A Method for Evaluating the Extent to which Farm Subsidies can be De-coupled Before Profitable Arable Land is Abandoned in the European Union

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Abstract

This paper evaluates concerns over the "abandonment of production" in the context of the recent CAP reform as it applies to the arable sector. The particular focus of the evaluation is on the extent to which the proposed "single farm payment" can be de-coupled from production and yet avoid the abandonment of land on which production is expected to be profitable. An analytical framework is developed which indicates the most important non-policy factors are the profitability of the land, the variability of yield and the grower's degree of risk aversion. The conclusion of a numerical analysis using this framework is that 85% de-coupling is unlikely to lead to abandonment of land in any arable region of the EU, and that 95% de-coupling is also unlikely to lead to abandonment in the majority of arable areas.

Introduction

At the end of June 2003 the European Union (EU) farm ministers "adopted a fundamental reform of the Common Agricultural Policy (CAP)" (European Commission, 2003). The key feature of this reform is that "In future, the vast majority of subsidies will be paid independently from the volume of production". This change will in effect "break the link between subsidies and production", otherwise referred to as "decoupling". (DEFRA 2003). In supporting this reform it is suggested that "severing the link between subsidies and production will make EU farmers more competitive and market orientated", while at the same time it will "strengthen the EU's negotiating land in the ongoing WTO trade talks" (European Commission, 2003). However, the reform also states that in order "To avoid abandonment of production, Member States may choose to maintain a limited link between subsidy and production" (European Commission, 2003). More specifically for cereals, "Those Member States who deem it necessary to minimise the risks of land abandonment, can maintain up to 25% of the current per hectare payments in the arable sector linked to production" (European Commission, 2003). Otherwise, farmers will receive a "single farm payment based on a reference amount in a reference period of 2000 to 2002" (European Commission, 2003).

The aim of this paper is to address in the context of the arable sector this concern over the "abandonment of production" and in particular the proposed use of a "limited link" to "minimise the risks of land abandonment". Since as currently proposed Member States will be able to link "up to 25%", of direct payments, the question examined in this paper is the extent to which Member States can decoupled the single farm payment and avoid the abandonment of land upon which cereal production is expected to be profitable. Note that the paper does not consider the issue of the abandonment of arable land which has only been cropped in order to receive direct payments net of associated production losses.

The structure of the paper is as follows. Based on the model of Fraser (2003), Section 1 develops an analytical framework for evaluating the cereal grower's post-reform choice between maintaining production and receiving the full single farm payment, or abandoning production and receiving only the de-coupled proportion of this payment.[1] For the cereal grower this choice involves a trade-off between the undertaking of production which is risky, but expected to be profitable, and the receipt of a smaller guaranteed sum. As a consequence, this trade-off will be dependent both on off-farm factors such as the expected level and variability of cereal prices, as well as on-farm factors such as yield variability and the cereal grower's attitude to risk. Moreover, in relation to the aim of this paper, the policy variable of the extent of de-coupling will

[1] Note it is assumed that abandoned land is kept "in good agricultural and environmental condition" as a requirement for receiving even the de-coupled payment (European Commission, 2003).

affect this trade-off by determining the magnitude of the de-coupled proportion of the single farm payment. Based on this analytical framework, Section 2 of the paper undertakes a numerical analysis of the cereal grower's trade-off, with a view to evaluating the role of the various factors outlined above. In particular the off and on-farm conditions underwhich the "limited link" can be kept to below 25% of current direct payments are examined. On this basis it is suggested that for most of the EU not de-coupling as little as 5% of these payments may be sufficient to avoid the abandonment of arable land upon which production has profitably been undertaken The paper ends with a brief conclusion regarding policy implications for the de-coupling decision of Member States.

Section 1: The Analytical Framework

As indicated in the Introduction, this Section develops an analytical framework for evaluating on EU cereal grower's post-CAP reform trade-off between maintaining risky production and receiving both the income from this production and the "single farm payment", or abandoning production and receiving only the de-coupled proportion of this payment.

