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RISK BEHAVIOUR IN THE PRESENCE OF GOVERNMENT PROGRAMS

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Abstract

Our paper assesses the impacts of the 1996 US Farm Bill on production decisions. We apply the expected utility model to analyze farmers' behavior under risk and assess how farmers' production decisions change in the presence of government programs. Specifically, we empirically evaluate the relative price and the risk-related effects of farm policy changes at the intensive margin of production, as well as the extra value that these policies add to farmers' certainty equivalent . We use farm-level data collected in Kansas to estimate the model. We find evidence that decoupled government programs have only negligible impacts on production decisions.

JEL classification: Q12

Keywords: policy, risk, risk preferences, intensive margin, extensive margin

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Introduction

Researchers have widely used the expected utility model in order to shed light on individuals' behavior under risk. This approach has been widely criticized in previous research. Buschena (2003) argued that the expected utility theory's axiomatic framework has been repeatedly violated in experimental settings. Rabin (2000) showed that attributing all risk behavior to diminishing marginal utility of wealth in small gambles can lead to unlikely levels of risk aversion.[1] As Bardsley and Harris (1987) noted, estimates of risk attitudes based on experiments are artificial and may offer poor guidance regarding behavior in real economic environments (see Wik et al., 2004 for an example of measurement of risk aversion from experimental data). Following this argument, Bar-Shira et al. (1997) and Roberts et al. (2004) pointed out that, though it is unclear that individuals have the ability to connect their beliefs to the rational concept of probability, it is possible that they actually behave according to expected utility theory outside an experimental framework.

The reason why the expected utility model may be a good approach to assess individual firms' behavior is that firms are often evaluated on the basis of their short-run profits. Shareholders may be unsure about the manager's ability, who in turn may be willing to give up some short-run profits in order to reduce longer-term losses. It is also true that many applied analyses based on the expected utility framework have obtained very reasonable results. Examples of these studies include Bar-Shira et al. (1997) and Isik and Khanna (2003). Additionally, one should note that the expected utility framework is

[1] Just and Peterson (2003) suggested that this criticism could be extended to more realistic risky situations.

useful in that it allows determination of the welfare costs of a firm's profit risk through the computation of the certainty equivalent (CE) of farm profits (Morduch, 1995).

Farming, like other entrepreneurial activities, is subject to many financial risks. Concerns about farm risks and farmers' abilities to manage these risks have led to a variety of government agricultural support programs in developed countries. As Roberts et al. (2004) explained, these programs are very relevant to US agriculture: direct payments from the Federal Government to farmers were around $22 billion annually in the period 1999-2001, while total crop sales receipts for this same period were about $92-$93 billion per year, suggesting that direct payments tended to be about 24% of total crop sales in each of the three years. Direct, decoupled payments, counter-cyclical payments, and price supports averaged about 75% of total direct payment outlays between 1990-2005, suggesting that most payments were made to major field crop producers. Roberts and Key (2003) noted that, in 2001, the year of the largest government outlays under the Federal Agriculture Improvement and Reform (FAIR) Act, of the $23 billion in total farm program payments, direct decoupled payments accounted for about $5 billion, marketing loan (price support) payments accounted for about $8 billion, and emergency assistance was about $8 billion. Given the magnitude of these payments, they may strongly influence agricultural production decisions, even in cases where payments are not directly tied to production.

In recent years, there have been important agricultural policy reforms worldwide that have often involved a change in the way farm incomes are supported (Gardner, 1992; Hennessy, 1998; Rude, 2001). Until recently, support was mainly provided through policies explicitly linked to production decisions (i.e., coupled policies). However, recent policy changes have attempted to break this link through a process known as "decoupling." Decoupling aims to support farm incomes while reducing efficiency losses related to coupled policies such as price-support measures or deficiency payments (Chambers, 1995). Our empirical study focuses on US agricultural policy reforms introduced by the 1996 Farm Bill.

The literature that assesses production impacts of policy instruments has shown that, in the context of a deterministic world with complete (credit) markets, or under the assumption that agents are risk neutral, only those policies that distort relative market prices have an impact on producers' decisions. In addition, an extensive literature shows that in a world with uncertainty, decoupled transfers, by means of altering total farm household wealth, can have an effect on economic agents' risk attitudes and thus on their production decisions (see, Sandmo, 1971; Hennessy, 1998; or Young and Westcott, 2000).

Under the assumption that farmers are characterized by decreasing absolute risk aversion preferences,[2] lump sum payments may potentially reduce farmers' absolute risk aversion, but likely not their relative risk aversion. Hennessy (1998) has shown that the willingness to assume more risk may result in an increase in production. These "second-order" effects are known as the wealth effects of policy. While a change in price supports is likely to exert a significant impact on production, it is less clear that producers will strongly react to decoupled government transfers. Second-order effects might be expected

[2] A number of previous studies that have tested for economic agents' risk preferences have provided evidence in favor of decreasing absolute risk aversion (see, for example, Isik and Khanna, 2003; Saha, 1997; or Bar-Shira et al. 1997).

to be small relative to the effects of coupled policies. The existence of these effects and their magnitude are issues requiring empirical analysis.

