Does risk matter for farm businesses? The effect of crop insurance on production and diversification.

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Abstract: We use a large increase in Federal crop insurance subsidies as a natural experiment to identify the impact of risk on acreage and diversification decisions. Subsidy increases induced greater crop insurance coverage, which reduced farmers' financial risks. Did this change in the risk environment alter production decisions? We merged crop insurance participation data with farm-level Agricultural Census data from 1992 and 1997 to examine how harvested acreage and diversification changed in response to the policy-induced change in insurance coverage. The difference in differences empirical approach controls for unobservable heterogeneity and our results are robust across multiple definitions of our key variables and various fixed effects. We find that changes in the risk environment caused larger farms to expand while smaller farms shrank. Regardless of size, producers showed some evidence of using diversification as a method to mitigate risk. However, risk does not seem to have large overall effects.

Keywords: acreage decisions, crop insurance, diversification, risk

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I. Introduction

Does risk matter to producers? If so, how does risk matter and how important is it? If risk is not important, why isn't it? This information is crucial for understanding producers' decisions (whether to enter, to exit, to alter production practices, etc.) and can help to explain the structures of firms and industries.

According to the Small Business Administration definitions, a small business is independently owned and operated and (the most common definition) has fewer than 500 employees. The share of businesses that fall into this category lies around 99 percent while the share of private, nonfarm GDP produced by small businesses lies around 50 percent.[1] Risk is highly endemic to these firms. Only about 50 percent of all small businesses remain solvent after their first three years. Understanding how risk can affect the majority of producers and influence half the production of the U.S. economy becomes an important issue.

While these figures relate to nonfarm GDP, agriculture is a natural setting in which to examine these questions. Even the largest farm operations tend to fall under the heading of small business owners as defined by the SBA. In addition, farm outputs tend to be homogenous, making it easier to compare results amongst operations. Operators must deal with many sources of risk, an inherent part of agriculture. Farmers face price risk (a source of risk all businesses, in particular small businesses, face) and production risk (a source less likely for most small businesses to face). Weather, pests, crop/animal diseases, and health risks make up a few of the risks farmers must contend with. Finally, there are about two million farms, each of which is mandated by law to fill out the Agricultural Census forms every five years. This allows us to construct a large panel data set to explore issues related to risk.

While much research has been devoted to studying risk and its implications for production, little consensus exists as to its effects. Part of the reason for this lack of agreement has to do with the difficulty of quantifying, isolating, and identifying risk and its role in production (Just and Pope, 2003). In theoretical work, scholars tend to assume a specific type and level of risk aversion on the part of the producer, obtaining results that follow directly from these assumptions. In empirical work, scholars have difficulty finding data that quantify risk well. Empirical methods often use endogenous explanatory variables (e.g, variability of profits, prices, yields, etc.) to explain the producer behavior toward risk. It is likely that the usual risk measures also suffer from omitted variable biases—firms with different levels of risk tend to differ in many other ways.

To estimate the causal impact of risk on production, one needs (1) a quantifiable measure of exposure to risk, (2) a source of identification that causes exposure to risk to be different for different firms, and (3) a way to limit the possibility of omitted variable biases and biases stemming from unobservable heterogeneity. Recent policy changes provide a source of identification that allows us to address all three empirical requirements.

Our exogenous source of variation in risk comes from a Congressionally mandated increase in subsidies aimed at making crop insurance more affordable for farmers, enacted in the Federal Crop Insurance Reform Act (FCIRA) of 1994. Figure 1 shows total subsidies, total premiums, and total acres enrolled in the crop insurance program from 1990 to 1998. The figure contains separate plots for all crops and for the three largest individual crops (in acreage): corn, soybeans, and wheat. In 1997, these three crops made up 78.9% of the acreage insured, 55.5% of the subsidies, 51.7% of the total premiums paid, and 53.8% of cultivated cropland (excluding

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[1] This estimate of share of GDP comes from Joel Popkin and Company, 2001, and was found at the website: http://216.239.57.104/search?q=cache:8Bz0-

hay). The premium includes the farmers' actual out of pocket expense plus the government subsidy, which we assume equals a market premium that a private insurer would have charged.[2]

The figure shows a marked increase in crop insurance coverage following implementation of the FCIRA. Across all crops, total premium payments more than doubled, providing a powerful source of identification. Furthermore, premiums for wheat increased somewhat less than for corn, which allows us to compare changes in production to differential changes in premium growth.[3] This differential effect of FCIRA across wheat and corn stems from ex-ante differences in risks and the structure of the subsidies. Since wheat tends to be grown on riskier farmland, a greater proportion was insured prior to FCIRA. Moreover, the subsidies were structured such that they were worth more to corn growers than to wheat growers which induced a larger growth in participation for corn growers.

Table 1 gives additional information on the FCIRA for ten crops that accounted for 85% of premiums paid in 1997. The table reports 1992 and 1997 levels of premiums, acres harvested, share of acres insured, premiums per acre harvested, premiums per insured acre, and subsidies per insured acre. There were large increases in insurance subsidies for most crops between 1992 and 1997. Larger subsidies induced an increase in the number of acres insured and greater coverage per acre, which in turn resulted in higher premiums paid. For barley, potatoes, and dry beans, premiums per acre harvested increased by about one-third; for wheat and sorghum, premiums increased by about one-half; and cotton, corn, and soybean premiums increased by almost two-thirds. The most extreme cases were peanuts, which showed little increase (the crop

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[2] We assume that the total insurance premiums represent actuarially fair assessments of the risk that would have been charged by a private market in the absence of government provision of subsidies. Also note that private provision of crop insurance without government involvement does not exist.

[3] Note that in 1995, but not in subsequent years, farmers were required to establish a minimum level of coverage in the crop insurance program in order to maintain eligibility for other kinds of government payments. This explains the spike in acres insured 1995 and the modest decline thereafter.

was heavily insured before the policy change), and tobacco, which showed a huge increase (no federal crop insurance was available in 1992).

The type of data we used limits any biases stemming from unobserved heterogeneity and omitted variables. The Federal Crop Insurance Corporation provides crop insurance to American producers and is managed and operated by the Risk Management Agency (RMA). The RMA maintains records of all the policies provided, allowing us to obtain county level data on the levels of insurance for each crop. From these data we construct a coverage level for each farmer based on their crop mix and the county levels of insurance purchased. However, due to the endogeneity of this variable, we construct an instrument using national level insurance data and lagged (1992) crop mixes. We use this as a measure of the amount of risk producers faced: more coverage implies less income risk. Since farmers valued the subsidy increases dependent upon various attributes, including their crop mix and location, they faced different levels of exposure to risk, allowing us to identify the effect of risk on production decisions. Finally, we use the Agricultural Census microfiles from 1992 and 1997, the immediate years surrounding the implementation of FCIRA, to construct a panel data set to estimate risk's impact on producers' decisions.

We estimate two sets of regressions using two stage least squares to handle our instrumental variable estimation. We regress the change in cropland on the change in risk faced by producers in the first set, using the change in coverage as our source of variation in risk. In the second set we regress the change in diversification on the farm on the change in coverage. In both sets of regressions we run many different specifications including various controls and multiple measures of our dependent variables to check for robustness.

We find that the smallest farms (less than $100,000 in sales) tended to shrink while larger farms (greater than $100,000 in sales) increased in size. When examining the structure of the farm, we find evidence that all producers appeared to become more specialized (less diversified) in response to risk reduction. However, overall magnitudes of changes in production practices were small.

