Do counter-cyclical payments in the 2002 US Farm Act create incentives to produce?\textsuperscript{\textregistered}

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Abstract

Analytical results in the literature suggest that counter-cyclical payments create risk-related incentives to produce even if they are 'decoupled' under certainty [Hennessy, D.A., 1998. The production effects of agricultural income support polices under uncertainty. Am. J. Agric. Econ. 80, 46–57]. This paper develops a framework to assess the risk-related incentives to produce created by commodity programmes like the loan deficiency payments (LDPs) and the counter-cyclical payments (CCPs) in the 2002 US Farm Act. Because CCPs are paid based on fixed production quantities they have a weaker risk-reducing impact than LDPs. The latter have a direct impact through the variance of the producer price distributions, while the impact of CCPs is due only to the covariance between the CCP and the producer price distributions. The methodology developed by [Chavas, J.-P., Holt, M.T., 1990. Acreage decisions under risk: the case of corn and soybeans. Am. J. Agric. Econ. 72 (3), 529–538] is applied to calculate the appropriate variance–covariance matrix of the truncated producer price distributions under the 2002 Farm Act. Risk premia are computed showing that the risk-related incentives created by CCPs are significant and do not disappear for levels of production above the base production on which CCPs are paid.

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1. Introduction

Between 1998 and 2001, market loss assistance (MLA) payments were paid to United States crop producers on 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 Act (Farm Security and Rural Investment Act or FSRI Act) has institutionalised this type of support measure in the form of the counter-cyclical payments (CCPs) programme, which will make payments according to fixed area and yields. However, the payment amount depends counter-cyclically on current market prices.

\textsuperscript{*} The views expressed are our own and not those of the OECD Secretariat or its member countries, nor those of INRA.

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This paper deals with the risk-related effects of the CCPs. The starting point is the derivation by Hennessy (1998) of 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 increase production and therefore are not decoupled.

There is econometric evidence of risk averse behaviour by US farmers as shown, for instance, in Love and Buccola (1991), Saha et al. (1994), Chavas and Holt (1996) and Lence (2000). Studies by Saha, et al. and Lence show consistency with decreasing absolute risk aversion (DARA) behaviour. Applications of these results to policy analysis can be found in OECD (2003 and 2004).

The design of the CCPs, the analytical work by Hennessy and the empirical evidence concerning farmers’ risk aversion imply that the CCPs 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 CCPs risk-related incentives.

The paper is organised as follows: In Section 2 an analytical expression for the risk premium is derived from first order condition for a maximum certainty equivalent profit. This expression is used to compute risk premia under CCPs in Section 3. The methodology requires using the developments in Chavas and Holt (1990) to calculate means and the variance-covariance matrix of truncated distributions of prices. Some insights on the sensitivity of the results to parameter values are provided in Section 4. Finally, concluding remarks are presented in Section 5.

2. 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 \( \pi(Q, \hat{P}) \). We assume that the derivatives of the profit with respect to the output price \( \hat{P} \) and the quantity produced \( Q \) are positive (i.e., \( \pi_{\hat{P}} > 0 \) and \( \pi_{Q, \hat{P}} > 0 \), as can be generally accepted. Let us also assume a payment \( m = \beta \times g(\hat{P}) \).

Proposition 1 in Hennessy (1998) implies that under decreasing absolute risk aversion (DARA) the derivative \( g_{\hat{P}} \leq 0 \) is a sufficient condition for optimal production to increase 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, \( g_{\hat{P}} = 0 \), they will have some production effects due to so-called ‘wealth effects’. Under constant absolute risk aversion (CARA), the sufficient condition for optimal production to increase with the level of support is \( g_{\hat{P}} < 0 \) since ‘wealth effects’ are zero and ‘insurance effects’ remain 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:

\[
\text{CCP} = \alpha \times \overline{Q} \times \left[ \max(P_T, \hat{P}) - \max(P_L, \hat{P}) \right]
\]

where \( P_L \) is the loan rate, \( \hat{P} \) the stochastic output price, \( \overline{Q} \) the base production of the representative producer (i.e., \( \overline{Q} = \text{base area} \times \text{base yield} \)) and \( \alpha \) the share of the base area used to calculate the CCP (i.e., \( \alpha = 0.85 \)). 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. This price is denoted \( P_T \) in Eq. (1) (i.e., \( P_T = \text{target price} - \text{direct payment rate} \), since PFC are now called direct payments, DP, in the FSRI Act) and is called the ‘net target price’ in the rest of this text.