This framework is based on the model of a specialist cereal grower developed in Fraser (2003). In this model, the grower's income stream before the reform is derived from three sources: uncertain production income, known compensatory payments and known set-aside payments. For homogenous land quality expected income before the reform $(E(R_o))$ can then be represented by:

$$E(R_o) = L(1-\propto)(E(p_o)\,\bar{y} + Cov_o(p,y)) + L(1-\propto)kr + L\propto sr \qquad (1)$$

where:

L	=	area of land *(ha)*
$\propto$	=	set-aside rate
$E(p_o)$	=	expected grower price before the reform *(Euros/t)*
$\bar{y}$	=	expected yield
$Cov_o(p,y))$	=	covariance between price and yield before the reform
r	=	reference yield *(t/ha)*
k	=	compensatory payment *(Euros/t)*
s	=	set-aside premium *(Euros/t)*.

In addition, the variance of the grower's income before the reform $(Var(R_o))$ can be approximated by[2] :

[2] See Mood, Graybill and Boes (1974, p181) for details.

$$Var(R_o) = L^2 (1-\propto)^2 \; \bar{y}^{\,2} \; Var(p_o)$$
$$+ L^2 (1-\propto)^2 (E(p_o))^2 Var(y)$$
$$+ 2 E(p_o) \; L (1-\propto) \; \bar{y} \;\; Cov_o (p,y) \quad (2)$$

where:

$Var(p_o)$ = variance of grower price before the policy change

$Var(y)$ = variance of yield.

Finally, specifying the costs of production to be known on a per hectare basis means that expected profit before the reform ($E(\pi_o)$) is given by:

$$E(\pi_o) = E(R_o) \; - cL(1-\propto) \quad (3)$$

where:

c = known production costs per hectare.

Note that because production costs per hectare are known, the variance of profit before the reform is as given by $Var(R_o)$ in equation (2).

In this basis consider the grower's post-reform trade-off. As indicated by the European Commission (EC) for the arable sector the new "single farm payment" (SFP) is to be based on "current per hectare payments" (EC, 2003). Therefore, as the EC also states that "Set-side is maintained", in what follows this payment is specified as equal to the total of direct payments prior to reform:

$$SFP = L(1-\propto)kr + L\propto sr \quad (4)$$

Moreover, as the EC states as well that "the current intervention price will be maintained", it follows that for the grower considering maintaining production post-reform, expected income will be unchanged from the pre-reform situation. In particular, using (4) and because:

$$E(p_1) = E(p_o),$$

and $Cov_1 (p, y) = Cov_o (p, y),$

$$E(R_1) = L(1-\propto)(E(p_1)\,\bar{y} + Cov_1(p,y)) + SFP = E(R_0) \quad (5)$$

where: $E(R_1)$ = expected income post-reform

$E(p_1)$ = expected price post-reform

$Cov_1\ (p, y)$ = covariance of price and yield post-reform.

Note that the grower's variance of income post-reform ($Var(R_1)$) also equals that of the pre-reform situation.

Alternatively, for the grower considering abandoning production, income post-reform (X) is given simply by the known de-coupled proportion of the single farm payment:

$$X = \beta SFP \quad (6)$$

where: β = de-coupled proportion $(0 < \beta < 1)$.

Recognising that by maintaining production the grower continues to incur the costs of production, expected profit from production post-reform $(E(\pi_1))$ is given by:

$$E(\pi_1) = E(R_1) - cL(1-\propto)L + SFP \quad (7)$$

While for the case of land abandonment, no costs of production are incurred. Moreover it is assumed that the costs of keeping all farmland "in good agricultural and environmental condition" are minimal, so that (known) profit in the case of abandonment is equal to income[3]:

$$\pi_x = X \quad (8)$$

Note that because the focus of this analysis is on whether profitable land will be abandoned post-reform:

$$E(R_1) > cL(1-\propto) \quad (9)$$

So that:

$$E(\pi_1) > SFP \quad (10)$$

and it follows from (6) that:

$$E(\pi_1) > \pi_x \quad (11)$$

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[3] The implications of relaxing this assumption are considered later.