The objective of this paper is to assess whether the 1996 US Farm Bill, aimed at decoupling government program payments from production decisions, succeeded in its objective. We apply the expected utility model to analyze farmers' behavior under risk and to determine the extent to which this framework leads to reasonable results when implemented in realistic, risky situations. Specifically, we evaluate the relative price and the risk-related effects of farm policy changes at the intensive margin of production, as well as the extra value that these policies add to farmers' certainty equivalent (CE). A large body of literature exists on the impacts of risk preferences and uncertainties on economic agents' decisions (see, for example, Just and Zilberman, 1986; Chavas and Holt, 1990; Pope, 1982; Pope and Just, 1991; Leathers and Quiggin, 1991; Just and Pope, 2002; or Kumbhakar, 2002). Most of these studies, however, have imposed restrictive assumptions on producers' risk preferences (see Love and Buccola, 1991). Isik and Khanna (2003), whose approach we follow in this analysis, use a functional form based on Saha's (1997) work that adds flexibility to previously used forms.

Though several published empirical studies have assessed the effects of (partially) decoupled policies, most of these analyses have assumed risk neutrality (see, for example, Moro and Sckokai, 1999; Guyomard et al., 1996; Adams et al., 2001). As a result, they have ignored the potential risk effects of policy. A few studies have considered risk and risk preferences (Ridier and Jacket, 2002; Serra et al., 2006)[3] but

[3] Goodwin and Mishra (2006) estimate a model which is only indirectly related to the expected utility conceptual model and do not derive risk preference parameters.

have not distinguished between the relative price and risk-related effects of policy, nor assessed the influence of policy on farmers' CE.[4] We extend this literature by providing an empirical investigation of the effects of decoupling that explicitly considers producers' risks and risk attitudes, that identifies the risk-related effects of policy, and that analyzes how the CE changes when farm programs are modified.

The article is organized as follows. In the next section, we present the methods employed in our analysis. In the empirical application section, we offer specifics on the data and the definition of the model variables. We then present estimation results derived from the analysis of farm-level data obtained from a sample of Kansas farms. Concluding remarks are offered in the last section.

Methods

Our model of production under uncertainty follows Meyer (1987) in that we assume that farmers rank alternative choices using a utility function that is defined on the first two moments of the random payoff. Farmers' risk attitudes are represented using Saha's (1997) nonlinear mean-standard deviation utility function. The same approach was recently used by Isik and Khanna (2003) to assess the value of site-specific technologies.

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[4] Sckokai and Moro (2006) is an exception. They assess the risk-related impacts of the partially decoupled payments of the 1992 Common Agricultural Policy (CAP) reform by using a dual approach of the EU model. As noted by an anonymous referee, with the use of duality, the ability to reflect risk issues adequately is highly questionable. Antón and Le Mouël (2004), on the other hand, compare the risk-reducing incentives to produce created by US loan defficiency and counter-cyclical payments.

Agricultural policy in developed countries usually involves the use of price-support measures (such as US deficiency payments) that keep market prices artificially high. We compare production impacts of lump sum payments with the effects of price supports, which represent a coupled element of support. A decoupled payment is defined as an income-support payment that is exogenously fixed and that does not depend on actual, current production or prices.

The effects of government cash transfers on land values has been widely considered in the literature (see, for example, Barnard et al., 1997; Goodwin and Ortalo-Magné, 1992; Weersink et al., 1999; Just and Miranowski, 1993; Schertz and Johnston, 1998) and there seems to be a general agreement that economic rents from policy are likely to influence land prices, which in turn are likely to cause changes in relative input prices. By considering government transfers as fully decoupled, our model does not capture these changes which certainly constitute an interesting avenue for future research.

Suppose a single-output firm produces output y using a technology that can be represented by $y = f(x) + u$, where x is the quantity utilized of a variable input, and u is a random error term with zero mean and variance σ_u^2. The mean and variance of output can be expressed as $\bar{y} = f(x)$ and $\sigma_y^2 = \sigma_u^2$, respectively. Farmers are assumed to maximize the expected utility of wealth. A farm's total wealth is represented by $W = \omega + pf\left(x\right) - wx + G$, where ω is a farm's initial wealth, p is the market output price which is assumed to be a random variable that is independently distributed from the production disturbance, with mean $\bar{p}$ and variance σ_p^2, w is the variable input price, and G are decoupled government payments. The producer's optimization problem is

$$\max_x U(\bar{W}, \sigma_W), \tag{1}$$

where $\bar{W}$, the farmer's expected wealth, is $\bar{W} = \omega + \bar{p}f(x) - wx + G$, and σ_W, the standard deviation of wealth, is $\sigma_W = \left(\bar{p}^2\sigma_y^2 + f(x)^2\sigma_p^2 + \sigma_y^2\sigma_p^2\right)^{1/2}$.

