THE MEASUREMENT OF DECOUPLED PAYMENTS' EFFECTS ON U.S. AGRICULTURAL PRODUCTION

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THE MEASUREMENT OF DECOUPLED PAYMENTS' EFFECTS ON U.S. AGRICULTURAL PRODUCTION

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ABSTRACT

Under World Trade Organization (WTO) rules, green box subsidies are those subsidies that do not distort trade, or cause at most minimal distortion. They include direct income support to farmers that is decoupled from current production levels and prices. In the current WTO negotiations, the developing and the developed countries take an opposite view regarding the criteria for green box subsidies. In this background, this study investigates whether U.S. PFC and direct payment subsidies are truly decoupled from production or not. Many studies introduce the risk attitude concept to explain the possible effect of decoupled payments and argue that decoupled payments may affect the allocation of resources through the change of producers' risk attitudes. However, it is hard to find an empirical study directly using risk attitude measures to estimate crop supply. Therefore, this study models the farmers' risk attitudes in a non-structural approach and estimates the effect of decoupled payments on production by the change in risk attitudes. The results show that farmers' risk attitudes are mostly risk loving and change over time, which is different from other studies. The results also show that only the amount of money matters in determining risk attitude. The effect of decoupled payments is not only statistically insignificant on corn and soybean acreage but also very small in magnitude.

Chapter 1

Introduction

1.1. Problem Statement

Under World Trade Organization (WTO) rules, countries must operate within certain limits when setting agricultural policies. These rules classify polices into categories of support called 'boxes' depending on the level of distortion. Amber box subsidies make reference to the programs that have a direct effect on production and trade. Those subsidies are subject to strict reduction commitments in the agreement. Blue box programs are amber box programs with certain conditions that are intended to reduce distortion, such as limiting production. Green box subsidies are those subsidies that do not distort trade, or cause at most minimal distortion. They are government funded but do not act to support prices. They include direct income support to farmers that is unrelated to ("decoupled" from) current production levels and prices. The value of green box subsidies is not limited by WTO, unlike other types of subsidies.

In the current 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. 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).

In the United States, examples of green box subsidies, namely "decoupled payments", are production flexibility contracts (PFC) in the 1996 Federal Agriculture Improvement and Reform (FAIR) Act and direct payments in the 2002 Farm Security and Rural Investment (FSRI) Act. PFC payments constitute approximately 35 percent of total government payments in agriculture ($36 billion / $104 billion) during the 1996-2002 period (U.S. Department of Agriculture / Economic Research Service (USDA/ERS)).

Recently, a WTO panel in the Brazilian cotton case ruled that U.S. cotton policies have encouraged production and export of U.S. cotton and hence lowered the world price of cotton and harmed Brazilian cotton producers. The panel ruled that PFC and direct payments do not completely meet the green box criteria. The panel pointed out that the prohibition against planting fruits and vegetables on acres receiving direct payments violates the rule that payments in the green box cannot be tied to production decisions. However, the panel did not find any significant trade-distorting effects from PFC and direct payments.

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.

As in the Brazilian cotton case, decoupled programs are sensitive issues in the current WTO trade negotiations. Thus, the measurement of production and trade effects of decoupled payments is important for further negotiations. For more reliable measurement, the validity of using risk attitude as an explanatory factor should be examined.

1.2. Objectives of the Research

This study has several objectives. A main objective is to determine whether U.S. PFC 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. Another objective is to measure farmer risk attitudes at the aggregate level over time. Unlike most previous studies, farmers' risk attitudes are estimated by considering many types of risk simultaneously and covering more aggregate regions over time. Lastly, an objective is to empirically test 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.

Therefore, the contributions of this study are to provide empirical evidence on the production impacts of decoupled payments in the United States and test the validity of risk attitude as a logical explanation of decoupled payments' impact. That will provide empirical evidence relevant to recent and ongoing trade disputes.

1.3. Organization of this study

This study is divided into seven chapters and an appendix. Chapter 1, as an introduction, gives the problem statement, objectives of this study and its organization. In chapter 2, U.S. decoupled payment programs are covered, mostly focused on the 1996 farm bill. Chapter 3 provides a literature review, which consists of two parts, measuring risk attitude and measuring decoupled payment's effect, in accordance with the methodological approach of this study. Chapter 4 gives the theoretical model for measuring risk attitudes. Chapter 5 describes the sources and the nature of the data used in the estimation of models, and the empirical models for measuring risk attitudes and decoupled payments' effects. Chapter 6 presents the results of estimation and hypothesis testing, and economic analysis is conducted to obtain meaningful implications of these results. Finally, the summary, conclusions and issues for further study are presented in chapter 7.

Chapter 2

Decoupled Payment Programs in the United States

2.1. A Definition of Decoupling

To discipline policy measures that distort agricultural trade, WTO classifies agricultural policies influencing agricultural trade into three major categories, which are market access, export competition and domestic support, and sets detailed rules and disciplines on each one. Briefly, the rule for market access aims at removing non-tariff measures or converting them to tariffs and reducing tariff rates in order to improve market access. Export competition is related primarily to the reduction and eventual elimination of export subsidies in the long run. The disciplines on domestic support are set based on an Aggregate Measure of Support (AMS), and aim to reduce the AMS and replace support programs distorting agricultural trade with less distorting ones. Since domestic support programs are not equally trade distorting, they are divided into three groups by the degree of trade distortion. The groups are called "boxes": amber box, blue box and green box. Amber box supports are significantly distorting trade, so those programs are subject to AMS limits and are required to be reduced. The AMS constraint does not limit programs under the blue box and the green box. Blue box supports are amber box programs with certain conditions such as production contraints, intended to reduce distortion. Programs under the green box such as agricultural research, food aid and nutrition programs, and decoupled income support are supposed not to distort or at most to minimally distort trade. Green box programs have to be "decoupled" from current production levels and prices and are directly provided by government funds.

A "Decoupled" payments are defined in the WTO Uruguay Round Agreement on Agriculture (URAA). However, there is a potential controversy in the operational programs because each country may have a slightly different interpretation of the criteria of decoupled supports in the URRA. WTO specifically addresses the criteria of decoupled income support in paragraph 6 of annex Ⅱ (Table 2-1).

Table 2-1. Criteria of decoupled income support in the WTO Agreement on Agriculture

6. Decoupled income support

(a) Eligibility for such payments shall be determined by clearly-defined criteria such as income, status as a producer or landowner, factor use or production level in a defined and fixed base period.

(b) The amount of such payments in any given year shall not be related to, or based on, the type or volume of production (including livestock units) undertaken by the producer in any year after the base period.

(c) The amount of such payments in any given year shall not be related to, or based on, the prices, domestic or international, applying to any production undertaken in any year after the base period.

(d) The amount of such payments in any given year shall not be related to, or based on, the factors of production employed in any year after the base period.

(e) No production shall be required in order to receive such payments.

Source: WTO Agreement on Agriculture, Annex 2, paragraph 6
Available from http://www.wto.org/english/docs_e/legal_e/14-ag_02_e.htm#annII

It states that the basic requirement of decoupled income support is that it is not tied to current production, factors of production, or market prices. Although an operational program of decoupled payments satisfies the criteria, the distortion of trade through the indirect effects of a decoupled support program may be still arguable.

2.2. Decoupled Payment Programs in the United States

In the United States, PFC payments in the 1996 Farm bill and direct payments as their successor in the 2002 farm bill are examples of direct income support measures[1]. The 1996 farm bill was a landmark in the history of U.S. agricultural policy. The FAIR Act changed the direction of agricultural policy toward less direct influence on agricultural markets. In order to reduce market distortion, it removed annual set-aside programs and deficiency payment programs, and introduced the PFC program as a decoupled income support.

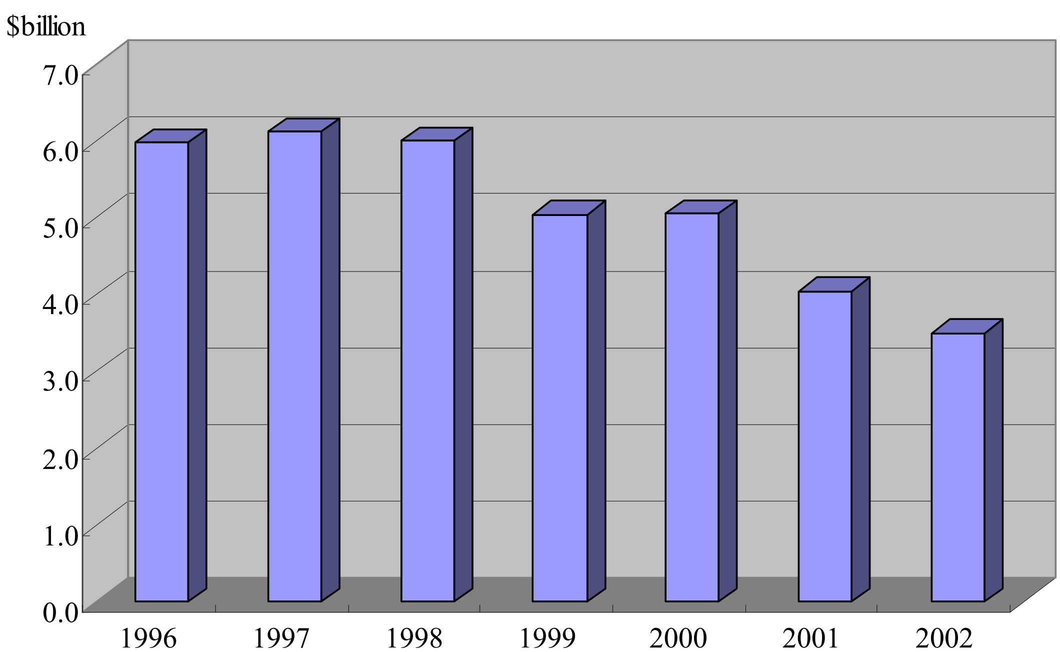
PFC payments are a lump-sum cash support to farm operators based on base acreage and yields established under historical supply management programs. Unlike previous farm bills, program participation is no longer tied to what producers plant. The only restrictions are that 1) the land cannot be put to a nonagricultural use, such as residential or industrial, and 2) producers cannot plant fruits or vegetables, on acreage eligible for payments with some exceptions where producers had grown fruits and

1 Somers (2005) specially addressed the distinction between the direct payments and direct income support. An example of direct income support is the direct payment program. As he mentioned, a study related to this topic has the objective determining whether direct payments including PFC can be classified as decoupled income support.

vegetables in the past. Producers can idle the land or convert cropland into pasture or forest. The payment goes directly to farm operators, including tenants, not to land owners who are not operators. The eligibility to participate in the program is transferable (Burfisher and Hopkins 2003).

Most producers qualified to enroll in the program signed up their eligible acreage. Total eligible acreage was 211 million acres, which is almost 50 percent of total cropped acres. The enrollment in the program was 99 percent of eligible acreage (Burfisher and Hopkins 2003). Total PFC payments were $36 billion from 1996 to 2002, which is 35 percent of total government payments to agricultural producers over that period. The payments in 1997 were the highest at $ 6.1 billion (Figure 2-1).

Figure 2-1. Annual PFC payments

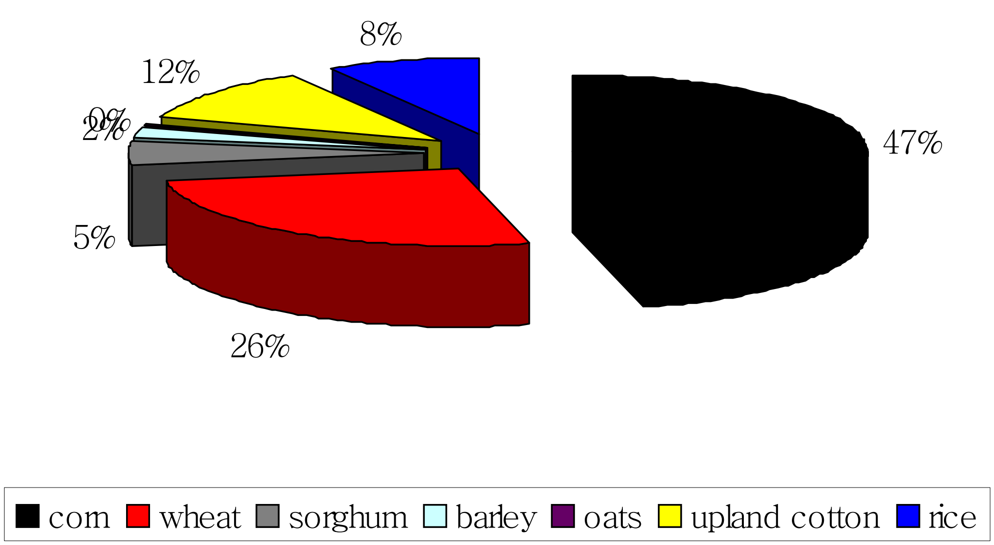


Source : USDA/ERS, *Farm and Commodity Policy : 1996-2001 program provisions*. Available from http://www.ers.usda.gov/Briefing/FarmPolicy/1996pfc.htm.

The payments were allocated 47 percent for corn, 26 percent for wheat, with lesser shares for upland cotton, rice, sorghum, barley and oats (USDA/ERS Figure 2-2).

Basic provisions of the PFC program were continued through 2007 in the relabeled direct payment program under the FSRI Act. There were two changes in the program under the FSRI Act. One was to give producers the opportunity to update the base acreage that is used to calculate the payment and the other is to expand the list of covered program crops to include oilseeds and peanuts. Base acreage in the 1996 farm bill was tied to 1991-1995 planting history. Farmers were allowed in the 2002 farm bill to update their base area depending on the 1998 - 2001 planting history or to keep their old base.

Figure 2-2. The share of PFC payments in commodities 1996-2002



Source : USDA/ERS, *Farm and Commodity Policy : 1996-2001 program provisions*. Available from http://www.ers.usda.gov/Briefing/FarmPolicy/1996pfc.htm.

However, the program yield base used to calculate direct payments was not changed from the 1996 farm bill (Burfisher and Hopkins 2003).

In addition to PFC payments, many previous studies related to measuring the effect of decoupled payments also estimated the impacts of Market Loss Assistance (MLA) payments, because MLA payments were tied to scheduled PFC payments not to current production (Key et al. 2004). MLA payments were enacted in October 1998 as part of "emergency assistance" to support producer incomes when the prices of major crops sharply dropped. Thereafter, subsequent acts provided additional MLA payments to compensate farmers for the loss of markets. MLA payments were up to $2.9 billion for 1998 crops, $ 5.5 billion for 1999 crops, $5.5 billion for 2000 crops, and $ 4.6 billion for 2001 crops (Abler and Blandford 2004).

Chapter 3

Literature Review

Westcott and Young (2002) argue that decoupled payments have three possible ways to affect production through a farmer's wealth: a direct wealth effect, a wealth-facilitated increased investment effect, and a secondary wealth effect resulting from increased investment. The relationship between production and a farmer's wealth depends on the farmers' risk attitudes. Agricultural production is characterized by considerable risk and significant governmental intervention, and thus aggregate measures of risk aversion and their properties with respect to wealth have very important policy implications (Bar-Shira et al. 1997; Hennessy 1998; Pope and Just 1991). In other words, farmers' risk attitudes affect their economic decisions, so the effects of decoupled payments may differ across farmers depending on their risk attitudes. Regarding the effects of decoupled payments, the risk preference structure of decision makers is more important than the status of risk attitudes, such as being risk averse or risk loving.[2] The risk preference structure of a decision maker implies a definite set of restrictions on the optimal input or output responses to changes in wealth and other parameters (Saha et al. 1994). For example, Constant Absolute Risk Aversion (CARA) implies that changes in

[2] In this study, risk preference structure means the change of risk attitudes by that of wealth. Decreasing Absolute Risk Aversion (DARA) is an example of risk preference structure. However, risk attitude means decision makers' response to risk, such as risk averse and risk loving.

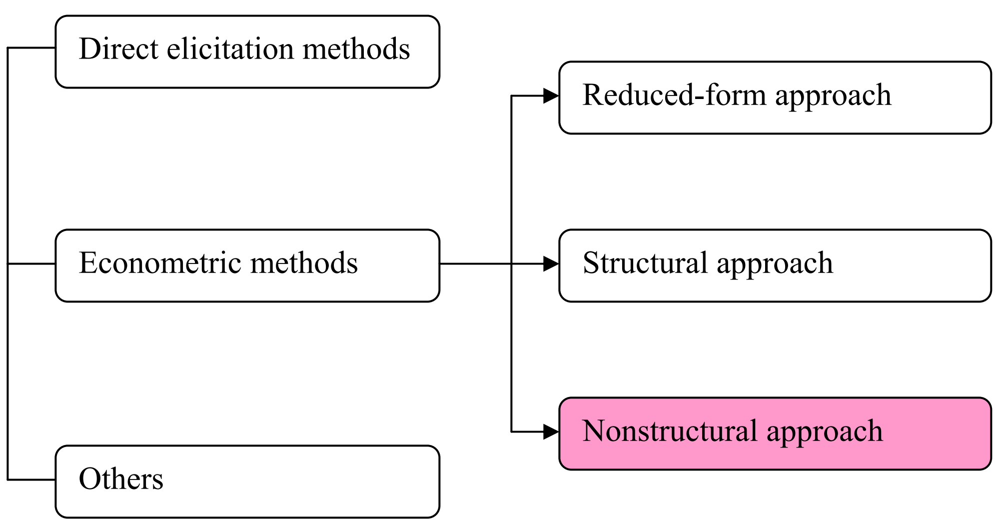
wealth do not alter optimal choices, and Decreasing Absolute Risk Aversion (DARA) implies that a decision maker becomes more willing to accept risk as his wealth increases.

Therefore, the literature review is presented in two parts. The first concerns measurement of farmers' risk attitudes and the second concerns measurement of the effects of decoupled payments on production decisions.

3. 1. Measuring Risk attitudes

In order to measure farmers' risk attitudes, the main methodologies are direct methods using interviews to elicit risk attitudes, and econometric methods using observed data to infer risk attitudes (Figure 3-1).

Figure 3-1. Methodologies for measuring risk attitudes



Note : the shaded method is used in this study to measure farmers' risk attitudes

The main econometric methodologies for measuring farmers' risk attitudes can be grouped under three approaches, which are the reduced-form approach, the structural approach, and the nonstructural approach (Saha et al. 1994; Antle 1989).

According to Saha, et al. (1994), the reduced-form approach does not deal with estimating the underlying utility function but instead focuses on a certain risk preference structure. The structural approach has been used in many previous research studies (Table 3-1). It directly estimates utility functions or risk aversion coefficients, mostly using farm level data. However, some studies find the risk preference of farmers and estimate farmers' risk attitudes as well.

