Do counter-cyclical payments in the FSRI Act create incentives to produce?

Jesús Antón[1]
Organisation for Economic Co-operation and development (OECD), Paris
jesus.anton@oecd.org

Chantal Le Mouel[1]
Institut National de la Recherche Agronomique (INRA), Rennes
clemouel@roazhon.inra.fr

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[1] Jesús Antón is economist in the Agricultural Directorate of the Organisation for Economic Co-operation and Development (OECD), where the underlying analysis was undertaken. Chantal Le Mouel is economist at the National Institute for Agronomic Research (INRA) at Rennes, France. The views expressed are our own and not those of the OECD Secretariat or its member countries, nor those of the INRA.

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Abstract

Analytical results in the literature suggest that counter-cyclical payments create risk-related incentives to produce even if they were "decoupled" under certainty (Hennessy, 1998). This paper develops a framework to assess the risk-related incentives to produce created by commodity programmes like the loan deficiency payments and the Counter-Cyclical Payments (CCP) in the FSRI Act. Because CCP are paid based on fixed production quantities they have a weaker risk-reducing impact than loan deficiency payments. The latter have a direct impact through the variance of the producer price distributions, while the impact of CCP is due only to the covariance between the CCP and the producer price distributions. The methodology developed by Chavas and Holt (1990) is applied to calculate the appropriate variance-covariance matrix of the truncated producer price distributions created by the FSRI in 2002. Risk premiums are computed showing that the risk related incentives created by CCP are significant and they do not disappear for levels of production that are larger than the base production on which they are paid.

Key words: Counter-cyclical payments, risk aversion, risk premiums, decoupling.

Introduction

Between 1998 and 2001, Market Loss Assistance (MLA) payments were paid to United States crop producers on the top of the fixed amount provided by Production Flexibility Contracts (PFC) established in the 1996 FAIR Act. These MLA payments were provided to offset low market prices. The 2002 Farm Security and Rural Investment Act (FSRI) has institutionalised this type of support measure in the form of the Counter-Cyclical Payments (CCP) programme which will make payments according to fixed area and yields. However, the payment amount depends counter-cyclically on current market prices. This paper deals with the risk related effects of the CCP[2].

The starting point of this paper is the results by Hennessy (1998) on general conditions under which optimal production decisions will be affected by support measures that are "decoupled" under certainty. Under quite general conditions, Hennessy finds that if farmers are risk averse, counter-cyclical payments will have an impact in increasing production and will not be decoupled. There is econometric evidence of risk averse behaviour by US farmers as shown in Lence (2000), Love and Buccola (1991), Chavas and Holt (1996), and Saha et al. (1994). These two latter studies show consistency with Decreasing Absolute Risk Aversion (DARA) behaviour.

The design of the CCP, the analytical work by Hennessy and the empirical evidence on farmers risk aversion imply that the CCP programme creates incentives to produce. However, the magnitude of these incentives remains an empirical question. This paper uses a mean-variance approach (see e.g., Newbery and Stiglitz (1981), or Coyle (1992) and (1999), in the context of duality models) to determine the magnitude of the risk-related incentives. In section 1 analytical expression for the risk premiums are derived from first order condition for a maximum certainty equivalent profit. This expression is used to compute risk premiums under CCP payments in section 2. The methodology requires using the developments in Chavas and Holt (1990) to calculate means and the variance-covariance matrix of truncated distributions of prices. Finally, some insights on the sensitivity of the results to parameter values are provided in section 3.

[2] The analysis in this paper covers only the risk related effects of CCP. The possibility of these payments having impacts on production through other channels as defined in OECD (2001) such as investment is not analysed.