We analyze production decisions at the intensive margin by assuming an internal solution, $x > 0$ which allows to express optimal input application as

$$\frac{\partial \bar{W}}{\partial x} = R\frac{\partial \sigma_W}{\partial x}, \tag{2}$$

where $\frac{\partial \bar{W}}{\partial x} = \bar{p}\frac{\partial f(x)}{\partial x} - w$ represents an input's expected marginal income, $\frac{\partial \sigma_W}{\partial x} = f(x)\frac{\partial f(x)}{\partial x}\frac{\sigma_p^2}{\sigma_W}$ measures the impact of a change in input use on the standard deviation of wealth, and $R = -\frac{\partial u}{\partial \sigma_W} \Big/ \frac{\partial u}{\partial \bar{W}}$ is the marginal utility ratio of the utility function representing a farmer's risk attitudes. Risk averse (neutral) [seeking] attitudes involve $R > (=)[<]0$. The expression $R\frac{\partial \sigma_W}{\partial x}$ is known as the marginal risk premium (MRP) and measures the impacts of uncertainty and risk preferences on production decisions.

The first-order condition in (2) shows that a farmer reaches an optimum when the MRP equals the wedge between the expected value of the marginal product and the input price. Under risk neutrality, the first-order condition simply consists of equating the expected value of the marginal product to the input price $\left(\frac{\partial \bar{W}}{\partial x}=0\right)$. While the left-hand side of the first-order condition captures the impacts of a change in relative prices on input use, the right-hand side measures the risk effects of policy changes. We attempt to empirically quantify the magnitude of both effects. To our knowledge, no previous analysis has assessed the overall risk-related effects of US agricultural policies.

We assume the following flexible utility function $U(\bar{W},\sigma)=\bar{W}^{\theta}-\sigma^{\gamma}$ (Saha, 1997), which allows measuring a producer's risk preferences by the following expression $R=\frac{\gamma}{\theta}\bar{W}^{1-\theta}\sigma^{\gamma-1}$, where $\theta>0$ and γ are parameters. If farmers are risk averse (neutral) [loving], $\gamma>(=)[<]0$. Under the assumption of risk aversion, decreasing absolute risk aversion (DARA), constant relative risk aversion (CARA), and increasing absolute risk aversion (IARA) are represented by $\theta>1$, $\theta=1$, and $\theta<1$, respectively. Decreasing relative risk aversion (DRRA), constant relative risk aversion (CRRA) and increasing relative risk aversion (IRRA) involve $\theta>\gamma$, $\theta=\gamma$, and $\theta<\gamma$, respectively.[5]

[5] As an anonymous referee notes, although Saha's (1997) utility function is flexible with respect to DARA, CARA, versus IARA and DRRA, CRRA, versus IRRA, it should be acknowledged that it also admits forms representing expected utility that cannot be derived from any underlying utility function.

Comparative Statics Analysis

Farmers are assumed to have two income sources: lump sum transfers and market revenue. We choose market prices to represent a form of coupled income support, and compare their production effects with production responses originated by decoupled payments. We assume throughout the comparative statics analysis that farmers have DARA ($\theta > 1$) and that the marginal productivity of the variable input is positive ($f_x > 0$). The elasticity of agricultural output with respect to decoupled transfers is given by

$$\varepsilon_{y\_G} = \frac{1}{A}\frac{R}{x}\frac{\partial \sigma_W}{\partial x}\varepsilon_{y\_x}\varepsilon_{R\_G} > 0\,, \qquad (3)$$

where $A < 0$ is the second order condition of the optimization problem, $\varepsilon_{R\_G} = (1-\theta)\frac{G}{\overline{W}}$ is the marginal utility ratio elasticity with respect to G, which shows the risk preference adjustment to a change in decoupled transfers, and ε_{y_x} is the input elasticity of output.

In accordance with previous literature (see Hennessy, 1998; or Leathers and Quiggin, 1991), expression (3) suggests that an increase in decoupled government transfers increases DARA farmers' willingness to assume more risk, which in turn stimulates production $\left(\varepsilon_{y\_G} > 0\right)$. From equation (3) it is also clear that, since decoupled government transfers do not alter relative prices, they do not have an impact on a farm's marginal income, thus causing only a risk effect.

