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EFFECT OF DECOUPLED PAYMENTS ON U.S. AGRICULTURAL PRODUCTION

KIM TAE-HUN*

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Abstract
In the current WTO negotiations, the developing and the developed countries take opposite view regarding the criteria for green box subsidies supposed to be decoupled from current production levels and prices. This study investigates whether U.S. PFC and direct payment subsidies are truly decoupled from production or not by modeling the farmers' risk attitudes in a non-structural approach and estimating the effect of decoupled payments on production by the change in risk attitudes. The effect of decoupled payments is not only statistically insignificant on corn and soybean acreage but also very small in magnitude.

I. Introduction

In the current world trade negotiations, several developing countries argue that some subsidies that developed countries designate as green box subsidies fail to meet the criteria. Because of the large amounts of money paid or because of the nature of these subsidies, they argue that trade distortions may be more than minimal. The developing countries assert that the developed countries avoid their responsibility to reduce their support by "box switching" from amber box to green box, and hence that such switching should be restricted.

* Fellow, Korea Rural Economic Institute, Seoul, Korea.

However, some other countries take an opposite view that the current criteria of the green box are adequate, and countries might even need more flexibility to take better account of non-trade concerns such as environmental protection and animal welfare (Josling 2003).

Since 2000, many studies have been performed to untangle this dispute by empirically measuring the effects of decoupled payments. The most important class of those studies was to measure the effect of decoupled payments on agricultural production, especially land allocation. Other classes of studies focused on land values, time allocation, credit constraints and so on (Abler and Blandford 2005). Those studies examining production impacts hypothesize that decoupled payments may affect decision makers' risk attitude and, in turn, change their production decision when they exhibit decreasing absolute risk aversion. However, it is hard to find empirical studies measuring production impacts directly using risk attitudes, although they infer that behind the logic of their results is the change of decision makers' risk attitude. More importantly, some of the previous research (Young and Westcott 2000; Westcott and Young 2002; Lin and Dismukes 2004) directly used a wealth variable or the elasticity of wealth to obtain the effect of decoupled payments on acreage, assuming that decoupled payments have the same impacts on production as wealth does. However, the validity of this assumption generally has not been empirically tested.

This study determines whether the U.S. Production Flexibility Contract (PFC) payment and direct payment subsidies are truly decoupled from production or not. To achieve this objective, 1) farmers' risk attitudes are modeled, 2) the effect of decoupled payments on the change in risk attitude is estimated, and 3) this is used to measure the effect of these payments on production. It also empirically tests the validity of an assumption that the effect of decoupled payments on risk attitudes is not different from that of wealth. Without verifying this assumption, the common explanation for the effect of decoupled payments making reference to wealth-induced changes in risk attitudes may be inappropriate

II. Measuring decoupled payments' effects

The econometric studies related to the effects of decoupled payments are divided into several categories by their focus of analysis. Abler and Blandford (2005) classified previous econometric studies on the effect of decoupled payments into studies of land allocation, time allocation, and land rents and land values. The effect related to production, especially land allocation, is more important than others with respect to trade distortion.

This study focuses on measuring production effects of decoupled income support subsidies. In terms of methodology, there are several ways to measure the effects of decoupled payments, including a single equation model, a general equilibrium model, and a partial equilibrium model. A single equation model estimates a single equation, such as an acreage supply response model, and then measures the change in acreage or input use in response to changes in wealth (Chavas and Holt 1990; Young and Westcott 2000; Westcott and Young 2002; Hennessy 1998; Goetz et al. 2003; Goodwin and Mishra 2002; Lin and Dismukes 2004; Key, Lubowski and Roberts 2004).[1] It is easy to estimate and utilize both farm and aggregate-level data, but it is hard to measure dynamic effects of decoupled payments.

The general equilibrium approach has involved using a Computable General Equilibrium (CGE) model in many previous studies (Burfisher, Robinson, and Thierfelder 2000;. Burfisher and Hopkins 2003). Although a CGE model takes into account all flows in an economy, it is much more aggregated than other models and it is mostly static. Also the results of CGE models are sensitive to the model specification, the calibration of the parameters, and the quality of created data (Charney and Vest 2003).