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 CCPs are to provide additional support. It also corresponds to the observed situation, as shown in Table 1 in the next section.

There are three possible cases depending on the level of the output price \( \hat{P} \) relative to the level of institutional prices \( P_T \) and \( P_L \):

- **Case 1**: \( P_L < \hat{P} < P_T \), then \( \max(P_T, \hat{P}) = P_T \) and \( \max(P_L, \hat{P}) = \hat{P} \). So, CCP1 = \( \alpha \times \overline{Q} \times (P_T - \hat{P}) \)
- **Case 2**: \( P_L < P_T < \hat{P} \), then \( \max(P_T, \hat{P}) = \hat{P} \) and \( \max(P_L, \hat{P}) = \hat{P} \). Thus, CCP2 = 0

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1 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 such as investment for instance (see, e.g., OECD, 2001) is not considered.
Case 3: $\bar{P} < P_L < P_T$, then $\max(P_T, \bar{P}) = P_T$ and $\max(P_L, \bar{P}) = P_L$. So, $CCP_3 = \alpha \times \bar{Q} \times (P_T - P_L)$.

Case 1 corresponds to the situation where the output price is higher than the loan rate but lower than the net target price. In this case, there is a positive CCP bridging the gap between the net target price and the output price. Case 2 corresponds to the situation where the output price is higher than the loan rate. In this case, there is a positive CCP bridging the gap between the net target price and the loan rate.

Let us assume that total income of the representative farmer is not known with certainty due to uncertainty about the 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 $\tilde{Y}$ that depends on expected income and the variance of income:

$$\hat{Y} = E[\tilde{Y}] - \left(\frac{1}{2}\right) \times R \times \left(\frac{V[\tilde{Y}]}{E[\tilde{Y}]}\right)$$

(2)

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.\(^2\) The farmer will produce a quantity $Q$ that maximises the certainty equivalent income as given by Eq. (2). Hence, the first order condition of the farmer’s maximisation programme can be derived as follows:

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

(3)

This condition depends on the derivatives of the expected income and of the variance of that income with respect to the quantity produced $Q$. 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 is given by:

$$\tilde{Y} = \alpha \times \bar{Q} \times \max(P_T, \bar{P}) + [Q - \alpha \times \bar{Q}] \times \max(P_L, \bar{P}) - TC(Q) + E$$

(4)

where $TC(Q)$ is the total cost function of the farm (with marginal cost $C' = \partial TC(Q)/\partial Q$) and $E$ the off-farm income.

The three possible outcomes in terms of the farmer’s income corresponding to the previous three output price cases are the following:

Case 1: $\tilde{Y} = \tilde{P} \times Q + CCP_1 - TC(Q) + E$

Case 2: $\tilde{Y} = \tilde{P} \times Q - TC(Q) + E$

Case 3: $\tilde{Y} = P_L \times Q + CCP_3 - TC(Q) + E = \tilde{P} \times Q + (P_L - \bar{P}) \times Q + CCP_3 - TC(Q) + E$.

