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# Safety Nets or Trampolines? Federal Crop Insurance, Disaster Assistance, and the Farm Bill

Barry K. Goodwin and Roderick M. Rejesus

We review the implications of the 2007 Farm Bill for the risk management dimensions of U.S. agriculture and policy. Legislative proposals suggest significant changes in risk management policy, including the introduction of state or national revenue insurance. We also pursue an empirical analysis of the interrelationships of crop insurance, disaster relief, and farm profitability. We find an inverse relationship between disaster assistance and insurance purchases. Our analysis also suggests that farmers that buy insurance and that receive disaster payments tend to have higher returns to farming.

*Key Words:* crop insurance, disaster payments, Farm Bill

**JEL Classifications:** Q18

The 2007 calendar year drew to a close without resolution on a new Farm Bill. Competing versions of the new legislation existed in the House and Senate. The House version of the Farm Bill passed on July 27, 2007, by a relatively wide margin, with a vote of 231–191. On December 14, 2007, a very similar version passed in the Senate by a vote of 79–14. Modest differences between the two versions of the legislation are yet to be resolved in conference. However, it is clear that a generous package of support, scored at about \$285 billion over the next 10 years, will be forthcoming.

Critics of U.S. farm programs have raised a number of objections about the evolution of policy (and the concomitant lack of perceived progress toward reform) over the last 10 years. The sheer magnitude of the financial support (\$190 billion under the 2002 Farm Bill and the aforementioned \$285 billion estimated for the proposed 2007 legislation) raises many questions regarding the intent of such support and the possible implications for U.S. and international agricultural markets. One complaint that is often raised about U.S. farm support pertains to its significant concentration among a relatively small number of producers. The Environmental Working Group (EWG) reports that, between 2003 and 2005, the top 1% of U.S. farmers received 17% of all farm subsidies while the top 10% received 66% of subsidies. Within the top 1%, the average annual payment was nearly \$126,000.<sup>1</sup> Other concerns involve the potential for various

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<sup>1</sup> See the “Farm Subsidy Database” posted on the EWG website at [www.ewg.org](http://www.ewg.org).

programs to work at cross-purposes. Programs that are directly tied to support (“coupled” programs) encourage more production by bringing more land into production. Other programs, such as the Conservation Reserve Program (CRP), serve to remove environmentally sensitive land from production by paying subsidies to farmers that agree to place their land in reserve for a 10- or 15-year period.

Perhaps one of the most obvious examples of agricultural policies that may not be entirely consistent with one another lies in the role of subsidized risk management and disaster relief. Throughout various legislative actions since 1980, the U.S. Congress has signaled its intentions that the primary instrument for managing agricultural risks and disasters should be through subsidized federal crop insurance. In recent years, legislative changes through the 1994 Federal Crop Insurance Reform Act and the 2000 Agricultural Risk Protection Act (ARPA) have significantly expanded the depth, scope, and range of U.S. crop insurance programs. The 1994 legislation made participation in the federal crop insurance program a mandatory requirement for eligibility for other farm program benefits. This requirement proved unpopular with producers and thus was repealed after the 1995 crop year. Significant premium subsidies have been used to encourage participation and by 2006, 55 million acres were insured with a total liability of over \$67 billion.<sup>2</sup>

Despite political rhetoric to the contrary, the U.S. Congress has repeatedly used ad hoc disaster payments as a means of addressing yield and price shortfalls. Between 1975 and 1981, Commodity Credit Corporation outlays for disaster assistance exceeded \$3.57 billion.<sup>3</sup> Since 1985, the U.S. Congress has approved nearly \$30 billion in emergency agricultural disaster aid to more than two million farm and

ranch operations (EWG). Payments were made in every year since 1985 and, in 12 of the 22 years of this period, disaster payments exceeded \$1 billion.

By its very nature, disaster relief is ad hoc, meaning that it is typically not part of a larger, multi-year package of farm programs but is rather intended to address a specific immediate problem. Critics of ad hoc disaster relief have argued that its continual provision, especially in the Upper and Lower Great Plains, results in a form of free insurance and thus reduces incentives to participate in the federal crop insurance program. Because of the systemic nature of agricultural risks, ad hoc disaster relief may skew participation in the federal crop insurance program toward higher-risk individuals. This is because lower-risk farmers may only experience yield losses when such losses are widespread, which would be more likely to trigger ad hoc payments.

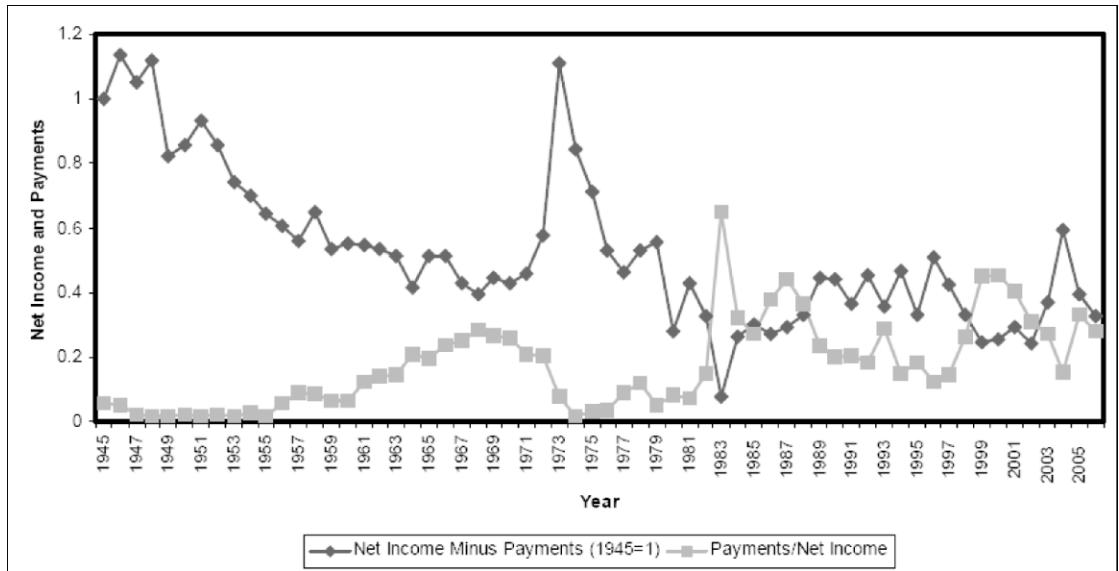
Disaster relief and federal crop insurance have played important roles in deliberations over the 2007 Farm Bill. Both versions of the Bill contain provisions to establish an optional revenue insurance plan. In the Senate version, a state-level revenue protection plan called the “Average Crop Revenue” program was included in the Bill. On the House side, an optional revenue-based, counter-cyclical payments program was included. This program would operate at the national level and would make payments when actual revenues for a covered commodity fall beneath a national target revenue, which is based on the 2007 Bill’s target prices. Both plans reinforce the objective of eliminating ad hoc support in favor of a standing disaster plan that would make payments whenever prices and/or yield shortfalls occurred.