The third approach is using a partial equilibrium model. It estimates the effects of decoupled payments on acreage using a single equation and then applies the results to a macro-econometric model. Such an approach can measure dynamic effects but is based on strong assumptions (Adams et al. 2001).

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[1] Chavas and Holt (1990) and Hennessy (1998) did not estimate the effect of decoupled payments but measured wealth effects on acreage and production effects of income support policies.

Most previous studies found that the effects of decoupled payments were small and sometimes statistically insignificant. And in the Brazilian cotton case, the panel did not find any significant trade-distorting effects from PFC and direct payments although the panel ruled that PFC and direct payments do not completely meet the green box criteria.

The methodology of this study is similar to the first approach but directly uses risk attitude measures to estimate effects of decoupled payments. Most previous studies explained their results by using the change of farmer's risk attitude but didn't directly use a risk attitude variable due to the absence of data.

III. Models and data

In order to measure the effect of decoupled payments, farmer's risk attitude is first estimated. The main methodologies for measuring farmers' risk attitudes can be classified into the reduced-form approach, the structural approach, and the nonstructural approach (Saha et al. 1994; Antle 1989). In this study, the nonstructural approach proposed by Antle(1989) is adopted because farmers' risk attitudes over time are necessary to achieve the main objective of this study.

Antle (1989) proposed a nonstructural approach which measures farmers' risk attitude by changes in the moments of the profit distribution. The nonstructural approach unlike a structural approach does not require specific functional forms for utility or production. This approach replaces optimal input choice with the assumption that farmers optimally manage their production activities while the structural approach uses optimality conditions to determine input choice under assumed functional forms.

From the theoretical derivation based on Antle(1989) and Gardebroek (2002), the final equation to be estimated for measuring farmers' risk attitudes is derived as

$$D_{1jt} = \alpha_0 + \alpha_1 d_t - \sum_{i=2} (\beta_{i0} + \beta_{i1} d_t) D_{ijt} + w_{jt} = \alpha_0 + \alpha_1 d_t - \sum_{i=2} \beta_{i0} D_{ijt} - \sum_{i=2} \beta_{i1} d_t D_{ijt} + w_{jt} \qquad (1)$$

Where D_{ijt} = the change in the moments of the profit distribution

$w_{jt} = \varepsilon_{jt} - \sum_{i=2} \nu_{ijt} D_{ijt}$, d_t = time dummy variables

Although previous studies used this approach did not measure farmers' risk attitude over time, Antle (1989) argued that it can be measured by manipulating $\beta_{it} = \beta_{i0} + \beta_{i1} d_t$. According to Antle (1989), $-2\beta_2$ approximates the absolute Arrow-Pratt measure of risk aversion. Therefore, the coefficient of absolute risk aversion (ARA) is calculated as $-2\beta_{it} = -2(\beta_{i0} + \beta_{i1})$. In order to estimate this equation, the change in the moments of the profit distribution(D_{ijt}) should be obtained. D_{ijt} is calculated by making difference of estimated first and higher moments of the profit distribution. Moment equations are defined as a function of implicit inputs, the crop portion of receipts, the agriculture portion of proprietors, and time dummy variables. Other characteristic variables are used as exogenous instruments where necessary.[2]

The first and higher moment equations to be estimated are specified as

$$FMPD = \alpha_f + \beta_{f1} QLS + + \beta_{f2} QFD + \beta_{f3} QSD + \beta_{f4} QFT + \beta_{f5} QNRLR$$
$$+ \beta_{f6} RATIO + \beta_{f7} NUM + \gamma_{ft} DM + e_f \qquad (2)$$

where FMPD= first moment (net realized income, \$ million) deflated by CPI
QLS(million \$) = Live animal purchased (\$1,000)/ live animal price index×100/1000
QFD(million \$) = Feed purchased (\$1,000)/ feed price index×100/1000
QSD(million \$) = Seed purchased (\$1,000)/ seed price index×100/1000
QFT(million \$) = Fertilizer purchased (\$1,000)/ fertilizer price index×100/1000
QLR(million \$) = Labor purchased (\$1,000)/ wage index×100/1000
RATIO(%)= Crop revenue/(crop revenue + livestock revenue)×100
NUM(%) =#of farm proprietors/(# of farm proprietors+# of non farm proprietors)×100
DM= time dummy variables from 1993 to 2002