Therefore, for a risk averse grower considering the choice between maintaining and abandoning production post-reform, this choice involves a trade-off between the higher expected profit from production and the avoidance of income risk associated with abandonment:

$$Var(\pi_1) \quad > \quad 0.$$

Based on this analytical framework, it can be seen that the risk averse grower's choice will be influenced by off and on-farm factors such as the expected level and variability of prices, and the variability of production, as well as the new policy parameter governing the extent of the de-coupling (β). Moreover, the extent of the grower's risk aversion will affect the perception of the value of avoiding income risk. In the numerical analysis of the next Section the role of each of these factors in determining the grower's decision to abandon or maintain production is evaluated.

Section 2: Numerical Analysis

In undertaking a numerical analysis of the decision framework developed in the previous section, the first step is to specify the grower's perception of risk. In what follows this is done using the mean-variance framework[4]:

$$E(U(\pi_1)) = U(E(\pi_1)) + \tfrac{1}{2} U''(E(\pi_1)) \,.\, Var(\pi_1) \qquad (12)$$

where: $E(U(\pi_1))$ = expected utility of post-reform profit from production

$U(E(\pi_1))$ = utility of $E(\pi_1)$

$U''(E(\pi))$ = second derivative of the utility function (< 0 to represent risk aversion).

Based on this specification the grower's choice of whether to maintain or abandon production will depend on :

$$E(U(\pi_1)) \lessgtr U(\pi_x). \qquad (13)$$

Note from (12) that the more risk averse is the grower the smaller will be the left-hand-side of (13) for given levels of $E(\pi_1)$ and $Var(\pi_1)$. It follows that for the same set of on and off-farm production circumstances, more risk averse growers may choose to abandon production while less risk averse growers *X* choose to maintain it.

Use is also made of the specification in Fraser (2003) of the relationship between world and grower prices. In particular, assuming a normally distributed world price $\overline{p}_w$, the impact of the CAP's price support on the expected level of grower prices is given by:

$$E(p) = F(\hat{p})\,\hat{p} + (1-F(\hat{p}))\,(\overline{p}_w + \sigma_p Z(\hat{p})/(1-F(\hat{p}))) \qquad (14)$$

where: $\hat{p}$ = intervention price

$\overline{p}_w$ = expected world price

σ_p = standard deviation of world price

(σ^2_p = variance of world price)

$F(\hat{p})$ = cumulative probability of world price being less than or equal to $\hat{p}$

$Z(\hat{p})$ = ordinate of the normal distribution at $\hat{p}$.

In addition, the variance of grower prices is given by:

$$Var(p) = (1-F(\hat{p}))\sigma^2_p[1-(Z(\hat{p})/(1-F(\hat{p})))^2 + ((\hat{p} - \overline{p}_w)/\sigma_p) . Z(\hat{p})/(1-F(\hat{p}))] + (1-F(\hat{p}))F(\hat{p})[\hat{p} - (\overline{p}_w + \sigma_p Z(\hat{p})/(1-F(\hat{p})))]^2 \quad (15)$$

Note from (14) and (15) than an increase in the variance of world prices (σ^2_p) increases both the expected level and variance of grower prices[5].

Moreover, the grower's utility function is specified to take the constant relative risk aversion form[6]:

$$E(U(\pi)) = \frac{\pi^{1-R}}{1-R} \quad (16)$$

where R = the grower's (constant) coefficient of relative risk aversion

= $- U''(\pi).\pi / U'(\pi)$

In relation to non-policy parameter values, the following are chosen as a Base Case[7]:

CV_p = 0.23 (coefficient of variation of world price)

$\overline{y}$ = 5

L = 100 (ha),

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[4] See Hanson and Ladd (1991) for arguments supporting the use of this framework.

[5] Based on the sensitivity analysis of Fraser (2003), the covariance between grower prices and yield is deleted from equations (1) and (2) for this numerical analysis.

[6] See Pope and Just (1991) for evidence to support the use of this form.

[7] See Hazell, Jaramillo, and Williamson (1990) regarding CV_p

along with a spread of values for CV_y based on the findings of European Commission (2001). In relation to policy parameter values, Agenda 2000 policy settings are given by:

$$k = 63 \text{ (Euros/t)}$$

$$s = 68.8 \text{ (Euros/t)}$$

$$\propto = 0.1$$

which combined with an assumed reference yield (r) of 5 t/ha and $L = 100$ gives:

$$SFP = 31{,}790 \text{ Euros}$$

In addition, the impact of a range of de-coupling proportions (β) between 0.75 and 0.95 is evaluated in what follows.