II. Background

If attitudes towards risk alter the level of production, this has important policy implications and has garnered some attention in the literature. Chavas and Holt (1990) used national data to examine the impact of wealth effects and risk on acreage allocation decisions. They found positive wealth effects, casting doubt on the commonly used constant absolute risk aversion assumptions and mean-variance risk analysis, both of which assume zero wealth effects. They also found acreage allocation decisions depended on the risk environment. Wu (1999), using a simultaneous set of equations to examine cropping pattern and insurance choices, found that crop insurance led to a change in cropping patterns for smaller farms, generally towards less productive and environmentally "sensitive" lands. Larger farms did not exhibit this pattern. Wu and Adams (2001) found that producers who adopted revenue insurance tended to shift production to corn and soybeans from other crops, the magnitude of which depended upon the level of coverage adopted.

Goodwin, et al (2002) used county level data and also found that crop insurance programs have resulted in additional land being brought into production, although they argued that these increases were economically insignificant. At a more aggregated level, Young, et al. (2001), using a simulation model with assumptions concerning adoption and returns to crop insurance, found similar results. However, they only explored the returns per acre in their model, and did not examine risk implications of crop insurance.

These papers tended to use county level data and attempted to jointly estimate choices of crop insurance adoption and acreage responses to adoption. Unobservable heterogeneity at the individual level could yield biased results. Also, the use of variables such as the coefficient of variation of yields and diversification indices are endogenous and tied to confounding factors associated with location.[4] It therefore remains unclear whether the associations reported in these studies between cropping patterns and insurance (or risk) were causal.

Important policy implications due to changes in the risk environment also include changes in the structure of the farm, and possibly the structure of industry. Diversification as a means of dealing with risk has garnered a good deal of attention in the literature. In a vein similar to Markowitz (1952) and Tobin's (1958) approach to portfolio theory, Heady (1952) argued that farmers could diversify production to mitigate the risk they face, generally trading off higher returns for a reduced variance in the returns. Carter and Dean (1960), Greve, Plaxico, and Lagrone (1960), Stovall (1966) and Johnson (1967) elaborated on the farm diversification problem, attempting to understand the normative implications of how to optimally diversify under uncertainty. Robison and Blake (1979) modified the theory to incorporate asset illiquidity and asset fixity, which serve to reduce the incentives of farmers to revise their portfolios as prices vary.

Empirical applications outside agriculture have had mixed results (Ahtiala, 2000; Berger and Ofek, 1995). However, those applications in agriculture have generally validated portfolio theory in both domestic (Schurle and Erven, 1979; Held and Zink, 1982; Falatoonzadeh, et. al,

1985) and developing economy (Ballivian and Sickles, 1995; Llewellyn and Williams, 1995) settings.

Alternative methods and rationales for portfolio adjustments have been developed in the literature with mixed results and often lacking causal arguments. For example, White and Irwin (1972) and Mishra and El-Osta (2002) found evidence that larger farms tended to specialize while Pope and Prescott (1980), Gasson (1988), Ilberry (1991), and Shucksmith and Smith (1991) all found the opposite.

Additionally, lifecycle hypotheses (Damianos and Skuras, 1996; Potter and Gasson, 1988), off-farm income (El-Osta et. al, 1995; Mishra and Goodwin, 1997; Mishra and Sandretto, 2002; and Ahearn, et al, 2002) and agronomic issues (El-Nazer and McCarl, 1986) all could play important roles in explaining how and why the farm operator manages risk.

III. Methodology

A. The General Model

To estimate risk's effect on producers' decisions, we take advantage of a policy change that occurred in 1994 where the government dramatically increased the subsidies for crop insurance. We use an event study, exploring the changes in production decisions before and after the implementation of FCIRA.

For producer i (i = 1,..., N) in time t (t = 1992, 1997), let Y_{it} represent the dependent variable. For our first and second set of regressions, Y_{it} denotes the number of acres of cropland harvested. For our third set of regressions, Y_{it} represents the level of diversification on the farm. Let Y_{it} be a function of a set of factors X_{it} that characterize the farm and the producer that

[4] For example, yield variations are not entirely due to chance. Fertilizer and chemical choices will affect yields, as

influence the propensity to alter the level of acreage used as cropland.[5] The producer's choice to alter the levels of cropland may also depend on the risk environment. We use the operator's per-acre crop insurance coverage, C_{it}, to measure the level of risk the producer faced. We also posit that this effect may depend on the size of the operation. Therefore, we interact the coverage variable with a dummy variable reflecting the farm's size (as defined by level of sales) category.[6] This gives us the following equation:

(1)
$$Y_{it} = \alpha + \beta X_{it} + \gamma C_{it} \cdot S_{it} + \varepsilon_{it}$$

where α, β, and γ are all coefficients to be estimated, S_{it} denotes a dummy variable reflecting the scale of the operation, and ε_{it} represents the random error term. We use a per-acre coverage level in (1) since producers choose the total coverage level and amount of acres in cropland simultaneously (i.e. we would expect a positive correlation between the acres of cropland chosen and the total coverage level, regardless of whether risk influences acreage decisions).

We want to look at the change of the decisions made by producers from before to after the implementation of FCIRA. Therefore, we want to estimate the difference between period one (1997, or post-FCIRA) and period zero (1992, or pre-FCIRA). Differencing gives us the following equation to estimate:

(2)
$$\Delta Y_i = \alpha + \beta \Delta X_i + \gamma \Delta C_i \cdot S_{i0} + \varepsilon_i \,.$$

Now the change in acreage allocation is a function of the change in any factors that characterize the farm and the producer that influence the propensity to alter the level of acreage used as

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well as seed choice and tillage practices. Of course, there will always be a stochastic component, that could be large, with respect to yields, but yields can be affected by choices made, making them not entirely exogenous.

[5] A similar exposition exists for our third set of regressions involving diversification rather than acreage allocation. For the sake of brevity, we only include a discussion of the acreage allocation decisions here.

[6] We used four categories of size of the operation. The first held farms that sold less than $25,000 worth of agricultural goods. The second contained farms that sold between $25,000 and $100,000 worth of agricultural commodities. Farms with sales between $100,000 and $250,000 comprised the third group, while farms with sales over $250,000 made up the fourth group.

cropland and the change in the coverage levels adopted as a result of FCIRA. We use the period zero (1992) size categories for the farms (S_{i0}) to ensure that any contemporaneous decisions on altering the size of the farm do not bias the estimates of γ.

This approach removes a large degree of the potential for biases attributable to unobservable heterogeneity and omitted variables. Variables of importance that we cannot measure easily or effectively (e.g. personality traits, the productivity of the land, etc.) could bias the results if not included in a cross-sectional analysis. This approach eliminates these variables and any biases they might have introduced, to the extent that these types of variables remain constant through time but vary spatially.