$$HMPD = (e_f)^h = \alpha_h + \beta_{h1} QLS + + \beta_{h2} QFD + \beta_{h3} QSD + \beta_{h4} QFT + \beta_{h5} QLR$$
$$+ \beta_{h6} RATIO + \beta_{h7} NUM + \gamma_{ht} DM + e_h \qquad (3)$$

where HMPD = higher moments. If superscript h=2, HMPD is the second moment

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2 In order to estimate moment equations, Gardebroek (2002) used fertilizer, seeds and plants, pesticides, contractor work, hired labor, family labor, machinery, and land as a set of independent variables. Antle(1989) used land in crops, total fertilizer quantity used in crop production, machinery input, human labor input, animal labor input, total value of land owned, area irrigated, an interaction term between area irrigated and fertilizer used, an index of crop diversification, and time dummy.

Since each farmer within a state may face similar input and output prices, input and output prices are not included in the estimated equations. If input prices and output prices are nonstochastic, the profit distribution is equivalent to a revenue or an output distribution(Antle 1987). Previous studies also did not use price variables.

In order to measure the effects of decoupled payments on agricultural production using farmers' risk attitudes obtained by the nonstructural approach, we should first measure the effect of decoupled payments on risk attitudes. By using estimated risk attitudes, a risk attitude function is estimated

$$R_t = f(NINC_t, PFC_t, OGP_t, NDET_i, NLAND_t, DM_i.) \quad \text{for } t=1\cdots T \quad (4)$$

where R = risk attitudes estimated by Antle's nonstructural approach,

$NINC$ = Net realized income-total government payments,
PFC = PFC payments,
OGP = Government payments-PFC payments,
$NDET$ = farm debt,
$NLAND$ = farm land per farm,
DM = state dummy variables

Farmers' risk attitude at the state level is defined as a function of different types of incomes, farm debt, size of farm, and state dummy variables. Coefficients on income and government payments are expected to be negative, which means that farmers are willing to take more risk as their income increases. From eq (4), we obtain the effect of PFC payments on risk attitudes and then use it later for calculating the effect of decoupled payments.

To measure the effects of PFC payments on production, an acreage function is estimated as a function of a lagged dependent variable, own expected price, cross expected price and risk attitude.

$$NA_t = f(NA_{t-1}, EP_{t,output}, EP_{t,other} R_{t-1}) \quad (5)$$

where NA = normalized acreage,

$EP_{t,output}$ = expected price of output,
= cross expected price

An expected price in this study is defined as

$$EP_t = P_{t-1} + MLDP_{t-1} \tag{6}$$

where EP= expected price, P= market price, MLDP = LDP and MLG supports (\$/bu)

So, the effect of decoupled payments is calculated by combining the results of eq (4) and eq (5). Decoupled payments affect farmer's risk attitudes according to eq (4) and, in turn, affect acreage according to eq (5). In other words, the effect of decoupled payments is expressed as follows.

$$\frac{\partial A}{\partial PFC} = \frac{\partial A}{\partial R} \times \frac{\partial R}{\partial PFC}$$

where A means acreage, R is risk attitude, PFC is PFC payments.

To estimate the empirical model for measuring farmers' risk attitudes and moment equations in each state, we need data on production costs, profits and farmers' characteristics for each state. This study uses county-level data from the Regional Economic Information System (REIS) database of the Bureau of Economic Analysis (BEA). This data covers the period from 1993 to 2002.