Chavas and Holt (1990) estimated an acreage supply response model for U.S. corn and soybean developed under expected utility maximization. In particular, a wealth variable is included in their acreage equations. The empirical results indicated that risk and wealth variables play an important role in corn and soybean acreage decisions. They found that risk preferences are not characterized by CARA over the period of analysis. Therefore, risk-less production theory may not apply to supply response analysis under risk. They also argued that there exists a positive wealth effect, which provides a possible justification for income transfers to corn-soybean farmers with low initial wealth.

Pope and Just (1991) tested farmer's risk preference using Idaho potato acreage data. The results showed that CARA and Constant Partial Relative Risk Aversion (CPRRA) hypotheses were rejected. They argued that the omission of wealth effects in empirical research might bias estimates of supply response in the presence of risk.

Table 3-1. Some empirical studies measuring risk attitudes and risk preferences

Study	Year	Target country	Results	Methods
Chavas & Holt	1990	U.S corn & soybean	Find wealth effect, reject CARA	RF
Pope & Just	1991	U.S Idaho potato	Reject CARA, CPRRA, not CRRA	RF
Saha, Shumway & Talpaz	1994	Kansas wheat farmers	Find DARA and IRRA ARA=0.0045-0.0083, RRA=3.759-4.075	RF/SA
Antle	1987	India a village rice	ARA = 3.272	SA
Love & Buccola	1991	Iowa corn & soybean	ARA=0.016-0.538	SA
Torkamani & Haji-Rahimi	2001	Iran	Utility function affects measuring risk attitudes: Power expo function preferred	SA
Antle	1989	India 3 villages	Partial ARA=0.11-1.40	Non SA
Gardebroek	2002	Netherlands	ARA=2.432(organic farm), 3.064(non organic)	Non SA

Note : RF means the reduced form approach, SA is the structural approach, and Non SA means the nonstructural approach.

ARA means Absolute Risk Aversion coefficients and RRA is Relative Risk Aversion coefficients.

However, Saha et al. (1994) not only measured their risk attitudes but also estimated the risk preference of farmers, although their method fell in the structural approach category. They developed a method to permit joint estimation of the risk preference structure, the degree of risk aversion, and the production technology. They used the expo-power utility function with sample data of Kansas wheat farmers. The results rejected the null hypothesis of risk neutrality, and suggested that Kansas farmers exhibit DARA and Increasing Relative Risk Aversion (IRRA). Results also indicated that combined estimation of production function parameters and utility function parameters is more efficient than the separate estimation of risk attitudes. They also estimated that absolute risk aversion coefficients are between 0.0045 and 0.0083 and relative risk aversion coefficients are between 3.759 and 4.075.

Antle (1987) proposed an econometric methodology for estimating the distribution of risk attitudes in a population of producers who utilize a similar production technology. He applied the moment-based model to rice data from a village in south central India to estimate absolute risk aversion coefficients and downside risk aversion coefficients. The results estimated the absolute Arrow-Pratt coefficient to be 3.272 and the downside risk aversion coefficient[3] to be 4.254.

Love and Buccola (1991) proposed a primal model that allows a firm's preferences and technology to be estimated in the presence of risk. They found that there is considerable variation in the risk aversion coefficients across Iowa corn and soybean farmers in three Iowa counties (0.016, 0.538, and 0.140 in Linn, Muscatine, and Fayette counties, respectively).

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[3] Down-side risk is concerned with skewed statistical distributions of profit. It is defined as $-\frac{u'''(w)}{u'(w)}$

Torkamani and Haji-Rahimi (2001) measured absolute risk aversion coefficients using several utility functional forms. They argued that the choice of utility functional form is an important issue in decision analysis under the expected utility hypothesis and can affect the classification of risk preferences. The results showed that exponential and expo-power utility functions classified all farmers as risk averse, but quadratic and cubic utility functions classified 75 percent and 65 percent of farmers as risk-averse, respectively.

The structural approach used in previous research can provide policy implications. However, it requires researchers to assume a specific utility functional form or production technology, and the resulting measured risk attitudes are not invariant to the assumed functional form. Table 3-2 shows different measures of decision makers' risk attitudes across utility functional forms.

Table 3-2. Risk attitude of alternative utility functions

Utility functional form	Absolute risk aversion	Relative risk aversion
Linear $u(w) = a + bw$	0 (CARA)	0 (CRRA)
Quadratic $u(w) = a + bw + cw^2$ b>o, c<0	$\frac{-2c}{b+2cw}$ (IARA)	$\frac{-2cw}{b+2cw}$ (IRRA)
Exponential $u(w) = -e^{-aw}$	a (CARA)	aw (IRRA)
Expo Power $u(w) = a - \exp(-\beta w^{\alpha})$ $\alpha \neq 0, \beta \neq 0, \alpha\beta > 0$	$\frac{1-\alpha+\alpha\beta w^{\alpha}}{w}$ α <1 (DARA) α =1 (CARA) α >1 (IARA)	$1-\alpha+\alpha\beta w^{\alpha}$ α <1 (DRRA) α =1 (CRRA) α >1 (IRRA)

Source : Torkamani, J. and M. Haji-Rahimi, "Evaluation of Farmer's Risk Attitudes Using Alternative Utility Functional Forms" *Journal of Agricultural Science and Technology* 3(2003):243-248.

For example, if we assume a linear utility function, decision maker's risk attitudes should be CARA and Constant Relative Risk Aversion (CRRA). The power expo utility function proposed by Saha (1993) is a more flexible function, as the decision maker's risk attitudes depend on the magnitude of α .

Antle (1989) and Gardebroek (2002) pointed out some drawbacks of the structural approach. First, the structural approach mainly focuses on production risk or price risk. Price and other types of risk (e.g. the risk of policy changes) are usually not taken into account. Second, the stochastic Just-Pope production function often used in these studies only allows for one output. But in reality, most farmers face various types of risk and may produce more than one commodity.

Antle (1989) proposed a nonstructural approach which measures farmers' risk attitude by changes in the moments of the profit distribution. The nonstructural approach for risk attitude estimation does not require joint estimation of the structure of the firm's technology and input decision rules. While the structural approach uses optimality conditions to determine input choice under assumed functional forms, the nonstructural approach replaces optimal input choice with the assumption that farmers optimally manage their production activities. The Antle's results in India indicated that decision makers in Aurepali and Shirapur are both Arrow-Pratt and downside partial risk averse and the risk attitude estimates are not significantly different across villages. Mean partial risk attitude coefficients in Aurepali and Shirapur were 1.11and 1.40 respectively.

Gardebroek (2002) estimated absolute risk aversion coefficients for a sample of Dutch organic and non-organic arable farms. Using a nonstructural approach to risk estimation, he took production risks, market risks and policy risks jointly into account. Moreover, this approach allowed for multiple outputs. Mean absolute risk aversion parameters were 2.432 for organic arable farms and 3.064 for non-organic arable farms, which indicate that on average, non-organic farms are more risk averse than organic farms.

The nonstructural approach might solve some problems of the structural approach. It allows for multiple outputs and various types of risk faced by farmers. Moreover, it doesn't require specific functional forms for utility or production. However, the nonstructural approach has also a disadvantage. After estimating risk attitudes using a nonstructural approach, a structural model incorporating the risk attitude estimates must still be estimated in order to study farm production decisions or analyze policy.

In general, studies of farmers' risk preference reject CARA and find their risk attitudes to be mixed, although risk aversion is predominant (Harwood et al. 1999; Moschini and Hennessy 2001). Table 3-3[4] summarizes the results of empirical studies on U.S. farmers' risk attitudes. Farmers' risk attitudes are mostly risk averse when Observed Economic Behavior (OEB) methods are used. However, their risk attitudes are mixed when Direct Elicitation of Utility (DEU) methods are implemented[5].

4 This table was cited from Burfisher and Hopkins (2004).

5 The DEU process consists of interviewing farmers to determine their preferences among risky alternatives for hypothetical gains and losses. The OEB method consists of estimating risk attitude parameters reflected in observed farming decisions, such as input levels and crop acreage mix (USDA 2004).

Table 3-3. Some empirical studies related to risk attitudes for U.S. farmers

Source	Description of producers	Measurment method	Risk attitudes	Effect of Wealth
Bard and Barry	Illinois Farmers	DEU	>50% averse	Not evaluated
Brink and McCarl	Midwest Grain Farmers	OEB	66% averse 34% neutral 0% loving	Not evaluated
Chavas and Holt, 1990	U.S. corn and soybean sectors	OEB	Averse	Decreases aversion
Chavas and Holt, 1996	U.S. corn and soybean sectors	OEB	Averse	Decreases aversion
Collins, Musser, and Mason	Oregon grass seed growers	DEU	16~32% averse 38~52% neutral 30~32% loving	Not evaluated
Halter and Mason	Oregon grass seed growers	DEU	About equal across averse, neutral, loving	Not evaluated
Hildreth and Knowles	Minnesota cattle producers	DEU	8~85% averse	Generally decrease aversion
Ling and Oamek	Eastern Colorado wheat farmers	DEU	30% averse 70% mixed	No clear relationship
Lence	U.S. agricultural sector	OEB	averse	Not evaluated
Lin, Dean, and Moore	California crop farmers	OEB	50% averse 33% neutral 17% mixed	Not evaluated
Love and Buccola	Iowa corn and soybean farmers	OEB	Averse for all 3 counties	No change
Ramaratnam, Rister, Bessler, and Novak	Texas grain sorghum farmers	DEU	73~100% averse	Varies by functional form
Saha, Shumway, and Talpaz	Kansas wheat farmers	OEB	averse	Decreases aversion
Schurle and Tierney	Kansas crop and livestock farmers	DEU	80% averse 2% neutral 18% loving	Not evaluated
Tauer	New York dairy farmers	DEU	34% averse 39% neutral 26% loving	Group test : decreases aversion
Thomas	Kansas crop and livestock farmers	DEU	20% averse 13% loving 67% mixed	Generally decrease aversion
Wilson and Eidman	Minnesota swine producers	DEU	42% averse 36% neutral 22% loving	33% decreases 21% constant 18% increases 28% mixed

Note : DEU= direct elicitation Utility, OEB= Observed economic behavior
source : Burfisher, M.E. and J. Hopkins (eds.), "Decoupled Payments in a Changing Policy Setting", Economic Research Service, US Department of Agriculture, Agricultural Economic Report No. 838(2004), Washington DC.

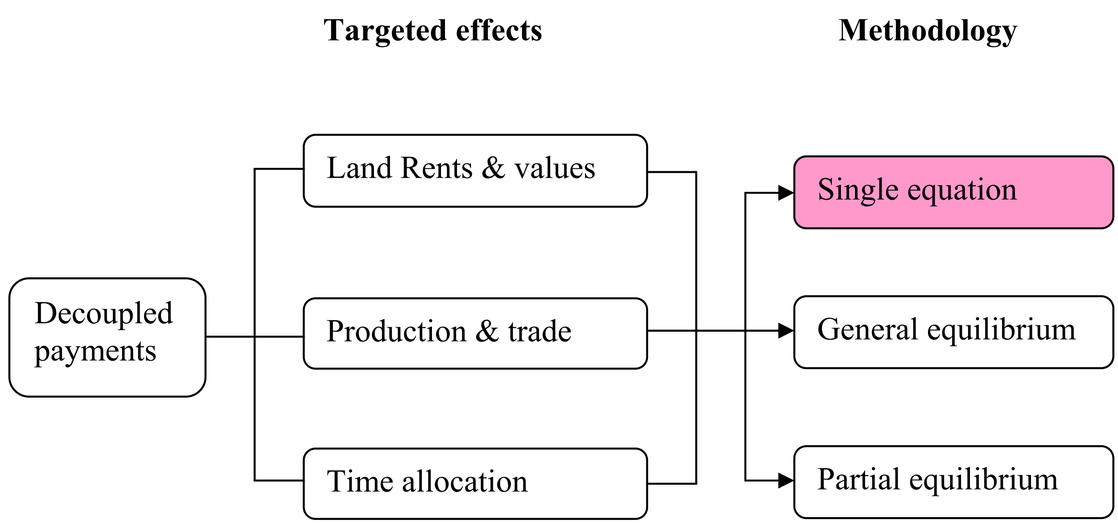
3. 2. Measuring the effect of decoupled payments

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. In this study, the literature review is focused on studies measuring production effects of decoupled income support subsidies (Figure 3-2). 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. It is easy to estimate and can 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. 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.

Figure 3-2. Econometric methodologies for measuring decoupled payments' effect



Note : the shaded method is used in this study to measure the effect of decoupled payments.

Using a single equation approach, Chavas and Holt (1990) estimated an acreage supply response model for U.S corn and soybeans with a wealth variable. They found that the elasticities with respect to initial wealth are 0.087 and 0.270 for corn and soybean acreage, respectively. Although they did not directly measure the effect of decoupled payments, their result is widely cited in other studies simply calculating the effect of decoupled payments.

Young and Westcott (2000) examined the links between four U.S. agricultural programs (production flexibility contracts, crop insurance, marketing loans, and disaster assistance), and agricultural production and trade. By using wealth elasticities from Chavas and Holt (1990) and assuming that farmers' wealth increases by the value of PFC payments, they argued that PFC payments have an aggregate acreage impact of 180 thousand to 570 thousand acres annually, a small effect relative to total U.S. cropland.

According to Westcott and Young (2002), decoupled payments affect agricultural production decisions through four avenues: wealth and investment effects, sector consolidation effects, benefit eligibility and payment basis effects, and producer expectation effects. Wealth and investment effects of decoupled payments can affect production in three ways: a direct wealth effect, a wealth- facilitated increased investment effect, and a secondary wealth effect resulting from increased investment. They argued that the effect of one time PFC payments is less than 60 thousand acres per billion dollars, the effect of permanent annual PFC payments of $ 1 billion per year is 0.3 to 1.0 million acres (0.4%) annually, based on a simple calculation using Chavas and Holt (1990)'s result.

Hennessy (1998) decomposed the production impacts of income support programs into wealth, insurance, and coupling effects. He concluded that studies of trade and domestic policy reform in stochastic environments should consider insurance and wealth effects. While the insurance effect in his example is large, the wealth effect is very small. The removal of a target price program for corn would reduce nitrogen use by 7 to 10 percent and production by 1.5 to 2.5 percent.

Goetz et al. (2003) analyzed the optimal behavior of farmers in Switzerland in the presence of direct payments and uncertainty. The results showed that direct payments increase agricultural production by 3.7 to 4.8 percent.

Goodwin and Mishra (2002) evaluated the extent to which U.S. farm program benefits bring about distortions in production using farm level data. They estimated acreage functions with wealth variables and government subsidy variables, including PFC payments and MLA payments. The results suggested that large PFC payments had what they describe as modest effects on the acreage of corn and soybeans and no effect on wheat acreage in the Corn Belt. A doubling of PFC payments would lead to a 5.9 percent increase in corn acreage and a 4.9 percent increase in soybean acreage.

Lin and Dismukes (2004) adopted Chavas and Holt (1990)'s framework to estimate the acreage response equations for U.S corn, soybeans and wheat. They found that the wealth effects[6] in soybean and wheat are statistically significant and are estimated to be 0.397 and 1.546, respectively, but the estimated wealth effect in corn is negative (-0.191).

Using farm-level data from the Agricultural Census, Key, Lubowski and Roberts (2004) compared the changes between 1992 and 1997 in commodity crop plantings of farms that participated in government programs with farms that did not participate. They found that the growth rate of program crop acreage of participants was 19 percentage points greater than that of non-participants. Therefore, they argued that payments associated with decoupled programs instituted with the 1996 Farm bill were distortionary and induced farmers to produce more than they would have without the payments.

Burfisher, Robinson, and Thierfelder (2000) used a multi-country CGE model of the United States, Mexico and Canada to analyze the effects of increased transfer payments (PFC payments in the United States) on risk premiums. They found that a 50 percent increase in transfer payments increases output of all four crops (wheat corn, feed grains, oilseeds) by 0.5(wheat) ~1.1 percent (oilseeds).

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[6] For example, the wealth effect in corn means that the change of the share of combined (corn, soybeans and wheat) acreage planted to corn (%) as farm operator household net worth ($ billion) changes.

Burfisher and Hopkins (2003) examined the U.S. experience with decoupled payments in its PFC program using a CGE model. They argued that the PFC program has a negligible impact on agricultural investment and production in the long run, but household consumption and off-farm investment have increased because of the program. The decoupled payments also increase the value of land by 8 percent.

Adams et al. (2001) measured the effects of PFC and MLA programs on production. They directly estimated acreage functions with variables considering PFC and MLA payments and then applied the results to an existing Food and Agricultural Policy Research Institute (FAPRI) model. They found weak empirical evidence that PFC and MLA payments increased the area devoted to production of major crops in 11 states between 1997 and 2000. These and other study results are summarized in Table 3-4.

Table 3-4. Previous studies' results for measuring production effects of decoupled income support subsidies

Study	Year	Main conclusions
Chavas & Holt.*	1990	Initial wealth elasticity: 0.087(corn), 0.270(soybeans)
Hennessy*	1998	Income support program: removal of a decoupled target price program-> reduce production 1.5~2.5%, nitrogen use: 7~10%
Young & Westcott	2000	PFC : 180 thousand~570 thousand acres annually
Lin & Dismukes	2004	Wealth effect(planted share/$billion) : -0.191(corn), 0.397(soybeans), and 1.546(wheat) Wealth elasticity: -0.063(corn), 0.139(soybeans), 0.003(wheat)
Goodwin & Mishra	2002	Doubling PFC ->5.9% increase in corn, 4.9% in soybean acreage
Goetz et al.	2003	Swiss payments increase production 3.7%~4.8%
Westcott & Young	2002	One time: less than 60 thousand acres for $1 billion Permanent: 0.3~1.0 million acres (0.4%) annually for $1 billion
Key et al.	2004	The growth rate of program crop acreage of participants was 19 percentage points greater than that of non-participants.
Burfisher et al.	2000	50% increase in transfer payments increases output of four crops by 0.5~1.1%
Burfisher & Hopkins	2003	PFC: negligible effect on production, land value increases 8%
Adams et al.	2001	$1 billion in PFC/MLA payments -> 659 thousand acres

Note :* did not estimate the effect of decoupled payments but measures wealth effects on acreage and production effects of income support policies

Chapter 4

Theoretical Framework

Antle (1987, 1989) published a series of papers to measure decision makers' risk attitude using moments of the profit distribution. In 1989, he developed the nonstructural approach based on his previous study. The current study mostly adopts Antle's nonstructural approach in order to measure farmers' risk attitudes.