For our analysis, we must construct a coverage level for each operator. We therefore make a couple of assumptions: (1) every producer with insurable crops adopts insurance; and (2) the level of adoption by each farmer is defined by her share of insurable crops and the total level of insurance actually adopted in each county. In particular, we construct a farm-level measure of insurance coverage based on the county average crop insurance premium per acre. The premium should provide a good measure of the level of coverage adopted in each county. We take this county level of adopted insurance and distribute it to each farmer based on their respective relative levels of insurable crops. Thus, the estimated level of coverage per acre for producer *i* in time *t* is

(3) $$C_{it} = \sum_j \left(P_{jt}^c / A_{jt}^c\right) s_{ijt}$$

where P_{jt}^{c} denotes the total premiums paid[7] in county c for crop j in time t; A_{jt}^{c} represents the total acres planted in county c of crop j in time t; and s_{ijt} is the share of land that operator i has in crop j in time t. We then split the farms into four separate groups depending on their level of sales by multiplying the coverage variable, C_{it} by S_{i0} as seen in equation (2). This gives us four coverage variables to be used in our regression analyses.

B. The Two-Stage Least Squares Approach

The coverage variable outlined above has potential endogeneity concerns. In particular, A_{jt}^{c}, the amount of land chosen to be in production for crop j in time t in county c, is endogenous. This means that estimation of equation (2) is likely to result in biased estimates of γ. We therefore use a two stage least squares instrumental variable approach to get rid of the source of endogeneity by constructing a set of instrumental variables that get used in the first stage to create the instruments for the second stage analysis. We construct our instrumental variable using the national average premium per acre for each crop (P_{jt}^{N} / A_{jt}^{N}) rather than the county average, along with the 1992 shares of cropland:

(4) $$C_{it}IV = \sum_{j} \left(P_{jt}^{N} / A_{jt}^{N} \right) s_{ij0}$$

This instrumental variable is now a function of the average national premium per acre (which, due to its high level of aggregation, should not run into the same endogeneity issues as the coverage level using the county level of aggregation) and uses only lagged (1992), rather than contemporaneous, shares of cropland for each farmer. We then construct the four

[7] For simplicity, we will refer to the contributions of the farmers plus the subsidies paid by the government as the "total premiums paid."

instrumental variables by multiplying $C_{it}IV$ by the size variable S_{i0}. The second stage regression then looks like the following:

(5) $$\Delta Y_i = \hat{\alpha} + \hat{\beta}\Delta X_i + \hat{\gamma}\Delta I_i \cdot S_{i0} + \varepsilon_i$$

where I_{it} represents the instrument derived from the first stage of the two stage least squares analysis using the two separate coverage variables outlined above.

C. Identification Based on Differences

By using two time periods, one before the policy and one after its implementation, we can examine the changes in per-acre coverage levels. Since the pre-FCIRA levels of coverage were relatively low and the post-FCIRA levels were substantially higher, we infer that the policy change was a major determinant of the dramatic growth in insurance coverage. We use this change in coverage to measure the change in the risk environment the producers faced. We therefore estimate how the acres of cropland changed in response to changes in the level of risk exposure (coverage).

Estimation of (5) allows us to identify the effect of risk on production decisions. Since the introduction of FCIRA led to such dramatic shifts in the levels of coverage, we inferred that the changes in coverage were exogenous. Additionally, we theorized that the introduction of FCIRA had different value for different types of farms in different regions. For instance, operators producing crops on riskier land would value the crop insurance more than those who grew crops on better ground, since it would be more likely that they would receive indemnities. Also, holding yield risk constant, the premium would be effectively greater for farms with higher average yields and those with higher valued crops (e.g. corn versus wheat).

To test this theory, we regress the percentage change in insured acreage on the county-level change in premiums per acre. We construct the dependent variable by dividing the number of insured acres in the county by the number of acres in the ten program crops in that county for both 1992 and 1997. We then calculate the percentage change from 1992 to 1997. For the independent variable, we subtract the total dollar amount of premiums paid in 1992 from the total in 1997 and divide by the number of acres actually insured in 1992. The results, found in table 2, show that those counties with low levels of pre-FCIRA coverage that increased their coverage post-FCIRA to take advantage of the high levels of subsidies were the counties that increased the number of acres to be insured the most as well. Similarly, those counties with high levels of pre-FCIRA coverage did not have to increase their post-FCIRA coverage levels to take advantage of the high subsidies. These counties did not show large increases in the number of acres insured over time. These results give us further confidence that we properly identified the effect of risk on production decisions.

D. Controls

We now have a methodology that (1) utilizes an exogenous source of variation (the introduction of FCIRA) of risk that can be measured (through the use of premiums); (2) allows us to identify the effect of risk (since we posit that the FCIRA had a different value for operators in different regions growing different crops); and (3) permits us to control for unobservable heterogeneity and omitted variables (by differencing). However, we must also control for those variables that do change over time (i.e. that would not get wiped out by differencing). Additionally, there is the possibility that in the years between 1992 and 1997 other factors could have arisen that might be correlated with changes in insurance coverage that also may have altered production decisions. If not controlled for, these factors would bias the estimates of $\hat{\gamma}$ in equation (5).

The matrix *X* contains a set of variables we use to control for certain characteristics of the producer and the operation, as well as the general environment within which the operator functioned. In this matrix we include the size (measured by sales category) and SIC code of the operation, along with the age, sex, and experience of the producer. To control for the general environment, we include state fixed effects and lagged prices of outputs multiplied by the share of production of each producer (in order to weight the lagged price by its relative importance to the operator). Since it was possible that many of these effects could interact with each other (for example, corn farms in Iowa could experience different concerns than wheat farms in Kansas), we constructed all the two-way interaction effects between size, prices, state fixed effects, and SIC codes.

One major change between 1992 and 1997 was the introduction of the 1996 Federal Agricultural Improvement Reform Act (FAIR), also known as the "Freedom to Farm Bill." The FAIR Act radically altered the structure of agricultural support payments by decoupling these payments from production practices. Prior to the FAIR Act, farmers had to limit current production to a share of historical plantings to qualify for payments. The FAIR Act lifted almost all of these restrictions and decoupled payments from commodity price levels. Basically, the FAIR Act changed the supports from contingency payments to lump-sum payments by land units based upon pre-FAIR Act participation in government programs.

Producers knew the level of payments they would receive upon implementation of the FAIR Act. Since this level was contingent upon their previous history of involvement in government programs, but was no longer tied to what they currently chose to produce, we included each farm's level of government payments received in 1997 to control for their level of involvement in the pre-FAIR Act support programs. If any production decisions changed as a result of the FAIR Act that could also be correlated with changes in the level of coverage, this variable should provide a good instrument for the degree to which the FAIR Act would have affected the operator's production decisions.[8]

Finally, price changes could have affected production decisions that could have been correlated with the changes in coverage. In order to control for the effects of prices, we included an interaction term that weighted the previous year's prices (1991 and 1996 respectively) with the share of the commodity produced on the farm. This should control for the effect that price changes would have on both the acreage and diversification decisions producers made.

IV. Data

The data we use come from the Agricultural Census and the Risk Management Agency. The National Agricultural Statistics Service (NASS) of the U.S. Department of Agriculture collects data concerning farm and operator characteristics every five years from essentially all farms in the country. These files make up the Agricultural Census data. Since every farm operator is required by law to respond to the survey, we can track operations across time, as long as they remain in business. Each respondent receives a unique Census File Number (CFN) to track the farm, ranch, or other agricultural entity controlled or operated by the individual filing the census.

