Price Insurance, Moral Hazard and

Agri-environmental Policy

by

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Abstract

Motivated by recent EC proposals to "strengthen risk management tools" in the CAP in relation to farmers' increased exposure to market price risk, this paper draws attention to a potential negative consequence of such a change in the CAP – an associated increase in cheating behaviour by farmers in the context of environmental stewardship. A theoretical framework for this policy problem is developed and used not just to illustrate the problem, but also to propose a solution – specifically to combine the introduction of CAP-supported policy changes which reduce farmers' exposure to market-based risk with changes in environmental stewardship policies which increase the riskiness of cheating and thereby discourage such behaviour.

Introduction

During the last two decades the key reforms to the European Union's Common Agricultural Policy (CAP) have been initially to reduce price support for agricultural production in favour of direct payments as "uncoupled" farm income support and, more recently, to shift farmer income support from agriculture-based payments ("Pillar 1") to environment-based payments ("Pillar 2"). Important consequences of these two changes are: i) that for agricultural production farmers are now exposed to far greater market price risk than previously; ii) that by contrast the "production" of environmental goods and services receives known payments and is therefore risk-free income; iii) that given i) and ii), farmers have been strongly attracted to environmental stewardship options such as field margins ("buffer strips") which replace the uncertain income from crop production with guaranteed payments for providing enhanced habitants, and where these payments are based on the average foregone agricultural income – in effect the substitution of agricultural production by the production of environmental goods and services, coupled with the replacement of uncertain income by its average level (see for example Natural England 2011).

Most recently, the European Commission's discussion document "The CAP towards 2020" has canvassed a set of further reform options for this policy (European Commission, 2010). One of the core components of these reform options, possibly further motivated by the strong variations in food prices in recent years, has been to "strengthen risk management tools" – specifically to advocate CAP support for farmers to deal with their far greater exposure to market price risk – typically in the form of market-based risk management options such as forward pricing, futures markets and price insurance schemes. Moreover, such proposals seem to have widespread support – perhaps based on their common use in US agriculture and their WTO-acceptability. For example, "Defra's position is that price volatility is best managed by encouraging the development of market based solutions such as futures markets or insurance" (Environment, Food and Rural Affairs Committee April 2011, paragraph 218). While the European Centre for International Political Economy advocates that the EU "assist farmers in employing financial risk management tools, promote the creation of risk-sharing markets, and subsidise private insurance schemes" (ECIPE, 2008, p4).

Give this policy reform background, the aim of this paper is to draw attention to one of the potential negative consequences for farmer behaviour of a CAP-supported reduction in market price risk for agricultural production: an associated increase in the risk of cheating by farmers in relation to environmental stewardship. In particular, a reduction in market price risk, by reducing the overall riskiness of farmer income, may encourage cheating behaviour by farmers in the context of their payments for producing environmental goods and services.[1]

However, having identified this problem as a consequence of CAP support for reducing market price risk, the paper also identifies a solution to this policy problem – an associated policy-based increase in the riskiness of cheating behaviour in the context of environmental stewardship.

The structure of this paper is as follows: Section 1 first develops a theoretical framework which identifies the policy problem and then provides a numerical illustration of its impact on farmer behaviour. Subsequently, Section 2 outlines the theoretical framework for the policy-based solution to this problem, and also numerically illustrates its operation. The paper concludes with a brief summary and discussion of its policy implications.

[1] Note that this paper builds on previous contributions by Fraser (2002) and Yano and Blandford (2009, 2011) which have highlighted the interplay between production income risk and non-compliance risk in determining a farmer's overall income risk – with consequent implications for farmer behaviour.

Section 1: The Policy Problem

1.1 Theoretical Framework

The central feature of this framework is the introduction of area-based payments for removing land from agricultural production and instead producing environmental goods and services – with the payment for this environmental provision being based on the average foregone agricultural production income from the designated area. Note that the most common farm of such area-based payments are field margins, or "buffer strips", which protect field boundaries as habitats and are of a specified width – for example six metres (see Natural England, 2011).

