particularly where the critical land/materials AES is set at a relatively high level. These findings imply yield increases on the “set aside” land and by implication significantly increased materials usage on this land. This outcome occurs because there is an incentive to substitute materials for the land input whose shadow value has increased because of the policy. This outcome is apparent from the observed increase in the land rental which is predicted from the simple “set aside” scheme. Extrapolating beyond these findings we can see why the EU authorities might seek to avoid “slippage” by combining “set aside” with price cuts. This consideration leads us to our final set of simulations, reported in Table 4, which concern those producers who face both price reductions and “set aside”.

In terms of the sectoral impact these simulation results are the most important since the category of producers concerned account for nearly 60 per

10. Since our model is linear, the impact of larger price reductions than those considered in Table 2 can easily be obtained from the implicit elasticities.

11. Gardner (1990) indicates “... that a 30 per cent acreage reduction cuts output by ... 19 per cent”.

Table 3: Policy Impact B — "Set Aside" Only

	I	II	III	IV
Ex	-5	-15	-8	-7
Ep _x	(0)	(0)	(0)	(0)
El	(-15)	(-15)	(-15)	(-15)
En	-1	-15	-1	-3
Ek	-1	-15	-1	-3
Em	-2	-15	-8	-4
Ep _l	6	68	7	16
Ep _n	-7	-75	-7	-17
Ep _k	-7	-75	-7	-17
Ep _m	-0	-1	-0	-0
Eπ	3	-3	3	1

Notes:

a: See Table 1 for a description of this producer category.

(-): Denotes an exogenously controlled variable.

Key: I Baseline assumptions.

II Leontief technology, i.e., all $\sigma_{ij}=0$, (i, j=l, n, k, m).III Cobb-Douglas technology, i.e., all $\sigma_{ij}=1$.IV $\sigma_{km}=\sigma_{km}=\sigma_{nm}=0.33$; $\sigma_{kl}=\sigma_{nl}=0$; $\sigma_{lm}=1$.

Table 4: Policy Impact C — Price Cuts and "Set Aside"

	I	II	III	IV
Ex	-18	-15	-17	-13
Ep _x	(-7.12)	(-7.12)	(-7.12)	(-7.12)
El	(-15)	(-15)	(-15)	(-15)
En	-5	-15	-4	-7
Ek	-5	-15	-4	-7
Em	-25	-15	-23	-14
Ep _l	-3	39	-9	3
Ep _n	-26	-75	-20	-35
Ep _k	-26	-75	-20	-35
Ep _m	-1	-1	-1	-1
Eπ	-24	-29	-24	-26

Notes:

a: See Table 1 for a description of this producer category.

(-): Denotes an exogenously controlled variable.

Key: I Baseline assumptions.

II Leontief technology, i.e., all $\sigma_{ij}=0$, (i, j=l, n, k, m).III Cobb-Douglas technology, i.e., all $\sigma_{ij}=1$.IV $\sigma_{km}=\sigma_{km}=\sigma_{nm}=0.33$; $\sigma_{kl}=\sigma_{nl}=0$; $\sigma_{lm}=1$.

cent of total production (see Table 1) and probably also account for the bulk of resources used in the sector. Producers in this policy category are set to suffer substantial welfare losses. Contrasting these results with Tables 2 and 3 we see that price cuts dominate "set aside" especially as far as the output and input use responses are concerned. This is hardly a surprising outcome in that price cuts will work most effectively in counteracting "slippage" in a simple "set aside" scheme precisely in those cases where slippage is apt to be a problem (e.g. AES set I). Consideration of the Leontief case indicates that the reverse of this argument also holds. Given that it appears reasonable to consider the Leontief technology an unlikely characterisation of reality, the question arises as to why the EU authorities opted at all for the twin policy of "set aside" and price reductions. A similar point is alluded to by Larsen (1992). The answer may simply lie in the degree of uncertainty which surrounds the issue of producer responses to relative price changes.

Our findings do however indicate that in two specific areas — production yields and land rents — the twin-policy option produces outcomes which are intermediate between the exclusive price reduction or "set aside" options. In Table 4, yields are observed to only marginally adjust for all AES values. This outcome is in marked contrast to the uniform decreases noted for the exclusive price cut option in Table 2 and the increases established for the exclusive "set aside" case in Table 3.

The results for land returns are particularly interesting. Land rents are seen to decline in two cases (AES sets I and III) but they are seen to increase for the Leontief technology and for AES set IV. In the absence of firm information on the AES values we thus cannot conclude much about the direction of impact.