The Cumulative Distribution Function (c.d.f) of profit is defined as

$$F(\pi \mid \mu_{jt}) \qquad j = 1,...N \quad t = 1,...,T \tag{4-1}$$

where $\mu_{jt} = (\mu_{1jt},....,\mu_{mjt})$ is a vector of m moments characterizing the profit distribution of farmer j in year t.

The j[th] farmer's utility function can be expressed as

$$U_{jt} = U(\pi_{jt}, \gamma_{jt}) \tag{4-2}$$

where π_{jt} = the profit for the j[th] farmer in year t

γ_{jt} = a parameter vector reflecting the j[th] farmer's risk attitudes in year t

Expected utility from eq (4-1) and eq (4-2) is

$$\int U(\pi_{jt}, \gamma_{jt}) dF(\pi \mid \mu_{jt}) = EU[\mu_{jt}, \gamma_{jt}]. \tag{4-3}$$

Therefore, the change in expected utility from year *t-1* to *t* from a change in the profit distribution is expressed by

$$\Delta EU_{jt} = \sum_{i=1}^{m} \frac{dEU_{jt}}{d\mu_{ijt}} \Delta\mu_{ijt} \tag{4-4}$$

where the $\frac{dEU_{jt}}{d\mu_{ijt}}$ are partial differentials of the expected utility function and the symbol Δ means change from the previous year and *d* means differential.

The first moment μ_{1jt} is the mean value of the profit distribution and $\frac{dEU_{jt}}{d\mu_{1jt}}$ is defined as the marginal utility of mean profits.

Through scaling by $\frac{dEU_{jt}}{d\mu_{1jt}}$, eq (4-4) is transformed from units of utility to money units

$$\Delta NEU_{jt} = \sum_{i=1}^{m} r_{ijt} D_{ijt} \tag{4-5}$$

where $\Delta NEU_{jt} = \frac{\Delta EU_{jt}}{(dEU_{jt} / d\mu_{1jt})}$, which means changes in expected utility in money terms. $r_{ijt} = \frac{\left(dEU_{jt} / d\mu_{ijt}\right)}{\left(dEU_{jt} / d\mu_{1jt}\right)}$, which implies farmers' risk attitude[7], and $D_{ijt} = \Delta\mu_{ijt}$, which denotes a change in the profit distribution.

[7] The mathematical proof is given in the appendix 2 of Antle(1987)'s paper. In that paper,

$$r_{ij} = \frac{\partial u[\mu_j^m, \gamma_j]}{\partial \mu_{ij}} / \frac{\partial u[\mu_j^m, \gamma_j]}{\partial \mu_{1j}} = \frac{\partial EU}{\partial \mu_i} / \frac{\partial EU}{\partial \mu_1} = \frac{U^i(\mu_{1j})}{i!} / E[U^1] = \frac{U^i(\mu_{1j})}{E[U_j^1] i!}$$

where γ_j means a parameter vector reflecting the j[th] farmer's risk attitudes

U^i denotes the i[th] derivative of U.

When i=2, $r_{2j} = \frac{U''}{U'2}$. So $-2r_{2j} = -\frac{U''}{U'}$ means the absolute Arrow-Pratt measure of risk aversion.

ΔNEU_{jt} is assumed to be distributed in the population in year t with a mean(α) and variance(σ_{jt}^2) that is,

$$\Delta NEU_{jt} = \alpha_t + \varepsilon_{jt}$$

$$\text{where } E\lfloor \varepsilon_{jt} \rfloor = 0 \text{ and } E\lfloor \varepsilon_{jt}^2 \rfloor = \sigma_{jt}^2 \quad (4\text{-}6)$$

Risk attitudes are also assumed to be distributed in the population in year t as

$$r_{ijt} = \beta_{it} + v_{ijt} \quad for\ i \geq 2$$

$$\text{where } E\lfloor v_{ijt} \rfloor = 0 \text{ and } E\lfloor v_{ijt}^2 \rfloor = \tau_{ijt}^2 \text{ and} \quad (4\text{-}7)$$

β_{it} = the i[th] characteristic of risk attitudes at the population mean in year t

Since $r_{1jt} \equiv 1$, eq (4-5) is rewritten by substituting with eq (4-6) and eq (4-7).

$$-\alpha_t + D_{1jt} + \sum_{i=2}^{m} \beta_{it} D_{ijt} = w_{jt} \quad (4\text{-}8)$$

$$\text{where } w_{jt} = \varepsilon_{jt} - \sum_{i=2}^{m} v_{ijt} D_{ijt}$$

According to Antle (1989), $-2\beta_2$ approximates the absolute Arrow-Pratt measure of risk aversion and $6\beta_3$ is an approximation to the absolute measure of downside risk aversion.

In order to estimate farmers' risk attitudes from eq (4-8), we need the change in the moments of the profit distribution ($D_{ijt} = \Delta\mu_{ijt}$). Suppose the Probability Density

Function (p.d.f) of profit, $f(\pi \mid x_{jt}, p_t, w_t)$, is conditional on a vector of variable inputs x_{jt}, output prices p_t , and input prices w_t.

By definition, the moments of the profit distribution are

First moment : $\mu_{1jt}(x_{jt}, p_t, w_t) = \int \pi f(\pi \mid x_{jt}, p_t, w_t) d\pi$ (4-9)

Higher Moments : $\mu_{ijt}(x_{jt}, p_t, w_t) = \int (\pi - \mu_{1jt})^i f(\pi \mid x_{jt}, p_t, w_t) d\pi, i \geq 2$

By assuming a linear relation between the moments and the explanatory variables,

$$\mu_{ijt}(X) = \delta_i X_{jt} \quad (4\text{-}10)$$

where X_{jt} = explanatory variables(x_{jt}, p_t , and w_t)

Then, since profits are random and $E(\pi_{jt}) = \mu_{1jt}$, the first moment equation is

$$\pi_{jt} = \delta_1 X_{jt} + \eta_{1jt} \quad (4\text{-}11)$$

where $E(\eta_{jt}) = 0$

Higher moment equations are[8]

$$\mu_{ijt}(X) = E\left[(\pi_{jt} - \mu_{1jt})^i\right] = E(\eta_{1jt}^i) \equiv \delta_i X_{jt} + \eta_{ijt}, \quad i \geq 2 \quad (4\text{-}12)$$

[8] To derive higher moment equations, mathematical manipulations are applied as the following;
$\pi_{jt} - \mu_{1jt} = \delta_1 X_{jt} + \eta_{jt} - \mu_{1jt} = \delta_1 X_{jt} + \eta_{1jt} - \delta_1 X_{jt} = \eta_{1jt}$

In order to obtain higher moments, we first need to estimate eq (4-11) then save the residual (η_{1jt}). By multiplying by itself, η_{1jt}^{i} is calculated. Then equation (4-12) can be estimated by regressing η_{1jt}^{i} on X_{jt}. From the estimation of eq (4-11) and eq (4-12), we obtain the first and the higher moments, and make a difference of moments from t-1 to t ($D_{ijt} = \Delta\mu_{ijt}$).

To estimate eq (4-8), it is rearranged as

$$D_{1jt} = \alpha_t - \sum_{i=2}^{m} \beta_{it} D_{ijt} + w_{jt} \tag{4-13}$$

If mean risk attitude (β_{it}) changes over time, it can be specified as $\beta_{it} = \beta_{i0} + \beta_{i1} d_t$, where d_t = time dummy variables. And time varying parameter (α_t) is also expressed as $\alpha_t = \alpha_0 + \alpha_1 d_t$.

By substituting those two specifications into eq (4-13), the final equation to be estimated for measuring farmers' risk attitudes is derived as

$$D_{1jt} = \alpha_0 + \alpha_1 d_t - \sum_{i=2}^{m} (\beta_{i0} + \beta_{i1} d_t) D_{ijt} + w_{jt} = \alpha_0 + \alpha_1 d_t - \sum_{i=2}^{m} \beta_{i0} D_{ijt} - \sum_{i=2}^{m} \beta_{i1} d_t D_{ijt} + w_{jt} \tag{4-14}$$

Although Antle (1989) and Gardebroek (2002) developed and used the nonstructural approach they did not measure farmers' risk attitude over time. They estimated an average farmers' risk attitude for several years assuming risk attitudes are stable over time. However, Antle (1989) left the possibility of time dependence of the mean risk attitudes and argued that it can be measured by the above manipulation ($\beta_{it} = \beta_{i0} + \beta_{i1} d_t$).

Chapter 5

Data and Empirical Model

5. 1. Data

To estimate the empirical model for measuring farmers' risk attitudes in each state, data on production costs, profits and farmers' characteristics are needed. However, it is hard to get those data for the farm level or county level over time. Although many studies estimating the effects of decoupled payments use the Agricultural Resource Management Survey (ARMS) data, it doesn't have sufficient observations in each county over time. The Agricultural Census data also provides county-level data. However, the problem in using the Agricultural Census data is that we can't directly obtain the coefficients of risk aversion every year, since the data are collected only once every five years.
Therefore, this study uses county-level data from the Regional Economic Information System (REIS) database of the Bureau of Economic Analysis (BEA) to measure farmer's risk attitude in each state. Each county is treated as if it is a single farm. Using this approach, we can measure changes in the level and variance of profit over time and thus measure changing levels of absolute risk aversion at the state level.

This data covers the period from 1993 to 2002. Table 5-1 is a data summary showing the number of observations in each state, and the mean and standard deviation for each variable used in this study. Appendix 1 provides a detailed description of major variables related to farm characteristics, income and costs, data manipulations required for estimation, and units and sources. 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 value 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.

Table 5-1. Data summary, 1993-2002

Variable name	Unit	Iowa		Illinois		Indiana		Missouri		Ohio	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Profit	Million $ of 1990-1992	13.20	11.80	7.99	8.04	4.14	4.97	2.45	4.65	5.73	7.20
Live	Million $ of 1990-1992	13.87	15.69	3.29	4.15	3.22	3.35	5.24	7.49	3.38	4.72
Feed	Million $ of 1990-1992	12.84	11.64	4.34	4.28	6.38	8.79	6.80	10.70	6.11	13.39
Seed	Million $ of 1990-1992	4.76	1.98	4.40	2.74	2.67	1.44	1.48	1.41	2.61	1.83
Fert	Million $ of 1990-1992	11.58	4.76	12.33	7.52	8.00	4.29	5.17	4.80	6.68	4.84
Fuel	Million $ of 1990-1992	2.95	1.21	2.56	1.48	1.77	0.90	1.56	1.02	1.70	0.98
Labr	Million $ of 1990-1992	4.32	2.08	3.98	2.76	2.88	2.01	2.63	3.16	3.47	3.05
Government payments	Million $ of 1990-1992	7.52	4.56	5.88	5.43	3.12	2.61	2.70	3.17	2.47	2.61
Crop portion	%	51.66	15.01	75.49	14.59	65.22	18.17	41.51	27.33	59.62	23.34
Number of farmers	1,000	0.99	0.30	0.81	0.37	0.72	0.29	1.02	0.40	0.96	0.36
Agriculture portion	%	34.62	11.86	23.84	11.91	21.11	11.25	35.42	15.38	18.32	10.71

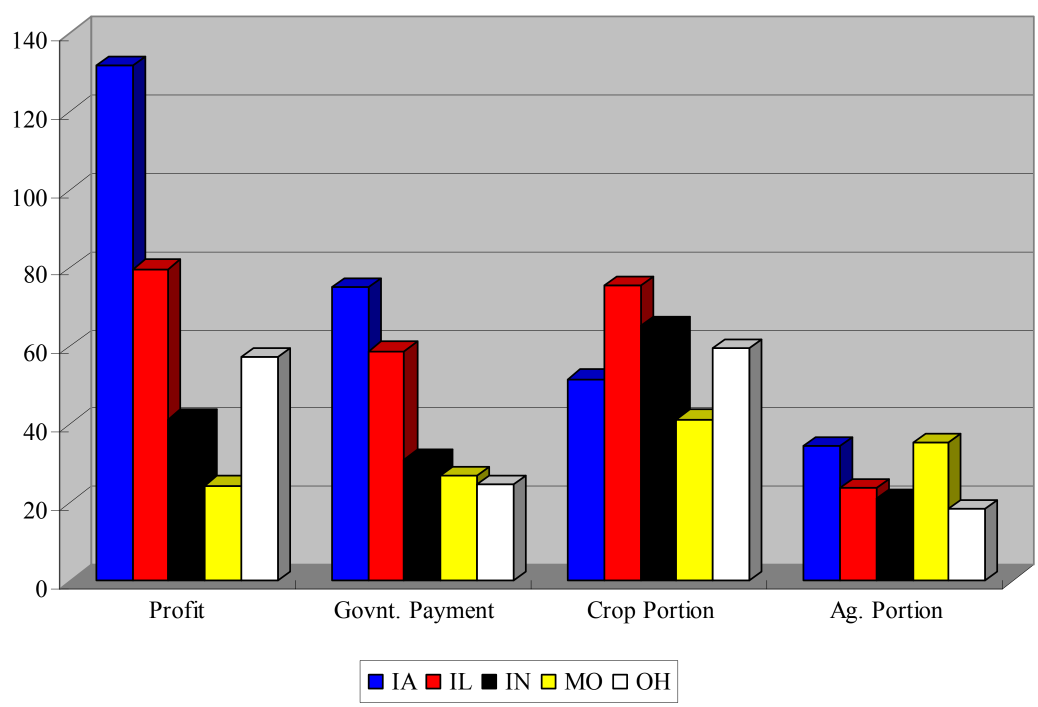
Note : 1) profit and government payment are deflated by CPI.
2) The portion of crop is calculated as crop revenue/(crop revenue+livestock revenue)
3) Agriculture portion is # of farm proprietors/(# of farm proprietors + # of nonfarm proprietors)

Source: Bureau of Economic Analysis

Iowa has the largest farm profit ($13.2 million) per county in the Corn Belt and receives the most government support as well (Figure 5-1). Missouri counties have the smallest average farm profit ($2.45 million) and Ohio counties get the smallest government support ($2.47 million). In terms of the number of farm proprietors, Missouri has the most (1,027) per county, while Indiana has the fewest (723). The crop portion of total revenue is lowest in Missouri counties (42%) and largest in Illinois (76%). Ohio has a relatively large portion of crop receipts (60%) in total agricultural receipts, but farm proprietors are a small portion of total proprietors (18%). The average ratio of government payments to total market revenues is 26.7 percent and 26.9 percent in Iowa and Missouri, respectively. In other states, it ranges from 14.4 to 18.5 percent.

Figure 5-1. The comparison of agriculture among states

Unit : $ 100,000, %



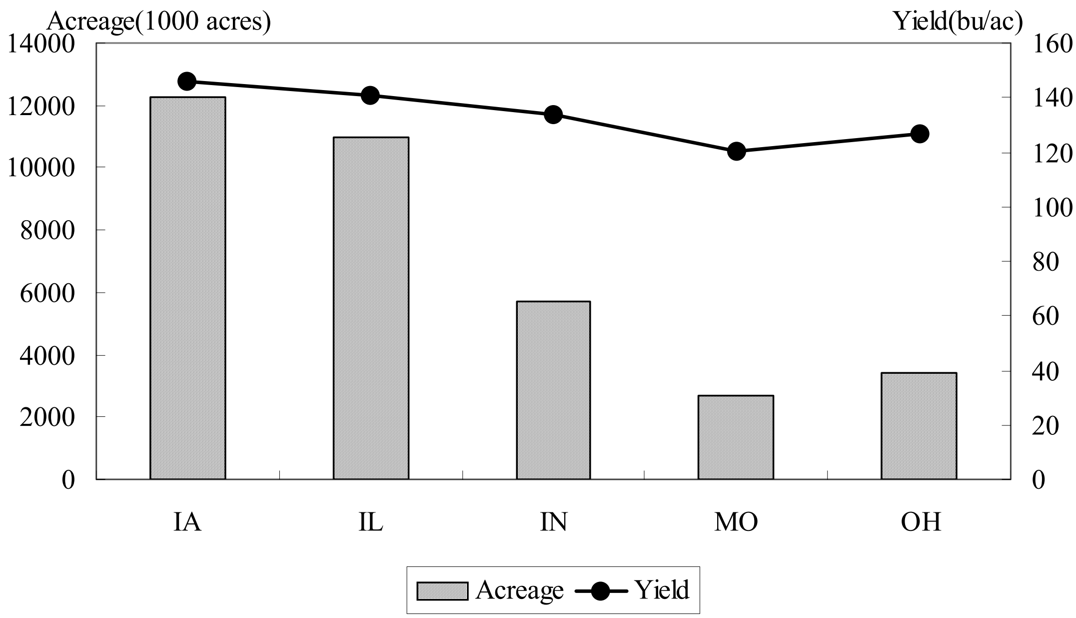
Source : Bureau of Economic Analysis

Ohio counties receive smaller government payments than Missouri counties, while they have much more net realized income than Missouri counties. The reason is that Ohio counties have more imputed other income and miscellaneous income. Missouri counties have an average of 1.4 million dollars in other income, while Ohio counties have 2.8 million dollars.

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 1996 to 2002 for each state. Average corn acreage for 1996-2002 in the Corn Belt is 34 million acres, which is 45 percent of total U.S. corn acreage. Among the Corn Belt states, Iowa has the largest acreage (Figure 5-2), which is 12.2 million acres (35%) and Illinois has 11.0 million acres (31%). Missouri has the least corn acreage among the five states (2.7 million acres). The pattern of corn yields among the five states is similar to that of its acreage. Iowa has the highest (146 bu/ac) average yield, while Missouri has the lowest (120 bu/ac) in the Corn Belt.