The elasticity of agricultural output with respect to the output price can be measured as follows

$$\varepsilon_{y\_\bar{p}} = -\frac{\bar{p}}{Ax}\varepsilon_{y\_x}\left[\frac{\partial f(x)}{\partial x} - \left(\frac{\partial R}{\partial \bar{p}}\frac{\partial \sigma_W}{\partial x} - \frac{R}{\sigma_W}\frac{\partial \sigma_W}{\partial x}\frac{\partial \sigma_W}{\partial \bar{p}}\right)\right], \qquad (4)$$

where $\frac{\partial R}{\partial \bar{p}} = R\left((1-\theta)\frac{\bar{y}}{\bar{W}} + (\gamma - 1)\frac{\sigma_y^2}{\sigma_W^2}\bar{p}\right)$ measures the impact of a price change on farmers' risk preferences. Expression (4) shows that output price variation generates two changes that can impact the level of output. The first is the relative price effect, which is measured through the marginal income effect $\left(\frac{\partial f(x)}{\partial x} > 0\right)$ and corresponds to the first summand in (4). The risk effect corresponds to the second summand and measures the impacts of price changes on risk and risk preferences. Specifically, $\frac{\partial R}{\partial \bar{p}}\frac{\partial \sigma_W}{\partial x}$ represents the risk aversion effect of price and captures the responses of a farmer's risk preferences to price changes. The sign of this effect depends upon the sign of $\frac{\partial R}{\partial \bar{p}}$ which cannot be anticipated by theory and thus must be empirically determined. Expression $\frac{R}{\sigma_W}\frac{\partial \sigma_W}{\partial x}\frac{\partial \sigma_W}{\partial \bar{p}} > 0$ is the risk effect of price and measures the impact of a price change on the risk faced by the farmer.

Our comparative statics analysis allows derivation of expressions (3) and (4) that capture the effects of coupled and decoupled policy instruments on the level of production. A comparison of these two expressions, however, does not allow a clear conclusion regarding their relative magnitudes. This is an issue requiring empirical determination. However, output price is likely to have a stronger impact on production relative to decoupled payments. This is because lump sum transfers only impact producers' behavior through a risk effect whereas output price influences production by means of the relative price and risk effects. However, it is unclear whether the risk-related effects of the change in price will be bigger or smaller than the risk effects of decoupled payments.

While price influences both risk and risk attitudes, lump sum transfers only impact risk attitudes. Hence, if a decline in the output price occurs, a farm's expected wealth will be smaller, which is likely to increase the degree of risk aversion and stimulate a reduction in output levels. However, this effect may be constrained by the fact that a reduction in price will also cause a decline in a farm's variance of wealth. Nevertheless, to the extent that cash receipts are larger than decoupled transfers, output prices may have stronger effects on wealth and thus on risk preferences than is the case for decoupled transfers.

In order to determine the extra value that government policies add to the farm business, we compute a farm's certainty equivalent (CE) at different levels of governmental support. By using the elasticities previously determined, we assess the sensitivity of a farm's CE to governmental direct payments and price-supports. Specifically, this measure is computed for different levels of decoupled transfers and price-supports. This analysis can also be used to predict the impacts of government programs on the extensive margin of production, since a negative value of the CE indicates that the farmer would be better off by abandoning the activity. As a result, we estimate the number of farms that are likely to stop production under different support levels. A reduction in both price supports and subsidies will reduce a farm's profit, but will also increase a farmer's degree of risk aversion. Both changes are likely to trigger a decline in farmers' CE.

Empirical Specification

In order to estimate our model, we provide a parametric representation. Generalizing the model outlined above, we allow for a multi-input production technology $f(\mathbf{x})$, where $\mathbf{x}$ is a vector of n inputs.[6] The technology structure is approximated through a quadratic production function $\bar{y} = \alpha_0 + \sum_{i=1}^{n} \alpha_i x_i + \sum_{i=1}^{n} \sum_{j=1}^{n} \alpha_{ij} x_i x_j$ with α 's being parameters. Following expression (2) a system of n first-order conditions can be derived as

$$\bar{p}\frac{\partial f(\mathbf{x})}{\partial x_i} - w_i - \frac{\gamma}{\theta}\bar{W}^{1-\theta}\sigma_W^{\gamma-1}\left(f(\mathbf{x})\frac{\partial f(\mathbf{x})}{\partial x_i}\frac{\sigma_p^2}{\sigma_W}\right) = 0, \quad i=1,...,n \tag{5}$$

Parameters of the production function are estimated by ordinary least squares. Parameters that represent producers' risk attitudes are derived through the estimation of the system of equations (5) by non-linear three-stage least squares, conditional on the parameters obtained in the first step.