The objective of this paper is to evaluate the interrelationships between ad hoc disaster assistance, participation in the federal crop insurance program, and the overall realized profitability of individual farm operations. To this end, we consider a multivariate model of insurance and disaster payment participation and the realized return to agricultural production. Our model is estimated using farm-level

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<sup>2</sup>Statistics were taken from unpublished data available from the Risk Management Agency of the USDA.

<sup>3</sup>Statistics are based upon unpublished data obtained from the USDA.



**Figure 1.** Net Farm Income Less Government Payments and the Ratio of Government Payments to Net Farm Income

data for the 2002–2005 calendar years. The plan of our paper is as follows. The next section reviews the current status of the 2007 Farm Bill. Particular attention is given to specific provisions affecting disaster assistance and crop insurance. The third section presents empirical estimates of the aforementioned model of disaster assistance, crop insurance participation, and farm profitability. The final section briefly reviews the results and offers concluding remarks.

### Disaster Assistance, Crop Insurance, and the 2007 Farm Bill

The overarching goal of our analysis is to consider the interactive roles of disaster relief and crop insurance in forming “safety nets” for farmers. Provision of “safety nets” has become a mantra for policy makers over the last 20 years. A relevant question—and an issue underlying our analysis—is whether such safety nets serve more of a wealth/income enhancing role than providing emergency risk management assistance. The perennial nature of disaster payments and their regional concentration suggests that some farmers’ production decisions may reflect expectations about disaster payment receipts.

### Disaster Assistance

In spite of much rhetoric to the contrary, U.S. farm programs have shown little sign of reform or “transition” to greater market orientation with less government involvement. Figure 1 illustrates net farmer income less government payments and the proportion of net farmer income represented by direct government payments. The former variable represents net income generated from the market (rather than through government payments) and the latter reflects the proportion of net income generated by direct government payments. The figure illustrates several important points. First, when government payments are excluded, real net farm income has fallen substantially over the postwar period and has experienced periods of very substantial volatility.

A second important point is that government involvement in U.S. agriculture has strengthened over time. Temporary periods of diminished government support are notable—especially in the years that surround the 1996 FAIR Act. Prior to the legislation, markets were strong and thus government involvement was modest. Such conditions are, of course, conducive to policy reforms that

promise less government involvement and a transition to the market—as was the case with the 1996 legislation. However, the decrease in market-based returns and the concomitant increase in government support that occurred in the late 1990s illustrate the will and intent of Congress to support U.S. agriculture. Ad hoc market loss assistance payments exceeded \$23 billion between fiscal years 1999 and 2004. Finally, the counter-cyclical nature of government support is obvious in the figure. Larger government payments correspond to periods of market declines. This occurs both through ad hoc support and through standing farm programs such as deficiency payments and other coupled support.

The goal of our empirical analysis is to consider the relationships among ad hoc disaster payments, participation in the crop insurance program, and the overall profitability of farming. We begin with an examination of the geographic patterns of the provision of ad hoc disaster payments. Figure 2 presents the geographic dispersion of ad hoc disaster payments (2005 real terms) made through the Farm Service Agency (FSA).<sup>4</sup> The figure illustrates the fact that ad hoc disaster assistance tends to be highly concentrated in several specific regions. In particular, a “disaster payment belt” is apparent throughout the upper, middle, and lower Great Plains. Likewise, geographic concentrations of disaster payments are apparent in California and in the southeastern United States. In light of our interest in the interactive roles of disaster payments and crop insurance, we focus our analysis on an area of the United States that has realized such a geographic concentration of payments—the Great Plains. In particular, we concentrate on two of the Economic Research Service’s farm resource regions—the Prairie Gateway and the Northern Great Plains.<sup>5</sup>