1. Modelling counter-cyclical payments

Let us consider a representative farmer producing one output. It is assumed that the output price is stochastic and the farmer tries to maximise expected utility from profit $\pi(Q,\tilde{P})$. We assume that the derivatives of the profit with respect to the output price $\tilde{P}$ and the quantity produced Q are $\pi_{\tilde{P}} > 0$ and $\pi_{Q,\tilde{P}} > 0$, as can be generally accepted. Let us also assume a payment $m = \beta * g(\tilde{P})$. Proposition 1 in Hennessy (1998) implies that under decreasing absolute risk aversion (DARA) the derivative $g_{\tilde{P}} \leq 0$ is a sufficient condition for optimal production increasing with the level of support: $\partial Q^* / \partial \beta > 0$. This means that payments that move inversely with prices create risk-related effects that will increase optimal production. Even if payments are independent from prices, $g_{\tilde{P}} = 0$, they will have some production effects due to the so-called "wealth effects". The result is more conclusive under constant absolute risk aversion (CARA) when "wealth effects" are null and "insurance effects" are the only driving force as shown in proposition 2 in Hennessy (1998).

The counter-cyclical payments of a given commodity in the FSRI Act take the following form:

[1] $$CCP = \alpha * \overline{Q} * \left[Max(P_T, \tilde{P}) - Max(P_L, \tilde{P}) \right]$$

Where we use the following notation:

- Net Target price[3]: $P_T = \text{Target Price - Direct payment rate}$
- Loan rate: P_L
- Output price (stochastic): $\tilde{P}$
- $\overline{Q} = \text{Base area} * \text{Base yield}$, is the base production of the representative producer

[3] In the FSRI Act, the price used to calculate the CCP rate is not the target price but the target price minus the corresponding PFC payment rate (i.e., the direct payment rate since PFC are now called Direct Payment, DP, in the FSRI Act).

- $\alpha = 0.85$ is the share of the base area used to calculate the CCP.

We assume that the net target price P_T is always greater than the loan rate P_L. This has to be the case if CCP are to provide additional support. It also corresponds to the observed situation, as shown in Table 1 in next section.

There are three possible cases depending on the level of the output price $\tilde{P}$ relative to those of both institutional prices P_T and P_L.

<u>Case 1</u>: $P_L < \tilde{P} < P_T$, then $Max(P_T, \tilde{P}) = P_T$ and $Max(P_L, \tilde{P}) = \tilde{P}$. So, $CCP_1 = \alpha * \overline{Q} * (P_T - \tilde{P})$

<u>Case 2</u>: $P_L < P_T < \tilde{P}$, then $Max(P_T, \tilde{P}) = \tilde{P}$ and $Max(P_L, \tilde{P}) = \tilde{P}$. Thus, $CCP_2 = 0$

This case corresponds to the situation where the output price is higher than the net target price. In such a high producer price context, there is no CCP.

<u>Case 3</u>: $\tilde{P} < P_L < P_T$, then $Max(P_T, \tilde{P}) = P_T$ and $Max(P_L, \tilde{P}) = P_L$. So, $CCP_3 = \alpha * \overline{Q} * (P_T - P_L)$

This case corresponds to the situation where the output price is lower than the loan rate. In such a low producer price context, there are positive CCP bridging the gap between the net target price and the loan rate. This is also the case in which the marketing loan assistance programme becomes active and a loan deficiency payment bridges the gap between the loan rate and the output price.

Let us assume that total income of the representative farmer is not known with certainty due to uncertain output price, and is represented by the random variable $\tilde{Y}$. The mean-variance approach for the expected utility of the farmer gives a certainty equivalent income that depends on expected income and its variance:

[2] $$\tilde{Y} = E[\tilde{Y}] - \frac{1}{2} * R * \frac{V[\tilde{Y}]}{E[\tilde{Y}]}$$

Where “R” is the Arrow-Pratt relative risk aversion coefficient, a key parameter representing the farmer's risk behaviour. We assume R is constant and, therefore, risk preferences are DARA[4]. The farmer will produce a quantity Q that maximises this certainty equivalent. Hence, the first order condition of the farmer's maximisation programme can be derived as follows:

[3] $$\frac{d\tilde{Y}}{dQ}=0\Leftrightarrow\left[1+\frac{R*V\left[\tilde{Y}\right]}{2*\left(E\left[\tilde{Y}\right]\right)^2}\right]*\frac{\partial E\left[\tilde{Y}\right]}{\partial Q}-\frac{R}{2*E\left[\tilde{Y}\right]}*\frac{\partial V\left[\tilde{Y}\right]}{\partial Q}=0$$

This condition depends on the derivatives of expected income and the variance of that income. In order to obtain appropriate expressions for these derivatives we need to define the income function for the representative farmer. The income of a farmer producing a given base commodity would be:

[4] $$\tilde{Y}=\alpha*\overline{Q}*Max(P_T,\tilde{P})+\left[Q-\alpha*\overline{Q}\right]*Max(P_L,\tilde{P})-TC(Q)+E$$

Where:

- TC is the total cost function of the farm with marginal cost C’.
- E is the off-farm income.

The three possible cases for the farmer's income corresponding to the previous three output price contexts are the following:

<u>Case 1</u>: $\tilde{Y}=\tilde{P}*Q+CCP_1-TC(Q)+E$

<u>Case 2</u>: $\tilde{Y}=\tilde{P}*Q-TC(Q)+E$

<u>Case 3</u>: $\tilde{Y}=P_L*Q+CCP_3-TC(Q)+E=\tilde{P}*Q+\left(P_L-\tilde{P}\right)*Q+CCP_3-TC(Q)+E$

[4] Analogous developments were done under the CARA assumption. However the quantitative simulation results reported in next sections differed only marginally for comparable levels of parameters of absolute and relative risk aversion. This is due to the small size of the “wealth effects” as compared to the “insurance effects”. Hennessy (1998) also finds relatively small “wealth effects”.

Hence, in this third case, corresponding to a low output price context, the farmer's market receipts, $\tilde{P} * Q$, are complemented by both a positive CCP, CCP_3, and a positive loan deficiency payment, $\left(P_L - \tilde{P}\right) * Q$.

The expected income and its derivative take the following form:

[5]
$$E\left[\tilde{Y}\right] = \alpha * \overline{Q} * E\left[Max(P_T, \tilde{P})\right] + \left[Q - \alpha * \overline{Q}\right] * E\left[Max(P_L, \tilde{P})\right] - TC(Q) + E$$
$$\frac{\partial E\left[\tilde{Y}\right]}{\partial Q} = E\left[Max(P_L, \tilde{P})\right] - C'$$

The variance of the income and its derivative take the following form:

[6]
$$V\left[\tilde{Y}\right] = \alpha^2 * \overline{Q}^2 * V\left[Max(P_T, \tilde{P})\right] + \left[Q - \alpha * \overline{Q}\right]^2 * V\left[Max(P_L, \tilde{P})\right] + 2 * \alpha * \overline{Q} * \left[Q - \alpha * \overline{Q}\right] * Cov\left[Max(P_T, \tilde{P}), Max(P_L, \tilde{P})\right]$$
$$\frac{\partial V\left[\tilde{Y}\right]}{\partial Q} = 2 * Q * V\left[Max(P_L, \tilde{P})\right] + 2 * \alpha * \overline{Q} * \left(Cov\left[Max(P_T, \tilde{P}), Max(P_L, \tilde{P})\right] - V\left[Max(P_L, \tilde{P})\right]\right)$$

Combining [3] and [6] the condition for a maximum becomes:

[7]
$$E\left[Max(P_L, \tilde{P})\right] * \left[1 - \frac{\partial V\left[\tilde{Y}\right] / \partial Q}{E\left[Max(P_L, \tilde{P})\right] * \left[\frac{2 * E\left[\tilde{Y}\right]}{R} + \frac{V\left[\tilde{Y}\right]}{E\left[\tilde{Y}\right]}\right]}\right] = C'$$