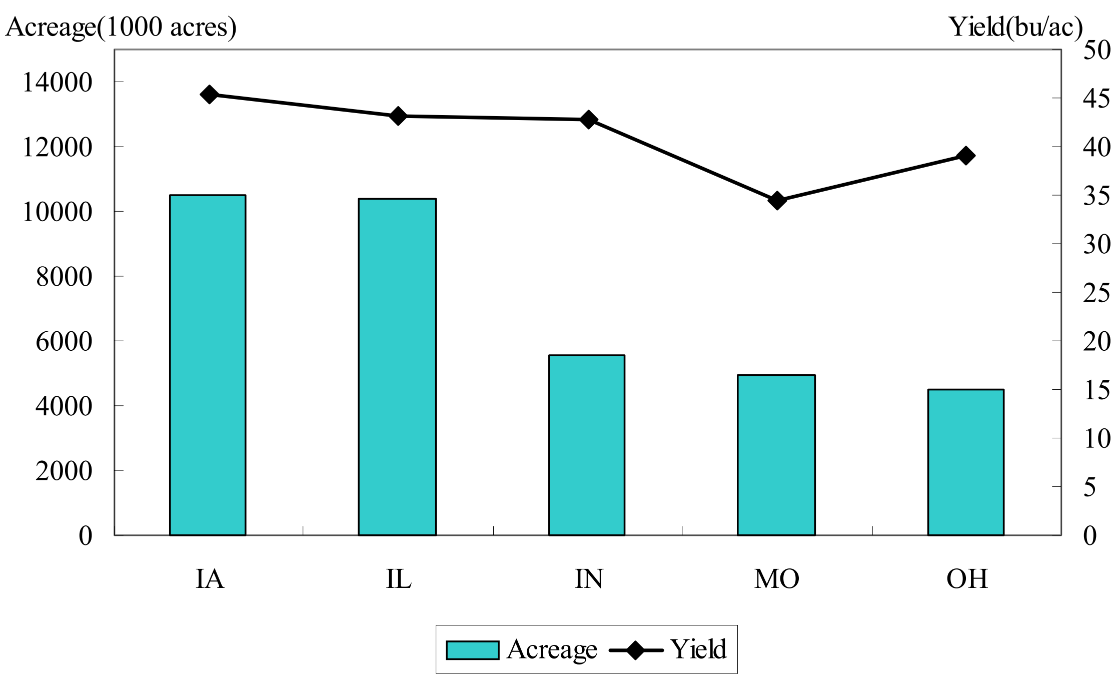
Soybean is also a major crop in the Corn Belt. Average soybean acreage in the Corn Belt is 36 million acres, which is 50 percent of total U.S. soybean acreage. Iowa and Illinois both produce about 10.5 million acres of soybeans (Figure 5-3). The rest of the states in the Corn Belt each have 4~6 million acres of soybeans each. The soybean yield in Missouri is relatively low (35 bu/ac), while Iowa has the highest yield.

Figure 5-2. Corn acreage and yield in the Corn Belt (average 1996-2002)



Source : USDA/NASS

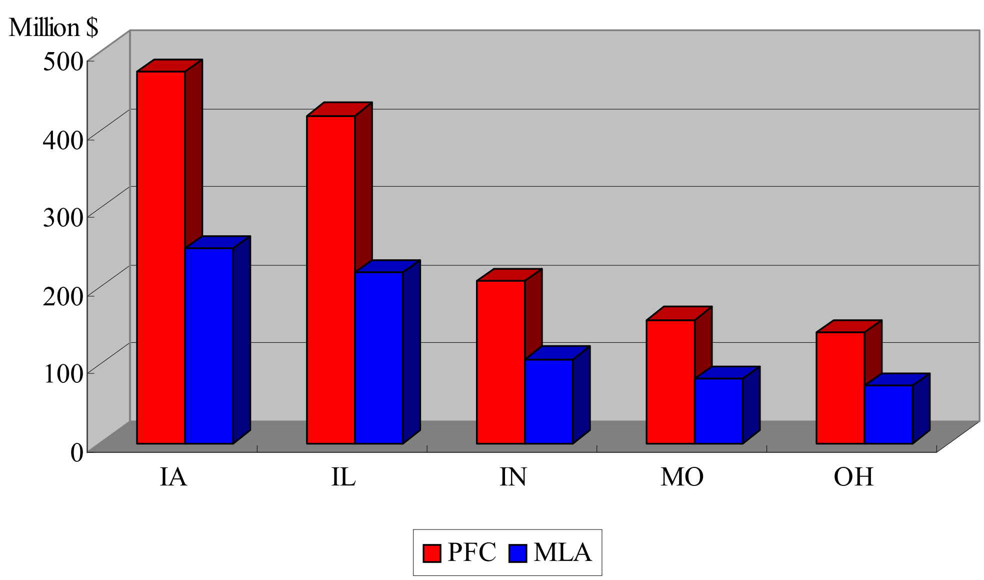
Figure 5-3. Soybeans acreage and yield in the Corn Belt (average 1996-2002)



Source : USDA/NASS

During 1996-2002, $9.8 billion of PFC payments were made to Corn Belt producers, which is 27 percent of total U.S. PFC payments. The five states in the Corn Belt also were paid a total of $5.1 billion of MLA payments from 1998 to 2002. During the same period, Iowa received an annual average of $475 million in PFC payments and $249 million in MLA payments, while Ohio received the least of those payments in the Corn Belt ($141 million and $73 million respectively), since eligibility was calculated on the basis of historical production (Figure 5-5).

Figure 5-5 PFC and MLA payments (average 1996-2002)



Source : the Environmental working Group (EWG) database.
Available from www.ewg.org/farm

Because they are fully coupled payments, LDPs and MLGs are used to enhance the return to producing each commodity. Farmers mainly had the benefit of LDPs and MLGs during the 1998-2001 period. Through the LDP and MLG programs, corn returns were supported by \$0.16~0.19/bu in the Corn Belt on average from 1998 to 2001 and soybean returns were increased by \$0.85~0.87/bu during the same period. As seen in Appendix 2, LDP and MLG supports help to stabilize total returns tied to production.

5. 2. Measuring farmers' risk attitudes

In actual estimation of moment equations for eq (4-11) and eq(4-12), implicit inputs, the crop portion of receipts , the agriculture portion of proprietors, and time dummy variables are used as explanatory variables. Other characteristic variables are used as exogenous instruments where necessary[9].

Actual model specifications for the first and higher moments are

$$FM = \alpha_f + \beta_{f1} NLIVE + + \beta_{f2} NFEED + \beta_{f3} NSEED + \beta_{f4} NFERT + \beta_{f5} NLABR$$
$$+ \beta_{f6} NRATIO + \beta_{f7} NNUM + \gamma_{ft} DM + e_f \qquad (5\text{-}1)$$

where FM = first moment (net realized income, \$ million) deflated by CPI
NLIVE = Live animal purchased (\$1,000)/ live animal price index*100/1000
NFEED= Feed purchased (\$1,000)/ feed price index*100/1000
NSEED= Seed purchased (\$1,000)/ seed price index*100/1000
NFERT= Fertilizer purchased (\$1,000)/ fertilizer price index*100/1000
NLABR= Labor purchased (\$1,000)/ wage index*100/1000
NRATIO= Crop revenue/(crop revenue + livestock revenue)*100
NNUM=# of farm proprietors/(# of farm proprietors + # of non farm proprietors)
DM_t = time dummy variables from 1993 to 2002

[9] 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.

$$HM = (e_f)^h = \alpha_h + \beta_{h1}NLIVE + + \beta_{h2}NFEED + \beta_{h3}NSEED + \beta_{h4}NFERT + \beta_{h5}NLABR$$

$$+ \beta_{h6}NRATIO + \beta_{h7}NNUM + \gamma_{ht}DM + e_h \qquad (5\text{-}2)$$

where HM = higher moments
if superscript $h=2$, HM is the second moment

In the model specification of moment equations, input and output prices are not included in the estimated equations. In reality, each county within a state may face similar input and output prices. As Antle (1987) pointed out, the profit distribution is equivalent to a revenue or output distribution, if input prices and output prices are nonstochastic.

For obtaining the risk attitudes, the actual model specification is exactly the same as eq (4-14) using the difference of estimated moments. According to Gardebroek (2002), there are two potential problems in the estimation. First, the residual terms (w_{jt}) may be expected to be heteroskedastic given the relation between the w_{jt} and D_{ijt} as shown in eq (4-8). Also, there is likely to be an endogeneity problem. The residuals (w_{jt}) partly reflect differences in risk attitudes that are expected to affect the moments of the profit distribution. That is, the covariance between w_{jt} and D_{ijt} may not be expected to be zero in eq (4-14). In that case, we should use Instrumental Variable (IV) or Generalized Method of Moments (GMM) estimation instead of Ordinary Least Square (OLS) estimation. Therefore, the choice of econometric methods depends on the results of hypothesis tests.

First, we need to conduct an endogeneity test using the Hausman test. The choice between OLS estimation and IV or GMM estimation depends on the testing results. If endogeneity exists, an OLS estimator is not consistent even asymptotically, so we have to use either an IV or GMM method (Baum, Schaffer, and Stillman 2003, Wooldridge 2001). Second, we should test for heteroskedasticity with a White test or a Breusch-Pagan test. The result is the criteria for choosing between IV and GMM. When there is a heteroskedasticity problem, a GMM estimator is more efficient than an IV estimator. If heteroskedasticity is not present, a GMM estimator is no worse asymptotically than an IV estimator (Baum, Schaffer, and Stillman 2003). But Hayashi (2002) points out the disadvantage of using a GMM estimator-the optimal weighting matrix $\hat{S}$ at the core of an efficient GMM is a function of fourth moments, and obtaining reasonable estimates of fourth moments requires very large sample size. Therefore, if the error is homoskedastic, IV is preferable to an efficient GMM (Baum, Schaffer, and Stillman 2003).

Lastly, we need to choose appropriate instruments. Relevant instruments have to satisfy two requirements. Appropriate instruments should be correlated with the included endogenous variables and orthogonal to the error term as well (Wooldridge 2002; Baum, Schaffer, and Stillman 2003). To test the relevance and validity of instruments, we have to check the correlation between endogenous variables and instruments and conduct the overidentifiying restriction test using Sargan's statistic or the J-statistic. In reality, it is hard to find appropriate instruments that fully satisfy both requirements. Recently, some papers (Staiger and Stock 1997; Klepinger, Lundberg, and Plotnick 1995; Stock, Wright, and Yogo 2002) point out the problem of weak or wrong instruments. In some cases, OLS estimation is better than IV/GMM estimation with weak instruments. Thus, we also need to consider the pertinence of instruments.

5. 3. Measuring the effect of decoupled payments

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

$$R_{i,t} = f(NINC_{i,t}, PFC_{i,t}, OGP_{i,t}, NDET_{i,t}, NLAND_{i,t}, DM_{i}.) \text{ for i=1,…,5, t=1…T} \quad (5\text{-}3)$$

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 (5-3), we obtain the effect of PFC payments on risk attitudes and then use it later for calculating the effect of decoupled payments.

The acreage function is estimated as a function of a lagged dependent variable, own expected price, cross expected price and risk attitude.

$$NA_{i,t} = f(NA_{i,t-1}, EP_{i,t,output}, EP_{i,t,other} RRA_{i,t-1}) \quad (5\text{-}4)$$

where $NA_{i,t}$ = planted acreage normalized by the acreage in 1995,

$EP_{i,t,output}$ = own expected price ,

$EP_{i,t,other}$ = expected price of other competitive commodity,

RRA_i = relative risk attitudes,

Since each state has different corn and soybean acreages, acreage is normalized by the acreage of 1995. An expected price in this study is defined as

$$EP_t = P_{t-1} + MLDP_{t-1} \quad (5\text{-}5)$$

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 (5-3) and eq (5-4). Decoupled payments affect farmer's risk attitudes according to eq (5-3) and, in turn, affect acreage according to eq (5-4). In other words, the effect of decoupled payments is expressed as follows.

$$\frac{\partial A}{\partial PFC} = \frac{\partial A}{\partial RRA} \cdot \frac{\partial RRA}{\partial PFC}$$

where A : acreage, RRA : coefficients of relative risk aversion, PFC : PFC payments.

Chapter 6

Results and Analysis

6. 1. Measuring farmers' risk attitudes

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 chapter 5 are estimated for each state. Appendix 3 shows the results of parameter estimation.

In the first moment equation, most input variables have a positive sign and are significantly different from zero at the 10 percent critical level. Although some of coefficients are negative, the negative coefficients are not statistically significant. Net realized income is increasing with the crop portion of total receipts (NRATIO) and the agriculture portion of total proprietors (NNUM). In Indiana, NNUM is negative but it is not significant at the 10 percent critical level. There may exist heteroskedasticity[10] and multicollinearity problems in the estimation. The estimated parameters are still consistent although not efficient, when those problems exist (Kennedy 1998; Wooldridge 2003). So, those issues are not a serious problem in this study, because they don't affect the

[10] In the estimation results, standard errors have been corrected for heteroskedasticity

consistency of the difference in the moments. We don't have much interest in the results of the moment equations themselves. We use the difference of estimated moments to estimate a risk attitude equation. Testing the overall significance of the regression for the first moment equation using a F-test rejects the null hypothesis that all slope parameters are zero (Table 6-1).

Table 6-1. 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

The results of the second and the third moment equations indicate that many coefficients are not statistically significant. It is hard to interpret the signs of independent variables, because the variance (second moment) and the skewness (third moment) of profit depend on the structure of agriculture and technology in each state. The test of overall significance of the second moment equations rejects the null that all parameters are equal to zero, while the test does not reject this hypothesis for the third moment equations (Table 6-1). Therefore, the first moment and the second moment are selected to estimate a risk attitude equation.

Using the difference of the first and the second moments estimated from the previous step, equation (4-14) in chapter 4 is estimated. Since Antle (1989) and Gardebroek (2002) point out the potential endogeneity problem in a risk attitude equation, the choice of an estimation method depends on the results of hypothesis tests. Before conducting an endogeneity test, appropriate instruments have to be chosen. Candidates of excluded instruments for a potential endogenous variable such as the second moment (DSMOM) are the difference in government payments (GOVERN), the crop portion of revenues (NRATIO), the agriculture portion in the economy of each county (NNUM), and input variables.

As briefly mentioned in chapter 5, relevant instruments should be correlated with an endogenous variable and uncorrelated with the error term[11]. Wooldridge (2002) mentions that the first requirement of instruments to have a high correlation with an endogenous variable can be examined by the fit of the first stage regression[12]. The first assumption is formally tested with Shea's partial R^2 that takes the intercorrelations among the instruments into account (Baum, Schaffer, and Stillman 2003).

[11] In actual practice, it is hard to identify a set of appropriate instruments. Klepinger et al.(1995) suggested a technique for choosing a set of instruments.

(1) Regress the residuals from IV estimation on all potential instruments and conduct the overidentifying restriction test. If the test fails, drop the instrument having the highest t-value. And do the first step again until satisfying the result of the overidentifying restriction test.
(2) With a set of instruments passed the first step, run backward-stepwise regression until each identifying instrument remaining in the first stage model achieves a certain level of significance.

In the study, we partially use their technique to find relevant instruments.

[12] The first regression is a reduced form regression of the endogenous variable on the full set of instruments (Baum, Schaffer, and Stillman 2003)

Table 6-2 gives Shea's partial R^2 statistic[13] and F-statistic in the case of one potential endogenous variable (DSMOM). The result in all states rejects the null that all excluded instruments are different from zero at the conventional critical level, which indicates that instrument candidates satisfy the first requirement.

Table 6-2. Shea's partial R^2 and F-statistic for a potential endogenous variable

	Shea's partial R^2	F-statistic	P-value
IOWA	0.039	F(2, 872) = 17.49	0.000
ILLINOIS	0.011	F(2, 876) = 5.00	0.007
INDIANA	0.076	F(2, 809)= 33.29	0.000
MISSOURI	0.051	F(2, 947) = 25.33	0.000
OHIO	0.053	F(3, 747) = 13.80	0.000

Note : F-test is the joint significance test of the excluded instruments in the first-stage regression.

Regarding the second assumption of relevant instruments, we can test whether or not the instruments are uncorrelated with the error term, using an overidentifying restriction test when the number of instruments excluded from the equation exceeds the number of included endogenous variables (Baum, Schaffer, and Stillman 2003). In the GMM estimation, Hansen's J-statistic is generally used for testing the overidentifying restrictions.

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[13] Shea (1997) suggested four step to obtain partial R^2. But Godfrey (1999) showed an easy way to get Shea's partial R^2 (Baum, Schaffer, and Stillman 2003)

$R_P^2 = \frac{v_{i,i}^{OLS}}{v_{i,i}^{IV}}\left[\frac{(1-R_{IV}^2)}{(1-R_{OLS}^2)}\right]$ where $v_{i,i}$ is the estimated asymptotic variance of the coefficient.

Hansen's J-statistic is defined as

$$J(\hat{\beta}(\hat{S}^{-1})) = n \cdot g_n(\hat{\beta}(\hat{S}^{-1}))' \hat{S}^{-1} g_n(\hat{\beta}(\hat{S}^{-1})) \overset{d}{\sim} \chi^2(L-K)$$

Where $\hat{S}$ is a consistent estimator of S($= E(g_i g_i')$), $g_i = X_i \cdot \varepsilon_i$,

g_n is the sample mean of g,

$\hat{\beta}(\ )$= the GMM estimator of β

L : the total number of moment conditions,

K : the total number of parameters

Table 6-3 shows the result of an overidentifying restriction test using the Hansen J-statistic. Missouri has a relatively large J-statistic, but all states accept the null that all instruments are uncorrelated with the error term at the conventional critical level. It implies that the instruments satisfy the orthogonality condition.

Table 6-3. Overidentifying restriction test (Hansen's J-statistic)

	Hansen's J statistic	Prob > χ^2_{L-K}
IOWA	0.81	0.37
ILLINOIS	0.23	0.63
INDIANA	0.55	0.46
MISSOURI	2.60	0.11
OHIO	1.65	0.44

From the two tests for instruments, we conclude that selected instruments are relevant. The following variables are appropriate as excluded instruments (Table 6-4), which satisfy the two requirements.

Table 6-4. The choice of excluded instruments[14]

State	Excluded Instruments
IOWA	DFEED, DFERT
ILLINOIS	DRATIO, DFERT
INDIANA	DLIVE, DFERT
MISSOURI	DFERT, DFARM
OHIO	DGOVERN, DLIVE, DFARM

Where DFEED : the difference of feed from t-1 to t,
DFERT : the difference of fertilizer and ag.chemical from t-1 to t,
DRATIO : the difference of crop portion from t-1 to t,
DLIVE : the difference of purchased live animals from t-1 to t,
DFARM : the difference of the number of farm proprietors from t-1 to t,
DGOVERN : the difference of government payments from t-1 to t

Now, given those instruments, an endogeneity test is conducted for the second moment (DSMOM). For the endogeneity test, Durbin-Wu-Hausman (DWH) test is used. According to Baum, Schaffer, and Stillman (2003), the DWH statistic is calculated as

$$H = n(\hat{\beta}^c - \hat{\beta}^e)' D^{-1} (\hat{\beta}^c - \hat{\beta}^e) \sim \chi^2(M)$$

Where $D = V(\hat{\beta}^c) - V(\hat{\beta}^e)$

$V(\hat{\beta})$ is a consistent estimate of the asymptotic variance of β

$\hat{\beta}^c$ is consistent under both the null and the alternative hypotheses

$\hat{\beta}^e$ is fully efficient under the null but inconsistent if the null is not true.

M: the number of regressors being tested for endogeneity.

[14] As instruments, Gardebroek (2002) used family labour, machinery, land, seeds and plants, contractor work, a standardized measure of size and an indicator of the region for organic farms and labour, land, pesticides, a standardized measure of size and an indicator of the region for non-organic farms. Antle(1989) chose acreage , machinery input, animal labor and their squares and interaction terms, value of land owned , irrigated area, an index of farm size, time dummy as appropriate instruments. All variables except time dummies are in difference form.