Profit in this study means realized net income, defined as cash receipts from marketing plus other income, including government payments, minus total production expenses. Profits are expressed in real terms by deflating by the Consumer Price Index (CPI). Input variables used in the estimation of farmers' risk attitudes are purchased livestock, feed, seed, fertilizer and agricultural chemicals, petroleum products, and hired farm labor. Those variables in the original data are expressed in value terms. Thus, to convert these value terms to implicit quantity terms, the value variables are deflated by their respective own-price indices having 1990-92 bases. Input prices were obtained from U.S. Department of Agriculture-National Agricultural Statistics Service (USDA-NASS). Since the values of fertilizer and agricultural chemicals are combined in the original data, a weighted input price index was calculated using annual weights for input components (Agricultural Prices, USDA-NASS). As county characteristic variables, the farm portion of proprietors is defined as the number of farm proprietors over the number of farm and non-farm proprietors, which may indicate the share of agriculture in the economy of each county. The crop portion of revenues is calculated by dividing crop revenue by crop and livestock revenue. This indicator reflects the relative importance of crop production in the agriculture of each county.

For the analysis of decoupled payments' effect on production, acreage, yield, and price data for corn and soybeans are collected from USDA-NASS. PFC payments and other government payment data are obtained from USDA-ERS, and Loan Deficiency Payments (LDPs) and Marketing Loan Gains(MLGs) data are collected from U.S. Department of Agriculture-Farm Service Agency (USDA-FSA). The data covers from 1996 to 2002 for each state.

Ⅳ. Estimation Results

As mentioned earlier, the first moment and higher moments have to be estimated in order to measure risk attitudes. The first, second and third moment equations derived in the previous section are estimated for each state. The first moment and the second moment are selected to estimate eq (1) by testing the overall significance of the regression for moment equations (appendix 1). Using the estimated first moment and second moment, the derived models for measuring risk attitude are estimated. The estimation results for each state are given in appendix 2. Both the second moment and its interaction terms with time dummy variables in each state are significant at the 10 percent critical level. And the result of the overall significance test (F-test) rejects the null that all parameters are equal to zero(appendix 2).

The coefficient of absolute risk aversion (ARA) is calculated as $-2\beta_{it} = -2(\beta_{i0} + \beta_{i1})$ from the risk attitude equation (Antle 1987, 1989). The calculated ARA in each state is shown in Table 1. Farmers' risk aversion coefficients of each state are negative in all states and entire periods except Iowa in 1999. Although negative risk aversion coefficients means producers are risk loving, we cannot be sure whether it is risk loving or risk neutral, because there are no formal criteria for how large the ARA coefficient can be and still be considered risk neutral. In terms of ARA, Indiana is relatively less risk averse than other states. And the ARA in Illinois and Missouri is stable over time.

The coefficients of Relative Risk aversion (RRA) are calculated as all negative except Iowa in 1999 (Table 1). The RRA in Illinois and Missouri is very stable over time, while that in Iowa and Indiana has changed much more over time. Moreover, the RRA becomes less negative over time, especially for Iowa, Indiana, and Ohio.

Table 1. The coefficients of risk aversion

	ARA					RRA				
	IA	IL	IN	MO	OH	IA	IL	IN	MO	OH
1995	-0.46	-0.24	-0.74	-0.48	-0.51	-11.04	-3.56	-5.25	-1.03	-3.95
1996	-0.38	-0.22	-1.04	-0.31	-0.71	-6.57	-1.37	-6.53	-0.77	-4.42
1997	-0.39	-0.01	-0.99	-0.24	-0.78	-8.85	-0.10	-8.00	-1.24	-7.07
1998	-0.58	-0.13	-1.07	-0.34	-0.55	-6.78	-0.87	-0.40	-0.76	-3.37
1999	0.35	-0.12	-1.41	-0.52	-0.27	3.01	-0.52	-2.83	-0.53	-1.41
2000	-0.22	-0.12	-1.10	-0.47	-0.48	-2.84	-0.79	-2.99	-1.23	-1.97
2001	-0.18	-0.23	-0.81	-0.23	-0.28	-1.79	-1.66	-4.33	-0.58	-1.32
2002	-0.14	-0.24	-0.79	-0.29	-0.41	-0.85	-1.02	-1.28	-0.07	-0.80

Note: RRA is calculated as multiplying ARA by an average net income in each state.