### *Farm Bill Crop Insurance Issues*

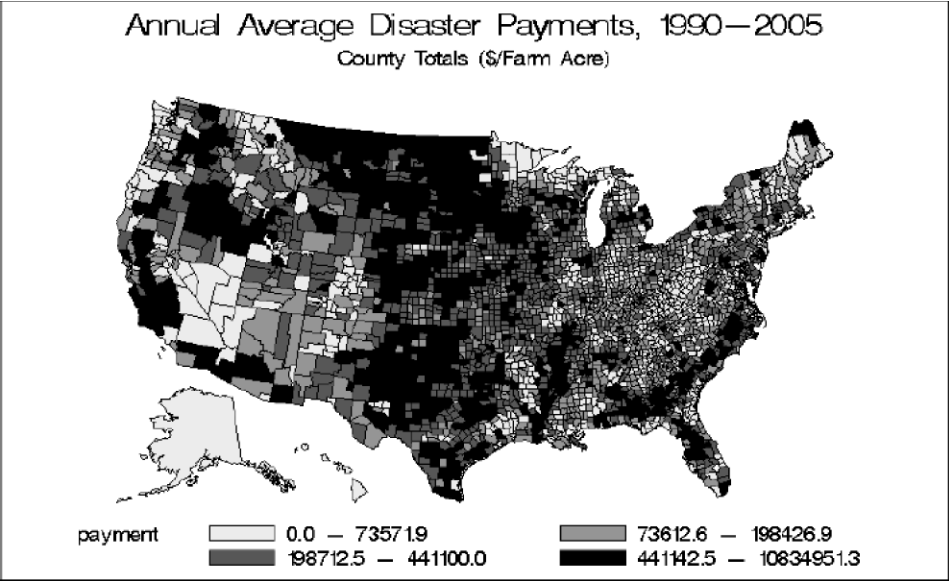
Federally subsidized crop insurance has been a major component of the U.S. government’s agricultural policy over the last three decades. It is a key element of the income safety net available to producers when they incur losses due to natural disasters (i.e., from adverse weather events, pests, diseases, and other unavoidable causes prevalent in agriculture). As such, crop insurance–related issues have played a central role in the debates that accompanied the development of the House and Senate versions of the 2007 Farm Bill.<sup>6</sup> The following subsections discuss the major crop insurance–related issues in both versions of the bill. However, the discussion here is not meant to be comprehensive of all the crop insurance–related issues, but only serves to highlight the issues that we think have more far-reaching welfare consequences to the farm economy.

*Revenue-based commodity payments.* In both the House and Senate bills, a new revenue-based commodity program is proposed where producers can receive payments if there are shortfalls in actual revenues per acre relative to some “target” revenue. The House and Senate versions of this program differ in terms of the geographic scope used to measure the actual and “target” revenues needed to calculate the revenue payment. In the House version, the geographic scope is at the national level. That is, payments are triggered when the actual national revenue per acre for the commodity is less than the national target revenue per acre (the latter being set by the government prior to the crop year). On the other hand, the Senate version calculates the revenue payments at the state level—a payment is triggered when actual state revenue falls below an average revenue guarantee. It is important to note that this revenue program is

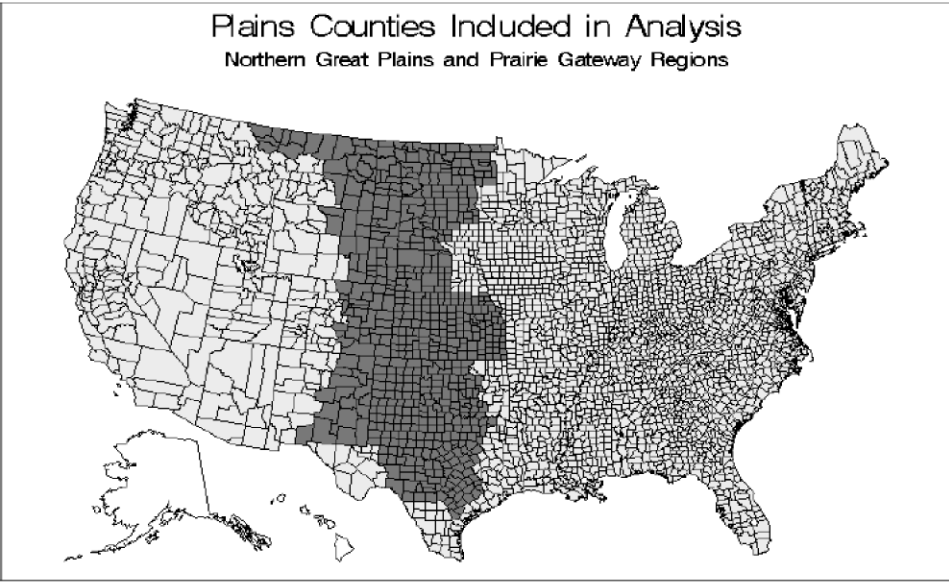
<sup>4</sup>All financial variables in this analysis were deflated using the aggregate consumer price index and are expressed in 2005 dollar equivalent terms.

<sup>5</sup>The USDA’s farm resource regions are defined to group counties according to production specialization.

<sup>6</sup>At the time of this writing (Dec. 20, 2007), the House and Senate has approved their respective versions of the 2007 Farm Bill. The next step is for the House-Senate farm bill conference committee to meet and work out the differences in the House and Senate versions of the proposed legislation.



(a) Disaster Payments (Real \$ / Farm Acre)



(b) Great Plains Counties Included in Analysis

Figure 2. Disaster Payments and the Counties Included in Empirical Analysis



in addition to the commodity programs that have been in place in the previous versions of the farm bill (i.e., direct payments, price-based counter-cyclical payments, marketing loan assistance, etc.).

Even though the revenue-based commodity program is not directly tied to the crop insurance program (per se), we include a discussion of this program because of its potential interaction and/or interrelationship with the crop insurance program participation and program efficiency/cost-effectiveness. With the availability of this additional income safety net, producers may decide not to purchase crop insurance if (in their view) the risk mitigation effect of this commodity program is sufficient for their purpose.<sup>7</sup> The introduction of this new revenue program may run counter to past government initiatives that increased premium subsidies to encourage noninsured producers to participate in the crop insurance program and for producers already insured to buy at higher coverage levels.