IV CONCLUDING REMARKS

The recently agreed EU reforms in the cereals' regime represent a radical departure with past policies and present the modeller with a number of challenges. The suite of policies is complex. Three instruments are now to be employed in the sector, namely, institutional price cuts, "set aside" and compensatory payments. Moreover, since compensatory payments are established on the basis of a fixed area and yield and also as small-scale producers are excluded from the "set aside" obligation, the impact on producer responses will depend on the policy category into which they fall. In the paper we suggest that the impact of four distinct policy impacts need to be considered:

- A. institutional price reductions only,
- B. "set aside" only,

- C. price reductions and "set aside",
- D. no price reductions or "set aside".

In terms of the economic implications of these policy categories for the sector, category "C" is critical as producers in this category in Ireland account for about 60 per cent of the total production in the industry. From the perspective of producer welfare, category "D" is the most important as producers who fall into this category account for an estimated 64 per cent of all producers while only contributing 16 per cent of the sector's production.

We developed a simple Applied Computable Equilibrium (ACE) model in the Johansen mould to assist us in developing some insights about the impact of these disparate policy measures. The relative complexity of the policy menu places severe constraints on the modelling approach as ideally one would want to construct a different model for each policy impact. This simply is not feasible given the absence of firm information on many of the policy parameters at even the sector level, let alone at the level of aggregation warranted by the policy impacts set out above.

However, because of the uncertainty which surrounds parameterisation we decided to perform model simulations for a range of the key Allen elasticity parameters. In these simulations we maintained the other parameters (e.g., factor supply elasticities and cost shares) of the ACE model at their assumed baseline levels. The degree of uncertainty which permeates the prediction of possible producer responses to policy changes could explain why the EU authorities choose to use a combination of "set aside" and price policy instruments. Our results have demonstrated that the effectiveness of an exclusive "set aside" policy depends on the magnitude of the land/materials elasticity of substitution. Where this parameter is large, the "set aside" instrument will not be effective in terms of reducing production. Conversely, if relative price responses are very sluggish, "set aside" would be very effective in the achievement of target reductions in production levels.

Our conclusions concerning these simulations are thus based on the set of simulations which are presented in the paper. While we have used Irish cost share data in the simulation of the model, we consider that the results should have relatively wide applicability given that our choice of AES parameters, in particular, was largely informed by the international literature.

The most important result concerns the likely effects of the overall policy package on production and resource use in the sector. Aggregating over the categories "A" to "D", having weighted each category by its estimated share in total production, our findings suggest that output could fall in a range of between 14 and 9 per cent depending on the AES assumptions. This may be viewed as a fairly modest impact which could, for example, be substantially

diluted by future factor-augmenting technical change.

In terms of resource use the most interesting effect concerns the materials' (mainly chemical fertilisers) input. While we do not have information on the share of materials' use by policy category, it appears reasonable to suppose that the shares are highly correlated with the production weights. On this basis our model simulations indicate that the aggregate impact of the measures could be such as to reduce materials' usage, depending on the assumed values for the Allen elasticities, in the sector by between 18 and 9 per cent. This is an interesting finding not simply because of the implications for the chemical firms which supply the sector but also because of the negative externalities which are considered, by many environmentalists, to be associated with intensive fertiliser usage.

Our model also allows us to say something about factor values and naturally the most interesting issue is the consequences for land values. The findings suggest that land rentals will be effected very differently depending, first, on the policy impact and second on the AES assumptions. For policy impact "A" we naturally predict that land rentals will fall for all AES values. For the exclusive "set aside" category (policy impact "B") the model predictions, again not surprisingly, imply a rise in rental values. The findings for category "C" are likely to provide the closest guide as to what might happen in the land market as estimated production in this category accounts for over 60 per cent of the sector's total, reveal that land rentals could vary from a decline of 9 per cent (Cobb-Douglas AES values) to an increase of 39 per cent (Leontief AES values). In terms of the incidence of these effects we need to differentiate between landowners and land renters (Gardner, 1990). Unlike other sectors in Irish agriculture, the renting of land is fairly commonplace in the cereals' sector. Thus, it is of some consequence whether the cereal farmer or the landowner receives the production rights. In the case of the EU "set aside" policy, it is the farmer who is granted the production right and not the landowner. If the farmer is the recipient, then a rise in rental values, as Gardner (1990) points out, represents a return *to the right to use land* for cereal production. The actual rent paid for the land area should decline. If the landowner is the recipient of the production rights than a rise in rental values can be interpreted as a return to land.

We conclude with some brief comments on the producer welfare effects of the reform measures. Measuring producer welfare as the impact on the returns to the quasi-fixed factors of production, producers in categories "A" to "C" lose out to varying degrees. Producers in category "C" lose to the greatest extent while producers in category "D" experience significant positive "lump sum" transfers.

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