For measuring the effect of decoupled payments on production, the structure of risk preferences is more important in this study than the absolute level of risk aversion itself. In other words, our main interest is how much farmers' level of risk aversion is changed when they get decoupled payments. Mathematically, becoming more risk loving as wealth increases has the same implications as becoming less risk averse.

In order to measure the effect of decoupled payments on production, we first need to calculate how much decoupled payments affect a farmer's risk aversion level. We split farmers' income into market income, PFC payments and other government payments, and then estimate several equations with combinations of those income and payment variables as independent variables. Estimating several models and conducting statistical tests suggest that income sources do not matter to farmers' risk attitude (appendix 3). All variables have the expected signs. All models have a negative sign on market income and other government payment variables at the 5 percent critical level. A PFC payment variable is significant at the 10 percent critical level in model 2 but not significant in model 4. The debt (DEBT) variable is significantly positive in each state, which implies that increasing debt makes farmers more risk averse or less risk loving. The result of testing whether or not the effect among different income sources is the same accepts the null in all the cases at the conventional critical levels. Therefore, we cannot reject the hypothesis that only the amount of wealth matters in determining risk attitudes, not the source of wealth.

This is an important finding. Some previous studies (Young and Westcott 2000; Westcott and Young 2002; Lin and Dismukes 2004) directly used the elasticity of wealth to calculate the effect of decoupled payments on acreage without testing the impact on the level of risk aversion. In other words, they assumed that decoupled payments have the same effect on acreage as other sources of wealth without empirically testing this assumption. The test in this study supports the validity of this approach.

Therefore, the model selected for measuring the effect of decoupled payments on risk attitude is

$$RRA = 12.1 - 3.98INC + 3.25DEBT - 111.13LAND$$

(0.92) (-4.05)* (1.88)** (-1.43)

$$1.96Dia + 11.75Dil + 1.47Din + 7.65Dmo + 6.19Dia99$$

(0.18) (1.04) (0.43) (1.25) (4.17)*

$R^2 = 0.85$, $F(8, 31) = 21.17$

where RRA=Relative Risk Aversion coefficients,
INC=net realized income deflated by CPI ($ billion),
DEBT=each state's debt deflated by CPI ($ billion),
LAND=farm land per farm (1000 acres),
Dia=dummy variable for IOWA, Dia99= dummy variable for IOWA and 1999.
*= 5% critical level, ** = 10% critical level

In the equation, the income (INC) and the debt (DEBT) variables are statistically significant and have an expected sign. It implies that farmers in the Corn Belt exhibit DRRA.[3] An increase of 1 billion dollars in real income results in making farmers more risk loving (less risk averse) by decreasing their RRA by 3.98 points, while an additional 1 billion dollars of debt causes RRA to increase

[3] DRRA means that farmers hold a larger percentage of wealth or income in risky assets as wealth or income increases.

by 3.25 points.

Now, by estimating acreage functions for corn and soybeans with an estimated risk attitude variable (RRA), the effect of decoupled payments is measured. Table 2 gives several estimation results of acreage functions. Both models are estimated by the Seemingly Unrelated Regression (SUR) method, because the planting decisions of commodities, especially corn and soybean, are closely related.

TABLE 2. The estimation results of acreage functions

	Model1		Model2	
	corn	soybean	corn	soybean
$NACR_{t-1}$	0.9833* (0.0577)	0.3677* (0.0913)	0.9878* (0.0570)	0.4176* (0.1082)
EP_corn,t			0.2726* (0.1009)	
EP_soybean,t			-0.0782 (0.0536)	
REP_corn,t	1.3272* (0.4380)			
REP_soybean,t		0.0932* (0.0327)		0.0858* (0.0339)
RRA_{t-1}	0.0076 (0.0063)	-0.0020 (0.0023)	0.00923 (0.0064)	-0.0021 (0.0024)
constant	-0.4603* (0.1930)	0.4582* (0.1040)	-0.0494 (0.1245)	0.4229* (0.1116)
R^2	0.81	0.45	0.82	0.44

where $NACR_{t-1}$= normalized acreage (thousand acres),
EP_corn,t=Expected corn price($/bu)(=(P_corn,t-1+P_cmldp,t-1)/CPI*100),
EP_soybean,t=Expected soybean price($/bu)(=(P_soybean,t-1+P_smldp,t-1)/CPI*100),
P_corn: corn market price($/bu), P_soybean : soybean market price($/bu),
P_cmldp: LDP+MLG for corn($/bu), P_smldp : LDP+MLG for soybean($/bu),
REP_corn,t= the ratio of prices(=EP_corn,t/EP_soybean,t),
REP_soybean,t = the ratio of prices(=EP_soybean,t/EP_corn,t),
RRA: relative risk attitudes,
CPI=Consumer Price Index
* : significant at the 5% critical level