In addition, this new commodity program may directly affect crop insurance program efficiency because of its similarity with a current area-based revenue product called Group Revenue Income Protection (GRIP). The concept behind GRIP is the same as the proposed revenue commodity program except that GRIP is at the county level and it is not free (i.e., insurance premiums has to be paid). The proposed revenue-payment scheme in the farm bill seems to be duplicative of GRIP and one has to ask the question whether the introduction of the revenue payment program is a good use of taxpayer money when there is an area-based revenue crop insurance program already in place. Is it cost-effective for the government to offer two revenue programs that seem to mitigate the same types of risks? Hence, the introduction of the revenue-based commodity program has the potential to adversely affect the crop insurance program from a

standpoint of program participation and cost-effectiveness (i.e., duplicative coverage).

*The Standard Reinsurance Agreement (SRA) and insurance company reimbursements.* A unique aspect of the federal crop insurance program is the role of private insurance companies in program delivery and risk sharing. The relationship between the U.S. government and these private insurance companies is governed by the Standard Reinsurance Agreement (SRA). The last SRA agreement was negotiated in 2005 and, at the moment, the government (through the Federal Crop Insurance Corporation [FCIC]) lacks the authority to do further renegotiations. In both the House and Senate versions of the farm bill, there are provisions to allow the FCIC to conduct more periodic renegotiations of the SRA to ensure that the crop insurance markets are reflective of current conditions.

Aside from the periodic renegotiation of the SRA, both the House and Senate versions of the proposed farm bill have language that reduces the Administrative and Operating Expenses (A&O) reimbursement rate given to crop insurance companies. In accordance with the 1980 Federal Crop Insurance Act and through the SRA, A&O reimbursements are given to crop insurance companies to cover the costs of delivering crop insurance to producers (i.e., payment of agent commissions, loss adjustment, etc.). The A&O reimbursement acts like a sales commission—for each dollar of premium the company brings in they retain a certain percentage.

For the 2006 crop year, the average reimbursement was 20.7% of net premiums (Gould). This percentage has steadily decreased over time (for example, in 2000, the rate was 25.7%). Nevertheless, with net premiums of \$4.6 billion in 2006, the companies received approximately \$958 million in A&O reimbursements. In 2000, the companies only received \$642 million in A&O reimbursements (based on approximately \$2.5 billion in net premiums that year). With this high level of reimbursements in recent years, the House and Senate versions of the proposed farm bill have provisions that decrease the A&O reimbursement rates of crop insurance companies. The

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<sup>7</sup>This assumes that there is no legislation that makes receipt of commodity program and/or disaster assistance payments conditional on participation in the crop insurance program.

House version proposes a 2.9 percentage point decrease, while the Senate version suggests a 2.0 percentage point reduction.

The farm bill provisions that allow for periodic renegotiation of the SRA and reduction in A&O reimbursements may have implications for the efficiency of the crop insurance program (especially in the delivery aspect of the program). As some of the companies have argued, these proposed provisions may hinder the effective delivery of crop insurance to the nation's farmers due to the higher cost burden that they have to bear. With some producers already raising the issue about slow loss adjustment process (see Smith, Dismukes, and Novak), the proposed SRA and reimbursement rate provisions in the farm bill may further exacerbate this problem (i.e., the higher cost burden to the companies may force them to reduce the number of adjusters and agents that service farmers). But note that it is not entirely clear whether the reductions will in fact significantly hinder the crop insurance companies' ability to effectively service the crop insurance needs of U.S. producers.

*Development of new crop insurance policies.* Under the current farm bill legislation, developers of new crop insurance policies bear all the research and development costs associated with the new policy. In the House and Senate versions of the proposed farm bill there are provisions that allow the FCIC to share some of the costs and the associated financial risks of developing a new crop insurance product. However, this proposed language in the bill again raises the issue of whether development of new policies is a cost-effective priority given the number of existing products, as well as the proposed revenue commodity program in the bill. There is already an initiative to consolidate and streamline the crop insurance program by combining some of the existing products into a "combo" policy to reduce transaction costs of servicing different policies. Development of new and complex policies would seem to go against the gains from consolidating existing products. Would the funds for sharing the financial risk of developing new products be better served for research initiatives to improve the actuarial

and underwriting performance of current products or the proposed combo policy?

*Increased funding to combat fraud, waste, and abuse.* Since the 2000 Agricultural and Risk Protection Act (ARPA of 2000), there has been an increased emphasis on deterring fraud, waste, and abuse in the crop insurance program through the use of information technology and "data mining" techniques. The idea is to strengthen the compliance function of the program by developing computer algorithms to look through the millions of crop insurance records and reveal patterns that indicate potential fraud, waste, and abuse. In the House and Senate versions of the proposed farm bill, there is language to increase the level of support for data mining activities aimed at uncovering patterns in the crop insurance records that are indicative of fraud, waste, and abuse. There have been several reports that have provided cost-saving figures to show the effectiveness of the program (i.e., dollars of illegal indemnities prevented and collected back). However, there is still uncertainty in the crop insurance industry about whether or not the increased funding for data mining activities is indeed a worthwhile initiative (Smith, Dismukes, and Novak). Furthermore, the amount of fraud and/or abuse deterrence due to this increased compliance function is hard to quantify and may not be truly known. Hence, there are questions whether the benefits from the increased funding for data mining would be more than the costs.

*Summary of farm bill insurance issues.* Crop insurance and risk management issues have always been part of the debates that accompany the development of farm bill legislation. The 2007 Farm Bill is no exception. Revenue-based commodity programs, the SRA, insurance company reimbursement rates, financial risk sharing with crop insurance policy developers, and funding to strengthen fraud detection are major issues in the House and Senate versions of the proposed farm bill that would potentially impact the functioning of the crop insurance program in the next few years. The potential interrelationships of these new provisions with the current commodity programs,



disaster programs, and crop insurance program will shape how farmers manage their risk and will eventually impact how the agricultural economy will evolve over the years.