A two-stage estimation approach such as the one followed in this analysis will usually lead to inaccurate estimates of the parameters' standard errors. We address this problem by using bootstrapping methods. Specifically, we draw 500 pseudo-samples with replacement and re-estimate the model for each one, thus generating a sample of

[6] See the empirical application section for a definition of the inputs considered.

parameter estimates. Bootstrapping allows to derive estimates that are both efficient and robust to heteroskedasticity. Parameter estimates and their variance-covariance matrix are derived from the distribution of the replicated estimates (i.e., estimates are given by the means and variances of the replicated sample). The elasticities of output with respect to coupled and decoupled policies are constructed based on the generalization of expressions (3) and (4) to a *n*-input model[7] and are computed from the replicated estimates generated in the bootstrap.

In this section we have shown that, though the sign of the effects of decoupled government programs can, to a certain extent, be predicted by theory, the sign of the impacts of a price change and the magnitude of both payment and price effects need to be determined by empirical analysis. We devote the next two sections to studying the impacts of decoupling on production decisions in a sample of Kansas farms.

Empirical Application

US farm policy underwent substantial changes in 1996. These changes involved a decoupling of certain aspects of US farm policy in that income-support payments were untied from production. Loan rates are used in US agricultural policy to determine marketing loans and loan deficiency payments which provide income-support to farmers. Subsequent to the 1996 legislation, producers could take the difference between the loan rate and the market price (if the price were beneath the loan rate) as a direct payment form of a price support, known as a "loan deficiency payment" or LDP. Thus, the loan rate served as a support price.

[7] Details of this generalization are available from the authors upon request.

The marketing loan program has long been providing agricultural price support by removing crops from the market when prices are below the loan rate, or below the loan rate plus the interest charged on the loan. While the 1996 Farm Bill continued marketing loans, it introduced important changes in the program that reduced its potential influence on market prices. The 1996 Act eliminated base acreage requirements to be eligible for price supports and instituted fully decoupled payments that were intended to compensate growers as policies were transitioned to a greater market orientation.[8]

Our empirical analysis focuses on a sample of Kansas farmers. Farm-level data were taken from farm account records from the Kansas Farm Management Association database for the period 1998-2001.[9] Thus, our period of analysis corresponds to a time during which the 1996 FAIR Act was effective. FAIR Act payments, also known as "Agricultural Market Transition Act" or AMTA payments, correspond to our definition of fixed payments per farm. Though the analysis is based on individual farm data, aggregate data are needed to define several important variables not recorded in the Kansas dataset. These aggregates are taken from the National Agricultural Statistics Service (NASS), the United States Department of Agriculture (USDA), and the Commodity Research Bureau (CRB) historical Commodity database. NASS provides country-level price indices and state-level output prices and quantities. USDA data include state-level marketing assistance loan rates (LR) and PFC payment rates. From the CRB database we extracted information on agricultural commodity futures prices.

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[8] To receive PFC payments, farmers who had participated in the wheat, feed grains, rice, and upland cotton programs in any of the years of the period 1991-95, had to enter a 7-year PFC program (1996-2002).

[9] Retrospective data for these farms are used to define several lagged variables used in the analysis. To be able to do so, a complete, balanced panel is built from our sample.

Summary statistics for the variables of interest are presented in table 1. Four variable inputs are considered; x_1 is chemical inputs, x_2 is fertilizers, x_3 is seed use, and x_4 is a composite input that includes energy (irrigation energy, gas and fuel-oil and electricity). Because input prices are not identified in the Kansas database, country-level input price indices are taken from NASS. Implicit quantity indices for variable inputs are derived through the ratio of input use in currency units to the corresponding price index. Following the theoretical model, a single output category is considered as a quantity index that includes production of wheat, corn, grain sorghum and soybeans- the predominant crops in Kansas.[10]

An aggregate output price index is defined as a Paasche index that represents a farmer's expected price. To build the expected price index, unit prices for the crops are defined as expected prices in the following way: $\bar{p} = \max\left[E\left(Cp\right), LR\right]$, where $E(Cp)$, the expected cash price, is computed as the futures price adjusted by the basis.[11] The basis is calculated as the five preceding years' average of the difference between the cash price and the futures price. The cash price is the state-level output price. The futures price is defined as the daily average price during the planting season for the harvest month

[10] Our database does not provide information on input allocation among different outputs and thus a single aggregate output is defined. In a recent paper, Davis, Lin and Shumway (2000) extend the generalised composite commodity theorem and provide support for consistent aggregation of US agricultural outputs into as few as two categories: crops and livestock. However the composite commodity theorem ignores risk aversion and thus may entail problems in a framework that allows for risk and risk preferences.

[11] When the futures price is unavailable, the lagged cash price is taken as the proxy for the expected price, thus assuming naïve expectations. This only occurs for the sorghum futures price. Chicago Board of Trade futures prices were used for wheat, corn and soybeans.

contract. State-level production is employed to derive the aggregate expected Paasche index.