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

The expected income and its derivative with respect to the quantity produced take the following form:

$$E[\tilde{Y}] = \alpha \times \bar{Q} \times E[\max(P_T, \bar{P})] + [Q - \alpha \times \bar{Q}] \times E[\max(P_L, \bar{P})] - TC(Q) + E$$

(5)

$$\frac{\partial E[\tilde{Y}]}{\partial Q} = E[\max(P_L, \bar{P})] - C'$$

The variance of the income and its derivative with respect to $Q$ take the following form:

$$V[\tilde{Y}] = \alpha^2 \times \bar{Q}^2 \times V[\max(P_T, \bar{P})]$$

$$+ (Q - \alpha \times \bar{Q})^2 \times V[\max(P_L, \bar{P})]$$

$$+ 2 \times \alpha \times \bar{Q} \times (Q - \alpha \times \bar{Q}) \times \mathrm{Cov}[\max(P_T, \bar{P}), \max(P_L, \bar{P})]$$

(6)

$$\frac{\partial V[\tilde{Y}]}{\partial Q} = 2 \times Q \times V[\max(P_L, \bar{P})]$$

$$+ 2 \times \alpha \times \bar{Q} \times (\mathrm{Cov}[\max(P_T, \bar{P}), \max(P_L, \bar{P})] - V[\max(P_L, \bar{P})])$$

\(^2\) Analogous calculations were made under a CARA assumption. However, the quantitative simulation results differed only marginally for comparable levels of the absolute and relative risk aversion coefficients. 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’.
Combining (3) and (5) the maximisation condition becomes:

\[
E[\max(P_L, \bar{P})] \\
\times \left[ 1 - \frac{\partial V[\bar{Y}] / \partial Q}{E[\max(P_L, \bar{P}) \times \{(2 \times E[\bar{Y}] / R) + (V[\bar{Y}] / E[\bar{Y}])\}]}
\]

\[
= C'
\]

(7)

which may be re-written as:

\[
E[\max(P_L, \bar{P})] \times (1 - \theta) = C'
\]

(8)

where \( \theta \) is the price risk premium.

Eq. (8) 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 reduced by a price risk premium \( \theta \). Provided that \( \partial V[\bar{Y}] / \partial Q > 0 \), 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. Eqs. (7) and (8) show the direct impact of loan rates on incentive prices. Target prices would have an impact on production decisions only if the derivative of the variance of income with respect to \( Q \) is not zero.

Substituting \( \partial V[\bar{Y}] / \partial Q \) by its expression given in (6) into the expression of \( \theta \) extracted from (7) gives the expression for the price risk premium. The latter, which represents the percentage gap between expected price (including loan rate truncation) and marginal cost is given by:

\[
\theta = \frac{2 \times Q \times V[\max(P_L, \bar{P})] + 2 \times \alpha \times Q \times (\text{Cov}[\max(P_T, \bar{P}), \max(P_L, \bar{P})] - V[\max(P_L, \bar{P})])}{E[\max(P_L, \bar{P}) \times \{(2 \times E[\bar{Y}] / R) + (V[\bar{Y}] / E[\bar{Y}])\}]}
\]

(9)

3. Computing production incentives

The expression for the risk premium given by Eq. (10) would become much simpler if the CCPs programme did not exist. It can be calculated by simply making \( \alpha = 0 \):

\[
\theta = \frac{1}{1/(\mu \times R \times CV^2[\max(P_L, \bar{P})]) + (\mu / 2)}
\]

(11)

\[\text{Eq. (9) shows that it is only through the covariance term in } \partial V[\bar{Y}] / \partial Q \text{ provided in (6) that the CCP may affect the risk premium, meanwhile the loan rate truncation has a direct effect through the variance term. Substituting } V[\bar{Y}] \text{ by its expression provided in (6) into (9), calling } \text{CV}[\max(P_L, \bar{P})] = V[\max(P_L, \bar{P})]^{1/2} / E[\max(P_L, \bar{P})] \text{ the coefficient of variation of the output price distribution, including the loan rate truncation, using the ratio } \mu = (E[\max(P_L, \bar{P}) \times Q] / E[\bar{Y}] \text{ and reorganising (9) give:}
\]

\[\text{Combining (3) and (5) the maximisation condition becomes:}
\]

\[
E[\max(P_L, \bar{P})] \\
\times \left[ 1 - \frac{\partial V[\bar{Y}] / \partial Q}{E[\max(P_L, \bar{P}) \times \{(2 \times E[\bar{Y}] / R) + (V[\bar{Y}] / E[\bar{Y}])\}]}
\]

\[
= C'
\]