## Empirical Analysis and Results

### Data

Our analysis is conducted using individual farm data collected under the Agricultural Resource Management Survey (ARMS) project by the National Agricultural Statistics Service of the USDA. The ARMS data are collected at the end of each calendar year by means of a survey of individual farmers. The ARMS data represent the USDA's primary source of information about U.S. agricultural production conditions, marketing practices, resource use, and economic well-being of farm households. We focus on data taken from the period between 2002 and 2005. These years were characterized by a common policy environment—the 2002 Farm Bill. Although the ARMS data provide a rich and valuable set of detailed farm household data, the database does have an important limitation—the lack of repeated sampling on individual farms. That is, the sample is taken randomly each year and it is thus impossible to observe the same farm in more than a single year. This implies an important reliance on cross-sectional variability and prevents one from conditioning observed events on the preceding year's experience or on fixed farm effects. In addition, identification issues may be complicated by an inability to condition on variables that are clearly predetermined (i.e., observed in previous time periods). As we discuss in detail below, we pursue a recursive identification structure that is supported by the sequence of production decisions, payment receipts, and realized net farm returns.

A variety of other sources were used to collect pertinent data. We collected annual, county-level measures of direct government payments from the Bureau of Economic Analysis (BEA) Regional Economic Information System (REIS). Farm program payment data were collected for each county in the study

area from unpublished Farm Service Agency (FSA) sources for the period covering 1998–2005. We grouped all disaster payments together into a single category. Our intent is to capture payment expectations—which should be the primary factor influencing producer decisions. In that realized farm program payments vary substantially from year to year and receipts in any single year may not be representative of the expected value of payments. This is especially true for ad hoc types of payments, such as disaster relief. We thus take the average of overall government payments and disaster payments over the 4-year period preceding each year of interest and use farm acreage for the county reported in the 2002 *Agricultural Census* to place the payments on a per-acre basis. So, for example, expected government payments for county  $i$  in year  $t$  would be given by the average of payments for the county over years  $t-1, \dots, t-4$ . County-level crop insurance statistics were taken from the Risk Management Agency's (RMA) summary of business database. We also used the preceding 4-year average value of the ratio of total indemnities to farmer-paid premiums and the ratio of insured to total farm acres in each county. Current-year values of disaster payments and crop insurance premium rates were also included in the empirical models, as we discuss below.

An important characteristic of the ARMS data relates to the stratified nature of the sampling used to collect the data. The statistical agency that directs the collection and analysis of the ARMS data—the National Agricultural Statistics Service (NASS)—recommends a jackknife procedure where the estimation data are split into a fixed number of subsamples and the estimation is repeated with each subsample omitted. However, this approach may not be entirely appropriate when analysis focuses on a subset of the sample, as is the case in our analysis. The ARMS data contains a population weighting factor, representing the number of farms in the population (i.e., all U.S. farms) represented by each individual observation. We used this weighting factor to weight each observation in the likelihood function used in estimation.

Our empirical model consists of three equations. The first represents the crop insurance participation decision. We define a discrete variable,  $d_{1it}$  that takes the value one if farmer  $i$  purchased crop insurance in year  $t$  and is zero otherwise.<sup>8</sup> A second discrete variable  $d_{2it}$  is one if farmer received disaster payments and zero otherwise. Finally, we define a measure of realized farm profitability. Specifically, we define a rate of return in terms of gross farm income and total expenses as:

$$(1) \quad y_{3it} = \ln\left(\frac{\text{Gross Farm Income}}{\text{Total Cash Expenses}}\right) \times 100.$$

Note that the rate of return is a continuous variable and can assume positive and negative values.

Our intent is to focus on commercial crop farms. Thus, we delete any farm that had less than 100 harvested crop acres in the year of the survey. Any farm that reported zero gross income or zero total expenses was also dropped from the analysis. Likewise, any farm that reported no sales of crop or livestock commodities was dropped from the analysis. In the end, we were left with 1,921 observations over the 4 years under consideration.

*Econometric Specification and Methods*

The discrete dependent variables  $d_{1it}$  and  $d_{2it}$  are assumed to represent continuous, normally distributed latent variables representing the propensity to purchase crop insurance and to receive disaster payments. We assume that the continuous variable  $y_{3it}$  is also normally distributed. A specific recursive structure underlies our econometric model. This structure is suggested by the timing of insurance purchase decisions, receipt of disaster relief, and reported gross sales and expenses at year's end. It is often the case that eligibility for ad hoc disaster relief requires participation in the federal crop insurance program. Insurance purchase decisions are made at planting time

while disaster payments would be expected to follow the harvest.<sup>9</sup> Gross farm income and expenses are reported at the end of the calendar year and thus would be preceded by any reported crop insurance expenditures and disaster payment receipts. In light of these timing issues, we expect that the insurance purchase decision is exogenous to all other dependent variables but that disaster payments may be endogenous to insurance purchases. Likewise, we assume that disaster payment receipts by an individual farmer will be predetermined relative to year-end farming returns and crop insurance purchase decisions. Thus, we allow farming returns to be endogenous to both crop insurance participation and disaster payments.<sup>10</sup> Our joint estimation approach allows for endogeneity of the right-hand-side binary dependent variables and permits explicit testing of the endogeneity through a consideration of the correlation of disturbance terms across equations.

This assumed recursive structure suggests the following structural model:

$$(2) \quad \begin{aligned} d_{1it} &= \delta_1 X_{1it} + u_{1it} = \beta_1 Z_{1it} + u_{1it} \\ d_{2it} &= \delta_2 X_{2it} + u_{2it} = \beta_2 Z_{2it} + \gamma_{2it} d_{1it} + u_{2it} \\ y_{3it} &= \delta_3 X_{3it} + u_{3it} = \beta_3 Z_{3it} + \gamma_{3it} d_{1it} \\ &\quad + \gamma_{3it} d_{2it} + u_{3it}. \end{aligned}$$

<sup>9</sup> Note that timing considerations and the calendar-year nature of the ARMS survey may complicate the matching of insurance purchases, planting decisions, and disaster payments across crop years. In particular, winter crops are typically planted in the preceding calendar year and disaster payments may arrive with a substantial delay. Despite these complications, it is clear that the reported insurance purchases will likely precede disaster payment receipts during the calendar year and that realized calendar year-end farming returns will follow crop insurance expenditures and disaster payment receipts.