The Kansas database does not register PFC government payments. Instead, a single measure including all government payments received by each farm is recorded. To derive an estimate of farm-level PFC payments, the acreage of the program crops (base acreage) and the base yield for each crop are approximated using farm-level data. The approximation uses the 1986-88 average acreage and yield for each program crop and farm. PFC payments per crop are derived by multiplying 0.85 by the base acreage, yield and the PFC payment rate.[12] PFC payments per crop are then added to get total direct payments per farm.[13] A farm's initial wealth is defined as the farm's net worth.

Results

Our article studies farmers' behavior under risk and uncertainty. The analysis is based on the expected utility model and explicitly models government farm programs. Results of the estimation of technology and risk preference parameters are presented in tables 2 and 3, respectively. Parameter estimates for the production function have the expected signs and linear and quadratic terms are, with one exception, statistically significant. At the data means, $f_{x_i} > 0$ and $f_{x_i x_i} < 0$ which implies that an increase in input "*i*" use will increase output at a decreasing rate. Production technology for the

[12] Base acreage for most crops was established in the 1980s and thus we use actual acreage during this period to measure a farm's base acreage.

[13] This estimate is compared to actual government payments received by each farm. If estimated PFC payments exceed actual payments, the first measure is replaced by the second. This happens to 7% of our observations.

farms in our sample is characterized by decreasing returns to scale. The mean and standard deviation of the scale elasticity take the value of 0.98 and 0.016, respectively.

Parameter estimates for the risk preferences function are all statistically significant and, as expected, provide evidence that farms in our sample exhibit DARA and IRRA preferences. The Wald test indicates the model is globally significant (see table 3). The estimated risk preference parameters are close to those derived by Isik and Khanna (2003) for a sample of Illinois farmers and by Saha (1997) for Kansas wheat farmers. Bar-Shira et al. (1997) also found evidence of DARA and IRRA risk preferences for a sample of Israeli farmers. Hence, the expected utility approach yields results that are reasonable and compatible with previous research. Similarities between our risk preference parameters and the ones derived by previous analyses should also allow one to use our results to predict farmers' behavior in other circumstances.

Price and payment elasticities of agricultural output are offered in table 4. Focusing first on the total effect, coupled instruments have a much stronger impact on production than decoupled public transfers, as expected. While the output price elasticity is 1.64, the decoupled payment elasticity is 0.00043, thus suggesting that very large decoupled payments would be required to generate perceptible production effects. This conclusion is reinforced by the fact that the payment elasticity is not statistically different from zero and is compatible with Hennessy's (1998) findings that, under DARA preferences, an increase in decoupled payments will have only a minor effect on production. From these results we can conclude that a policy reform involving a reduction in price supports compensated by an increase in lump-sum payments is very likely to have the effect of reducing agricultural output.

Focusing on the decomposition of the total output effect of price into a relative price effect and a risk effect, the first effect is found to dominate the second. In a risk neutral scenario, an increase in output prices by 1 percent would generate an increase in output on the order of 1.45 percent. The difference between the relative price effect and the total effect is 0.19 which represents the risk effect of a price change. The risk effect of prices dominates the risk effect of payments (0.19 versus 0.00043). Again, this result is not surprising. For our sample farms and for the crops, decoupled payments represent less than 10% of total cash receipts. Hence, a change in output prices is likely to have a substantially stronger impact on wealth than a change in PFC payments, which reinforces the risk effect of price.

We evaluate the impacts of government programs on farmers' CE by computing this magnitude for different levels of public support and on a per acre basis. In figures 1 and 3 we represent mean CE and their 95% confidence intervals (CI). Figures 2 and 4 are the result of counting the number of farms that obtain a negative CE for different levels of support. According to USDA baseline policy variables (see USDA 2000), marketing assistance loan rates for the crops considered were reduced by about 6.3 per cent over the period of analysis. We assume that any cut in marketing assistance loan rates will correspond to an equivalent decrease in market output prices and consider three possible scenarios involving a 5, 10 and 15% decline in loan rates, which in turn involves a reduction in output prices of the same magnitudes. We analyze CE levels for a wide array of PFC cuts, from 10 to 100%.

Results confirm our findings at the intensive margin of production, i.e., that PFC payments have a negligible impact on farmers' production decisions, while the influence of price supports is potentially very powerful. If PFC payments were cut by half (figure 1), average CE could suffer a decline on the order of 10%. In spite of this decline in the CE, only 0.1% of the farms would be better off by abandoning their activity (figure 2). The elimination of PFC payments would reduce the mean CE by almost 20%, causing 0.22% of the farms to have a negative CE.

Conversely, if one assumes a reduction in market prices, the results are substantially different. A reduction in output prices on the order of 10% implies a 62% decline in the CE and triggers the abandonment of almost 9% of the sample farms. A 15% cut in market prices would reduce the CE by 86% and would motivate the abandonment of almost 45% of the farms. Finally, a 5% decline in prices has an impact at the extensive margin that is equivalent to the elimination of decoupled transfers, i.e., it causes abandonment of 0.2% of the farms.