Given this specification, the area-based payment will in effect represent the substitution of uncertain income from agricultural production with guaranteed income set at the average level of agricultural production income:

$$x = \bar{p}q \qquad (1)$$

where:

x = environmental stewardship payment for the specified area

$\bar{p}$ = expected market price of agricultural output

q = agricultural output from the specified area.

Note that with this specification it is assumed that there is no yield variability in agricultural production.

Moreover, given that agricultural production income from the specified area will have a variance given by:

$$q^2 \, Var(p)$$

where: $Var(p)$ is the variance of the market price of agricultural output,

then it follows that a risk averse farmer will always prefer the guaranteed environmental stewardship payment to the uncertain agricultural production income, and therefore this farmer will always choose to participate in this form of environmental stewardship rather than choosing not to participate and instead to produce agricultural output on the specified area.

However, this farmer also has the behavioural option of cheating by accepting the environmental stewardship payment, but still producing agricultural output on the specified area in order to receive both the guaranteed environmental stewardship payment without providing the environmental stewardship, and the uncertain agricultural production income. Note that both of these actions are risky activities and the farmer's choice between this form of cheating and instead behaving truthfully and accepting *x* in return for removing the specified land from production will depend on the following factors:

i) the level of risk aversion of the farmer
ii) the probability of being caught cheating (=*b*)
iii) the penalty if caught cheating $(= tx, where\ t \geq 1)$
iv) the riskiness of agricultural production income from the specified area $(= q^2 Var(p))$.

More specifically, for a particular farmer the decision is based on whether:

$$U(x) \lessgtr E(U(Ic)) \tag{2}$$

where:

$U(x)$ = certain utility from behaving truthfully

$E(U(Ic))$ = expected utility from cheating.

Given this specification, income from cheating (Ic) will be:

$$\begin{aligned} Ic &= x + pq \text{ if not caught} \\ &= x + pq - xt \text{ if caught,} \end{aligned} \tag{3}$$

and taking account of the probability of being caught (b):

$$E(Ic) = \bar{p}q + x(1 - bt) \tag{4}$$

$$Var(Ic) = q^2 Var(p) + x^2 t^2 (1 - b)b \tag{5}$$

where: $E(Ic)$ = expected income from cheating

$Var(Ic)$ = variance of income from cheating[2]

Bearing in mind that:

$$x = \bar{p}q \tag{6}$$

an examination of equation (4) shows that if:

$$bt \leq 1 \tag{7}$$

then

$$E(Ic) > x \tag{8}$$

and in this case whether:

$$U(x) \lessgtr E(U(Ic)) \tag{9}$$

will depend both on the level of risk aversion of the farmer, and on the size of $Var(Ic)$ – which as shown by equation (5) is dependent both on the riskiness of agricultural production income and on the riskiness of cheating behaviour.

Moreover, the policy problem outlined in the Introduction can now be identified within this theoretical framework. Specifically, consider initially the situation where in the absence of CAP-support for reduced market price risk:

$$E(Ic) > x \tag{10}$$

but:

$$U(x) > E(U(Ic)) \tag{11}$$

because of the overall riskiness of cheating behaviour, and as a consequence the farmer chooses to behave truthfully.

[2] This expression for *Var(Ic)* is derived in the Appendix.

Then suppose that CAP-support for reduced market prices risk is introduced in the form of actuarially-fair price insurance.[3] As a consequence, *Var(p)* is decreased, so that $Var(Ic)$ is also decreased. Therefore, the possibility arises that a farmer who chooses to behave truthfully in the absence of such price insurance, now finds that the decrease in $Var(Ic)$ associated with the introduction of price insurance results in:

$$U(x) < E(U(Ic)) \qquad (12)$$

so that this farmer now prefers to cheat by both accepting the environmental stewardship payment and producing agricultural output on the specified land – with the associated removal of the provision of environmental goods and services on this land.