In model 1, the ratio of expected prices and the lagged dependent variable are significant at the 5 percent critical level in both corn and soybean equations. Those variables have a positive sign, which is consistent with theory. The coefficient of the lagged dependent variable in the corn equation is large but that is more reasonable in the soybean equation. The RRA in the soybean acreage equation has a negative sign, indicating that producers increase soybean planting as they become more risk loving (less risk aversion), but the effect is not significant. In the corn equation, RRA has a positive sign but is statistically insignificant

In model 2, the lagged dependent variable and the own-price in the corn equation are significant at the 5 percent critical level and have a positive sign. The lagged dependent variable in the corn equation is also high in model 2. In the soybean equations, the price and the lagged dependent variable are statistically significant at the 5 percent critical level but RRA is not. Although all variables have the expected sign, the lagged dependent variable is significant but other variables are not.

Ⅴ. Economic analysis

The estimation result of the risk attitude equation indicates that the effect of income on RRA depends on the amount of income, not the source of it. Thus, an additional dollar of PFC payments has the same effect on producer risk aversion levels as any other source of income. However, RRA variables are not significant in the estimated acreage functions. The results suggest that the change of farmers' risk aversion levels cannot explain well the change of corn and soybean acreage in the Corn Belt. In other words, although the RRA in this study had greater variance than other studies, it still did not exhibit a significant impact on planting decisions. Therefore, this study has not found any statistically significant effects of PFC payments on corn or soybean acreage, although PFC payments have significant effects on RRA levels.

Although the coefficients of RRA in acreage equations are insignificant, it is informative to calculate the impacts of one billion dollars of PFC payments. In soybean equations, increasing one billion dollars of PFC payments would increase soybean plantings by 51 thousand to 53 thousand acres. In corn equations, one billion dollars of PFC payments would decrease corn plantings by 197 thousand to 238 thousand acres. As already noted, the impacts of PFC payments on corn acreage do not have the expected sign, but for both crops the impacts are not only statistically insignificant but also very small in magnitude.

As compared with previous studies, the result in this study is not surprising. Burfisher et al. (2003) argued that the effect of PFC payments is negligible. Adams et al. (2001) also found only weak evidence that PFC and MLA payments increase acreage. Westcott and Young (2002) estimated that the one-time effect of PFC payments is 60 thousand acres per one billion dollars and the permanent effect of PFC payments is 0.3 to 1.0 million acres per one billion dollars. However, Goodwin and Mishra (2002) estimated that a doubling of PFC payments would increase corn and soybean acreages by 5.9 percent and 4.9 percent, respectively. Although they suggested that this effect was modest, it is quite large relative to other studies. In sum, this study and many previous studies found that decoupled payments did not have any significant effect on production, and the effect of PFC payments is small under most model specifications.

Meanwhile, expected price variables in the acreage equations are statistically significant and have the expected signs. Using the elasticity of expected price[4], the effect of coupled payments is calculated. Given the production of the Corn Belt in 1999-2001[5], one billion dollars of coupled payments have the effect of increasing the returns by $0.20 and $0.65 for corn and soybean, respectively. Increasing one billion dollars of coupled corn payments increases corn acreage by 354 thousand to 460 thousand acres. In the case of soybean, one billion dollars of coupled payments increase soybean acreage by 245 thousand to 266 thousand acres.

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[4] The elasticity of own-price ranges from 0.23 to 0.45 for corn and from 0.11 to 0.21 for soybean. This is close to the result of Lin and Dismukes (2004). They estimated own-price elasticity, of 0.33 for corn and 0.25 for soybean.