This expression is analogous to the standard price equal to marginal cost condition. The incentive price is the expected price given the truncation of the distribution of price at the loan rate minus a price risk premium equal to the second element in the brackets. Provided that $\partial V\left[\tilde{Y}\right] / \partial Q > 0$, the risk premium contributes to decrease the effective incentive price that will be made equal to marginal cost. In that context, a policy measure acting to decrease the risk premium increases the effective incentive price, leading farmers to produce more. Equation [7] shows the direct impact of loan rates on incentive prices. Target price would have an impact on production decision only if the derivative of the variance with respect to Q is not zero. Substituting $\partial V\left[\tilde{Y}\right]/\partial Q$ by its expression given in [6] into the multiplicative price risk premium extracted from [7] gives the following expression for the price risk premium, which represents the percentage gap between expected incentive price (including loan rate truncation) and marginal cost:

[8] $$\theta = \frac{2*Q*V\left[Max(P_L,\tilde{P})\right] + 2*\alpha*\overline{Q}*\left(Cov\left[Max(P_T,\tilde{P}),Max(P_L,\tilde{P})\right] - V\left[Max(P_L,\tilde{P})\right]\right)}{E\left[Max(P_L,\tilde{P})\right]*\left[\frac{2*E\left[\tilde{Y}\right]}{R} + \frac{V\left[\tilde{Y}\right]}{E\left[\tilde{Y}\right]}\right]}$$

It is only through the covariance term in $\partial V\left[\tilde{Y}\right]/\partial Q$ provided in [6] that the CCP may affect the risk premium, meanwhile the loan rate truncation has a direct effect through the variance term. Substituting $V\left[\tilde{Y}\right]$ by its expression provided in [6] into [8], calling $CV\left[Max\left(P_L,\tilde{P}\right)\right] = \sqrt{V\left[Max\left(P_L,\tilde{P}\right)\right]}\Big/E\left[Max\left(P_L,\tilde{P}\right)\right]$ the coefficient of variation of the output price distribution including the loan rate truncation, using the ratio $\mu = \frac{E\left[Max(P_L,\tilde{P})\right]*Q}{E[\tilde{Y}]}$ and reorganising [8] give:

[9]

$$\theta = \frac{1+\alpha*\frac{\overline{Q}}{Q}*\frac{Cov\left[Max(P_T,\tilde{P}),Max(P_L,\tilde{P})\right]-V\left[Max(P_L,\tilde{P})\right]}{V\left[Max(P_L,\tilde{P})\right]}}{\frac{1}{\mu*R*CV^2[Max(P_L,\tilde{P})]} + (1-\alpha*\frac{\overline{Q}}{Q})^2*\frac{\mu}{2} + \alpha*\mu*\left[\frac{\alpha}{2}*\left(\frac{\overline{Q}}{Q}\right)^2*\frac{V\left[Max(P_T,\tilde{P})\right]}{V\left[Max(P_L,\tilde{P})\right]} + \frac{\overline{Q}}{Q}(1-\alpha*\frac{\overline{Q}}{Q})*\frac{Cov\left[Max(P_T,\tilde{P}),Max(P_L,\tilde{P})\right]}{V\left[Max(P_L,\tilde{P})\right]}\right]}$$

The expression for the risk premium would become much simpler if the CCP programme did not exist. It can be calculated by simply making $\alpha = 0$:

[10] $$\theta = \frac{1}{\frac{1}{\mu*R*CV^2[Max(P_L,\tilde{P})]} + \frac{\mu}{2}}$$

2. Computing production incentives

Deriving the risk premium in [9] requires calculating the variance-covariance matrix of the truncated price distributions $Max(P_T, \tilde{P})$ and $Max(P_L, \tilde{P})$. These distributions determine the new "stochastic" environment faced by each representative producer of each programme commodity. The first column in Table 1 shows the average producer price in 2001 for each programme commodity, extracted from OECD databases[5]. It also shows the standard deviation for each commodity, calculated as the standard deviation of the producer price annual series over the period 1986/2001. Subsequent columns show the distribution of producer prices for different policy related truncation prices applied to column (1): the loan rate in 2001 (column (2)), the loan rate for 2002/03 (column (3)), and the target price net of the direct payment rate for 2002/03 (column (4)), those latter as foreseen in the FSRI Act. The calculations of these distributions were made using the methodology developed in Chavas and Holt (1990) and are valid under the assumption of normality for the underlying producer prices in column (1).