If the OLS estimate of the error variance is used to calculate this statistic, the D matrix in the formula of the DWH statistic becomes

$$D = \hat{\sigma}^2_{OLS}((X'P_Z X)^{-1} - (X'X)^{-1})$$

where $\hat{\sigma}^2_{OLS}$ is the error variance of OLS estimates

P_Z is the projection matrix ($= Z(Z'Z)^{-1}Z'$)

Table 6-5 gives the result of the DWH test. All states have a large value of the statistic and reject the null hypothesis that the regressor is exogenous. It implies the second moment variable is endogenous, so that we must use the IV or GMM method instead of OLS estimation.

Table 6-5. The endogeneity test using DWH statistic

	DWH statistic	p-value
IOWA	657.35	0.00
ILLINOIS	287.19	0.00
INDIANA	561.86	0.00
MISSOURI	492.58	0.00
OHIO	561.60	0.00

The conclusion of these hypothesis tests is that GMM estimation is adopted. Since each state has over 800 observations, the choice of GMM estimation is desirable, regardless of the result of a homoskedasticity test. The GMM estimates for the derived risk attitude equation are given in Appendix 4. 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.

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)[15]. The calculated ARA in each state is shown in Table 6-6. 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 (Figure 6-1).

The coefficients of Relative Risk aversion (RRA) are calculated as all negative except Iowa in 1999 (Table 6-7 and Figure 6-2). 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.

In contrast to the results of this study, farmers' risk attitudes are generally considered to be risk averse and very stable. However, some empirical studies, as we have seen in the literature review section, show that this is not always true. Some studies show farmers' risk attitudes are risk loving, although risk aversion cases are more frequent. Moreover, it is hard to find an empirical study estimating risk attitudes over

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[15] Antle(1987) gives the proof of this relationship in Appendix 2 of his paper. A positive number of ARA means risk loving and a negative value of ARA indicates risk averse.

time. The fundamental difference between this study and others is the definition of risk attitude. Other studies measuring risk attitude focus on a specific type of risk like production risk, price risk or policy risk, and a specific place and year. But in this study, risk attitude is defined as the response of farmers to the change of their circumstances for agricultural production. It includes all types of risk. In other words, risk attitude is revealed as their resource allocation reacts to changes in their production circumstances. Also farmers' risk attitude is measured at a more aggregate level as risk attitude at the state level. That is why the results of this study may be a bit different from previous studies.

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.

Table 6-6. The coefficients of absolute risk aversion

	IOWA	ILLINOIS	INDIANA	MISSOURI	OHIO
1995	-0.46	-0.24	-0.74	-0.48	-0.51
1996	-0.38	-0.22	-1.04	-0.31	-0.71
1997	-0.39	-0.01	-0.99	-0.24	-0.78
1998	-0.58	-0.13	-1.07	-0.34	-0.55
1999	0.35	-0.12	-1.41	-0.52	-0.27
2000	-0.22	-0.12	-1.10	-0.47	-0.48
2001	-0.18	-0.23	-0.81	-0.23	-0.28
2002	-0.14	-0.24	-0.79	-0.29	-0.41

Figure 6-1. State-level coefficients of absolute risk aversion, 1995-2002

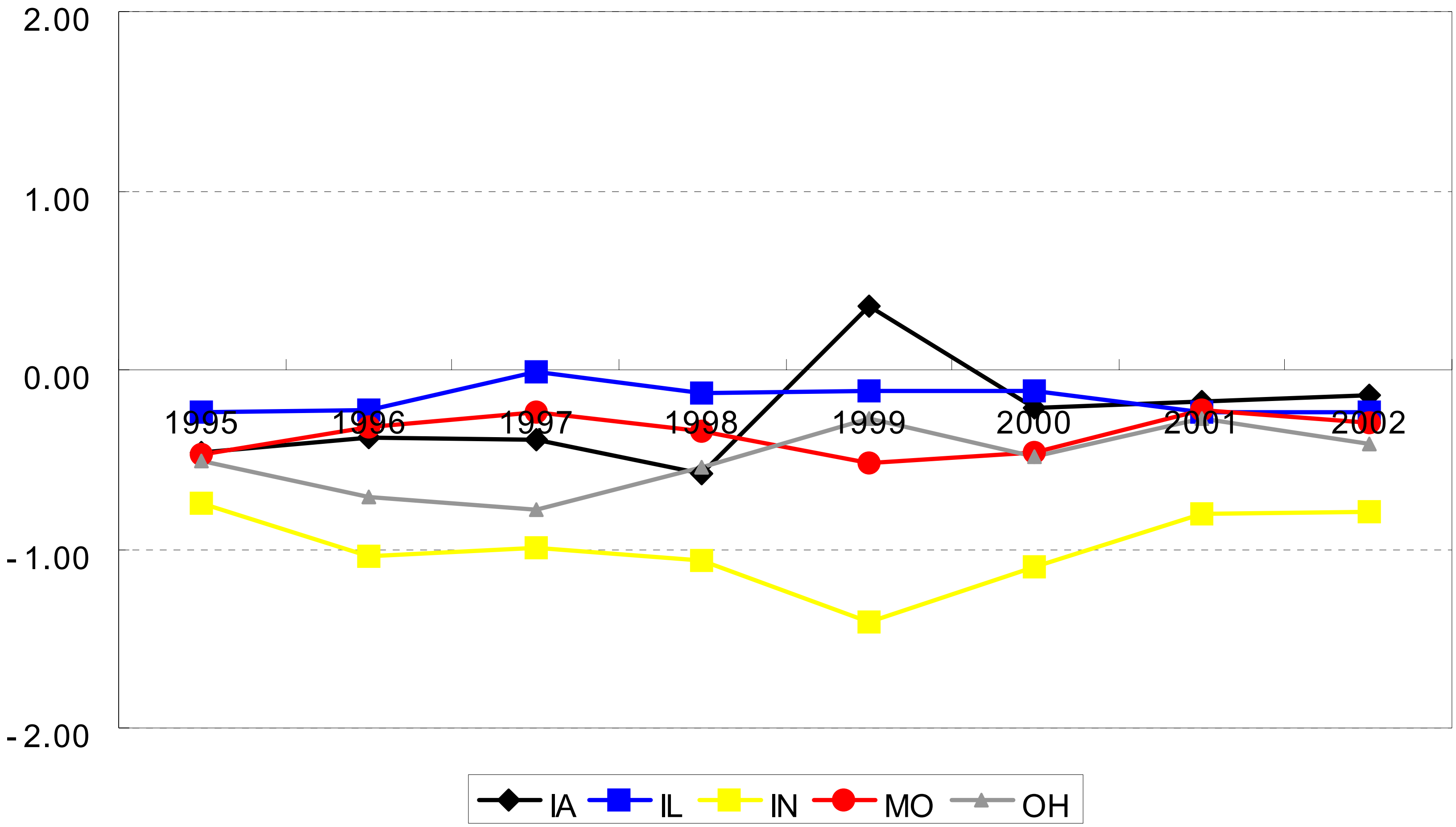
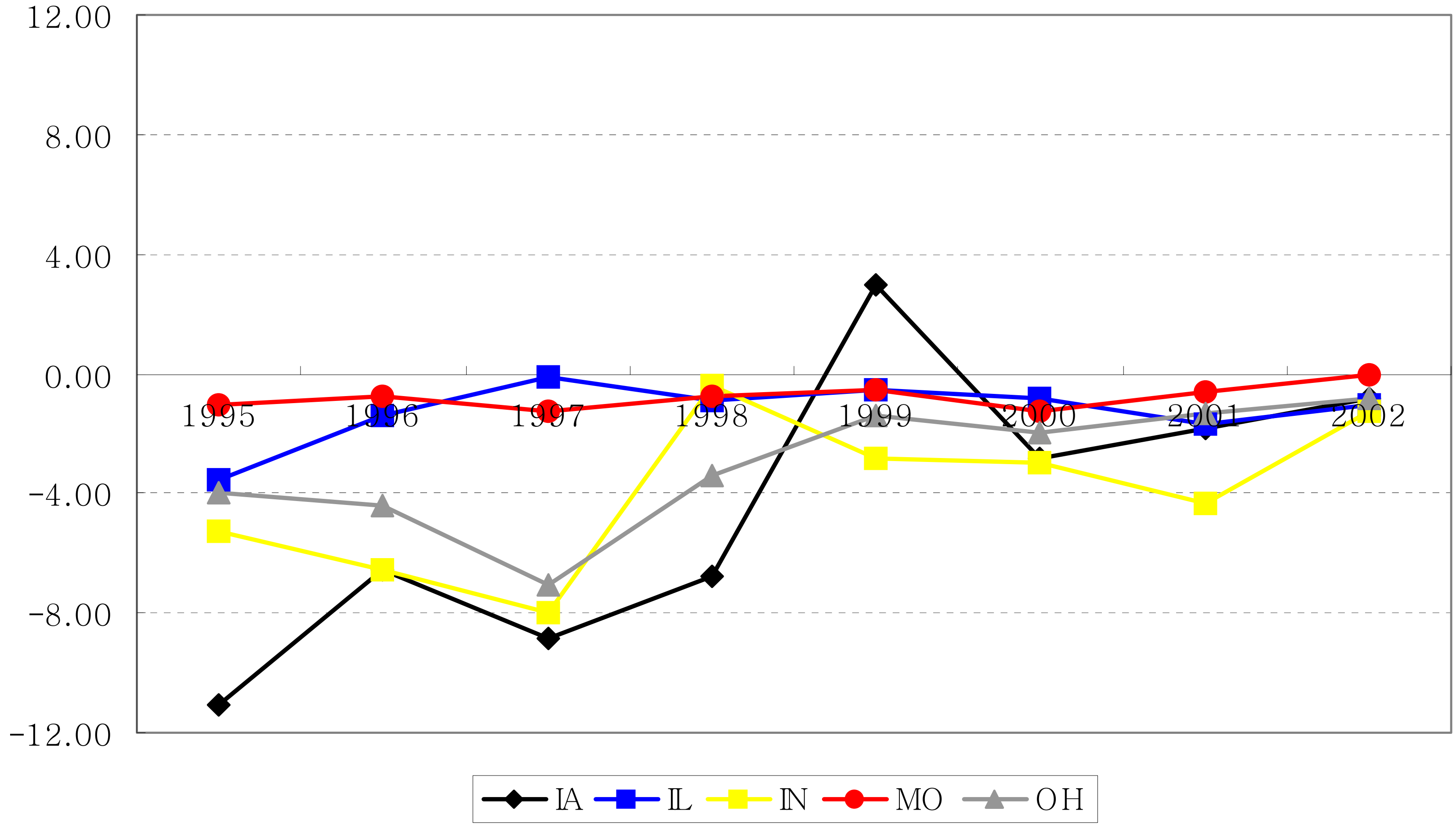


Table 6-7. The coefficients of relative risk aversion

	IOWA	ILLINOIS	INDIANA	MISSOURI	OHIO
1995	-11.04	-3.56	-5.25	-1.03	-3.95
1996	-6.57	-1.37	-6.53	-0.77	-4.42
1997	-8.85	-0.10	-8.00	-1.24	-7.07
1998	-6.78	-0.87	-0.40	-0.76	-3.37
1999	3.01	-0.52	-2.83	-0.53	-1.41
2000	-2.84	-0.79	-2.99	-1.23	-1.97
2001	-1.79	-1.66	-4.33	-0.58	-1.32
2002	-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.

Figure 6-2. State-level coefficients of relative risk aversion, 1995-2002



6. 2. Measuring effects of decoupled payments on production

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 (Table 6-8 and Table 6-9). 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 (Table 6-8). 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 (Table 6-9). 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 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.

Table 6-8. The estimation results of risk attitude functions

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

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(1000acres),
Dia=dummy vaiable for Iowa, Dil=dummy vaiable for Illinois, Din=dummy vaiable for Indiana, Dmo=dummy vaiable for Missouri,
Dia99= dummy variable for IOWA and 1999.
* = 5% critical level, ** = 10% critical level.

Table 6-9. The results of the F-test on coefficients in the risk attitude functions

	Model1	Model2	Model3	Model4
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
Obs	40	40	40	40
R^2	0.85	0.85	0.85	0.85

Where 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

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 (1000acres),
Dia=dummy vaiable 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[16]. 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 by 3.25 points.

Second, by estimating acreage functions for corn and soybeans with an estimated risk attitude variable (RRA), the effect of decoupled payments is measured. Tables 6-10~ 6-12 give several estimation results of acreage functions. All models are estimated by the Seemingly Unrelated Regression (SUR) method, because the planting decisions of commodities, especially corn and soybean, are closely related.

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

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

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. 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, a price and a lagged dependent variable are statistically significant at the 5 percent critical level but RRA is not.

Unlike model 1 and model 2, model 3 has both price variables in each equation. So, symmetry constraints in the short run and the long run are imposed. In model 3, the magnitude of the lagged dependent variable in the corn equation is less than that in model 1 and model 2. However, RRA has a positive sign and is significant at the 5 percent critical level, counter to our expectations. Lin and Dismukes (2004) also estimate a negative wealth effect, which means that an increase in wealth reduces corn planting. In the soybean equation, although all variables have the expected sign, the lagged dependent variable is significant but other variables are not.

Table 6-10. The result of acreage function estimation (model 1)

	Corn		Soybean	
	coef.	Std. Err	coef.	Std. Err
$NACR_{t-1}$	0.9833*	0.0577	0.3677*	0.0913
REP_corn_t	1.3272*	0.4380		
$REP\_ soybean_t$			0.0932*	0.0327
$RRA_{\ t-1}$	0.0076	0.0063	-0.0020	0.0023
constant	-0.4603*	0.1930	0.4582*	0.1040
R^2	0.81		0.45	

Where $NACR_{t-1}$= normalized acreage (thousand acres),
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),
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),
RRA: relative risk attitudes,
CPI=Consumer Price Index
* : significant at the 5% critical level

Table 6-11. The result of acreage function estimation (model 2)

	Corn		Soybean	
	coef.	Std. Err	coef.	Std. Err
$NACR_{t-1}$	0.9878*	0.0570	0.4176*	0.1082
EP_corn_t	0.2726*	0.1009		
$EP\_soybean_t$	-0.0782	0.0536		
$REP\_ soybean_t$			0.0858*	0.0339
RRA_{t-1}	0.00923	0.0064	-0.0021	0.0024
constant	-0.0494	0.1245	0.4229*	0.1116
R^2	0.82		0.44	

Where $NACR_{t-1}$= normalized acreage (thousand acres),
REP_soybean,t = the ratio of prices(=EP_soybean,t/EP_corn,t),
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),
RRA: relative risk attitudes,
CPI=Consumer Price Index
* : significant at the 5% critical level

Table 6-12. The result of acreage function estimation with symmetry constraints (model 3)

	Corn		Soybean	
	coef.	Std. Err	coef.	Std. Err
$NACR_{t-1}$	0.9399*	0.0582	0.9399*	0.0582
EP_corn_t	0.2326*	0.0955	-0.0345	0.0475
$EP\_soybean_t$	-0.0345	0.0475	0.0332	0.0294
RRA_{t-1}	0.0123*	0.0062	-0.0015	0.0030
constant	-0.0892	0.1224	0.0060	0.0932
R^2	0.83		0.17	

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),
RRA: relative risk attitudes,
CPI=Consumer Price Index
* : significant at the 5% critical level
Note : In this model, symmetry constraints(short run and long run) are imposed.
The short run constraint : EP_corn, soybean = EP_soybean, corn
The long run constraint : NACR_corn = NACR_soybean.

6. 3. Economic Analysis

The estimation result of the risk attitude equation in section 6.2 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 generally not significant in the estimated acreage functions. In model 3, the corn acreage equation has a significant and positive coefficient of RRA. Although RRA is significant in this model specification, RRA is insignificant in other model specifications, casting doubt on the one significant positive effect. 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 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 40 thousand to 53 thousand acres. In corn equations, one billion dollar of PFC payments would decrease corn plantings 197 thousand to 319 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. The elasticities of expected prices[17] are given in Table 6-13. The ratio of expected prices in model 1 and in the soybean equation of model 2 forces the own- and cross-price elasticities to be the same magnitude but of opposite signs. In the corn equations, model 1 has the largest elasticity in both own-price and cross-price, while model 3 has the smallest. The elasticity of own-price is bigger than that of cross-price in the corn equations.

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[17] The formula to calculate the elasticity of price is as follows.
In the case of a price variable : elasticity of own-price = coef. *(AP_corn / ANA_corn)
where AP : average price,
ANA : average normalized acreage(=average of dependent variable)
In the case of a price ratio variable
Own-price = (coef. / AP_soybean)* (AP_corn / ANA_corn)
Cross-price = coef. *(- AP_corn/ $AP\_soybean^2$)*(AP_soybean / ANA_corn)

Table 6-13. Short-run supply elasticities of expected prices

Models	Corn		soybean	
	own price	soybean price	own price	corn price
Model 1	0.452*	-0.452*	0.213*	-0.213*
Model 2	0.347*	-0.250	0.196*	-0.196*
Model 3	0.296*	-0.110	0.113	-0.047

Note : * indicates that the coefficients of those variables are significant at the 5% critical level.

In the soybean equations, model 1 has the largest elasticity, while model 3 has the smallest. But expected prices are not significant in model 3. The elasticities of own and cross-prices are the same in model 1 and model 2 owing to the use of a price ratio variable. 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.

Using the elasticity of expected price, the effect of coupled payments is calculated. Given the production of the Corn Belt in 1999-2001[18], one billion dollars of coupled payments have the effect of increasing the returns by $0.20 and $0.65 for corn and soybean, respectively[19]. Increasing one billion dollars of coupled corn payments increases corn acreage by 302 thousand to 460 thousand acres. In the case of soybean, one billion dollars of coupled payments increase soybean acreage by 141 thousand to 266 thousand acres.

In the acreage functions, a lagged dependent variable is significant and has an expected sign. But the coefficient on the lagged dependent variable in the corn equation is larger than anticipated. The implication would be that long-run elasticities of corn supply with respect to prices and coupled payments are extremely large.

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

[19] For example, the effect of coupled corn payments from the corn equation is calculated as follows.
Coupled effect = E_corn *(ANA_corn/ AP_corn)*(BA_corn)*$0.20/bu
where E_corn: the elasticity of corn price, AP : average price,
ANA : average normalized acreage(=average of dependent variable)
BA_corn : an average corn acreage in 1995(base year for normalization)
$0.20/bu : the effect of $1 billion of LDP/MLG(=$1billion/avg. corn production)

Chapter 7

Summary and Conclusions

7.1. Summary

The main objective of this study is to provide empirical evidence of the effect of decoupled payments. To fulfill the objective, farmers' risk attitudes over time were estimated and used for the evaluation of decoupled payments' effect on production.