<sup>10</sup> Note that, to the extent that an individual farmer's receipt of disaster relief and realized farming returns are influenced by unobserved variables affecting both variables, endogeneity issues may remain. However, in light of the fact that disaster relief is usually determined by Congress on the basis of the hardships experienced by a large group or region, one can argue that disaster payments are endogenous to the returns of any single farmer. Such endogeneity and identification issues remain an important topic of current research.

<sup>8</sup> Crop insurance purchases are indicated if positive expenditures for crop or hail insurance is reported in the survey.

Note that identification requires each set of exogenous variables  $Z_{ki}$  to contain at least one variable that is unique to that equation.<sup>11</sup>

The three-equation system suggests a trivariate normal distribution with a density of the form:

$$(3) \quad \begin{pmatrix} d_{1it} \\ d_{2it} \\ y_{3it} \end{pmatrix} \sim N \left[ \begin{pmatrix} \beta_1 Z_{1it} \\ \beta_2 Z_{2it} + \gamma_{2it} d_{1it} \\ \beta_3 Z_{3it} + \gamma_{3it} d_{1it} + \gamma_{3it} d_{2it} \end{pmatrix}, \begin{pmatrix} 1 & \rho_{12} & \rho_{13} \sigma_3 \\ \rho_{21} & 1 & \rho_{23} \sigma_3 \\ \rho_{31} \sigma_3 & \rho_{23} \sigma_3 & \sigma_3^2 \end{pmatrix} \right].$$

This, in turn, suggests a trivariate distribution describing the discrete and continuous outcomes for farmer  $i$  in year  $t$  of

$$(4) \quad \begin{aligned} & f(d_{1it}, d_{2it}, y_{3it}) \\ &= \phi(y_{3it}, Z_{1it}, \sigma_3^2) \\ & \quad \times \int_{-\infty}^{\beta_2 Z_{2it}} \int_{-\infty}^{\beta_3 Z_{3it}} \phi_2(d_{1it}, d_{2it} | y_{3it}, \Sigma) dd_{1it} dd_{2it}, \end{aligned}$$

where  $\phi_2(\bullet)$  is a bivariate probit density function and  $\Sigma$  is the covariance matrix defined in Equation (3).<sup>12</sup> Monfardini and Radice discuss exogeneity testing in recursive bivariate probit models of the form applied here. Endogeneity of the binary right-hand-side variables is implied if the correlation coefficients for residual terms across equations are statistically different from zero. Monfardini and Radice discuss a range of tests to evaluate simultaneity of the explanatory discrete variables.

Estimation of joint models containing more than two endogenous variables can be complicated by the numerical complexity associated with the joint likelihood function. We utilize the numerical simulation methods of Geweke, Hajivassiliou, and Keane (GHK) to estimate the joint model.<sup>13</sup> The GHK

method simulates truncated normal distributions and then conditions on the simulated values in simulations of other truncated normal distributions, thereby using products of conditional densities to simulate joint densities. The method makes use of the fact that normal random variables, when conditioned on other normal variables, remain normally distributed. Geweke, Keane, and Runkle present Monte Carlo evidence demonstrating that the GHK method works very well for estimating multivariate probit models.

### Results

Table 1 defines the empirical variables of interest and presents summary statistics for our sample. The means and standard deviations were calculated using the ARMS population weights. The statistics indicate that 28.8% of the individual farms received disaster payments in the year of the survey. A large proportion of the farms—82.1%—purchased some form of crop insurance in the year of the survey. The average rate of return, defined as the logarithm of the ratio of gross income to total cash expenses, was 38%.<sup>14</sup> The average farm was over 1,880 acres in size and had 789 harvested crop acres. Over the preceding 4-year period, the average farm was in a county that had received over \$29 per farm acre in government payments and over \$3 per farm acre in disaster payments. About 32% of total farm acres (which includes noncrop acres) were insured under the federal crop insurance program. Wheat was the predominant crop, followed by corn and soybeans. Cotton was produced in localized areas in the study region, particularly in Texas and Oklahoma.

Table 2 presents simulated maximum likelihood estimates of the recursive system of

<sup>11</sup>Other restrictions can also be used to ensure identification. In particular, restrictions on the covariance matrix of the residual terms can be used to achieve identification.

<sup>12</sup>See Regan and Catalano for a discussion of the derivation and estimation of multivariate models containing mixtures of discrete and continuous variables. A similar recursive, bivariate probit model was developed and estimated by Buchmueller, et al.

<sup>13</sup>For a discussion of simulation methods of estimation and the GHK algorithm, see Geweke, Keane, and Runkle; Hajivassiliou; Keane; and McFadden.

<sup>14</sup>Note that this figure is based on calendar-year cash expenses only and thus does not include amortized expenses for fixed inputs and other noncash expenses. Thus, the high rate of return corresponds to returns to such fixed assets. Many other measures of farm profitability are conceivable.