Merging the two years together by CFN resulted in a panel data set with 2,083,171 observations. We then restricted our sample of farms by SIC classification to those who fell into

[8] Another change that occurred in 1995 that we have not had time to explore yet was the large enrollment that

the major (insurance) program crops: namely wheat, corn, soybeans, cash grains (oilseed and grain combination farms), cotton, tobacco, and Irish potatoes. This resulted in a data set with 571,358 observations. We want to test whether or not the change in the risk environment altered operators' decisions. Since our exogenous source of variation in risk comes from a policy induced change in the crop insurance market, we need to ensure that our sample of farms consisted of those that had the potential to be affected by the insurance market. In other words, our sample needs to consist of those farms with a majority of their production in the insurable crops. To create such a dataset, we kept farms with the major insurable crops making up at least 90% of their total cropland harvested in 1992, leaving us with 474,843 observations. To ensure a balanced panel, we kept only those producers who had entries in both 1992 and 1997, leaving us with 318,725 observations. We then deleted operations where the respondents' age did not track across time, leaving us with 281,465 observations.[9] Dropping entries with missing observations left us with our final data set consisting of 239,992 observations or 119,996 differences.

A. Dependent Variables

Our first set of dependent variables consists of the amount of cropland harvested. Two main categories exist: the summation of all cropland harvested for each farm and the summation of the acres of the insurable crops harvested for each farm.

For our second set of dependent variables, we constructed several measures of diversification. We started by creating commodity shares by dividing each operation's sales of

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occurred in CRP. If a lot of riskier land went into CRP, enrollment could be correlated with both the coverage adopted and the acreage decisions made. We have yet to explore this avenue.

[9] Since the Census is required every five years, the age of the respondent should have changed by five years. However, we allow for a range of 4-6 years to account for potential timing issues. Some entries had the same CFN number in 1992 and 1997 but had much different ages. Perhaps someone else on the same operation filed the census and (mistakenly) received the same CFN. Alternatively, a farm could have exited in 1992 and an entrant in 1997 might have received the same CFN. Finally, it could have been a recording error of some kind.

the commodity by the operation's total sales, including livestock. The first diversification measure is simply the largest share of production of a single commodity for each producer. For example, if corn made up 80% of the total sales generated on the farm, then the farm's first diversification measure equals 0.8.

The second diversification measure is an entropy index that ranges from 0 to 100, depending on the number of activities the firm engages in and their relative importance. For example, a firm that produces only one commodity would have an entropy measure of 0, reflecting complete specialization. A producer that divides his efforts equally amongst multiple activities would receive a value of 100. One difficulty with this measure is that an operation that produces equal levels (measured by sales) of related outputs (e.g., corn and soybeans) would receive the same entropy value as would an operation that produced equal levels of unrelated outputs (e.g., barley and hogs), despite the fact that a broader range of skills, machinery, etc. would be required for the second operation than for the first. Theil (1972) showed that the entropy measure could be broken down into two parts: within and between group entropy, gaining insight into the level of diversification between related and unrelated activities. These two measures make up our third and fourth measures of diversification.

In order to construct the entropy measure using Theil's method, we placed outputs into related and unrelated groupings. Following Jinkins (1994), we constructed groups in the following manner:

Table 3: Commodity Groupings

Group	Commodity
1	Barley, Oats, Wheat
2	Corn, Soybeans, Sorghum
3	Hay, Miscellaneous, Other crops
4	Vegetables, Fruits
5	Beef, Sheep, Hogs, Other livestock
6	Poultry
7	Dairy

Using these groupings and sales data, we constructed the three entropy measures: *Related Entropy*, *Unrelated Entropy*, and *Total Entropy*. *Related Entropy* is defined as

(6) $$\textit{Related Entropy} = \sum_g \left\{ s_{gy} \times \sum_g \left[s_{ig} \times \frac{\ln\left(\frac{1}{s_{ig}}\right)}{\ln(n)} \right] \right\} \times 100,$$

where $g \in \{1,2,...,7\}$ denotes the group, s_{gy} represents the commodity groups' share of total output *y*, s_{ig} is commodity *i*'s share of group *g*'s output, *n* is the number of commodities (we considered 17 commodities, see Table 3), and ln is the natural log operator.

Using the same notation, *Unrelated Entropy* is defined as

(7) $$\textit{Unrelated Entropy} = \sum_g \left[s_{gy} \times \frac{\ln\left(\frac{1}{s_{gy}}\right)}{\ln(n)} \right] \times 100.$$

Total Entropy is simply the sum of *Related Entropy* and *Unrelated Entropy*.

The last measure of diversification that we use is a Herfindahl index to measure the concentration of commodity production in each farm. We calculate the Herfindahl index by summing the squares of the commodity's shares of total output. Following the notation above, define s_{iy} as commodity *i*'s share of total output *y*. Equation 8 then defines the Herfindahl index:

$$(8) \qquad \textit{Herfindahl Index} = \sum_i (s_{iy})^2$$

B. Independent Variables

Table 4 holds summary statistics for the variables used in our analysis. In 1997, farms in our sample harvested an average of 544 acres of cropland, of which 527 acres were planted in the ten program crops (the "insurable acres") we focus on. On average, farms increased their cropland harvested by more than 57 acres, 48 of which came from the insurable acres.

We created a variable, Sales, to capture the size of the operation. Approximately 29% of the operations had sales less than $25,000 while around 12% had sales over $250,000. Producers were fairly uniformly distributed between 9% to 13% for each of the nine five year age categories we created from "less than 35" years of age to "more than 70," the exception being those "less than 35," which only had 6% of all operators. Nearly 98% of the farmers were male with an average of almost 25 years of experience. Corn farms were the most common type of farms (representing 36% of all farms) while wheat, soybean, and cash grain farms comprised a little more than one-half of all farms. Finally, farmers received an average of $14.57 per acre in government payments (excluding Conservation Reserve Program payments) in 1997.

Table 5 shows the average insurance coverage for farms in the sample in 1992 and 1997 by sales category. The table illustrates the FCIRA resulted in a much larger increase in total insurance coverage for small farms relative to larger farms. For example, the introduction of FCIRA resulted in a $404 increase in total coverage for very small firms (category 1) while the very large firms (category 4) experienced a growth of $3693.40. Since larger farms had a greater absolute increase in insurance coverage, we theorize that their risk environment was affected more by the introduction of FCIRA than was the risk environment of smaller farms. As a result, we expect the operators of larger farms to have made larger changes in their production decisions than smaller operators – either by increasing their farm's output or through specialization.

V. Results

A. Specifications using various controls

The results of several models of the relationship between the change in cropland harvested and the change in coverage lie in table 6. The first specification included the SIC codes, but no price or state fixed effects, or interaction terms between the fixed effects. The second specification added state fixed effects, the third added price effects, while the fourth, our "full model," included interaction terms for our various controls. Specifically, these terms included (1) [lag SIC]*[State]; (2) [lag SIC]*[lag Price*Share Commodity]; (3) [lag SIC]*[lag Sales]; (4) [State]*[lag Price*Share Commodity]; (5) [State]*[lag Sales]; and (6) [lag Price*Share Commodity]*[lag Price*Share Commodity].[10] The first four specifications used our first coverage variable (using county-level average premiums) while the fifth used our "full model" with the second coverage variable (using national-level average premiums).

The most important finding from these specifications is that the coefficient for the change in coverage for the largest farms was positive and significant at the one percent level for the largest set of farms. At the same time, the smallest two categories of farms had negative and

[10] We used the term [lag Price*Share Commodity] to control for the price effects in the economy. We used lag prices since the previous year's prices affect the current year's production decisions. We weighted these prices by each farmer's share of the commodity to control for the degree of importance the price had on the farmer's

significant coefficients. In other words, the largest farms appeared to have increased their size of operation upon the introduction of FCIRA while the two smallest categories reduced the sizes of their operations. This could mean that the increased size of the larger farms came at the expense of the smaller farms, especially since the overall level of farmland in production tends to remain constant over time. The FCIRA could have contributed to an increase in concentration of farming.