As emphasized in the first part of this study, the choice of methodology for measuring risk attitude is very important. In this study, Antle's nonstructural approach was adopted to estimate the risk attitudes of farmers. Unlike other methodologies for measuring risk attitude, this approach covers all types of risk and can measure it over time.

In order to estimate risk attitudes, the first and the second moments were selected by the test of overall significance. Since the second moment in the risk attitude function turned out to be endogenous, GMM was used for estimation to avoid the problem of endogeneity. For using GMM, excluded instruments were tested and chosen. Selected instruments satisfied the two requirements of relevant instruments, which are correlation with the endogenous variable and lack of correlation with the error term. The result of the nonstructural approach was that estimated risk aversion coefficients were mostly negative, suggesting producers were more likely to be risk loving than risk averse. Among five states in the Corn Belt, Indiana in ARA is relatively less risk averse than other states. Risk aversion measures in Illinois and Missouri are more stable over time. The RRA in Iowa and Indiana has changed relatively more over time, and the RRA in Iowa, Indiana and Ohio has become more risk averse over time.

In the second step, an acreage function was estimated in order to measure the effect of decoupled payments on the acreage decision. Before estimating the acreage equation, the risk attitude function was reestimated with several alternative ways of combining payments. By running several model specifications and conducting hypothesis tests on whether different payments have different effects, the hypothesis that PFC payments have the same effect on risk attitude as do other types of income cannot be rejected. And the results reject the null hypothesis that PFC payments do not change risk aversion. Therefore, one billion real dollars of PFC payments make farmers willing to take more risk (become more risk loving or less risk averse) by a change of –3.98 in their RRA.

For measuring the effect of PFC payments on planting decisions, an acreage function was estimated by the SUR method. The results do not reject the null that RRA have no impact on planting decisions. A risk attitude variable in the corn and soybean equations is not significant at the 10 percent critical level. This implies that levels of risk aversion do not significantly affect the corn acreage decision, although PFC payments do make farmers more willing to take risks. So, this study has not found any significant impact of PFC payments on corn and soybean acreages. Even though the coefficients of RRA are not significant at the conventional critical levels, the impact of PFC payments is informative. Increasing one billion dollars of PFC payments would increase soybean plantings by 40 thousand to 53 thousand acres. One billion dollar of PFC payments would decrease corn plantings 197 thousand to 319 thousand acres. Even if the impacts of PFC payments for corn do not have the expected sign, the impacts for both crops are not only statistically insignificant but also very small in magnitude. This result is not much different from that of previous studies. Some studies found that the effect of decoupled payments on production is statistically significant but small, and other studies did not obtain significant results.

With respect to the expected prices, own-price elasticities are found to be positive and statistically significant in most specifications. The short-run elasticity of own-price is 0.23 to 0.45 for corn and 0.11 to 0.21 for soybean. The elasticity of prices is not much different from that of previous studies. An additional one billion dollars of coupled corn payments increases corn acreage by 302 thousand to 460 thousand acres. Increasing one billion dollars of soybean coupled payments increase soybean acreage by 141 thousand to 266 thousand acres. So, the coupled effects of one billion dollars on planting decisions are much larger than the decoupled payments' effects. The lagged dependent variable is significant and has a positive sign in all models. It ranges from 0.94 to 0.99 in the corn equations, suggesting very large long-run elasticities.

7.2. Conclusions

The basic idea for this study is rather simple. 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 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.

This study has a different result than conventional wisdom may suggest about farmers' risk attitudes. The analysis found that farmers' risk attitudes are mostly risk loving and change over time, while farmers' risk attitude is generally assumed 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.

7.3. Issues for further study

While the main objectives of this study were achieved; that is, the measurement of decoupled payments' effect on risk attitude and on planting decision, there are some issues for further analysis. In measuring risk attitudes, the results show that farmers are mostly risk loving in five states over time except Iowa in 1999. This result differs from conventional wisdom. It would be useful to be determined whether the result of this study is robust or is the consequence of using a different measurement approach or a particular data set. This difference may be verified by comparing with results obtained by using other methods or the same method with a different data source.

The nonstructural approach used in this study is a method more appropriate for farmers' actual situation. In other words, farmers face many types of risk and produce more than one commodity in many cases. The nonstructural approach considers this situation of farmers, while other methods focus on a certain type of risk and a specific commodity. Despite the benefits of this approach, the use of the non structural approach is limited due to unavailability of data. In reality, it is hard to obtain panel data at the farm level. So, this study used county level data, in measuring farmers' risk attitudes. If panel data at the farm level including production costs and income data were available, it would possibly estimate risk attitudes more accurately, because actual decisions are made at the farm level.

References

Abler, D. and D. Blandford.(2004) “Review of Empirical Studies on the Production Impacts of PFC and MLA Payments under the U.S. FAIR Act,” Presented at Modeling U.S. and EU Agricultural Policy: Focus on Decoupled Payments, October 4-5, 2004, Washington, D.C.

Adams, G., P. Westhoff, B. Willott, and R. E. Young II. (2001) “Direct Payments, Safety Nets .and Supply Response: Do ‘Decoupled’ Payments Affect U.S. Crop Area? Preliminary Evidence from 1997-2000,” *American Journal of Agricultural Economics,* 83: 1190-195.

Antle, J.M. (1987) “Econometric Estimation of Producers’ Risk Attitude,” *American Journal of Agricultural Economics,* 69: 509-22.

__________(1989) “Nonstructural Risk Attitude Estimation,” *American Journal of Agricultural Economics,* 71: 774-84.

Bar-Shira, Z., R.E. Just, and D. Zilberman. (1997) “Estimation of farmers’ risk attitude: an econometric approach,” *Agricultural Economics,* 17: 211-22.

Baum, CF, ME, Schaffer, and S. Stillman,(2003) "Instrumental variables and GMM: Estimation and testing," Working Paper 545, Boston college, Boston, MA.

BEA, *Regional Economic Information System (REIS) database*. Available from http://www.bea.gov/bea/regional/data.htm

Burfisher, M.E. and J. Hopkins (eds.) (2003) “Decoupled Payments: Household Income Transfers in Contemporary U.S. Agriculture,” Agricultural Economic Report No. 822, Market and Trade Economics Division, Economic Research Service, US Department of Agriculture, Washington DC.

________(eds) (2004) “Decoupled Payments in a Changing Policy Setting,” Agricultural Economic Report No. 838, Economic Research Service, US Department of Agriculture, Washington DC.

Burfisher, M. E., S. Robinson and K. Thierfelder.(2000) “North American Farm Programs and the WTO,” *American Journal of Agricultural Economics,* 82: 768-74

Charney, A. H. and M. Vest. (2003) “Modeling Practices and Their Ability to Assess Tax/Expenditure Economic Impacts,” *The AUBER conference 2003,* New Orleans, LA.

Chavas, J.P., and M. T. Holt. (1990) “Acreage Decisions under Risk: The Case of Corn and Soybeans,” *American Journal of Agricultural Economics,* 72: 529-38.

EWG, Farm Subsidy Database. Available from http://www.ewg.org/farm/

Gardebroek, C. (2002) “Do Organic Farmers Have Different Risk Attitudes Than Non-Organic Farmers?” *The Conference on Risk and Uncertainty in Environmental and Resource Economics, 2002,* Netherlands.

Godfrey, L. G. (1999) “Instrument Relevance in Multivariate Linear Models,” *Review of Economics and Statistics*, LXXXI: 550–52.

Goetz, Renan-Ulrich, A. Keusch and J. R. Tur, “The Efficiency of Direct Payments versus Tax Reductions under Uncertainty” (2003)

Goodwin, B.K. and A.K. Mishra.(2002) “Are ‘Decoupled’ Farm Program Payments Really Decoupled? An Empirical Evaluation,” Department of Agricultural, Environmental and Development Economics Working Paper, Ohio State University, Columbus, OH.

Harwood, J., R. Heifner, K. Coble, J. Perry and A. Somwaru. (1999) “Managing Risk in Farming: Concepts, Research, and Analysis,” Agricultural Economic Report No. 774, Economic Research Service, USDA, Washington DC.

Hayashi, F. (2000) *Econometrics*, Princeton University Press.

Hennessy, D.A.(1998) “The Production Effects of Agricultural Income Support Policies Under Uncertainty,” *American Journal of Agricultural Economics,* 80: 46-57.

Josling, T. (2003) “After Cancun: what next for agricultural subsidies?” *EuroChoices 2*: 12-17.

Kennedy, P. (1998) A Guide to Econometrics, 4th ed.,The MIT Press, Cambridge MA.

Key, N., R. Lubowski and M.J. Roberts. (2004) “The 1996 Federal Agriculture Improvement and Reform Act: Correcting a Distortion?” Paper presented at the AAEA Annual Meeting 2004, Denver, CO.

Klepinger, D, S. Lundberg, R. Plotnick (1997) “Instrument Selection: The Case of Teenage Childbearing and Women’s Educational Attainment,” Discussion Paper no. 1077-95, Institute for Research on Poverty.

Lin, W. and R. Dismukes. (2004) "Risk Considerations in U.S. Supply Response," Paper presented at workshop on Modeling U.S. and EU Agricultural Policy: Focus on Decoupled Payments, October 4-5, 2004, Washington, D.C.

Love, H. A., and S. T. Buccola. (1991) "Joint Risk Preference-Technology Estimation with a Primal System," *American Journal of Agricultural Economics,* 73: 765-74.

Moschini, G. and D.A. Hennessy (eds.). (2001) "Uncertainty, Risk Aversion, and Risk Management for Agricultural Producers," in B.L. Gardner and G.C. Rausser, Handbook of Agricultural Economics, vol. 1A, pp. 87-153, Amsterdam, Elsevier.

Pope, R.D., and R.E. Just. (1991) "On Testing the Structure of Risk Preferences in Agricultural Supply Analysis," *American Journal of Agricultural Economics,* 73: 743-748.

Saha, A. (1993) "Expo-Power Utility: A 'Flexible Form for Absolute and Relative Risk Aversion," *American Journal of Agricultural Economics,* 75: 905-13.

_______, C.R. Shumway and H.Talpaz. (1994) "Joint Estimation of Risk Preference Structure and Technology Using Expo-Power Utility," *American Journal of Agricultural Economics,* 76: 173-84.

Shea, J.(1997) "Instrument relevance in multivariate linear models: A simple measure," *Review of Economics & Statistics,* 79: 348-52.

Staiger, D. and J. H. Stock. (1997) "Instrumental Variables Regression with Weak Instruments," *Econometrica,* 65: 557-86.

Stock, J. H., J. Wright and M. Yogo. (2002) "A Survey of Weak Instruments and Weak Identification in Generalized Method Of Moments," *Journal of Business & Economic Statistics,* 20: 518–29.

Torkamani, J. and M. Haji-Rahimi. (2003) "Evaluation of Farmer's Risk Attitudes Using Alternative Utility Functional Forms," *Journal of Agricultural Science and Technology,* 3: 243-48.

USDA/ERS, Briefing room: *Farm and Commodity Policy : 1996-2001 program provisions*.
Available from http://www.ers.usda.gov/Briefing/FarmPolicy/1996pfc.htm

__________, Data : *Farm income*.
Available from http://www.ers.usda.gov/data/FarmIncome/finfidmu.htm

USDA/FSA, Price Support Program.
Available from http://www.fsa.usda.gov/dafp/psd/reports.htm

USDA/NASS, *Agricultural prices*, Various Issues.

___________, Data and Statistics : Agricultural Statistic Database.
Available from http://www.nass.usda.gov/Data_and_Statistics/Quick_Stats/index.asp

Somers. M. (2005) "Decoupled Income Support: The Case of United States Direct Payments", Honors Thesis , Economics Department, Stanford University.

Westcott, P. C. and C. E. Young. (2002) "Influences of Decoupled Farm Programs on Agricultural Production," Conference on Free Trade of the Americas, the WTO, and New Farm Legislation: Responding to Opportunities and Challenges, May 23-24, 2002, San Antonio, TX.

Wooldridge, J. M. (2001) "Applications of Generalized Method of Moments estimation," *Journal of Economic Perspectives,* 15: 87-100.

____________ (2002) Econometric Analysis of Cross Section and Panel Data, 1st ed., MIT Press, Cambridge, MA.

____________, (2003) Introductory Econometrics: A Modern Approach, 2nd ed., Thomson Learning, New York.

WTO, *WTO Agreement on Agriculture, Annex 2, paragraph 6.*
Available from http://www.wto.org/english/docs_e/legal_e/14-g_02_e.htm#annII

Young, C.E. and P.C. Westcott (2000) "How Decoupled Is U.S. Agricultural Support for Major Crops?" *American Journal of Agricultural Economics,* 82: 762-67.

Appendix 1
The description of major variables, units and manipulations

1. The description of major variables in production costs.

■ **Cash receipts from marketings**

Cash receipts from marketings are the value of gross revenues received from the marketing of agricultural commodities, both livestock and crops

► Cash receipts: crops

Cash receipts from crops is the value of gross revenues received from the marketing of crop commodities. Crop commodities include grains, such as corn, wheat, and soybeans; hay; vegetables; fruits and nuts; greenhouse and nursery products; tobacco; cotton; and other miscellaneous crops.

► Cash receipts: livestock and products

Cash receipts from livestock and products is the value of gross revenues received from the marketing of livestock and livestock products. This includes the marketing of meat animals such as cattle and calves, hogs and pigs, sheep and lambs; poultry and poultry products (including eggs); and dairy products. Also included is the marketing of horses, bees, animal aquaculture, and other miscellaneous animal species raised on agricultural operations.

■ Other incomes

► Government payments

Federal government payments to farmers are payments made to farm operators under several federal government farm subsidy programs during a given calendar year. These payments include deficiency payments under price support programs for specific commodities, disaster payments, conservation payments, and direct payments to farmers under federal appropriations legislation.

► Imputed and miscellaneous income received

Imputed and miscellaneous income received consists of imputed income, such as gross rental value of dwellings and value of home consumption, and other farm related income components, such as machine hire and custom work income, rental income, and income from forest products (1978 to present).

■ Total production expenses

Farm Production Expenses are expenditures incurred by farm operators in the production of agricultural commodities, including livestock and crops. The major categories of production expenses are intermediate product expenses, which provide inputs to the production process (feed, livestock and poultry, seed, fertilizer, etc.), labor expenses (cash wages, employer contributions to social security, perquisites, and contract labor expenses), and other expenses (interest, net rent paid to nonoperator landlords, capital consumption, property taxes, etc.).

► Fertilizer and lime (incl. ag. chemicals 1978-fwd.)
Fertilizer and lime are expenditures on fertilizer and lime by all farms during a given calendar year. After 1977, this estimate includes expenditures on agricultural chemicals (pesticides), as well.

► Hired farm labor expenses
Hired farm labor expenses are expenditures for hired labor by all farms during a given calendar year. It consists of hired workers' cash pay and perquisites, employers' contributions for social security and Medicare, and payments for contract labor, machine hire, and custom work.

■ Realized net income
Realized net income consists of total cash receipts and other income less total production expenses.

■ Characteristic variables
► Proprietors' income
This component of personal income is the current-production income (including income in kind) of sole proprietorships and partnerships and of tax-exempt cooperatives. Corporate directors' fees are included in proprietors' income, but the imputed net rental income of owner-occupants of all dwellings is included in rental income of persons. Proprietors' income excludes dividends and monetary interest received by nonfinancial business and rental incomes received by persons not primarily engaged in the real estate business; these incomes are included in dividends, net interest, and rental income of persons, respectively.
All state and local area dollar estimates are in current dollars (not adjusted for inflation).

► Farm proprietors' income
Farm proprietors' income consists of the income that is received by the sole proprietorships and the partnerships that operate farms. It excludes the income that is received by corporate farms.

► Nonfarm proprietors' income
Nonfarm Proprietors' Income consists of the income that is received by nonfarm sole proprietorships and partnerships and the income that is received by tax-exempt cooperatives. The national estimates of nonfarm proprietors' income are primarily derived from income tax data. Because these data do not always reflect current production and because they are incomplete, the estimates also include four major adjustments

► Number of farm proprietors

Farm self-employment is defined as the number of non-corporate farm operators, consisting of sole proprietors and partners. A farm is defined as an establishment that produces, or normally would be expected to produce, at least $1,000 worth of farm products--crops and livestock--in a typical year. Because of the low cutoff point for this definition, the farm self-employment estimates are effectively on a full-time and part-time basis. The estimates are consistent with the job-count basis of the estimates of wage and salary employment because farm proprietors are counted without regard to any other employment. Also referred to as farm self-employment. The distinction between place-of-work and place-of-residence is not significant because most farmers live on or near their land. Similarly, because of the annual production cycle of most farming, the distinctions between the point-in-time, the average annual, and the any-activity temporal concepts of employment measurement are not significant.

► Number of nonfarm proprietors
The BEA local area estimates of nonfarm self-employment consist of the number of sole proprietorships and the number of individual business partners not assumed to be limited partners. The nonfarm self-employment estimates resemble the wage and salary employment estimates in that both series measure jobs-as opposed to workers-on a full-time and part-time basis. However, because of limitations in source data, two important measurement differences exist between the two sets of estimates. First, the self-employment estimates are largely on a place-of-residence basis rather than on the preferred place-of-work basis. Second, the self-employment estimates reflect the total number of sole proprietorships or partnerships active at any time during the year-as opposed to the annual average measure used for wage and salary employment.