**Table 1.** Variable Definitions and Summary Statistics<sup>a</sup>

Variable	Definition	Mean	SD
Disaster	1 if farm received disaster payments, 0 otherwise	0.2880	4.0631
Insured	1 if farm bought insurance, 0 otherwise	0.8213	3.4372
Return to farming	Log of the ratio of gross farm income to total farm expenses (times 100)	35.3326	442.6555
County acres insured	Average ratio of insured acres to total farm acres (preceding 4 years)	0.3723	1.8680
County government payments	Average government payments per farm acre (preceding 4 years)	29.1860	149.8728
County disaster payments	Average disaster payments per farm acre (preceding 4 years)	3.0623	27.4803
Farm size	Total farm size (hundred acres)	1.8869	23.6640
Harvested acres	Harvested acreage for all crops (hundred acres)	0.7887	8.0157
Diversification	1 Herfindahl index of diversification	0.3164	2.3624
Corn	Proportion of harvested acreage planted to corn	0.1726	2.4474
Cotton	Proportion of harvested acreage planted to cotton	0.0680	2.1487
Wheat	Proportion of harvested acreage planted to wheat	0.4728	3.5565
Soybeans	Proportion of harvested acreage planted to soybeans	0.1315	1.9559
Sorghum	Proportion of harvested acreage planted to grain sorghum	0.0786	1.6166
Loss-Ratio	Average ratio of indemnities to farmer-paid premium (preceding 4 years)	2.8644	14.1626
Premium rate	Crop insurance premium rate	0.1327	0.4628
Off-farm work	Proportion of household income from off-farm sources	0.4212	65.7843
Tenure	Ratio of rented to total acreage	0.4829	3.1816
Leverage	Ratio of debts to assets	0.2078	7.3325
Livestock	Ratio of livestock sales to total farm sales	0.2781	3.0148
Disaster payments	Current year county average disaster payments (\$/farm acre)	2.3238	22.1173

<sup>a</sup> Number of observations is 1,921. Summary statistics weighted by ARMS population sampling weights.

equations. The first equation in the system represents the demand for crop insurance, which is expressed in discrete terms (participation or no participation). A number of existing studies have examined factors associated with the demand for crop insurance, including Goodwin and Smith and Goodwin. The coefficients generally are of the correct sign and correspond to the direction of the effect of changes in the explanatory variables on the probability of insuring.<sup>15</sup> Farms located

<sup>15</sup> Marginal effects in a probit model are given by the product of the standard normal density and the coefficient. Many versions of the marginal effects are possible, depending on the observations at which the density is evaluated. A good approximation involves a consideration of the value of the standard normal density that corresponds to the proportion of observations for which the binary variable is one. In our case, these values are approximately 0.25 and 0.34 for the insurance and disaster equations, respectively.

in counties that have realized significant participation in the crop insurance program over the preceding 4 years are much more likely to insure. This is as expected and may reflect a number of county-level factors associated with insurance participation, including average losses, premium rates, and the marketing efforts of insurance agents. Farms in counties that have realized substantially higher total government payments are more likely to buy insurance. However, an important result is that farms in counties that have realized high disaster payments over the preceding 4 years are significantly less likely to buy insurance. This result suggests that the constant provision of ad hoc disaster relief serves as a disincentive for farmers to buy insurance. Farmers in counties that have realized larger returns to crop insurance, as represented by the ratio of indemnities to

**Table 2.** Empirical Estimates and Summary Statistics for Trivariate Normal Model

Variable	Parameter		
	Estimate	SE	t-ratio
<b>Probit Model of Insurance Decision</b>			
Intercept	-0.2224	0.0229	-9.71*
County acres insured	1.9259	0.0365	52.79*
County government payments	0.0029	0.0005	5.29*
Loss-Ratio	0.0468	0.0011	41.44*
Premium rate	-4.0583	0.0869	-46.71*
County disaster payments	-0.0645	0.0030	-21.52*
Harvested acres	0.3580	0.0048	74.86*
Diversification	1.0618	0.0206	51.45*
Corn	0.6011	0.0218	27.53*
Cotton	2.2991	0.0444	51.74*
Wheat	0.5390	0.0176	30.61*
Soybeans	-0.1777	0.0257	-6.92*
Livestock	0.0976	0.0126	7.75*
Off-farm work	-0.0114	0.0019	-6.15*
Leverage	0.1903	0.0209	9.11*
<b>Probit Model of Receipt of Disaster Payments</b>			
Intercept	-2.0496	0.0200	-102.64*
Insured	1.4633	0.0208	70.48*
Disaster payments	0.1286	0.0014	93.34*
County government payments	-0.0076	0.0003	-26.31*
Harvested acres	0.0174	0.0045	3.88*
Corn	-0.4351	0.0197	-22.12*
Cotton	-1.4737	0.0466	-31.59*
Wheat	-0.0047	0.0164	-0.29
Soybeans	0.2700	0.0231	11.67*
Livestock	0.8557	0.0126	67.69*
<b>Continuous Regression Model of Farm Returns</b>			
Intercept	-4.6838	0.6933	-6.76*
County government payments	-0.1389	0.0124	-11.23*
Disaster	3.2026	0.9404	3.41*
Insured	42.6544	0.9281	45.96*
Harvested acres	-2.4812	0.2063	-12.03*
Diversification	-1.9397	0.6770	-2.87*
Corn	-13.7561	0.6856	-20.06*
Cotton	39.4559	0.9704	40.66*
Wheat	8.2612	0.6240	13.24*
Soybeans	5.4280	0.8630	6.29*
Off-farm work	-0.1145	0.0090	-12.7*
Tenure	13.2715	0.3720	35.68*
$\sigma$	49.5657	0.0877	565.39*
$\rho_{\text{Insured/Income}}$	-0.4444	0.0090	-49.62*
$\rho_{\text{Disaster/Income}}$	0.1051	0.0122	8.64*
$\rho_{\text{Insured/Disaster}}$	-0.4821	0.0139	-34.69*

\* Indicates statistical significance at the  $\alpha = .10$  or smaller level.

farmer-paid premium (i.e., premiums net of subsidies), are significantly more likely to purchase insurance. However, farmers in counties with higher overall average premium rates are less likely to insure. This is in accordance with existing research on the demand for insurance, which has shown that higher premiums will lower the demand for insurance. Larger crop farms, as represented by the number of harvest acres, are more likely to insure. This result is also consistent with existing research, which has argued that fixed costs to insurance and the marketing efforts of agents tend to favor larger farms.