Results in Table 1 measure the increase in the mean and the reduction in the variability of producer prices resulting from each consecutive truncation in the distribution. For example the standard deviation of the corn producer price is reduced from 0.37 to 0.22 as a result of the loan rate decided for the period 2002/03. If we count the truncation from the target price net of the direct payment rate, the standard deviation is reduced to 0.11.

The computation of risk premiums given by [9] requires the information in Table 1 plus three parameter values: an estimate of μ at equilibrium[6], an estimate of the ratio between current and base production $Q/\overline{Q}$ at equilibrium (a first good guess is unity), and an estimate of the relative

[5] Those are the average producer prices used in the Producer Support Estimate database and in both the AGLINK and PEM models developed by the OECD.

[6] To calculate this ratio, we use average market revenue and average total income of US farms extracted from table A1 in OECD (1999). The calculated ratio is equal to 1.48.

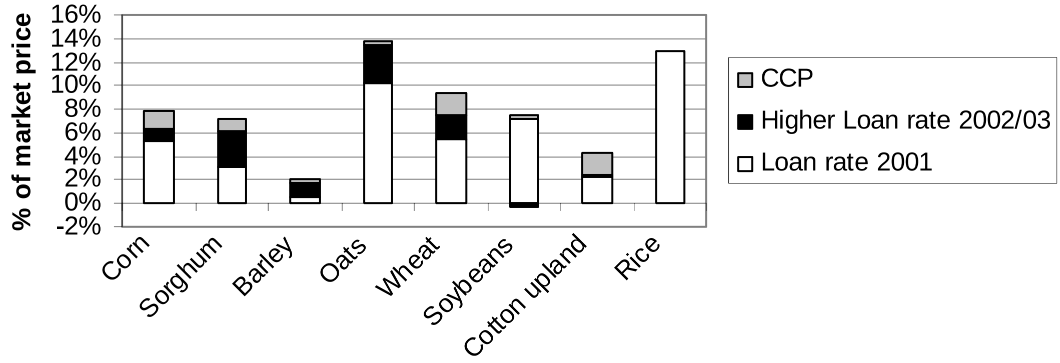
risk aversion of the representative farmer. Econometric results in Lence (2000), Love and Buccola (1991), Chavas and Holt (1996), and Saha et al. (1994) show estimates of relative risk aversion in the range between 1.1 and 18.8. In this article we use a relative risk aversion R=2 as a base value for our simulation exercise. Results are very sensitive to the value of the risk aversion coefficient as shown in the next section.

Table 1. Calculated distributions of prices under normality ($/bu.)

		(1) **Price distribution in 2001**	(2) **Price distribution truncated at Loan rates 2001**	(3) **Price distribution truncated at Loan rates 2002/03**	(4) **Price distribution truncated at Target price - DP**
Corn	Truncation	none	1.89	1.98	2.32
	Mean	2.00	2.10	2.14	2.36
	Std.Dev.	0.37	0.25	0.22	0.11
	Covariance ((3),(4))				0.02
Sorghum	Truncation	none	1.71	1.98	2.19
	Mean	2.00	2.04	2.14	2.26
	Std.Dev.	0.37	0.30	0.22	0.15
	Covariance ((3),(4))				0.03
Barley	Truncation	none	1.65	1.88	1.97
	Mean	2.25	2.26	2.28	2.29
	Std.Dev.	0.36	0.35	0.31	0.29
	Covariance ((3),(4))				0.09
Oats	Truncation	none	1.21	1.35	1.38
	Mean	1.35	1.44	1.50	1.51
	Std.Dev.	0.38	0.26	0.22	0.21
	Covariance ((3),(4))				0.05
Wheat	Truncation	none	2.58	2.80	3.34
	Mean	2.85	2.97	3.06	3.41
	Std.Dev.	0.58	0.43	0.36	0.18
	Covariance ((3),(4))				0.05
Soybeans	Truncation	none	5.26	5.00	5.36
	Mean	4.40	5.30	5.08	5.39
	Std.Dev.	0.72	0.15	0.22	0.13
	Covariance ((3),(4))				0.03
Cotton upland	Truncation	none	0.52	0.52	0.66
	Mean	0.56	0.57	0.57	0.66
	Std.Dev.	0.08	0.06	0.06	0.01
	Covariance ((3),(4))				0.00
Rice	Truncation	none	6.50	6.50	8.15
	Mean	4.25	6.50	6.50	8.15
	Std.Dev.	0.94	0.04	0.04	0.00
	Covariance ((3),(4))				0.00