Concluding remarks

This article develops a model of production under uncertainty based on the Isik and Khanna (2003) framework and evaluates the effects of the FAIR Act policy changes both at the intensive and extensive margins. Though the theoretical framework allows prediction of the sign of the effects of decoupled government transfers, the impacts of a price change cannot be predicted by theory. Additionally, the theoretical framework does not allow drawing a conclusion regarding the relative magnitudes of the price and payment effects. Farm-level data for a sample of Kansas farms are used to estimate the model.

Results show that farmers in the sample have risk preferences that are characterized by decreasing absolute risk aversion (DARA) and increasingly relative risk aversion (IRRA). The expected utility framework leads to reasonable results that are comparable with previous research. Similarities between our risk preference parameters and the ones derived by previous analyses suggest that our results could be used to predict farmers' behavior in other circumstances.

Though decoupled government transfers are found to motivate an increase in input use and thus in agricultural output, elasticity values are very small, requiring substantial changes in payments to generate perceptible effects on production. Conversely, the effects of coupled policies such as price-supports are found to be substantially higher. Hence, a decoupling process consisting of a reduction in price supports in favor of decoupled government transfers is very likely to involve a reduction in output. The risk effect of a price change is found to dominate the risk effect of payments, a result which is not surprising in light of the magnitude of crop cash receipts relative to decoupled transfers.

The impact of lump sum payments on farmers' CE is found to be negligible. An elimination of PFC payments may reduce the mean CE by almost 20%, but would result in only 0.22% abandonment. In comparison, a 15% price decline would cause almost 45% of the farms to have a negative CE. Hence, though PFC payments are not fully decoupled in the presence of risk and uncertainty, their effects on agricultural production seem to be of a very small magnitude.

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Table 1. Summary statistics for the variables of interest

Variable n= 2,241	Mean	Standard deviation
y (output)	146,910.66	123,608.74
$\bar{p}$ (expected price)	0.92	0.06
x_1 (chemical input)	15,022.37	17,390.11
w_1 (x_1 price)	0.99	0.01
x_2 (fertilizer)	19,798.01	21,076.48
w_2 (x_2 price)	1.01	0.06
x_3 (seed)	13,861.41	16,678.80
w_3 (x_3 price)	1.02	0.03
x_4 (energy)	15,028.54	16,471.51
w_4 (x_4 price)	1.01	0.03
G (PFC payments)	12,014.92	9,233.03
ω (initial wealth)	669,663.10	587,319.18

Note: all monetary values are expressed in constant 1998 currency units

Table 2. Parameter estimates and summary statistics for the production function

Parameter	Coefficient estimate	Standard error
α_0	-1,688.82	3,512.69
α_1	3.45**	0.37
α_2	2.23**	0.28
α_3	2.15**	0.46
α_4	2.44**	0.38
α_{11} (1)	-1.79**	0.62
α_{22}	-0.45*	0.27
α_{33}	-0.14	1.02
α_{44}	-2.18**	0.71
α_{12}	-0.94	0.79
α_{13}	0.50	1.36
α_{14}	0.66	1.41
α_{23}	0.48	11.60
α_{24}	1.72	1.08
α_{34}	0.11	1.64

Note: An asterisk (*) denotes statistical significance at the α = 0.1 level

Two asterisks (**) denote statistical significance at the α = 0.05 level

(1) All cross terms were scaled by 1/100,000

Table 3. Parameter estimates and summary statistics for the risk preferences function

Parameter	Coefficient estimate	Standard error
γ	1.26**	0.03
θ	1.02**	0.01
Wald test for global significance $H_0 : \alpha_i = \alpha_{ii} = \alpha_{ij} = \gamma = \theta = 0$		23,647.00**

Note: An asterisk (*) denotes statistical significance at the α = 0.1 level

Two asterisks (**) denote statistical significance at the α = 0.05 level

Table 4. Elasticity estimates at the data means

	Elasticity value	Standard error
	Total Effect	
ε_{y_p}	1.64*	0.88
ε_{y_G}	4.43E-4	6.66E-4
	Risk Effect	
ε_{y_p}	0.19*	0.10
ε_{y_G}	4.43E-4	6.66E-4
	Relative price effect	
ε_{y_p}	1.45*	0.88
ε_{y_G}	-	-

Note: An asterisk (*) denotes statistical significance at the α = 0.1 level

Government payments have no relative price effect, which is denoted by '-'