2. data manipulations and units

■ data manipulation for estimating moments

- nprofit=profit/cpi*100/1000:
  profit=realized net income = Cash receipts from marketings+other income including Government payments –total Production expenses
- nlive=live/livep*100/1000: live= Livestock purchased
- nfeed=feed/feedp*100/1000: feed= feed purchased
- nseed=seed/seedp*100/1000: seed= Seed purchased
- nfert=fert/fertp*100/1000: fert= Fertilizer + ag. chemicals
- nfuel=fuel/fuelp*100/1000: fuel= Petroleum products purchased
- nlabr=hlabr/labrp*100/1000:hlabr= Hired farm labor expenses
- nfarm=farm/1000 : farm= # of farm proprietors
- nnum=farm/(farm+nonfarm) : farm= # of farm proprietors, nonfarm== # of nonfarm proprietors
- nratio=cropr/(cropr+liver) : cropr =crop revenue, liver = livestock revenue

- ngovern=(govern-pfc)/cpi*100/1000: govern = Government payments
- npfc=pfc/cpi*100/1000: pfc=production flexibility contract payments

■ **data unit and source**

► revenue and costs
source : BEA(Bureau of Economic Analysis / U.S. Department of Commerce)
original unit : $1000

► # of proprietors of farm and nonfarm
source : BEA(Bureau of Economic Analysis / U.S. Department of Commerce)
original unit : $1000(income), number(# of proprietor)

► Total Government payment
source :
state-level -> ERS/USDA
county level-> BEA(Bureau of Economic Analysis / U.S. Department of Commerce)
original unit : $1000(state-level), $1000(county level)

► PFC payments / LDP payments
source : ERS/USDA, FSA/USDA
original unit : $1000

► # of farm and asset/debt
source : ERS/USDA
original unit : number(# of farm), $1000(asset/debt)

► input price index
source : Agricultural Prices ,National Agricultural Statistics Service (NASS/USDA)
original unit : 1990-92=100
manipulation : fertilizer and ag.chemical-> weighted average(weight from Agricultural Prices)

► CPI
source : Bureau of Labor Statistics, U.S. Department of Labor
original unit : 1982-84=100

► acreage, yield, price($) of corn and soybean
source : NASS database
original unit : 1000acre(acreage), bushel(yield), dollar /bu(price)

■ unit change in the program code

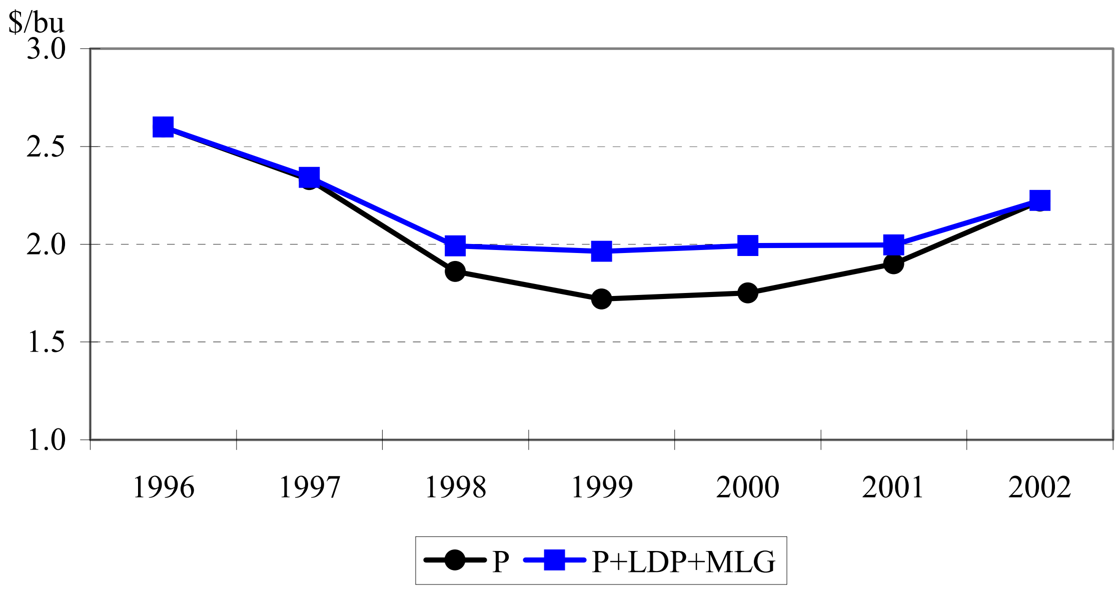
► moment equations
- original unit : $1000->million dollar : profit, government payment, implicit inputs
- ratio(%) : income ratio, # of farm proprietors, crop ratio
- # of farm proprietors : 1000 numbers
- profit and government payments are deflated by CPI

► risk attitude function
- original unit : $1000->billion dollar : income, government payment, asset , debt
- # of farm proprietors : million numbers
- income, pfc, government payments, asset, debt are deflated by CPI
- land per farmer: acre/farmer
- acreage : 1000 acres

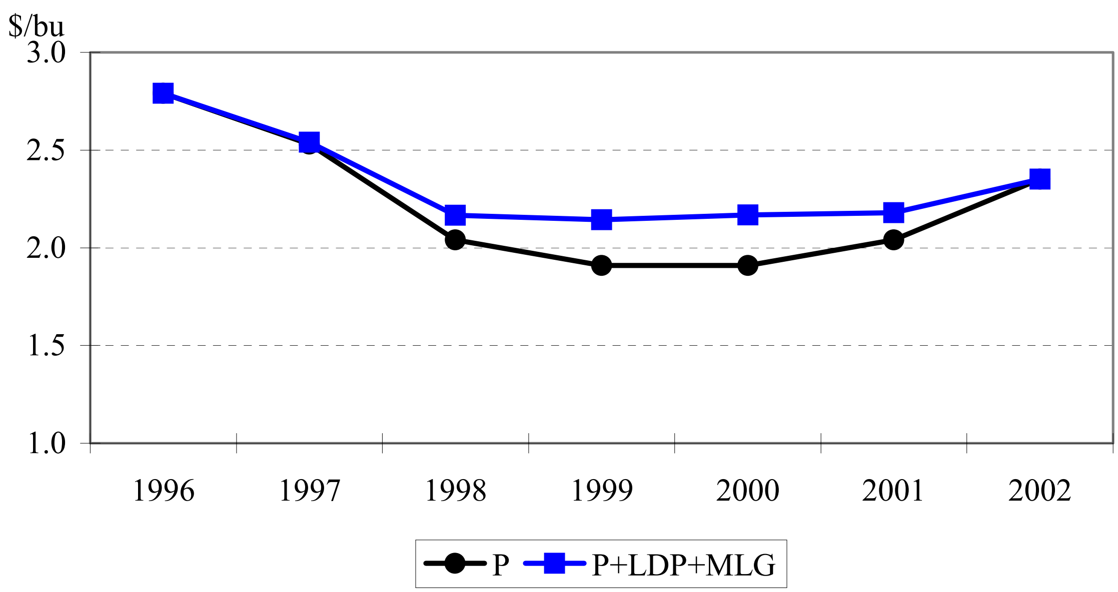
► acreage function
- prices(bu/ac) are deflated by CPI