Figure 1 shows the estimated effect on risk premiums following the implementation of the FSRI Act. The risk related impact of the whole FSRI is estimated to vary from an increase of 2% in the incentive price of barley up to 14% of the oats' incentive price. Most of these incentives already existed under the 2001 loan rates. However loan rates for 2002/03 are higher than in 2001 for all commodities except soybeans (lower), and cotton and rice, which are the same. This creates additional risk related incentives to produce for these commodities, up to 3% of the price for sorghum and oats. The new CCP programme would create additional risk related incentives on production which are computed to be in the order of 0.9% of the price for sorghum, 1.5% of the price for corn and 1.9% of the price for wheat. Out of the total risk related effects, CCP represent a smaller share as compared to loan rates: 13% for sorghum, about 20% for corn and wheat and up to 46% for cotton. This relative magnitude of the risk incentive impacts of CCP with respect to loan rates is very stable for different parameter assumptions.

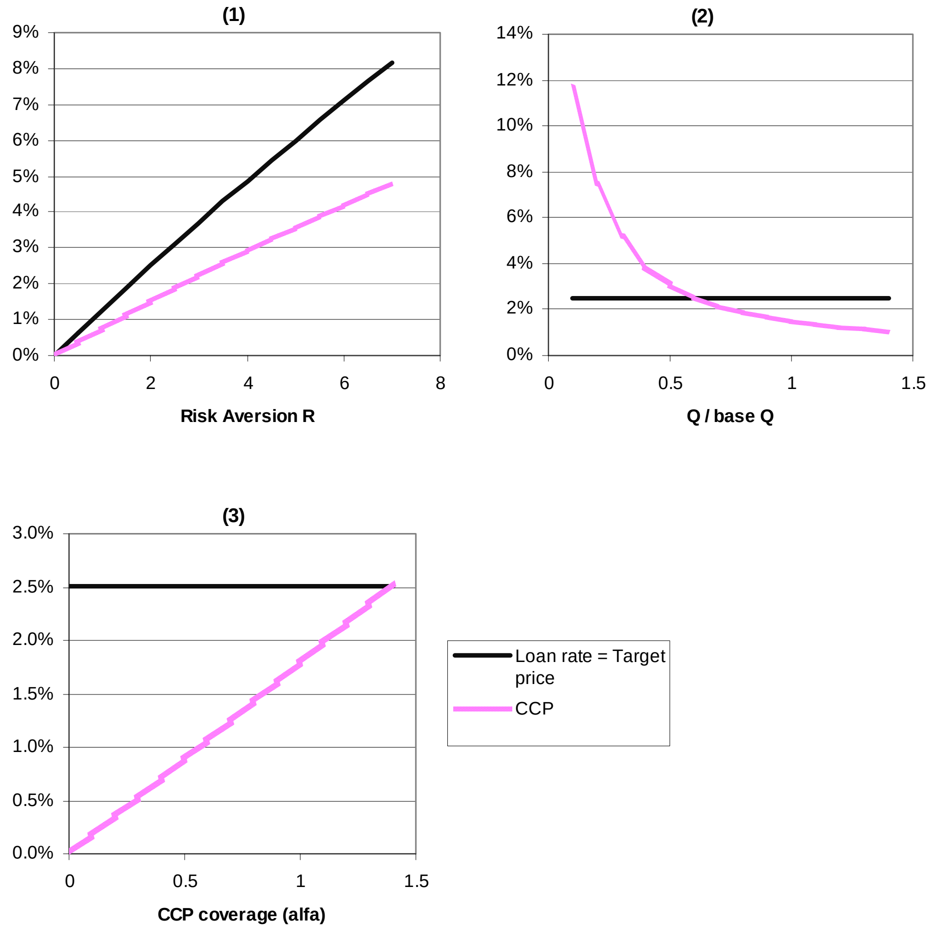
Figure 1. Reduction in risk premiums under the FSRI Act