The most consistent results belonged to the variables accounting for age, experience, and 1997 government payments. Controlling for experience, compared to farmers younger than 35, all other farmers had less cropland harvested on the farm. Additionally, as they aged, producers tended to continue to decrease the size of their farm. However, more experience translated into larger number of acres of harvested cropland which mitigated this effect to some degree. Finally, larger 1997 government payments, which we used as an instrument to control for the introduction of the 1996 FAIR Act, led to fewer acres of cropland harvested on the farm.

The sex of the operator became significant in the final two specifications, using the "full model." Surprisingly, male operators tended to have smaller increases in their farm's size than female operators. Finally, the size of the operation did not have a consistent direct effect on the change in the number of acres of cropland harvested after including all the various controls. The first three specifications had positive and significant coefficients for the size categories. This meant that, compared to the largest farms, the smaller farms each increased their cropland harvested to a greater degree. In fact, the smaller the farm, the more the operator increased the size of the farm. While counterintuitive, once we introduce all the fixed effects and interaction

production decisions. For example, if a producer had a share of zero of corn, they would not care about the price of corn. However, if they had 75% of their output in wheat, they would care very much about the price of wheat.

effects, this effect disappears and, in fact, reverses itself, giving us the result we expected – namely that the larger farms expanded more than the smaller farms.

Most of the coefficients did not change across the different specifications, showing the robustness of our results. The remainder of our results will utilize the “full model,” including all the controls and all the various interaction effects.

B. Land Allocation

Table 7 contains results pertaining to land allocation decisions, including four different specifications of the dependent variable using equation (5). In the first specification we use the change in cropland harvested while we use the 1997 levels of cropland harvested regressed on 1992 levels of cropland harvested to check for robustness in the second specification. In the third specification we use changes in cropland in the ten program crops we focused on (which we call the “insured crops”) while in the fourth specification we use 1997 levels of these insured crops regressed on 1992 levels.

The results across specifications (1) and (2), using cropland harvested, were remarkably robust, as were those across specifications (3) and (4), using insurable cropland harvested. There were some differences between the use of cropland harvested and insurable cropland harvested, although the signs and levels of most of the coefficients remained the same. The magnitudes, however, did change.

In the specifications using cropland harvested, which include those crops outside the ten major insurable crops we focus on, the two smallest sets of farms reduced the level of their cropland harvested upon implementation of FCIRA. The third largest set of farms kept the same levels of cropland harvested while the largest farms increased their levels of cropland harvested.

The smallest farms reduced the amount of cropland harvested by nearly 1.5 acres for each dollar change in coverage per acre. Given the change in coverage averaged approximately four dollars per acre, this means a drop of about 6 acres – a 5% change in the overall size of the farm's cropland harvested. The second smallest set of farms reduced their levels of cropland harvested by approximately 2.7 acres for each dollar change in coverage per acre, translating into a drop of nearly 11 acres for each farm in this category, representing a 3% change in the overall size of the average small farm's cropland harvested. On the other side of the spectrum, the largest farms increased their holdings of cropland harvested by nearly 9 acres for each dollar change in coverage per acre. This means that the largest farms increased their cropland harvested by approximately 36 acres, representing a 2.4% change in the size of their overall size.

The specifications using insurable cropland harvested had slightly different results. The largest difference was with the second largest set of farms – which now show a significant and positive increase in the size of insurable cropland harvested as a result of the changes imposed by FCIRA. Additionally, the coefficients on the largest farms increased from nearly 9 acres per one dollar/acre increase in the coverage level to approximately 11 acres per one dollar/acre increase in the coverage level. Finally, the coefficients on the two smallest groups of farms retained their significance and sign, but were smaller than those of the first two specifications.

These results appear to show that FCIRA had a significant, albeit small, effect on the size of the farms. Upon implementation, the smallest groups of farms shrank, with most of their decrease in size coming from those crops that could be insured. The largest farms, however, grew in response to FCIRA, with their growth coming exclusively from these insurable crops. In fact, it appears that these farms might have gotten rid of some of their non-insurable crop harvested acres while adding to their insurable crop acres. It appears that FCIRA might have caused a transfer of resources from smaller operations to larger ones.

Over time, older producers decreased their cropland harvested to a greater extent than younger producers. Surprisingly, this effect remained consistent across all age categories. To some extent, this effect was mitigated by the experience variable which showed an increase over time in cropland harvested as the producer accrued experience. Additionally, compared to females, males tended to increase their cropland harvested more while an increase in 1997 government payments per acre tended to reduce cropland harvested. For an additional dollar of per-acre government payments, the operator harvested nearly one-third of an acre less. With an average of about $13 dollars per acre, this translated into less than a five acre difference between those with the mean value of payments and those without any payments at all. Finally, the size of the operation tended to have a direct negative effect on the changes in acreage. Compared to the largest producers, the other producers tended to have significantly smaller levels and changes in cropland harvested.[11]

C. Diversification Decisions

Defining the dependent variable in equation (5) as diversification measures, the estimated relationships between the change in diversification and the change in insurance coverage per acre lie in table 8. Note that the coefficients corresponding to the different diversification indices have different interpretations. The Entropy indices increase with the level of diversification while the Herfindahl index and the "largest share" index decrease. Hence, we expect the various

[11] Recall that all the analyses reported were performed with farms with at least 90% of their cropland harvested in the 10 major (insurable) crops we examined. This could have biased results in some fashion so we extended the analysis to include farms with 75% or more of their crops in the 10 major insurable crops. The results did not change significantly.

coefficients for the two sets of specifications to have opposite signs. Upon inspection of table 8 we find that, indeed, this is the case. Additionally, we see that the results are robust across the different specifications in terms of signs and significance levels (magnitudes are somewhat difficult to interpret across the various diversification measures).

For all size farms, the coverage variables show that producers tended to specialize more after the introduction of FCIRA. The bulk of this specialization appeared to come from between group specialization (specification (4)). In other words, it appears that producers specialize by cutting back their activities from activities that have little or no connection to the main focus of their current operations.

The simplest interpretation for the dependent variables (most of which are difficult to interpret the implications of the magnitude of the coefficients) comes from the first specification using our crudest measure of diversification: the largest share of total output for a single commodity. For a one dollar change in the coverage per acre, the share of the commodity with the largest share of total output increased by 0.003 for the smallest farms. For an average change in coverage of $3.71 per acre, this translated into an average increase of 0.01 (or a one percent change) in the largest share.

Similarly, the largest producers also specialized after FCIRA was passed, experiencing an increase of 0.004 in the share of the commodity with the largest share of total output for a one dollar change per acre of coverage. This translates into the share of the largest commodity of the largest farms increasing by approximately 1.5 percent of the total share (i.e. if the largest share was 40% before FCIRA, it tended to be over 41.5% after FCIRA).

The results for the diversification of the farm enterprise did not entirely conform to our expectations. We had expected the change in the risk environment to cause the largest farms to specialize more. However, we thought that the smallest producers would remain largely unaffected by FCIRA since they purchased relatively small quantities of crop insurance in the first place. Overall, producers appear to use diversification as a risk management strategy. When the risk environment became more favorable for producers, they tended to specialize more, regardless of farm size.