Appendix 2
Market price and LDP supports

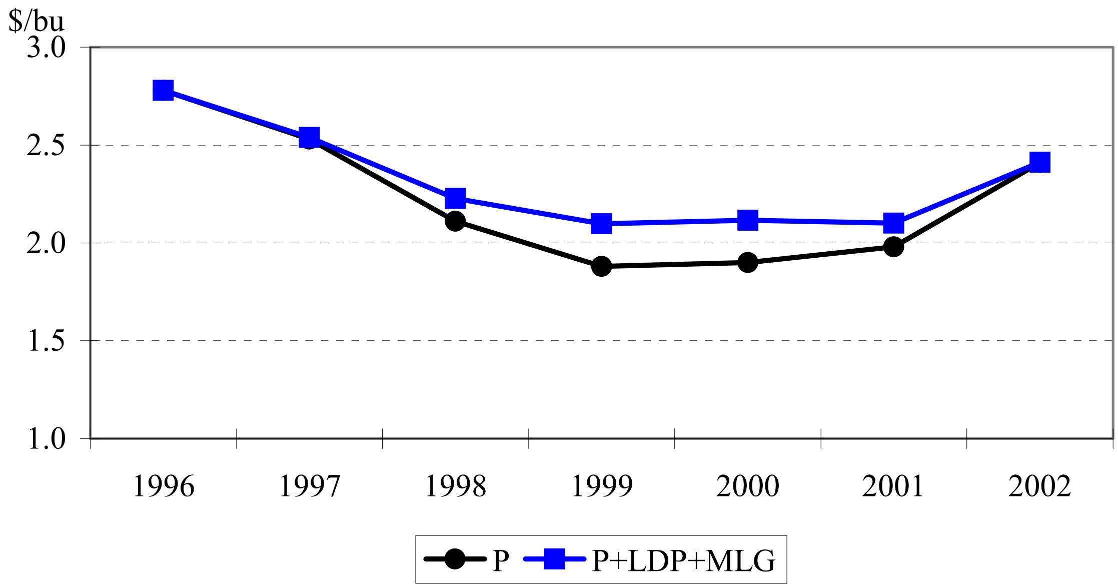
<Corn : IOWA>



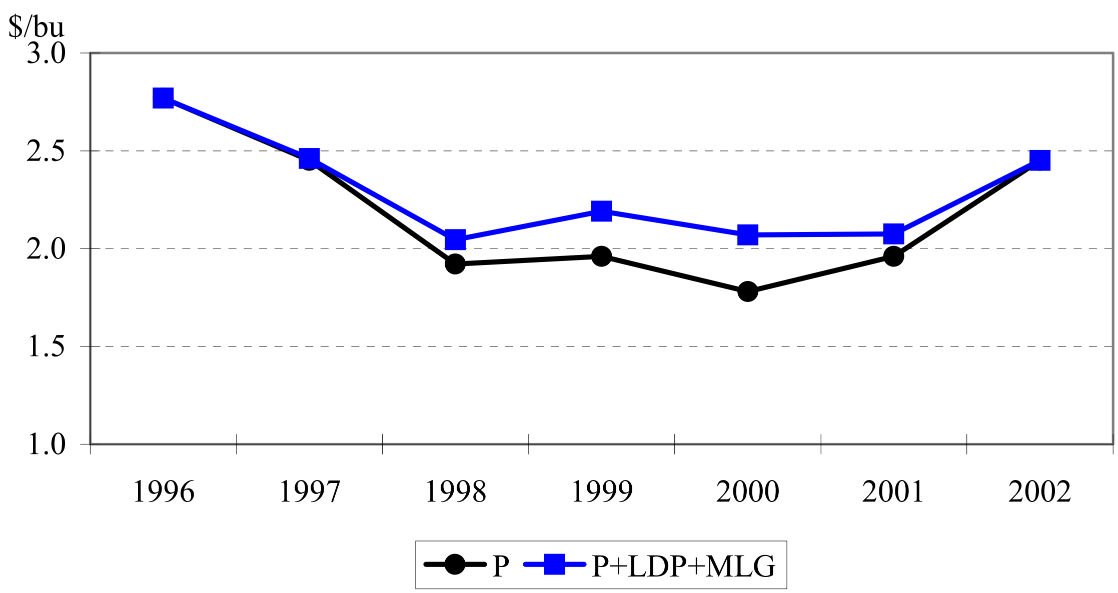
< Corn : ILLINOIS>



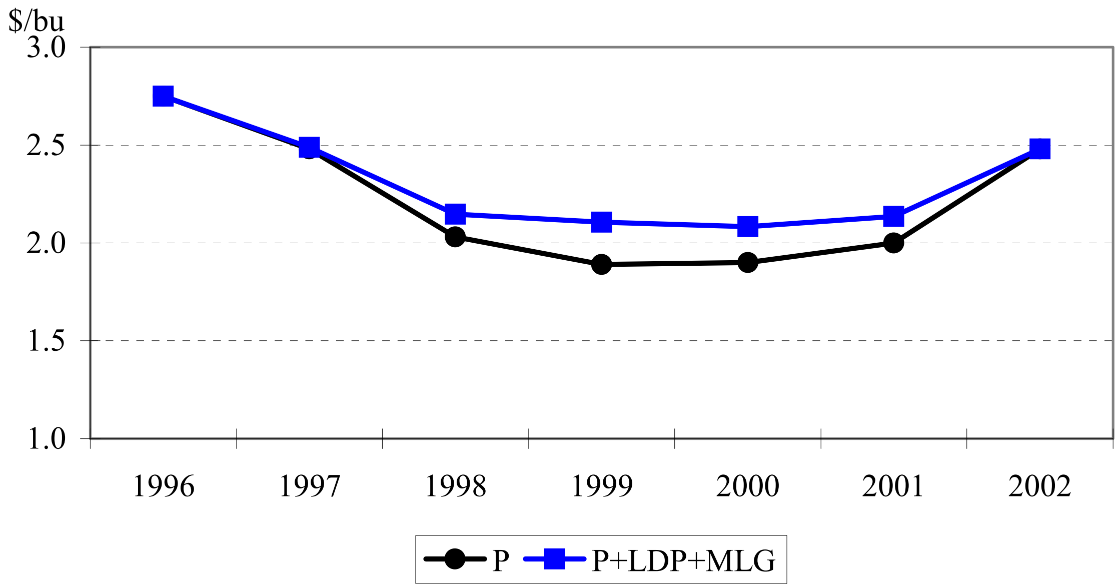
< Corn : INDIANA>



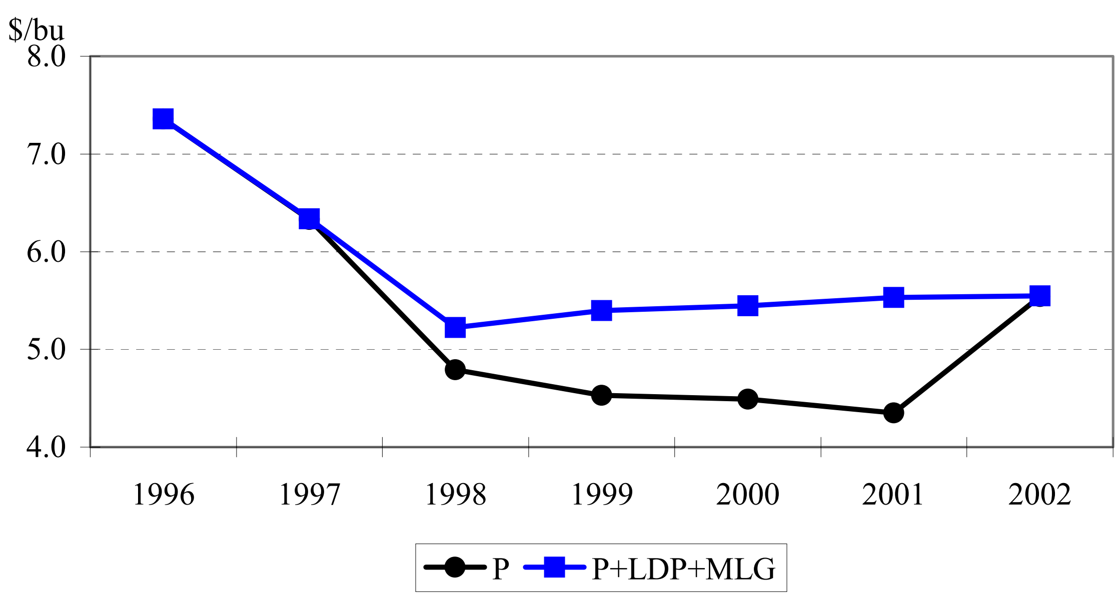
< Corn : MISSOURI>



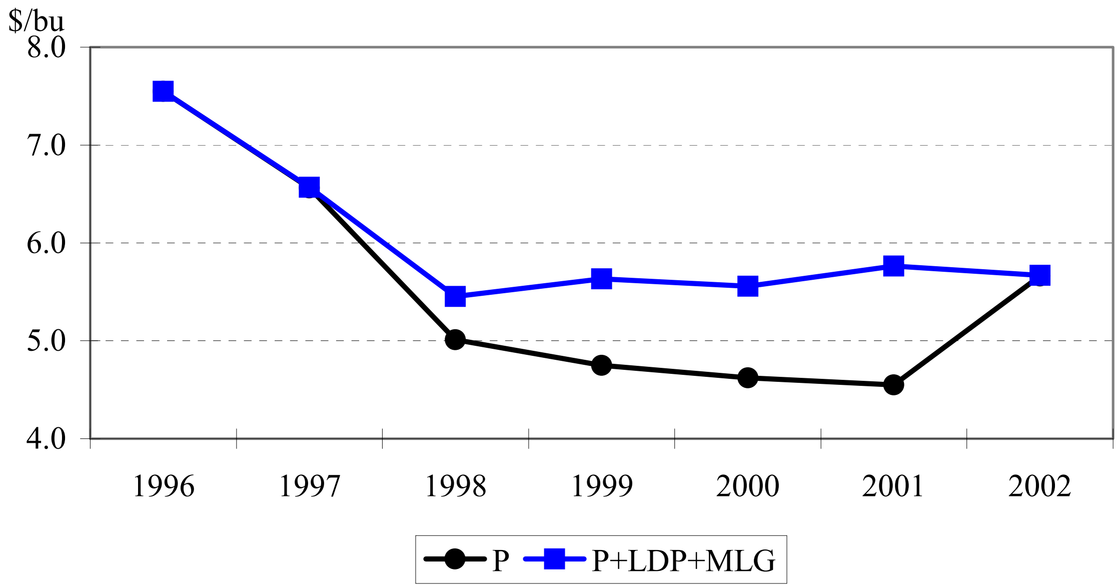
< Corn : OHIO>



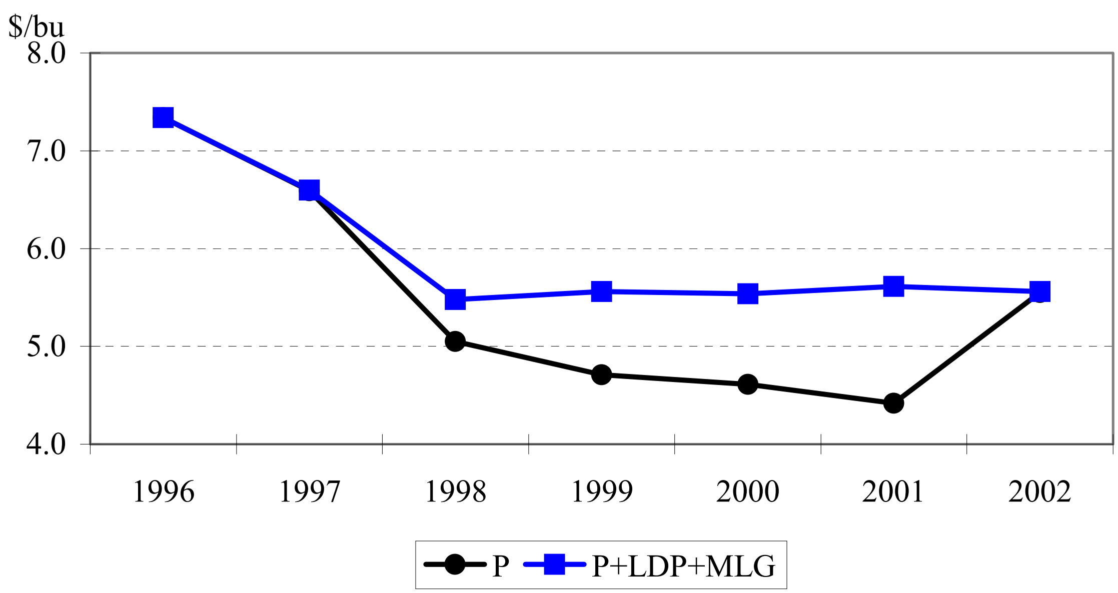
< Soybean : IOWA>



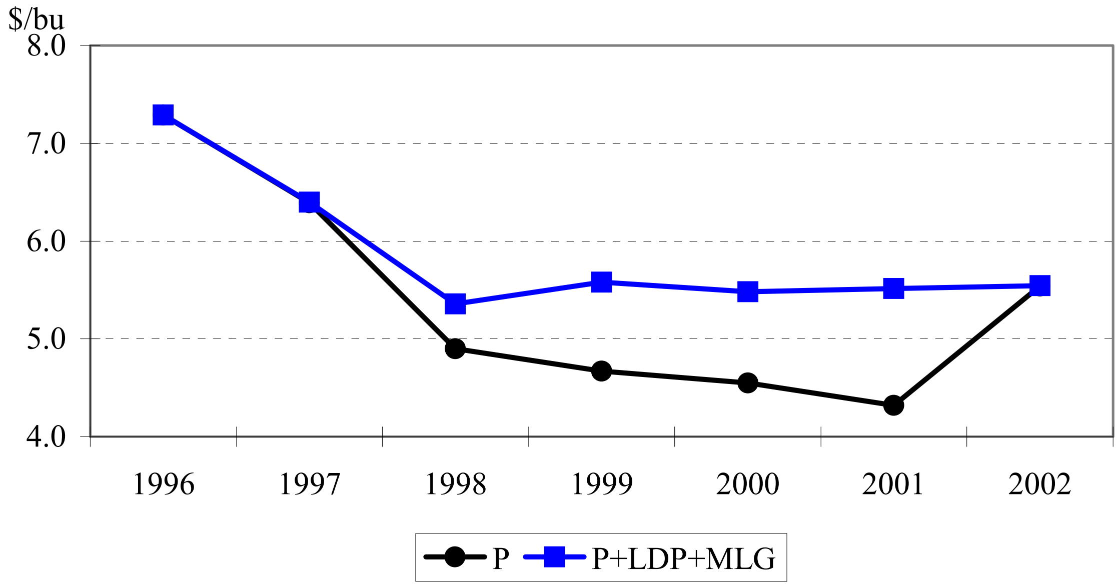
< Soybean : ILLINOIS>



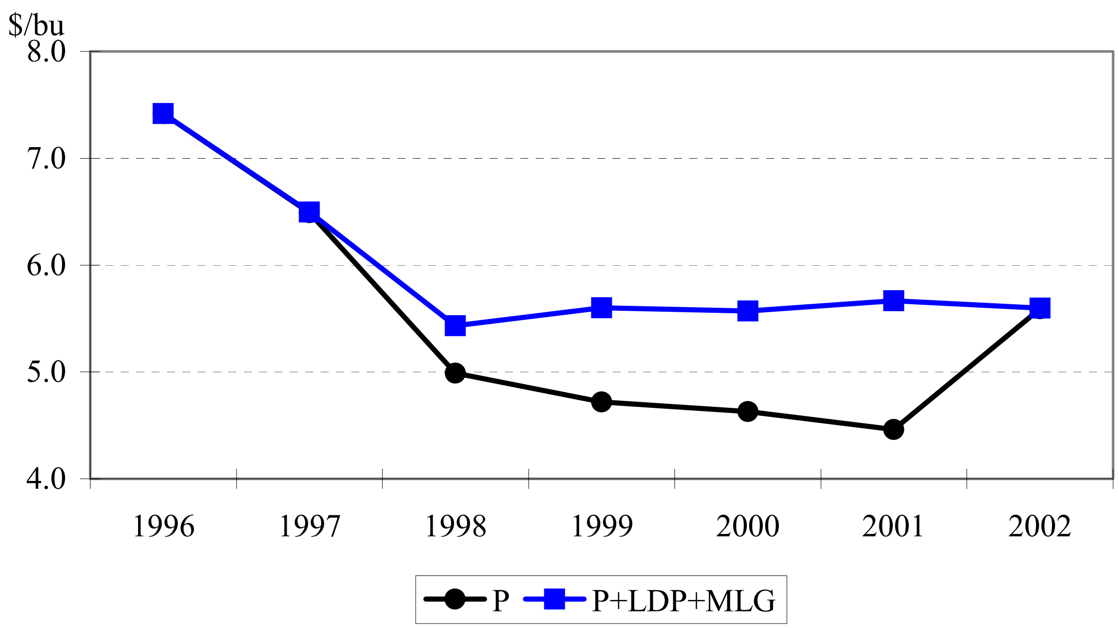
< Soybean : INDIANA>



< Soybean : MISSOURI>



< Soybean : OHIO>



Appendix 3
The estimation results of moment equations

IOWA

IA	1st		2nd		3rd	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
y94	-15.15*	0.89	-0.01*	8.08	-289.88	190.33
y95	7.28*	1.23	62.45	11.71	-100.90	271.49
y96	1.24	0.93	2.61	8.27	-51.89	210.52
y97	6.54*	0.89	2.86	7.58	-123.66	164.75
y98	-5.69*	0.81	-12.67*	6.98	-255.76	169.49
y99	-8.63*	0.83	-5.47	7.52	-331.00*	190.75
y00	-3.75*	0.79	-9.93	7.25	-161.43	158.33
y01	-6.07*	0.84	-7.53	7.27	-106.67	163.17
y02	-10.63*	0.84	-5.82	7.16	-206.93	166.22
nratio	0.06*	0.03	0.05	0.22	2.09	6.11
nlive	0.13*	0.04	1.33*	0.41	5.76	13.85
nfeed	0.31*	0.06	0.34	0.60	-11.09	14.67
nseed	-0.49	0.59	-10.72*	4.99	-71.17	126.10
nfert	0.60*	0.22	3.42*	2.01	42.38	44.38
nlabr	0.69*	0.22	2.71	1.81	27.18	47.37
nnum	0.01*	0.02	0.08	0.14	1.82	2.76
_cons	-0.07*	1.75	4.99	15.44	-223.13	369.63
obs	990		990		990	
R-squared	0.74		0.30		0.02	
F(16, 973)	118.46		8.95		1.08	
Prob >F	0.00		0.00		0.37	

Note : a. Standard errors(S.E.) have been corrected for heteroskedasticity
b. * indicates that the coefficients of those variables are significant at the 10% critical level.

ILLINOIS

IL	1st		2nd		3rd	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
y94	-10.18*	1.00	-34.46*	17.58	-1243.01*	563.56
y95	1.86	1.15	-0.96	20.09	-520.86	626.14
y96	-6.85*	0.93	-52.70*	18.13	-1178.51*	599.99
y97	-2.03*	0.95	-49.47*	18.17	-1130.94*	594.63
y98	-6.52*	0.98	-54.26*	18.75	-1274.73*	618.46
y99	-9.20*	0.96	-57.41*	18.65	-1249.16*	615.62
y00	-6.42*	0.96	-57.95*	18.50	-1182.60*	610.48
y01	-5.78*	0.98	-57.91*	18.49	-1144.06*	603.32
y02	-8.59*	1.01	-47.30*	19.67	-1372.48*	641.23
nratio	0.05*	0.02	-0.19	0.29	8.95	9.15
nlive	0.10	0.07	-3.17*	0.94	-11.80	24.88
nfeed	0.57*	0.11	1.05	2.06	-18.74	63.01
nseed	-0.04	0.36	2.86	4.95	-49.15	149.97
nfert	0.40*	0.12	1.92	1.97	54.27	62.98
nlabr	-0.01	0.16	3.07	2.23	29.98	64.24
nnum	0.02	0.02	0.06	0.20	-1.31	5.99
_cons	1.75	1.83	38.96	27.71	74.03	888.59
obs	1001		1001		1001	
R-squared	0.57		0.18		0.06	
F(16, 984)	54.02		5.75		1.05	
Prob >F	0.00		0.00		0.40	

Note : a. Standard errors(S.E.) have been corrected for heteroskedasticity
b. * indicates that the coefficients of those variables are significant at the 10% critical level.

INDIANA

IN	1st		2nd		3rd	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
y94	-7.95*	0.52	-2.91	2.71	-56.76*	28.71
y95	-0.91*	0.50	-4.31	3.02	-8.34	35.11
y96	-1.84*	0.52	-3.02	2.97	-6.37	31.35
y97	0.18	0.55	0.34	2.81	-20.46	29.56
y98	-7.78*	0.51	-4.30	2.65	-48.60*	28.17
y99	-6.05*	0.46	-8.90*	2.51	-47.96*	27.32
y00	-5.07*	0.46	-7.87*	2.50	-48.83*	27.40
y01	-2.31*	0.44	-9.19*	2.45	-41.88	26.49
y02	-6.06*	0.50	-4.03	2.59	-61.07*	27.80
nratio	0.02*	0.01	-0.04	0.04	-0.23	0.36
nlive	0.22*	0.08	0.27	0.46	3.27	5.41
nfeed	0.00	0.03	-0.05	0.15	-1.68	1.68
nseed	-0.34	0.26	-1.53	1.15	-0.57	11.92
nfert	0.54*	0.09	1.19*	0.43	3.45	4.59
nlabr	0.23*	0.09	0.12	0.39	1.42	3.20
nnum	-0.02	0.01	-0.04	0.04	-0.39	0.31
_cons	2.37*	0.83	10.59*	3.64	38.13	36.57
obs	920		920		920	
R-squared	0.63		0.10		0.03	
F(16, 903)	71.38		5.14		1.22	
Prob >F	0.00		0.00		0.25	

Note : a. Standard errors(S.E.) have been corrected for heteroskedasticity

b. * indicates that the coefficients of those variables are significant at the 10% critical level.

MISSOURI

MO	1st		2nd		3rd	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
y94	-0.98*	0.47	-9.50*	3.72	-99.94	64.62
y95	-0.82	0.57	0.57	6.69	98.96	154.17
y96	-0.61	0.48	-8.77*	3.85	-64.95	63.76
y97	2.21*	0.50	-6.39	3.95	-59.91	64.86
y98	-1.06*	0.46	-13.11*	3.79	-107.45*	64.65
y99	-2.15*	0.48	-9.31*	3.68	-127.87*	64.88
y00	-0.57	0.46	-11.55*	3.73	-122.45*	65.61
y01	-0.43	0.47	-8.29*	4.12	-158.67*	77.92
y02	-2.81*	0.49	-6.41*	3.89	-144.42*	69.23
nratio	0.03*	0.01	0.03	0.08	-1.45	1.55
nlive	0.02	0.02	-0.26	0.17	-5.51	3.60
nfeed	0.13*	0.01	0.26*	0.08	2.36	1.60
nseed	-0.11	0.40	-6.69*	3.46	62.95	67.26
nfert	0.47*	0.11	3.90*	1.14	0.79	24.23
nlabr	0.23*	0.05	0.98*	0.34	13.04*	6.93
nnum	0.01	0.01	-0.13*	0.04	-0.75	0.85
_cons	-2.37*	0.45	6.80*	3.34	73.00	59.19
obs	1068		1068		1068	
R-squared	0.58		0.21		0.05	
F(16, 1051)	54.48		3.55		1.24	
Prob >F	0.00		0.00		0.23	

Note : a. Standard errors(S.E.) have been corrected for heteroskedasticity
b. * indicates that the coefficients of those variables are significant at the 10% critical level.

OHIO

OH	1st		2nd		3rd	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
y94	-2.65*	0.58	-3.34	4.37	10.41	68.98
y95	0.88*	0.61	-1.31	4.37	32.14	60.15
y96	-1.10*	0.60	2.82	4.80	0.02	103.91
y97	2.34*	0.62	3.80	4.44	99.70	74.41
y98	-0.71	0.68	8.59	6.41	222.32*	132.24
y99	-1.26*	0.65	5.88	5.63	162.74	99.17
y00	-2.24*	0.60	0.97	4.46	98.91	73.05
y01	-1.89*	0.64	5.25	5.63	73.86	94.71
y02	-3.98*	0.71	14.02*	7.33	34.85	154.11
nratio	0.06*	0.01	0.39*	0.12	6.02*	2.68
nlive	1.00*	0.13	2.52*	1.15	53.17	33.04
nfeed	-0.05	0.04	0.94*	0.43	-10.96	9.87
nseed	0.32	0.23	-4.96*	1.98	-22.00	34.94
nfert	-0.16*	0.08	0.06	0.57	-28.05*	12.31
nlabr	0.93*	0.10	2.58*	0.87	3.08	16.29
nnum	0.08*	0.02	0.18	0.13	6.76*	2.48
_cons	-3.97*	0.96	-24.27*	9.05	-413.95*	199.13
obs	855		855		855	
R-squared	0.68		0.30		0.04	
F(16, 838)	54.34		4.55		0.80	
Prob >F	0.00		0.00		0.69	

Note : a. Standard errors(S.E.) have been corrected for heteroskedasticity
b. * indicates that the coefficients of those variables are significant at the 10% critical level.

Appendix 4
The result of GMM estimation for risk attitudes

IOWA

	Coef.	Std. Err	t	p-value
y95	26.348	1.885	13.980	0.000
y96	23.290	4.533	5.140	0.000
y97	24.277	0.984	24.670	0.000
y98	10.773	1.022	10.540	0.000
y99	16.055	1.104	14.540	0.000
y00	23.407	0.995	23.530	0.000
y01	15.386	0.956	16.100	0.000
y02	13.757	0.954	14.430	0.000
s95	-2.196	0.856	-2.570	0.010
s96	-2.238	0.847	-2.640	0.008
s97	-2.233	0.854	-2.610	0.009
s98	-2.136	0.857	-2.490	0.013
s99	-2.605	0.870	-3.000	0.003
s00	-2.319	0.857	-2.710	0.007
s01	-2.337	0.856	-2.730	0.006
s02	-2.357	0.856	-2.750	0.006
dsmom	2.428	0.856	2.840	0.005
_cons	-18.268	0.953	-19.160	0.000
obs		891		
F(17, 873)		28572.51		
Prob >F		0.00		

ILLINOIS

	Coef.	Std. Err	t	p-value
y95	-56.755	35.157	-1.610	0.106
y96	-68.329	35.220	-1.940	0.052
y97	-60.213	35.163	-1.710	0.087
y98	-69.152	35.136	-1.970	0.049
y99	-67.429	35.168	-1.920	0.055
y00	-62.454	35.163	-1.780	0.076
y01	-64.497	35.163	-1.830	0.067
y02	-68.789	35.165	-1.960	0.050
s95	-2.049	1.007	-2.030	0.042
s96	-2.056	1.008	-2.040	0.041
s97	-2.162	1.007	-2.150	0.032
s98	-2.103	1.008	-2.090	0.037
s99	-2.105	1.009	-2.090	0.037
s00	-2.107	1.007	-2.090	0.036
s01	-2.050	1.008	-2.030	0.042
s02	-2.048	1.007	-2.030	0.042
dsmom	2.166	1.007	2.150	0.031
_cons	64.968	35.163	1.850	0.065
obs		895		
F(17, 877)		12722.40		
Prob >F		0.00		

INDIANA

	Coef.	Std. Err	t	p-value
y95	3.25	2.63	1.24	0.22
y96	-6.05	2.63	-2.30	0.02
y97	-4.02	2.64	-1.52	0.13
y98	-9.95	2.63	-3.78	0.00
y99	0.46	2.64	0.18	0.86
y00	-3.99	2.63	-1.52	0.13
y01	-1.05	2.63	-0.40	0.69
y02	-10.31	2.78	-3.71	0.00
s95	-4.47	1.02	-4.40	0.00
s96	-4.32	1.01	-4.26	0.00
s97	-4.35	1.01	-4.28	0.00
s98	-4.31	1.02	-4.24	0.00
s99	-4.14	1.02	-4.06	0.00
s00	-4.29	1.02	-4.22	0.00
s01	-4.44	1.02	-4.37	0.00
s02	-4.45	1.01	-4.40	0.00
dsmom	4.84	1.02	4.77	0.00
_cons	4.44	2.63	1.69	0.09
obs		828		
F(17, 810)		49497.60		
Prob >F		0.00		

MISSOURI

	Coef.	Std. Err	t	p-value
y95	-21.948	3.520	-6.240	0.000
y96	-18.094	3.555	-5.090	0.000
y97	-17.234	3.517	-4.900	0.000
y98	-21.871	3.518	-6.220	0.000
y99	-21.862	3.516	-6.220	0.000
y00	-17.759	3.518	-5.050	0.000
y01	-19.939	3.517	-5.670	0.000
y02	-22.552	3.517	-6.410	0.000
s95	-2.055	0.391	-5.250	0.000
s96	-2.137	0.397	-5.380	0.000
s97	-2.173	0.395	-5.510	0.000
s98	-2.123	0.392	-5.410	0.000
s99	-2.032	0.394	-5.160	0.000
s00	-2.061	0.393	-5.240	0.000
s01	-2.179	0.392	-5.560	0.000
s02	-2.148	0.396	-5.430	0.000
dsmom	2.294	0.392	5.850	0.000
_cons	19.778	3.517	5.620	0.000
obs		966		
F(17, 948)		5590.77		
Prob >F		0.00		

OHIO

	Coef.	Std. Err	t	p-value
y95	-9.924	8.011	-1.240	0.215
y96	-15.200	8.014	-1.900	0.058
y97	-10.168	8.011	-1.270	0.204
y98	-17.160	8.014	-2.140	0.032
y99	-13.819	8.003	-1.730	0.084
y00	-12.725	8.009	-1.590	0.112
y01	-12.896	8.015	-1.610	0.108
y02	-17.542	8.013	-2.190	0.029
s95	-4.035	2.114	-1.910	0.056
s96	-3.933	2.107	-1.870	0.062
s97	-3.896	2.114	-1.840	0.065
s98	-4.015	2.114	-1.900	0.058
s99	-4.154	2.111	-1.970	0.049
s00	-4.047	2.114	-1.910	0.056
s01	-4.149	2.114	-1.960	0.050
s02	-4.081	2.114	-1.930	0.054
dsmom	4.288	2.114	2.030	0.043
_cons	13.057	8.010	1.630	0.103
obs		767		
F(17, 749)		1198.97		
Prob >F		0.00		

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VITA

TaeHun Kim was born in AnDong, South Korea on June 1, 1972. He grew up in Andong where he attended local primary school. After graduating high school, he went to Kyungpook National University in TaeGu where he received B.S and M.S degrees in Economics. Since 1997, he had worked at Korea Rural Economic Institute (KREI) financially supported by Korean government. TaeHun's work at KREI entailed the development of a mid-and long-term agricultural forecasting model for the Korean agricultural sector. In August 2001, TaeHun enrolled in the doctoral program in Agricultural Economics at the University of Missouri-Columbia from where he received his Doctor of philosophy (Ph.D) degree in Agricultural Economics and concurrently worked as a research assistant at Food and Agricultural Policy Research Institute (FAPRI).

TaeHun is married to MiOk Jung and they have two children: Ji-Hyun and Brian.