(7)

\[
\theta = \frac{1 + \alpha \times (\overline{Q} / Q) \times (\text{Cov}[\max(P_T, \bar{P}), \max(P_L, \bar{P})] - V[\max(P_L, \bar{P})]) / V[\max(P_L, \bar{P})]}{1 / (\mu \times R \times CV^2[\max(P_L, \bar{P})]) + (1 - \alpha \times (\overline{Q} / Q)^2 \times \mu / 2 + \alpha \times \mu \times (\alpha / 2 \times (\overline{Q} / Q)^2
\]

\[
\times (V[\max(P_T, \bar{P})]) / (V[\max(P_L, \bar{P})] + \overline{Q} / Q(1 - \alpha \times (\overline{Q} / Q)
\]

\[
\times (\text{Cov}[\max(P_T, \bar{P}), \max(P_L, \bar{P})] / (V[\max(P_L, \bar{P})] )])
\]

\[
\]

\[\text{which may be re-written as:}
\]

\[
E[\max(P_L, \bar{P})] \times (1 - \theta) = C'
\]

(8)

\[\text{where } \theta \text{ is the price risk premium.}
\]

\[\text{Eq. (8) is analogous to the standard price equal to marginal cost condition. The incentive price is the expected price given the truncation of the distribution of price at the loan rate reduced by a price risk premium } \theta \text{. Provided that } \partial V[\bar{Y}] / \partial Q > 0 \text{, the risk premium contributes to decrease the effective incentive price that will be made equal to marginal cost. In that context, a policy measure acting to decrease the risk premium increases the effective incentive price, leading farmers to produce more. Eqs. (7) and (8) show the direct impact of loan rates on incentive prices. Target prices would have an impact on production decisions only if the derivative of the variance of income with respect to } Q \text{ is not zero.}
\]

\[\text{Substituting } \partial V[\bar{Y}] / \partial Q \text{ by its expression given in (6) into the expression of } \theta \text{ extracted from (7) gives the expression for the price risk premium. The latter, which represents the percentage gap between expected price (including loan rate truncation) and marginal cost is given by:}
\]

\[
\theta = \frac{2 \times Q \times V[\max(P_L, \bar{P})] + 2 \times \alpha \times Q \times (\text{Cov}[\max(P_T, \bar{P}), \max(P_L, \bar{P})] - V[\max(P_L, \bar{P})])}{E[\max(P_L, \bar{P}) \times \{(2 \times E[\bar{Y}] / R) + (V[\bar{Y}] / E[\bar{Y}])\}]}
\]

(9)

\[\text{Eq. (9) shows that it is only through the covariance term in } \partial V[\bar{Y}] / \partial Q \text{ provided in (6) that the CCP may affect the risk premium, meanwhile the loan rate truncation has a direct effect through the variance term. Substituting } V[\bar{Y}] \text{ by its expression provided in (6) into (9), calling } \text{CV}[\max(P_L, \bar{P})] = V[\max(P_L, \bar{P})]^{1/2} / E[\max(P_L, \bar{P})] \text{ the coefficient of variation of the output price distribution, including the loan rate truncation, using the ratio } \mu = (E[\max(P_L, \bar{P}) \times Q] / E[\bar{Y}] \text{ and reorganising (9) give:}
\]

\[\text{The expression for the risk premium given by Eq. (10) requires calculating the variance–covariance matrix of the truncated price distributions } \max(P_T, \bar{P}) \text{ and } \max(P_L, \bar{P}). \text{ These distributions determine the new ‘stochastic’ environment faced by each representative producer of each programme commodity. The first column in Table 1 shows the average producer price in 2001 for each programme commodity, extracted from OECD databases.\textsuperscript{3} \text{ It also shows the standard deviation of the producer price annual series over the period 1986–2001. Subsequent columns show the distribution of producer prices for different policy-}
\]