Similar to previous results, age again factored heavily into the explanation of the dependent variable. As producers aged, they tended to specialize more. This was somewhat tempered by the level of experience of the operator. However, the age effect again tended to dominate. The more government payments received, the more the producer specialized. Finally, males tended to specialize more than females.

VI. Conclusions

In this paper we used a natural experiment, an exogenous increase in crop insurance subsidies mandated by the Federal Crop Insurance Reform Act of 1994, to identify and estimate how producers responded to changes in the risk environment. The increase in the subsidies induced operators to expand their coverage, which reduced their exposure to risk. We used data from the 1992 and 1997 Agricultural Census and from the Risk Management Agency's records of crop insurance adoption to analyze producers' acreage and diversification decisions in response to the implementation of FCIRA. By using a differences-in-differences approach, we controlled for unobservable heterogeneity (to the extent that this heterogeneity remained constant over time). Finally, our identification strategy relied upon the hypothesis that the subsidy would be valued differently, depending on the region of the country and the crop being produced. We tested this proposition and found that the counties with largest increase in coverage were the counties with the largest percentage increase in number of acres insured, which validated our identification strategy.

We found that the largest two categories of farms (with at least $100,000 of sales) increased their level cropland harvested in response to FCIRA, while the smallest two categories of farms (with less than $100,000 of sales) decreased their acres of cropland harvested. Given the relative stability of the number of acres involved in agricultural production, this seems to imply that a transfer of acres from the smaller producers to the larger producers occurred due to the implementation of FCIRA (controlling for lagged prices of commodities, industry and state fixed effects, and various interactions between the controls). While these trends do appear to exist, they do not seem to be large ones.

Additionally, regardless of size, we found evidence that producers tend to utilize diversification as a risk mitigation strategy. This is somewhat surprising for the smallest farms since they do not tend to purchase much insurance (i.e. they should not be affected by FCIRA). While producers do seem to use diversification as a risk mitigation strategy, it does not appear to be used very heavily. Results show that farmers increase the level of their main activity by only about 1-2%.

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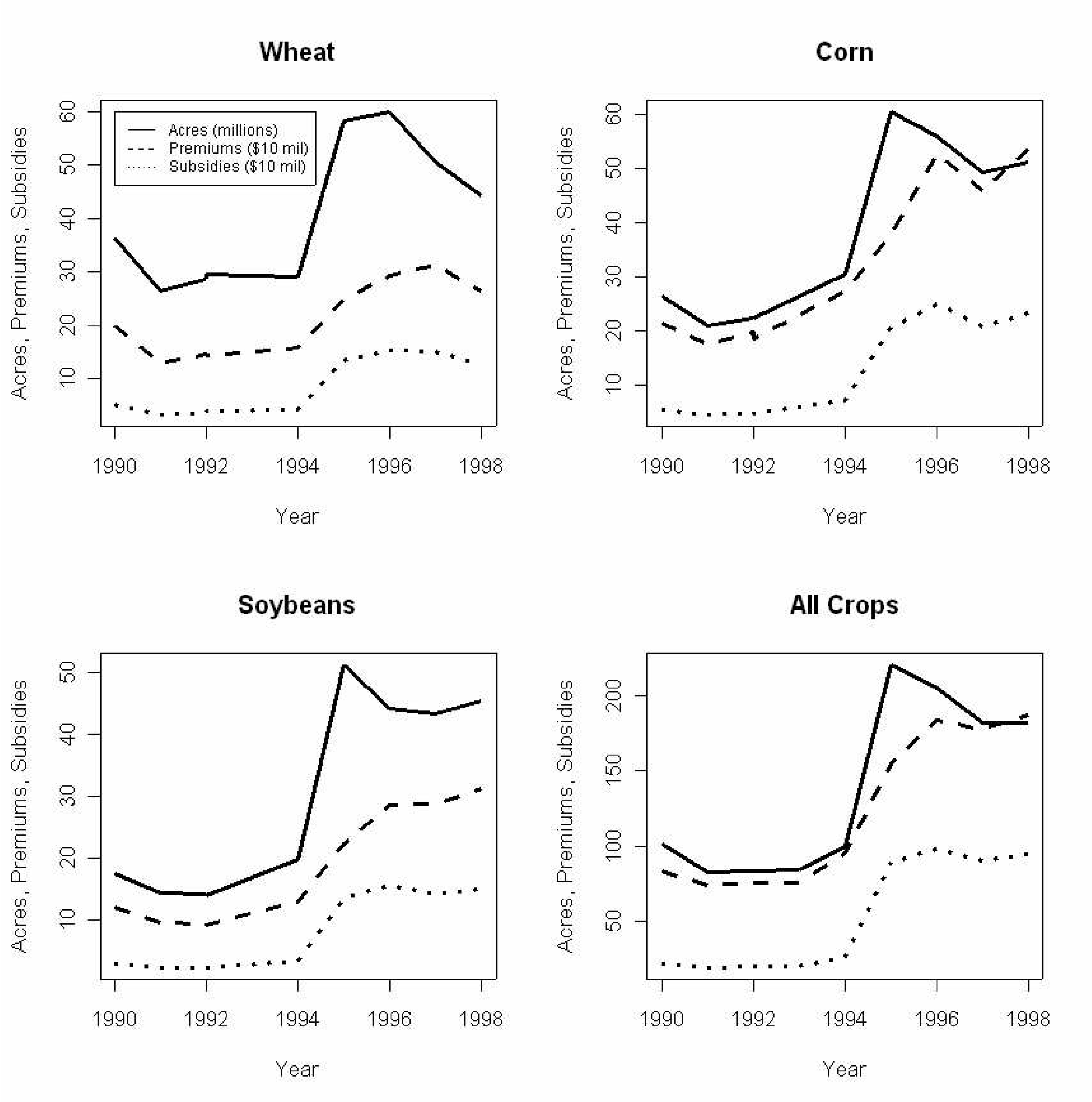
Figure 1. Insurance coverage of all crops and largest individual crops in years preceding and following the FCIRA of 1994



Source: Risk Management Agency, at http://www.rma.usda.gov/data/

Table 1. Insurance coverage before and after FCIRA of 1994

	Total premiums ($1,000)		Total Acres Harvested (1,000)		Share of Acres Insured		Average Premium per Acre Harvested ($/acre)		Average Subsidy per Acre Insured ($/acre)		Average Premium per Acre Insured ($/acre)	
	1992	1997	1992	1997	1992	1997	1992	1997	1992	1997	1992	1997
Wheat	146,118	313,933	59,003	60,953	0.497	0.833	2.53	5.16	1.36	2.98	5.09	6.2
Cotton	90,657	252,676	11,742	13,787	0.371	0.835	7.86	18.36	6.22	12.84	21.21	21.98
Corn	196,412	460,662	68,905	70,371	0.327	0.702	2.87	6.55	2.23	4.18	8.78	9.34
Dry Beans	13,326	25,136	1,159	1,530	0.628	0.848	11.57	16.47	5.15	9.56	18.43	19.42
Sorghum	24,974	44,788	10,336	8,351	0.351	0.755	2.45	5.38	1.96	3.59	6.98	7.13
Peanuts	39,840	36,153	1,354	1,292	0.780	0.914	29.54	28.01	8.77	13.67	37.86	30.63
Soybeans	93,715	288,374	54,672	66,135	0.262	0.659	1.74	4.37	1.69	3.29	6.62	6.63
Potatoes	12,497	28,857	905	1,107	0.326	0.626	15.91	26.52	11.68	23.55	48.73	42.35
Barley	17,486	23,708	6,463	5,893	0.474	0.763	2.78	4.06	1.55	2.61	5.86	5.32
Tobacco	0	31,768	783	806	0	0.826	0	68.66	0	31.17	0	83.15

Source: Risk Management Agency at http://www.rma.usda.gov/data/

Table 2. Dependent Var: %Δ Insured Acres

Parameter	Estimate	Standard Error
Intercept	5.19**	0.51
Δ Coverage	0.03**	0.001
Adj. R^2	0.39	
N	2648	

Note: ** denotes significance at the 1% level.