Finally, for the Base Case the level of production cost per hectare (c) is chosen such that expected profit from production only just exceeds the single farm payment as required for the land in question to be on average profitable prior to CAP reform (see equation (10)). In subsequent sensitivity analysis this assumption is relaxed to consider more profitable land.

On this basis Table 1 contains the Base Case set of results. These results are presented in terms of the minimum level of risk aversion required for the grower to choose to abandon production. In this context note that available empirical evidence regarding the value of R is non-existent in the EU, but that previous empirical studies put this value at between *0.5* and *1.2* across a range of countries, with cereal growers in developing countries towards the higher levels, and towards the lower levels in developed countries[8]. As a consequence, it seems reasonable to expect the majority of EU cereal growers to be clustered between $R = 0.5$ and *0.9*.

In addition, the results are presented in terms of the indicated range of de-coupled proportions, and in terms of the range of levels of yield variability applying to cereal production in the EU.

[8] See Newbery and Stiglitz (1981) for a survey of empirical studies. Note also that Bardsley and Harris (1987) estimated a value of 0.7 for cereal growers in Australia.

In this context note from European Commission (2001) that the vast majority of wheat growing areas in the EU feature a CV_q of less than *0.23*. Exceptions to this are Spain and Portugal, and small areas in France and Italy, which vary up to a maximum of *0.4*. Finally, the results in Table 1 are presented in two panels to help evaluate the role of the expected level of world prices at the time of implementing the policy reforms. (i.e. $\overline{p}_w = 100$ *and 120 Euros/t).*

An examination of the minimum values of R in Table 1 for which abandonment occurs suggests that it is extremely unlikely any even marginally profitable arable land in the EU would be abandoned by growers if the minimum proportion of the SFP allowed by the reform was de-coupled (i.e. 75%). Moreover, even if the level of de-coupling was raised to 85%, cited estimates of attitudes to risk and yield variability suggest that only the most risk averse growers in those regions of greatest yield variability would choose to abandon production on marginally profitable land. However, if the level of the de-coupling was raised to 95% the potential exists for widespread abandonment of marginally profitable land especially in regions of greater yield variability and at the higher level of expected world prices. The explanation for this role of expected world prices is related to the lower levels of price support provided to growers, and therefore the higher level of exposure to income risk from fluctuating market prices, at higher expected price levels.

These findings clearly suggest a sensitivity of the land abandonment decision to the level of production income risk faced by growers. In this context consider the impact on the Base Case results of a higher level of world price variability at the time of policy implementation. The estimates of Hazell, Jaramillo and Williamson, (1990) suggest this level is unlikely to exceed $CV_p = 0.35$ for wheat, and so the results in Table 2 are based on this higher value for CV_p. Note that because a higher level of world price variability implies a higher expected grower price (see equation (14)), a higher level of cost/ha is required to reflect marginally profitable land (see notes b and c in Table 2).

In general the results in Table 2 suggest the finding in Table 1 of a low potential for land abandonment for a de-coupling proportion of 85% is robust with respect to the level of world price variability. However, the potential for widespread abandonment of marginally profitable land for 95% decoupling is accentuated by a higher level of world price variability. In particular Table 2 suggests that, even at the lower level of expected world price, most growers with marginally profitable land and yield variability of about 0.2 would find abandoning production and thereby avoiding income risk to be preferable. It may be concluded that most EU Member States would experience abandonment of marginally profitable land if they opted for 95% de-coupling at a time of higher expected levels and variability of world prices. However, opting for 85% de-coupling is likely to result in very little land abandonment, regardless of world market conditions.