This policy problem, and the role of various parameter values in determining its occurrence is illustrated numerically in the next sub-section.

[3] Actuarially-fair price insurance means that although the farmer is provided with a guaranteed minimum price which therefore both increases the expected price and decreases the variance of price, the cost of this insurance provision is set equal to the increment in the expected price, so that overall only *Var(p)* is affected.

1.2 Illustration of the Policy Problem

In order to undertake a numerical analysis which illustrates the policy problem identified in the previous sub-section, first assume the following parameter values as a Base Case:

$$x = 100; \quad \bar{p} = 10; \quad CV_p = 0.35; \quad q = 10; \quad t = 2; \quad b = 0.4.$$

Note at this point that with $t = 2$ and $b = 0.4$:

$$bt < 1$$

and as a consequence:

$$E(Ic) = 120 > x = 100$$

which, as shown in sub-section 1.1, is a requirement for cheating behaviour to potentially be preferred. In addition, assume the attitude to risk of the farmer can be represented by the mean-variance framework and the constant relative risk aversion functional form.[4]

$$E(U(I)) = U(E(I)) + \frac{1}{2}U''(E(I)).Var(I) \qquad (13)$$

where:

$$U(I) = I^{(1-R)}/(1-R)$$

and R = constant coefficient of relative risk aversion $= -U''(I).I/U'(I)$

where: $U''(I)$ is the second derivative of the utility function $(U''(I) < 0)$.

Finally consider the alternative specifications of the impact of the price insurance scheme on the existing variability of market price: i) where CV_p is reduced from 0.35 to 0.25; ii) where CV_p is reduced from 0.35 to 0.15.

[4] See Hanson and Ladd (1991) and Pope and Just (1991) for arguments supporting these assumptions.

On this basis Table 1 contains details of the numerical results regarding the levels of expected utility from cheating and truth-telling behaviour for a range of attitudes to risk and the alternative impact of the price insurance scheme on CV_p.[5]

Table 1 shows that in the absence of a price insurance scheme only the least risk averse farmer (*R*=0.25) finds cheating to be preferred to truth-telling behaviour (i.e. 44.93 > 42.16). In addition, Table 1 shows that following the introduction of a price insurance scheme which reduces CV_p from 0.35 to 0.25 it remains the case that only the least risk averse farmer prefers to cheat. However, if with the introduction of the price insurance scheme CV_p is reduced from 0.35 to 0.15, then in this case the farmer with the middle level of risk aversion (*R*=0.5) now finds cheating behaviour is preferred to truth-telling (i.e. 20.04 > 20.00). It follows that this scenario illustrates the policy problem identified in sub-section 1.1 – specifically that a price insurance scheme, by reducing the overall riskiness of income, will generally increase the attractiveness of cheating behaviour (note all values for $E(U(Ic))$ in Table 1 are increased for lower values of CV_p) and, as a consequence, the potential arises for this increase to result in a farmer switching from behaving truthfully to cheating. In addition, it can be concluded from the results in Table 1 that the more successful the price insurance scheme is in reducing market price risk, the more likely this switch in behaviour is to occur. Finally, Table 1 shows that this switching behaviour is more likely among farmers with moderate levels of risk aversion, where both the incentive to cheat, and the aversion to income variability, have a role in determining behaviour.

[5] Note from Hazell, Jaramillo and Williamson (1990) that a CV_p of 0.35 is consistent with historical evidence for the world wheat market. Also note that Newbery and Stiglitz (1981) suggest levels of *R* between 0.5 and 1.2 are consistent with most empirical estimates.