Table 4. Variable Definitions and Summary Statistics for Sample

Variable Name	Definition	Mean	Std. Dev.
	Dependent Variables		
Δ Cropland Harvested	Change in the number of acres of harvested cropland	57.27	409.31
Δ Insurable Cropland Harvested	Change in the number of insurable acres of harvested cropland	48.51	393.40
Cropland Harvested (1997)	Number of acres of cropland harvested in 1997	544.08	687.92
Insured Cropland Harvested (1997)	Number of acres of harvested cropland in insurable acres	527.57	664.51
Δ Largest Share	Change in the Largest Commodity Share (of Total Output)	0.0005	0.18
Δ Total Entropy	Change in the Total Entropy	-0.03	10.40
Δ Related Entropy	Change in the Related Entropy (amongst like commodities)	0.02	7.52
Δ Unrelated Entropy	Change in the Unrelated Entropy (amongst unlike commodities)	-0.05	8.13
Δ Herfindahl Index	Change in the Herfindahl Index	0.01	0.21
	Independent Variables		
Sales <25	% Farms with Sales ($) < $25,000	0.29	--
Sales 25-100	% Farms with $25,000 < Sales ($) ≤ $100,000	0.34	--
Sales 100-250	% Farms with $100,000 < Sales ($) ≤ $250,000	0.25	--
Sales >250	% Farms with Sales ($) > $250,000	0.12	--
Age <35	% Farmers where Age (years) ≤ 35	0.06	--
Age 35-40	% Farmers where 35 < age (years) ≤ 40	0.09	--
Age 40-45	% Farmers where 40 < age (years) ≤ 45	0.12	--
Age 45-50	% Farmers where 45 < age (years) ≤ 50	0.13	--
Age 50-55	% Farmers where 50 < age (years) ≤ 55	0.12	--
Age 55-60	% Farmers where 55 < age (years) ≤ 60	0.13	--
Age 60-65	% Farmers where 60 < age (years) ≤ 65	0.12	--
Age 65-70	% Farmers where 65 < age (years) ≤ 70	0.09	--
Age >70	% Farmers where 70 < age (years)	0.14	--
Sex	Dummy variable = 1 if male; 0 else	0.98	--
Experience	Years of farming experience of operator	25.06	13.19
Wheat	SIC 111 (% farms classified as wheat farms)	0.12	--
Corn	SIC 115 (% corn farms)	0.36	--
Soybeans	SIC 116 (% soybean farms)	0.18	--
Cash Grains	SIC 119 (% oilseed and grain combination farms)	0.23	--
Cotton	SIC 131 (% cotton farms)	0.04	--
Tobacco	SIC 132 (% Tobacco farms)	0.07	--
Potatoes	SIC 134 (% Irish potato farms)	0.006	--
Δ Coverage per Acre	Change in Coverage per acre	3.71	10.94
Coverage 1997	Estimated value of crop insurance purchased per acre harvested, 1997 – See text for details	6.08	11.14
Coverage 1992	Estimated value of crop insurance purchased per acre harvested, 1992– See text for details	2.36	4.48
Gov_pay_acre 97	Total government payments per acre harvested in 1997, excluding Conservation Reserve Program payments	14.57	55.10
Observations	Number of observations in panel	119996	

Source: All variables from the Census of Agriculture, 1992 and 1997 and RMA 1992, 1997.

Table 5. Mean Total Insurance Coverage by Sales Category and Year

Sales category	1992	1997	1997-1992
Sales < $25,000	146.40	550.40	404.00
	(275.20)	(1347.10)	
$25,000 < Sales ≤ $100,000	771.40	1913.80	1142.40
	(990.90)	(2964.00)	
$100,000 < Sales ≤ $250,000	1827.10	4016.10	2189.00
	(2003.40)	(4665.40)	
Sales > $250,000	3771.40	7464.80	3693.40
	(5518.60)	(9197.00)	

Note: Standard Deviation in parentheses. Source: Census of Agriculture, 1992 and 1997 and Risk Management Agency 1992 and 1997.

Table 6. Change in Cropland Harvested - using various fixed effects, and interactions of fixed effects

	(1)		(2)		(3)		(4)	
Parameter	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.
Intercept	127.70**	16.16	96.49**	21.54	98.49**	23.07	268.55	227.05
Δ Cov * lag Sales < 25	-1.63**	0.23	-1.75**	0.23	-1.76**	0.24	-1.46**	0.27
Δ Cov * lag Sales 25-100	-2.01**	0.35	-2.01**	0.35	-2.01**	0.35	-2.71**	0.47
Δ Cov * lag Sales 100-250	0.10	0.51	0.18	0.51	0.21	0.51	0.12	0.65
Δ Cov * lag Sales > 250	8.32**	0.73	8.68**	0.74	8.67**	0.74	8.98*	0.90
lag Sales < 25	124.15**	4.98	132.53**	5.04	132.38**	5.06	-209.96*	95.23
lag Sales 25-100	113.73**	4.75	117.19**	4.78	117.25**	4.79	-158.74*	75.73
lag Sales 100-250	86.25**	4.98	87.22**	4.99	87.30**	5.00	-87.98	73.21
Age 35-40	-17.02**	6.12	-16.62**	6.11	-16.47**	6.11	-16.17**	6.09
Age 40-45	-43.32**	5.83	-42.95**	5.83	-42.75**	5.83	-42.02**	5.81
Age 45-50	-80.68**	5.84	-80.19**	5.83	-79.89**	5.84	-79.30**	5.82
Age 50-55	-112.75**	6.00	-112.17**	5.99	-111.96**	6.00	-111.50**	5.98
Age 55-60	-138.32**	6.14	-137.45**	6.14	-137.26**	6.15	-136.62**	6.13
Age 60-65	-173.83**	6.38	-173.39**	6.38	-173.20**	6.38	-171.91**	6.36
Age 65-70	-241.33**	6.79	-241.80**	6.80	-241.63**	6.80	-240.02**	6.78
Age >70	-252.42**	6.97	-253.30**	6.98	-253.25**	6.99	-252.12**	6.97
Sex=male	-36.79**	7.96	-36.80**	7.95	-37.12**	7.95	-37.88**	7.93
Experience	1.78**	0.13	1.85**	0.13	1.86**	0.13	1.88**	0.13
Gov_pay_acre 97	-0.11**	0.02	-0.12**	0.02	-0.12**	0.02	-0.15**	0.02
lag SIC Codes	yes		yes		yes		yes	
State Fixed Effects	no		yes		yes		yes	
lag Price*Share (Commodity)	no		no		yes		yes	
Fixed Effect Interaction Terms	no		no		no		yes	
Adj. R^2	0.038		0.042		0.042		0.054	
N	119996		119996		119996		119996	

Notes: * denotes significance at the 5% level; ** at the 1% level
Fixed Effects Interaction Terms include: (1) [lag SIC]*[State]; (2) [lag SIC]*[lag Price*Share Commodity]; (3) [lag SIC]*[lag Sales]; (4) [State]*[lag Price*Share Commodity]; (5) [State]*[lag Sales]; and (6) [lag Price*Share Commodity]*[lag Price*Share Commodity].