[5] During the 1996 farm bill period, LDP and MLG have been mainly supported for 1999-2001. So, an average price support of 1 billion dollars ($/bu) is calculated as dividing 1billion dollars by average production during 1999-2001.

Ⅵ. Conclusion

While decoupled payment programs are an important and controversial subject in the current WTO negotiations, the optimization theory for production or profit in neoclassical economics unfortunately cannot explain the possible effects of decoupled payments well. According to standard neoclassical economics analysis ignoring the effect of risk, an additional lump sum income or fixed costs do not affect the optimal choice of inputs. For this reason, many studies introduce the risk attitude concept to explain the possible effect of decoupled payments. They argue that decoupled payments may affect the farmers' level of risk aversion, and then the change of their risk attitude may affect the allocation of resources. However, it is hard to find an empirical study directly using risk attitude measures to estimate crop supply. Although some studies measured the effect of decoupled payments using a wealth effect variable, they have failed to test the validity of the assumption that decoupled payments have the same impact on production as that of wealth. Therefore, this study measures the farmers' risk attitude over time and directly uses it to measure the effect of decoupled payments.

The result of risk attitude estimation suggests that farmer's risk attitudes are mostly risk loving and change over time. In contrast to the results of this study, farmers' risk attitudes are generally considered to be risk averse and very stable over time. However, it is hard to judge the validity of this result in comparison with others. Some empirical studies show that farmers' risk attitude is sometimes risk loving, and there has not been previous empirical research estimating risk attitudes over time. More importantly, the definition of risk attitude in this study is different from most other studies. While other methodologies measure risk attitude with respect to a specific type of risk and in a specific place and time, the non-structural approach in this study is not bounded by the type of risk or by the range of region and time. So, the result may well differ from previous studies.

From the result of the risk attitude function, it is possible to conclude that only the amount of money matters in determining risk attitude. PFC payments and other types of income have the same effect on risk attitudes, which implies that the elasticity of wealth or a wealth variable can be used to measure the effect of decoupled payments.

In measuring the effect of decoupled payments on the planting decision, the impacts of PFC payments on corn and soybean acreage are not only statistically insignificant but also very small in magnitude. Therefore, this study has not found any significant impact of PFC payments on corn and soybean acreages. Compared to the coupled effects of an additional one billion dollars on acreage, the decoupled effects are much smaller, which is what we expect.

Appendix1. The test of the overall significance of moment equations

	d.f	First moment	Second moment	Third moment
IOWA	F(16, 973)	118.46	8.95	1.08
	Prob >F	0.00	0.00	0.37
ILLINOIS	F(16, 984)	54.02	5.75	1.05
	Prob >F	0.00	0.00	0.40
INDIANA	F(16, 903)	71.38	5.14	1.22
	Prob >F	0.00	0.00	0.25
MISSOURI	F(16, 1051)	54.48	3.55	1.24
	Prob >F	0.00	0.00	0.23
OHIO	F(16, 838)	54.34	4.55	0.80
	Prob >F	0.00	0.00	0.69