Finally in this section consider further the potential for 95% de-coupling to result in widespread land abandonment as indicated by the results in Tables 1 and 2. In particular, the results in Tables 1 and 2 are based on land being only marginally profitable, with *c* values chose such that:

$$E(\pi) \quad > \quad SFP$$

by less than 0.5%. Consider instead the consequences of land being slightly more profitable. Specifically, the results in Table 3 are calculated based on the expected profit from production exceeding the SFP by 5%.

$$E(\pi_1) \quad = \quad 1.05SFP$$

In general, the results in Table 3 suggest that for just slightly more profitable land, even 95% decoupling is unlikely to lead to abandonment for the vast majority of arable regions in the EU, unless world market volatility is at extreme historical levels. It follows that, with 95% decoupling, to the extent that there is land abandonment, it is likely to be concentrated in those arable regions which feature both marginal expected profitability and relatively high levels of yield variability. Therefore, for EU Member States for which most cereal growing land both is reasonably profitable and features low yield variability, the results in Tables 1, 2 and 3 suggest little land abandonment will occur in association with even 95% de-coupling. Finally, note that this conclusion is only strengthened if growers are required to incur costs keeping abandoned land in "good agricultural and environmental condition".

Conclusion

The aim of this paper has been to evaluate concerns over the "abandonment of production" in the context of the recent CAP reform as it applies to the arable sector (European Commission, 2003). In particular, the focus of the evaluation has been on the extent to which the proposed "single farm payment" can be de-coupled from production and yet avoid the abandonment of land on which production is expected to be profitable.

Section 1 of the paper developed an analytical framework for examining a specialist cereal grower's post-reform choice between maintaining production and receiving both production income and the single farm payment, or abandoning production and receiving only the de-coupled proportion of this payment. This framework was subjected to a numerical analysis in Section 2 which evaluated the role of a range of on and off-farm factors, including that of the extent of decoupling. It was shown in this context that the most important non-policy factors determining the grower's choice were: the expected profitability of production; the level of yield variability; and the grower's risk aversion. In addition, it was concluded that 85% decoupling is unlikely to lead to the abandonment of even marginally profitable land in regions with high yield variability, and that 95% de-coupling is also unlikely to lead to land abandonment in regions where production is only slightly more profitable and yield variability is typical of EU levels (CV_q between 7.5% and 22.5%).

It follows that Member States such as Spain and Portugal may prefer to opt for only 85% de-coupling in the arable sector, but that more northern States could opt for 95% decoupling with little concern of land abandonment resulting.

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Table 1
Base Case Results for the Minimum Level of
Risk Aversion (*R*) at which Production is Abandoned

	CV_q				
$\overline{p}_w = 100^a$ / β	0.1	0.2	0.25	0.3	0.4
0.75					>1
0.85				>1	0.8
0.95	>1	0.9	0.6	0.5	0.3
$\overline{p}_w = 120^b$ / β					
0.75					>1
0.85			>1	0.9	0.6
0.95	0.9	0.5	0.4	0.3	0.2

Notes: a: c = 549.4 Euros/ha
b: c = 620.6 Euros/ha

Table 2
Sensitivity of the Base Case Results to the Level of World Price Variability
($CV_p = 0.35$)[a]

			CV_q		
$\bar{p}_w = 100^b$ / β	0.1	0.2	0.25	0.3	0.4
0.75					>1
0.85				>1	0.7
0.95	>1	0.6	0.5	0.4	0.3
$\bar{p}_w = 120^c$ / β					
0.75				>1	0.9
0.85		>1	0.9	0.7	0.5
0.95	0.5	0.4	0.3	0.3	0.2

Notes: a: All other Base Case parameter values apply
b: c = 573.1 Euros/ha
c: c = 645.2 Euros/ha

Table 3
Sensitivity of the Results to the
Expected Profitability of Production $\left(E(\pi_1) = 1.05SFP\right)^a$

			CV_q		
$\overline{p}_w = 100$	0.1	0.2	0.25	0.3	0.4
CV_p = 0.23[b] *β = 0.95*			>1	0.9	0.6
CV_p = 0.35[c] *β = 0.95*		>1	0.95	0.7	0.5
$\overline{p}_w = 120$					
CV_p = 0.23[d] *β = 0.95*		>1	0.9	0.6	0.4
CV_p = 0.35[e] *β = 0.95*	>1	0.7	0.6	0.5	0.2

Notes: a: All other Base Case parameter values apply
b: c = 531.7 Euros/ha
c: c = 555.4 Euros/ha
d: c = 603.0 Euros/ha
e: c = 627.5 Euros/ha