Table 7. Acreage Decisions – various measures

	(1) Δ Cropland Harvested		**(2) Cropland Harvested**		**(3) Δ Insurable Cropland Harvested**		**(4) Insurable Cropland Harvested**	
Parameter	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.
Intercept	268.55	227.05	489.06*	225.73	321.74	218.83	546.32*	217.33
lag Cropland Harvested	–	–	0.87**	0.003	–	–	–	–
lag Insured Cropland Harvested	–	–	–	–	–	–	0.86**	0.003
Δ Cov * lag Sales <25	-1.46**	0.27	-1.42**	0.27	-0.99**	0.26	-0.94**	0.26
Δ Cov * lag Sales 25-100	-2.71**	0.47	-2.60**	0.47	-1.61**	0.45	-1.50**	0.45
Δ Cov * lag Sales 100-250	0.12	0.65	-0.03	0.65	1.70**	0.63	1.55*	0.62
Δ Cov * lag Sales >250	8.98*	0.90	8.31**	0.90	11.40**	0.87	10.71**	0.86
lag Sales <25	-209.96*	95.23	-316.62**	94.69	-182.53*	91.78	-291.51**	91.17
lag Sales 25-100	-158.74*	75.73	-267.53**	75.32	-120.63	72.99	-231.54**	72.52
lag Sales 100-250	-87.98	73.21	-184.26*	72.80	-51.44	70.56	-150.88*	70.09
Age 35-40	-16.17**	6.09	-14.67*	6.06	-13.50*	5.87	-11.91*	5.83
Age 40-45	-42.02**	5.81	-39.36**	5.78	-37.99**	5.60	-35.15**	5.56
Age 45-50	-79.30**	5.82	-75.19**	5.78	-73.57**	5.61	-69.23**	5.57
Age 50-55	-111.50**	5.98	-108.96**	5.94	-104.44**	5.76	-101.75**	5.72
Age 55-60	-136.62**	6.13	-134.10**	6.09	-128.62**	5.91	-125.98**	5.87
Age 60-65	-171.91**	6.36	-170.97**	6.32	-161.16**	6.13	-160.16**	6.09
Age 65-70	-240.02**	6.78	-240.50**	6.74	-227.42**	6.54	-227.87**	6.49
Age >70	-252.12**	6.97	-255.90**	6.93	-238.41**	6.72	-242.35**	6.67
Sex=male	-37.88**	7.93	-37.73**	7.88	-37.28**	7.64	-37.11**	7.59
Experience	1.88**	0.13	2.06**	0.13	1.81**	0.12	1.99**	0.12
Gov_pay_acre 97	-0.15**	0.02	-0.16**	0.02	-0.14**	0.02	-0.15**	0.02
All Fixed Effects and Interaction Fixed Effects	yes		yes		yes		yes	
Adj. R^2	0.054		0.665		0.051		0.667	
N	119996		119996		119996		119996	

Notes: ** significant at the 1% level; * 5% level.
Fixed Effects include: lag SIC codes; State fixed effects; lag Price*Share of Commodity.
Interaction Fixed Effects include: [lag SIC]*[State]; [lag SIC]*[lag Price*Share Commodity]; [lag SIC]*[lag Sales]; [State]*[lag Price*Share Commodity]; [State]*[lag Sales]; and [lag Price*Share Commodity]*[lag Price*Share Commodity].

Table 8. Diversification – various measures

	(1) Δ Largest Share		(2) Δ Total Entropy		(3) Δ Related Entropy		(4) Δ Unrelated Entropy		(5) Δ Herfindahl Index	
Parameter	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.
Intercept	0.03	0.10	-1.79	5.50	4.59	3.99	-6.38	4.28	0.08	0.11
Δ Cov * lag Sales < 25	0.003**	0.0001	-0.13**	0.01	-0.03**	0.005	-0.09**	0.005	0.004**	0.0001
Δ Cov * lag Sales 25-100	0.005**	0.0002	-0.29**	0.01	-0.08**	0.008	-0.21**	0.01	0.006**	0.0002
Δ Cov * lag Sales 100-250	0.005**	0.0003	-0.33**	0.02	-0.09**	0.01	-0.24**	0.01	0.007**	0.0003
Δ Cov * lag Sales > 250	0.004**	0.0004	-0.29**	0.02	-0.09**	0.02	-0.20**	0.02	0.005**	0.0004
lag Sales < 25	0.07	0.04	-6.98**	2.31	-1.51	1.67	-5.47**	1.80	0.07	0.05
lag Sales 25-100	-0.01	0.03	-1.73	1.83	0.97	1.33	-2.70	1.43	0.002	0.04
lag Sales 100-250	0.008	0.003	-0.96	1.77	0.88	1.29	-1.84	1.38	0.01	0.04
Age 35-40	0.01**	0.003	-0.81**	0.14	-0.45**	0.11	-0.36**	0.11	0.02**	0.003
Age 40-45	0.02**	0.002	-1.35**	0.14	-0.78**	0.10	-0.57**	0.11	0.03**	0.003
Age 45-50	0.03**	0.002	-1.86**	0.14	-1.06**	0.10	-0.80**	0.11	0.04**	0.003
Age 50-55	0.04**	0.003	-2.41**	0.14	-1.36**	0.10	-1.04**	0.11	0.05**	0.003
Age 55-60	0.04**	0.003	-2.64**	0.15	-1.53**	0.11	-1.11**	0.12	0.05**	0.003
Age 60-65	0.05**	0.003	-3.15**	0.15	-1.91**	0.11	-1.24**	0.12	0.06**	0.003
Age 65-70	0.06**	0.003	-3.93**	0.16	-2.38**	0.12	-1.56**	0.13	0.08**	0.003
Age >70	0.07**	0.003	-4.34**	0.17	-2.76**	0.12	-1.58**	0.13	0.09**	0.003
Sex=male	0.01**	0.003	-0.80**	0.19	-0.30**	0.14	-0.50**	0.15	0.01**	0.004
Experience	-0.0007**	0.0001	0.05**	0.003	0.03**	0.002	0.02**	0.002	-0.001**	0.0001
Gov_pay_acre 97	0.00005**	9.38E-6	-0.004**	0.001	-0.002**	0.0004	-0.002**	0.0004	5.3E-5**	1.1E-5
All Fixed Effects and Interaction Fixed Effects	yes		yes		yes		yes		yes	
Adj. R^2	0.206		0.209		0.200		0.210		0.193	
N	119996		119996		119996		119996		119996	

Notes: ** significant at the 1% level; * at the 5% level.
Fixed Effects include: lag SIC codes; State fixed effects; lag Price*Share of Commodity.
Interaction Fixed Effects include: [lag SIC]*[State]; [lag SIC]*[lag Price*Share Commodity]; [lag SIC]*[lag Sales]; [State]*[lag Price*Share Commodity]; [State]*[lag Sales]; and [lag Price*Share Commodity]*[lag Price*Share Commodity]