Appendix 2. The result of GMM estimation for risk attitudes

	Iowa	Illinois	Indiana	Missouri	Ohio
y95	26.348 (1.885)	-56.755 (35.157)	3.25 (2.63)	-21.948 (3.520)	-9.924 (8.011)
y96	23.290 (4.533)	-68.329 (35.220)	-6.05 (2.63)	-18.094 (3.555)	-15.200 (8.014)
y97	24.277 (0.984)	-60.213 (35.163)	-4.02 (2.64)	-17.234 (3.517)	-10.168 (8.011)
y98	10.773 (1.022)	-69.152 (35.136)	-9.95 (2.63)	-21.871 (3.518)	-17.160 (8.014)
y99	16.055 (1.104)	-67.429 (35.168)	0.46 (2.64)	-21.862 (3.516)	-13.819 (8.003)
y00	23.407 (0.995)	-62.454 (35.163)	-3.99 (2.63)	-17.759 (3.518)	-12.725 (8.009)
y01	15.386 (0.956)	-64.497 (35.163)	-1.05 (2.63)	-19.939 (3.517)	-12.896 (8.015)
y02	13.757 (0.954)	-68.789 (35.165)	-10.31 (2.78)	-22.552 (3.517)	-17.542 (8.013)
s95	-2.196 (0.856)	-2.049 (1.007)	-4.47 (1.02)	-2.055 (0.391)	-4.035 (2.114)
s96	-2.238 (0.847)	-2.056 (1.008)	-4.32 (1.01)	-2.137 (0.397)	-3.933 (2.107)
s97	-2.233 (0.854)	-2.162 (1.007)	-4.35 (1.01)	-2.173 (0.395)	-3.896 (2.114)
s98	-2.136 (0.857)	-2.103 (1.008)	-4.31 (1.02)	-2.123 (0.392)	-4.015 (2.114)
s99	-2.605 (0.870)	-2.105 (1.009)	-4.14 (1.02)	-2.032 (0.394)	-4.154 (2.114)
s00	-2.319 (0.857)	-2.107 (1.007)	-4.29 (1.02)	-2.061 (0.393)	-4.047 (2.114)
s01	-2.337 (0.856)	-2.050 (1.008)	-4.44 (1.02)	-2.179 (0.392)	-4.149 (2.114)
s02	-2.357 (0.856)	-2.048 (1.007)	-4.45 (1.01)	-2.148 (0.396)	-4.081 (2.114)
dsmom	2.428 (0.856)	2.166 (1.007)	4.84 (1.02)	2.294 (0.392)	4.288 (2.114)
_cons	-18.268 (0.953)	64.968 (35.163)	4.44 (2.63)	19.778 (3.517)	13.057 (8.010)
obs	891	895	828	966	767
	F(17, 873)= 28572.51	F(17, 877)= 12722.40	F(17, 810)= 49497.60	F(17, 948)= 5590.77	F(17, 749)= 1198.97

Appendix3. The estimation results of risk attitude functions and the F-test on coefficients

Dependant Var. : RRA	Model1		Model2		Model3		Model4	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
NINC	-3.98*	0.98						
NINCP			-4.00*	1.00				
NINCT					-3.97*	1.00	-4.00*	1.02
NTGP					-4.00*	1.33		
NTGPX							-4.03*	1.35
NPFC			-5.04**	3.01			-5.07	3.19
NDET	3.25**	1.73	3.31**	1.76	3.28**	1.94	3.33**	1.98
NLAND	-111.14	77.60	-113.69	79.00	-111.57	80.33	-114.12	81.81
Dia	1.96	11.02	2.27	11.20	1.92	11.30	2.23	11.49
Dil	11.75	11.34	12.17	11.56	11.76	11.54	12.18	11.76
Din	1.47	3.42	1.58	3.48	1.47	3.48	1.59	3.54
Dmo	7.65	6.13	7.82	6.24	7.67	6.26	7.84	6.37
Dia99	6.19*	1.48	6.22*	1.51	6.20*	1.62	6.24*	1.65
_cons	12.10	13.10	12.54	13.34	12.13	13.36	12.57	13.61
Hypothesis			NINCP=NPFC		NINCT=NTGP		NINCT=NTGPX =NPFC	
F-Statistic			F(1, 30) = 0.14		F(1, 30) = 0.00		F(2, 29) = 0.07	
Prob > F			0.71		0.98		0.93	
R^2	0.85		0.85		0.85		0.85	

where RRA=Relative Risk Aversion coefficients, NINC=net realized income deflated by CPI,
NINCP=(net realized income-PFC) deflated by CPI,
NINCT= =(net realized income-government payments) deflated by CPI
NTGP= total government payment deflated by CPI,
NTGPX=(total government payment-PFC) deflated by CPI,
NPFC=PFC payments deflated by CPI, NDEBT=each state's debt deflated by CPI,
NLAND=land per farm(1000 acres),
Dia=dummy variable for Iowa, Dil=dummy variable for Illinois,
Din=dummy variable for Indiana, Dmo=dummy variable for Missouri,
Dia99= dummy variable for IOWA and 1999.
* = 5% critical level, ** = 10% critical level.

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