3. Main determinants of risk premiums associated with CCP

From [9] it can be proved that the effective incentive price (including the risk premium) is a decreasing function of risk aversion R and the level of current production Q, and an increasing function of the coverage of CCP α. This is illustrated for corn in Figure 2 that shows the sensitivity of the risk-related impacts on incentive prices resulting from the CCP with respect to three key variables or parameters. In each graph, two alternative methodologies are implemented. The first one makes the standard truncation in the price distribution at a level equal to the target price net of the DP rate (this corresponds in fact to the loan rate methodology)[7]. The second one is the proposed methodology developed in this paper (CCP methodology).

Figure 2. Reduction in corn risk premiums due to CCP



For all levels of risk aversion the proposed CCP methodology creates incentives which are around 60% of the incentives measured with the standard truncation methodology (Figure 2 (1)). This result clearly shows that for the same level of price truncation, *ceteris paribus*, the CCP programme has weaker risk related production incentive effects than the loan deficiency programme. This result is reversed when the quantity produced is low relative to the base

[7] According to this methodology, CCP would act as loan deficiency payments. The loan rate would be fixed at the level of the target price net of the direct payment rate and risk premiums are calculated as if CCP would not anymore be granted based on fixed production quantities, but on current production quantities.

quantity. Figure 2 (2) indicates that incentives calculated with the CCP methodology are larger than those resulting from the loan rate methodology at the same triggering level when the production level is below 60% of the base production. The behaviour of the CCP curve in Figure 2 (2) suggests that the incentives induced by the CCP decrease smoothly when the quantity produced increases up to the base production level, without any kink at 85% of the base, which is the actual CCP coverage. The CCP programme creates production incentives even at levels of production above the base production for the payments. Finally, Figure 2 (3) indicates that incentives calculated with the CCP methodology increase with the CCP level of coverage but are much lower than those resulting from the loan rate methodology at the same triggering level. In fact, the risk related incentives induced by CCP would be the same as those of an equivalent loan rate if the CCP were paid on 140% of the base production.

Conclusions

Previous analytical work by Hennessy provided a general proof that counter-cyclical payments create incentives to produce. This paper has used specific functional forms to model the impacts of payments under the CCP programme as they were decided in the FSRI Act, in the context of a risk averse farmer maximising expected utility. The methodology proves to be useful to assess risk-related impacts of crop programmes. Both CCP and loan deficiency payments are found to create risk-reducing incentives to produce. The risk effects of counter-cyclical payments are smaller than those of loan deficiency payments but they can be of comparable magnitude. The production incentives due to CCP are smaller the larger the quantity produced relative to the base production, but this reduction is smooth and production incentives can be positive even for levels of production above the base production for the payments. Quantitative measurements of the price risk premiums created by CCP depend critically on the level of risk aversion of the farmers. In this paper a level in the lowest range of the empirical estimates has been used to avoid overestimation of risk premiums.

This paper shows that although the CCP, adopted as part of the FSRI Act, are granted to farmers according to the same criteria as the old PFC payments (Direct Payments in the new FSRI Act) this programme does create incentives to produce when risk is taken into account. Obtained results show that because farmers are risk averse and the amount of CCP is clearly dependent on current market prices, the CCP programme induces risk-reducing incentives to produce.

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