The Crowd-out Effect of Crop Insurance on Farm Survival and Profitability*

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Abstract

The Federal Crop Insurance program has expanded dramatically over the past two decades—from $140 million in subsidies and 84 million acres covered to nearly $10 billion in subsidies and 260 million acres covered. The effect this has had on farmers' overall risk exposure and profitability is unclear. Self-selection and market dynamics have masked the direct effect of crop insurance. This paper uses numerous changes to the crop insurance program to isolate crop insurance's direct effect on risk exposure and, ultimately, profitability. I find that crop insurance increases debt holdings and acres cash rented and decreases the use of marketing contracts. Crop insurance has no effect on farm profitability. Taken together, crop insurance crowds out other risk-management strategies without improving farm profitability.

Introduction

Today, as U.S. farmers face the challenge of increasing productivity enough to feed 2 billion more people by 2050, they also face a dynamic, changing policy environment. The 2013 Farm Bill promises to eliminate direct payments and refocus commodity policy on crop-insurance-type risk management. Since 1933, federal policy has supported farm income and, consequently, farm investment and innovation. Now as policy shifts from explicit income support to risk management, the impact on farm structure, investment, and capital demand is uncertain.

Between 2005 and 2011, farm debt increased by 26.1% in real terms (40.3% nominal). At the same time the acres covered by federal crop insurance increased by 8% while premium subsidies more than tripled. How closely related are these events? As farm policy shifts from income support to risk management, it becomes important to examine the impact on credit demand and investment. Investment has lead the agricultural sector to have one of the highest productivity growth rates over the last half century. But debt-financed investment is risky; low yield or a low price could cause the farmer to default, potentially leading to bankruptcy. If crop insurance fills a missing market and gives the farmer an otherwise unavailable way to hedge, credit demand and investment will rise from a sub-optimal to an optimal level. If, on the other hand, crop insurance simply substitutes for an already-available risk-management strategy, there would be no change in credit demand or investment; publicly-provided crop insurance would only allow the farmer to shift the risk to the taxpayer. Establishing the impact of crop insurance on credit

demand thus indicates the efficiency gain or loss from government-provided crop insurance.

Numerous problems impede accurate assessment of the impact new farm policy will have on credit demand. One approach to the problem is to examine farmers' credit demand as they have increased crop insurance coverage over the past decade; if past behavior is the best predictor of future behavior, the effect of crop insurance on credit demand will be the best predictor of the effect of new farm policy aimed at risk management. The greatest impediment to this kind of approach, however, is that farmers choose crop insurance and debt, and that choice can be influenced by outside factors that obscure the direct connection between the two. For example, a strongly risk-averse farmer might choose low levels of debt and high crop insurance coverage. Observing this choice, one might (incorrectly) suppose that having more crop insurance causes farmers to have *lower* debt. In other words, one would conclude that crop insurance and financial debt are negatively related—the two are substitutes—which seems unlikely. To clearly see the problem of relying on simple correlations from observational studies, suppose crop insurance were determined by a lottery, and the strongly risk-averse farmer was awarded a very low level of crop insurance coverage. Since debt is risky, he would likely respond by decreasing his debt. One would, therefore, (correctly) conclude that crop insurance and debt financing are positively related—lower crop insurance leads to lower debt. The two are complements instead of substitutes. This example illustrates that to determine the *causal* effect of crop insurance we need to rely on things that influence crop insurance take up and coverage but are otherwise unrelated to determinants of credit demand.

This paper examines the response of credit demand to greater crop insurance coverage. I solve the selection problem with the Risk Management Agency's rate-making rules that lead to intra-state variation in premiums that is unrelated to producers' actual experiences. These rules effectively redistribute costs from relatively higher-risk counties to lower-risk counties. Farmers in lower-risk counties end up paying a higher price for crop insurance than they otherwise would, which will lead them to purchase less coverage. Conversely, farmers in higher-risk counties will pay less-than-actuarially-fair prices and will, consequently, purchase more insurance. This rule-induced variation—as opposed to experience-induced—is unrelated to producer characteristics, which would otherwise confound estimates of crop insurance's causal effect on credit demand. Consequently I isolate the causal effect of crop insurance on credit demand.

To illuminate the relationship between crop insurance and credit demand, I first examine credit demand. Next I look at agricultural risks and the Federal

Crop Insurance program. After this overview I carefully examine the data to establish the causal effect of crop insurance on farm debt. I report my results, and conclude that crop insurance does, in fact, cause farm financial debt to increase. Determining whether this is efficiency enhancing is left to future work.