Section 2: The Policy Solution

2.1 Theoretical Framework

Drawing on the mainstream economics contributions of Polinsky and Shavell (1979) and Kaplow and Shavell (1994) it is clear that the most straightforward, if politically unacceptable, way to discourage cheating is to increase the penalty that follows being caught. This can be demonstrated using the theoretical framework of sub-section 1.1 where it can be seen that both the expected penalty $(E(z))$ from being caught cheating:

$$E(z) = xtb \tag{14}$$

and the variance of income $((Var(z))$ associated with being caught cheating:

$$Var(z) = x^2t^2(1-b)b \tag{15}$$

are increased by an increase in *t*:

$$\frac{\partial E(z)}{\partial t} = xb > 0 \tag{16}$$

$$\frac{\partial Var(z)}{\partial t} = 2x^2t(1-b)b > 0. \tag{17}$$

However, as shown in Fraser (2002), for risk averse farmers it is also possible to discourage cheating simply by increasing the riskiness of cheating, and without increasing the expected penalty from cheating. In particular because the expected penalty associated with cheating, is linear in the two compliance parameters, *b* and *t*, but the variance of income associated with cheating is non-linear in *b* and *t*, it is possible to utilise the concept of an expected-penalty preserving increase in the riskiness of cheating in order to discourage a risk averse farmer from cheating. More specifically, Fraser (2002) shows that an increase in *t* which is offset in terms of its impact on $E(z)$ by a decrease in *b*, so that the expected penalty is unchanged, will nevertheless increase the riskiness of cheating and thereby act to discourage farmers from such behaviour. Moreover, Fraser (2002) argues that such changes in the non-compliance parameters not only have the desirable feature of discouraging cheating while leaving the expected penalty if caught unchanged, but also reduce the costs of policy enforcement through the reduction in monitoring effort that occurs with a decrease in the probability of being monitored (*b*). Therefore, on both these counts an expected penalty preserving change in the values of the compliance parameters is likely to be more politically acceptable than just an increase in the penalty if caught cheating.

In the following sub-section the numerical example of sub-section 1.2 is further developed to illustrate how this approach to exploiting the risk aversion of farmers to discourage cheating can solve the problem identified previously.

2.2 Numerical Illustration of the Policy Solution

The policy problem as previously identified is that the decrease in the riskiness of cheating behaviour that follows the introduction of a CAP-supported market price insurance scheme has the potential to cause farmers to switch from behaving truthfully to cheating by accepting payment for but not providing environmental goods and services and instead producing agricultural output on specified land.

The policy solution proposed in the previous sub-section is to combine the introduction of the CAP-supported price insurance scheme with an adjustment in the compliance parameters of the environmental stewardship policy which leaves the expected penalty from being caught cheating unchanged, but which increases the riskiness of cheating as outlined in Fraser (2002).

To illustrate this policy solution consider two alternative adjustments in the compliance parameters from their Base Case values of t=2 and b=0.4.

Specifically:

(a) $b = 2.4$; $t = 0.333$

(b) $b = 4$; $t = 0.2$

Note that in both cases the expected penalty if caught cheating $(E(z))$ is unchanged but the variance of income associated with being caught cheating $(Var(z))$ is increased (and the cost of monitoring resources is reduced). Table 2 contains details of the impact of combining this environmental stewardship policy change with the introduction of a CAP-supported price insurance scheme. In particular, the results in Table 2 shown that for change (a) in the compliance parameters (i.e. $b = 2.4$; $t = 0.333$) the example of the policy problem illustrated in Table 1 for a farmer with an attitude to risk represented by $R=0.5$ no longer applies – that is the farmer now finds that continuing to behave truthfully remains the preferred choice because the reduced riskiness of cheating brought about by the price insurance scheme is more than offset by the increased riskiness of cheating brought about by the change in the policy compliance parameters.

Finally in this sub-section, the potential for an expected penalty preserving change in the compliance parameters of the environmental stewardship policy to ameliorate the problem of cheating behaviour is illustrated by the impact of change (b) in these parameters. In particular, the bottom row of results in Table 2 show that for this policy charge even the least risk averse farmer now prefers behaving truthfully to cheating.