\[\text{3 Underlying price series are the annual producer prices used in the OECD producer support estimates (PSE) and in both the AGLINK and PEM models developed by the OECD.} \]
related truncation prices applied to column (1): the loan rate in 2001 (column (2)), the loan rate for 2002/2003 (column (3)), and the target price net of the direct payment rate for 2002/2003 (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 2002/2003. 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 premia given by (10) requires the information provided in Table 1 plus three parameter values: an estimate of $\mu$ at equilibrium, an estimate of the ratio between current and base production $Q/Q_{eq}$ at equilibrium and an estimate of the relative risk aversion coefficient $R$ of the representative farmer.

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

<table>
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<tr>
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<tr>
<td>Corn</td>
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<td>1.98</td>
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<tr>
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<tr>
<td></td>
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<td>2.04</td>
<td>2.14</td>
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<tr>
<td></td>
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<td>0.35</td>
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<td>2.97</td>
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<tr>
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<tr>
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</tr>
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</table>
There is not much empirical information for estimating these parameters. We use the following approximate base values. The ratio $\mu$ is estimated using average total market revenue and average total income of US crop farms (data are extracted from Table A1 in OECD, 1999). The calculated ratio is equal to 1.48. Then, we assume a base situation in which $Q = \bar{Q}$. Finally, econometric results in Love and Buccola (1991), Saha et al. (1994), Chavas and Holt (1996) and Lence (2000) show estimates of relative risk aversion coefficients in the range between 1.1 and 18.8. In this article we use a relative risk aversion coefficient $R = 2$, which is towards the lowest part of that range. Results are very sensitive to the value of the risk aversion coefficient as shown in the next section.

Fig. 1 shows the estimated effect on risk premia following the implementation of the FSRI Act. The risk-related impact of the whole FSRI Act 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 2002/2003 are higher than in 2001 for all commodities except soybeans (lower), and cotton and rice (unchanged). This creates additional risk-related incentives to produce these commodities, up to 3% of the price for sorghum and oats. The new CCPs programme would create additional risk-related incentives to produce, which are computed to be in the order of 0.9% of the price of sorghum, 1.5% of the price of corn and 1.9% of the price of wheat. Out of the total risk-related effects, CCPs 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 CCPs with respect to loan rates is very stable for different parameter assumptions.

4. Main determinants of risk premia associated with CCPs

From Eqs. (8) and (10) 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 CCPs $\alpha$. In this section, we analyse the

![Fig. 1. Estimated increase in effective incentive prices due to lower risk premia created by the FSRI Act provisions.](image-url)
sensitivity of the results in Fig. 1 that estimate the changes in the effective incentive price due to lower risk premia created by the new CCPs. This is illustrated for corn in Fig. 2 that shows the sensitivity of the incentive price impacts resulting from the CCPs 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 (loan rate methodology).\(^4\) The second one is the proposed methodology developed in this paper (CCP methodology).

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 (Fig. 2(1)). This result clearly shows that for the same level of price truncation, ceteris paribus, the CCPs 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 quantity. Fig. 2(2) indicates that incentives calculated with the CCP methodology are larger than those resulting from the loan rate methodology at the same trigger level, when the production level is below 60% of the base production. The behaviour of the CCP

\(^4\) According to this methodology, CCP would act as loan deficiency payments. The loan rates are fixed at the level of the target prices net of the direct payment rates and risk premiums are calculated as if CCP were not granted anymore based on fixed production quantities, but on current production quantities.
5. 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 LDPs and CCPs programmes 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 CCPs 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 CCPs 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 premia created by CCPs depend critically on the level of risk aversion of the farmers.

This paper shows that although the CCPs, adopted as part of the FSRI Act, are granted to farmers according to historical area and yield parameters as were the old PFC payments (direct payments in the new FSRI Act) this programme does create incentives to produce when risk is taken into account. Results show that because farmers are risk averse and the amount of the CCP is clearly dependent on current market prices, the CCPs programme induces risk-reducing incentives to produce.

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