Figure 1. Farm's certainty equivalent for different levels of PFC payments

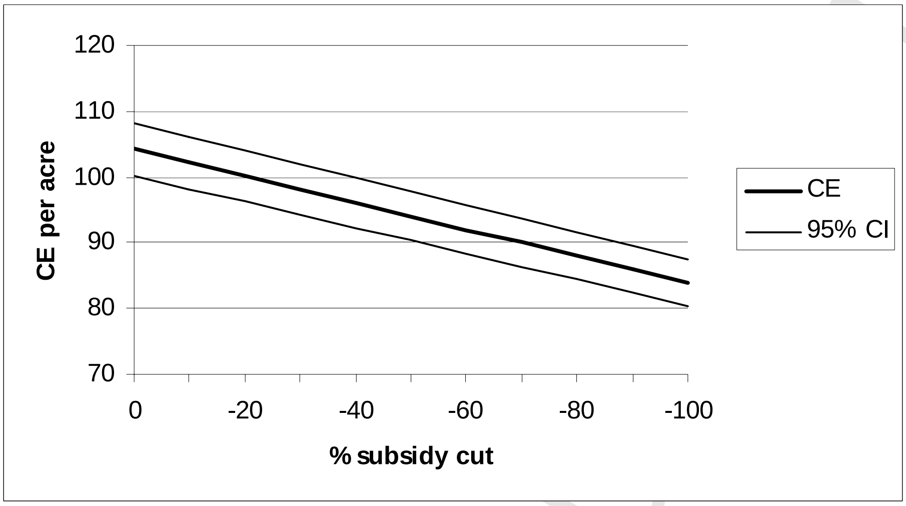

Figure 2. Percentage of farms that will obtain a negative certainty equivalent if PFC payments are reduced

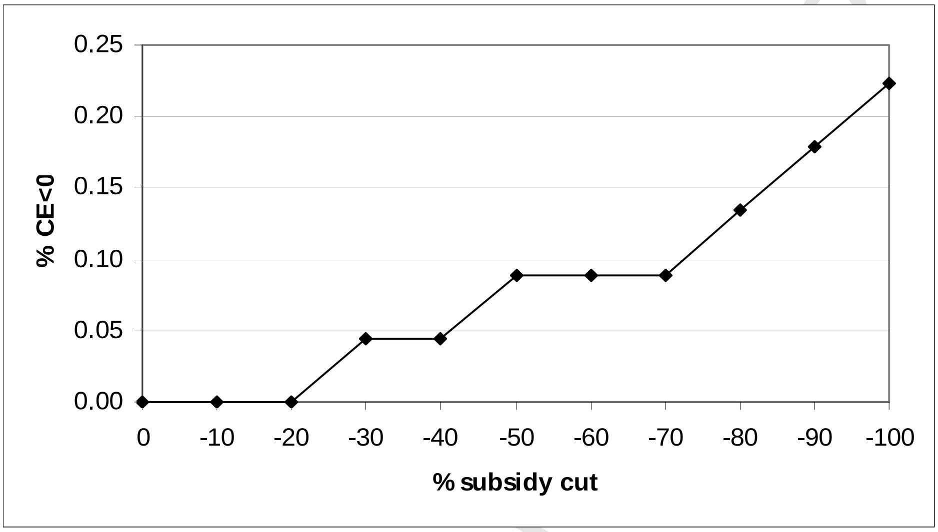

Figure 3. Farm's certainty equivalent for different levels of price supports

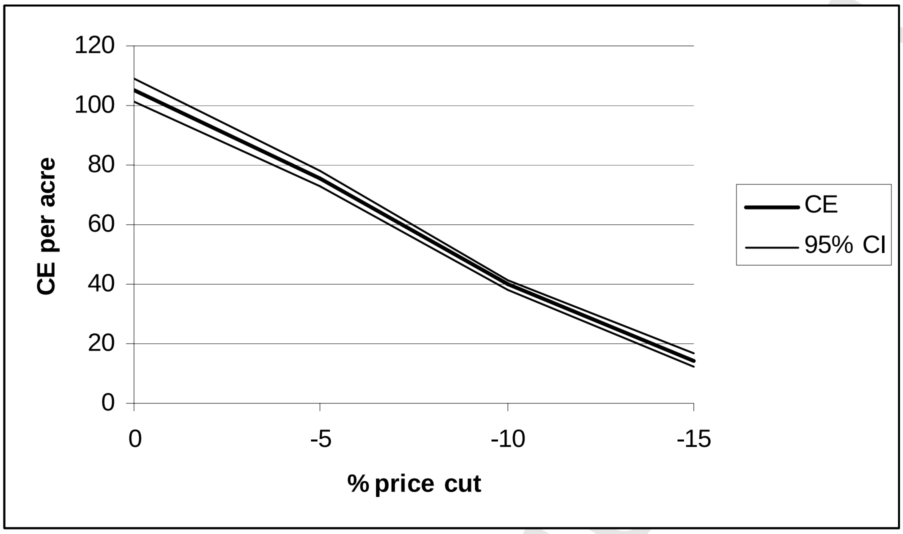

Figure 4. Percentage of farms that will obtain a negative certainty equivalent if price supports are reduced