Conclusion

This paper has been motivated by recent EC proposals to provide CAP support to "strengthen risk management tools" such as futures markets and market price insurance (EC, 2010). The aim of such support is to enable farmers to reduce their exposure to market price risk, typically by removing to some extent this risk from them by using market-based mechanisms. The aim of the paper has been not just to draw attention to a potential negative consequence of such a change in the CAP – specifically an associated increase in cheating behaviour by farmers in relation to environmental stewardship – but also to provide a solution to this policy problem.

Section 1 outlined a theoretical framework for identifying this policy problem and demonstrated how CAP-supported price insurance would reduce the overall riskiness of cheating behaviour – thereby potentially enabling an expected increase in income associated with cheating behaviour to dominate a farmer's decision process. This outline was further developed with a numerical illustration of the policy problem – specifically showing how, with the introduction of CAP-supported price insurance, a farmer could switch from behaving truthfully by accepting payment for taking land out of agricultural production and as required using it to provide environmental goods and services, to cheating by accepting such a payment but continuing to produce agricultural output on the specified land. It was also shown that the extent of this policy problem depended both on the extent to which the price insurance scheme removed market price risk, and the level of risk aversion of the farmer.

Section 2 then proposed a solution to this policy problem based on the demonstration in Fraser (2002) that cheating behaviour can be discouraged simply by exploiting the risk aversion of the farmer and increasing the riskiness of cheating behaviour. Specifically this can be done using the concept of an expected penalty preserving change in the two compliance parameters, the penalty itself and the probability of being monitored, which not only increases the riskiness of cheating behaviour but also reduces the costs of monitoring. Therefore, by combining the introduction of CAP-supported price insurance with such a change in the environmental stewardship policy it was shown using a numerical example how the potential for incentivising cheating behaviour by reducing market risk can be removed – even for farmers with relatively low levels of risk aversion.

The policy implications of this paper are two-fold. First, policy charges should not focus on market-based risk to the exclusion of other types of risk in determining farmer behaviour because such behaviour is based on the broader notion of income risk, which itself is a composite of multiple sources of risk. Second, exploiting the risk aversion of farmers can be a powerful method of ensuring appropriate delivering by farmers of desired policy outcomes – both in the context of agricultural production and in the context of the provision of environmental goods and services.

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Appendix

$$Var(Ic) = \int^{p} (1-b)\left[pq + x - E(Ic)\right]^2 fpdp + \int^{p} b\left[pq + (1-t)x - E(Ic)\right]^2 fpdp \quad \text{(A1)}$$

With:

$$E(Ic) = \bar{p}q + x(1-bt)$$

the first term on the right-hand-side of (A1) may be rearranged and simplified to give:

$$(1-b)q^2 Var(p) + (1-b)x^2 t^2 b^2 \quad \text{(A2)}$$

While the second term on the right-hand-side of (A1) may be rearranged and simplified to give:

$$bq^2 Var(p) + bx^2 t^2 (1-b)^2 \quad \text{(A3)}$$

Combining (A2) and (A3) and simplifying gives:

$$Var(Ic) = q^2 Var(p) + x^2 t^2 (1-b)b \quad \text{(A4)}$$

Table 1

The Policy Problem

	R		
	0.25	0.5	0.75
$U(x)$	42.16	20.00	12.65
$E(U(Ic))$ for CVp = 0.35	44.93	19.85	12.30
$E(U(Ic))$ for CVp = 0.25	45.12	19.96	12.36
$E(U(Ic))$ for CVp = 0.15	45.25	20.04	12.39

Table 2

The Policy Solution

		R	
	0.25	0.5	0.75
$U(x)$	42.16	20.00	12.65
$E(U(Ic))$ for CVp = 0.15; t=2; b= 0.4	45.25	20.04	12.39
$E(U(Ic))$ for CVp = 0.15; t=2.4; b= 0.333	44.25	19.43	12.12
$E(U(Ic))$ for CVp = 0.15; t=4; b= 0.2	40.21	17.00	11.01

I_i = income in period *i (i=1,2)*