Diversification of crop enterprises, which is represented by one minus a Herfindahl index of diversification, are more likely to insure. Although diversification is typically assumed to lower risk exposure, this effect may be offset by efficiency gains that occur with specialization. Production agriculture has become more specialized and of increasing scale and thus highly diversified operations may face more production risk and have a greater demand for insurance. The results reflect significant differences in the level of participation in crop insurance across different crops. Farms with a significant share of acreage devoted to cotton production are the most likely to insure. Corn- and wheat-producing farms are the next most likely to insure, while farms devoting a large share of acreage to soybeans are the least likely to insure. Farms that have a larger share of their total farm sales coming from livestock products are more likely to purchase crop insurance. Again, this may reflect higher risks that are associated with diversification across crop and livestock enterprises. Farm households that derive a significant share of their total income from off-farm sources are less likely to buy insurance. This accords with the results of Mishra and Goodwin, who found that off-farm work was an important measure used to manage farming risks. In this way, off-farm work may be a valid substitute for purchases of crop insurance.

Table 2 also contains parameter estimates of a probit model of disaster payment receipts.



Again, note the recursive nature of the probit models—crop insurance participation has a significant positive relationship with disaster payment receipts. This may reflect requirements that were introduced when the mandatory provisions of the 1994 Crop Insurance Reform Act were lifted.<sup>16</sup> Current period disaster payment receipts at the county level are included in the probit model to reflect the idiosyncratic weather shocks that would be expected to underlie aggregate provision of disaster payments. As expected, farms in counties that receive more payments in a given year are more likely to receive disaster payments. In contrast, farms in counties receiving a large share of government payments are less likely to receive disaster payments. This suggests that disaster payments are a substitute for other forms of government support. This may also reflect the negative correlation between aggregate yields and price. When yields losses are widespread, prices will be higher and thus government support that is tied to the market (i.e., deficiency payments) will be lower. However, it is in such periods that ad hoc disaster relief will be more likely. Larger farms are more likely to receive disaster payments. Cotton growers appear less likely to receive ad hoc disaster assistance while soybean growers and farms with a significant share of livestock sales appear more likely to receive disaster assistance. This may reflect the fact that a substantial share of ad hoc disaster assistance is targeted toward livestock growers who have suffered feed and grazing losses.

Table 2 also presents parameter estimates for a conventional regression model of our measure of gross farm returns to total cash production costs. An interesting result is that farms in counties with more government payments appear to realize lower returns to

their cash costs. However, farms that receive disaster payments appear to have significantly higher rates of return to farming. Likewise, farmers that purchase crop insurance appear to have higher returns over their cash production costs. This may suggest that crop insurance plays an important role in the management of farm risks in that farmers that purchase crop insurance appear to be more profitable. The result for disaster payments and crop insurance may also suggest the “trampoline” effect implied by the title of this paper. Disaster payments and insurance may raise farm incomes.

Larger crop farms appear to be less profitable. This may reflect the “inverse productivity puzzle” often observed in agriculture (see, for example, Assuncao and Ghatak). Diversification also appears to lower farm profitability. This is consistent with the results for crop insurance participation in that more diversified farms were more likely to insure, perhaps reflecting greater production risk. Tenure status appears to be significantly correlated with profitability, with farmers that own a higher share of their operated acreage appearing to be more profitable. Cotton farms appear to be the most profitable, followed by wheat and soybean farms. Corn farms in this region appear to be the least profitable. As would be expected, off-farm work appears to lower the profitability of farming. This is in agreement with the results of Goodwin and Mishra who found that farmers who tended to work more off the farm were less efficient.

Finally, Table 2 presents correlation coefficients for the residual terms across the three equations. In each case, the correlations appear to be statistically significant, suggesting endogeneity of insurance participation in the disaster payments equation and endogeneity of both insurance participation and disaster payment receipts in the farm profitability equation.

## Summary and Conclusions

The objectives of this paper were twofold. First, we intended to review the im-

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<sup>16</sup>For a single year—1995—farmers were required to purchase crop insurance in order to be eligible for any farm program benefits. Congress quickly lifted this unpopular requirement but made eligibility for disaster payments dependent upon the purchase of crop insurance.

plications of the 2007 Farm Bill for the risk management dimensions of U.S. agriculture and policy. Our efforts in this regard were hampered in that agreement on the specific terms of a farm bill does not exist as of the writing of this paper. However, we do know the specific terms of the competing versions of the bill passed by the House and Senate. Both versions of the legislation suggest the possibility of some rather significant changes in risk management policy. In particular, optional revenue insurance plans based on state or national farm revenues are proposed. We review the details of these policies as well as other changes contained in the proposed legislation that may impact the federal crop insurance program.

We also pursue an empirical analysis of the interrelationships of crop insurance, disaster relief, and farm profitability. Several important results arise from this analysis. First, farmers in counties that tend to continually receive a significant level of ad hoc disaster payments are less likely to buy insurance. This is consistent with the conventional wisdom that the continual provision of ad hoc disaster support serves to reduce incentives to buy insurance. Other aspects of the demand for crop insurance are confirmed in our analysis, including the negative effect of higher premium rates and the positive inducement to insure brought about by higher returns to insurance.

Our analysis also suggests that farmers that buy insurance and that receive disaster payments tend to have higher returns to farming. This may suggest that farmers that insure and are in areas with greater disaster assistance are better farm managers. Alternatively, this may suggest that crop insurance and disaster relief payments represent wealth transfers that tend to increase farm incomes.

Our results are preliminary and tentative. Hopefully, the final terms of the new farm bill will become clear in the early part of 2008 and thus will provide a fruitful arena for discussion in the session that includes this paper.

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