Credit Demand

Unmet Demand

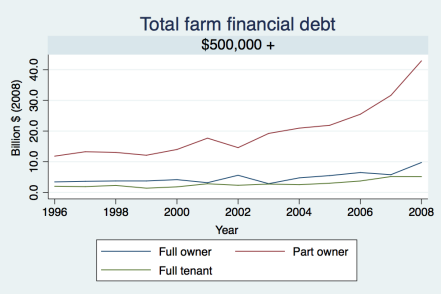
Few data sources report the credit demand of individual farmers. Financial debt typically is used to proxy for credit demand, but it fails to capture unmet credit demand. Researchers have consistently shown that farmers behave as though they cannot access as much debt financing as they would like (Hart and Lence 2004; Bierlen and Featherstone 1998;Bierlen et al. 1998). The reasons for this are many and varied. Often farmers lack the repayment capacity to secure debt financing. Small farms sometimes struggle to convince lenders of their ability to repay the loan from future farm earnings. Consequently there is insight to be gained from looking at the data by farm sales class and land-ownership status.

Between 2005-2007, the USDA collected data on farmers whose request for credit had been turned down sometime in the previous five years. In 2006, 2.5% of farms reported having been turned down for a loan. What's remarkable, however, is that 6.2% of large commercial farms with over $500,000 in sales reported having been turned down for a loan. By tenure status, 4.2% of full tenants, 3,9% of part-owners, and only 1.7% of full owners reported having been turned down. The denial rate also varied by region from a low 0.5% in the Southeast and Delta to 6.2% in the Mountain region and 4.0% in the Pacific region.

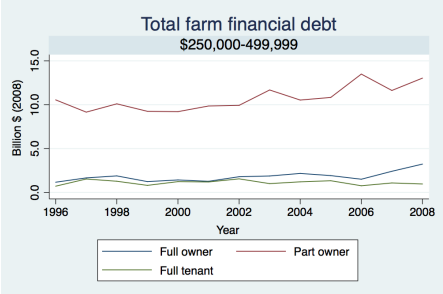
Debt

As asset values have risen since 2005, so has the level of financial debt. Figure 1 illustrates the evolution of farm debt from 2000 to 2011. The figures depicts the debt evolution by the three tenure classes. Each panel shows the pattern for one of four sales classes. Together, these figures illustrate the variety of credit demand among U.S. farms.

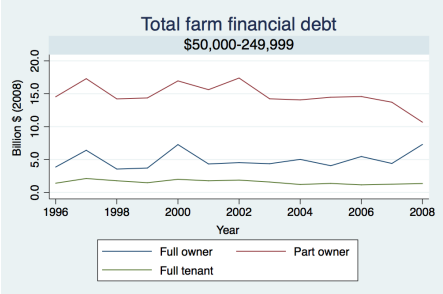
Despite the increase in total debt, farm leverage has fallen. Figure 2 show the evolution of the debt-to-asset ratio by tenure class for each sales class. These figures illustrate a declining, but variable, debt-to-asset ratio.



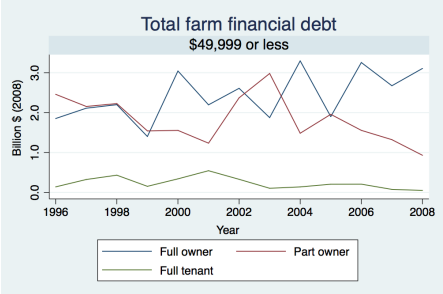
(a) Total Debt by Tenure, Sales¿$500,000



(b) Total Debt by Tenure, Sales=$250,000-$500,000



(c) Total Debt by Tenure, Sales= $50,000-$250,000



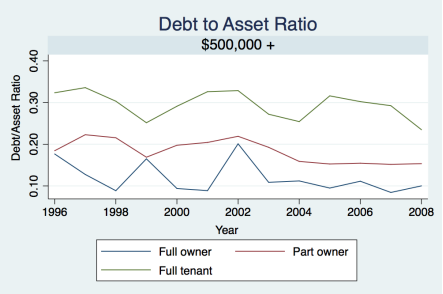
(d) Total Debt by Tenure, Sales¡$50,000

Figure 1: Comparison of the evolution of total farm financial debt by tenure across sales classes from 2000-2011

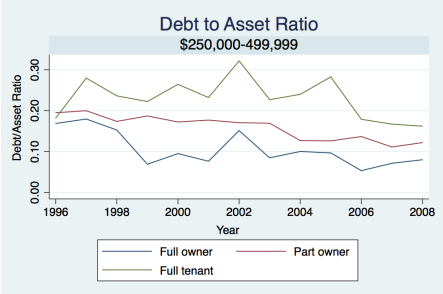
Investment

Debt, of course, is only a means to an end. Farmer investment and profitability is ultimately the objective. Agriculture is the sixth most productive industry in the U.S., behind computer manufacturing and ahead of both telecommunications and software publishing. U.S. agriculture accounted for fifteen percent of U.S. productivity growth between 1960-2007 (Jorgenson, Ho, and Samuels 2010). Farmers' ability to invest in new technology has been the driving force behind the sector's success. Direct support from federal farm programs has enhanced farmers' ability to invest and become more productive. Now, however, as federal policy shifts its focus from direct support to risk management, it becomes important to understand the ramifications this will have on agricultural investment.

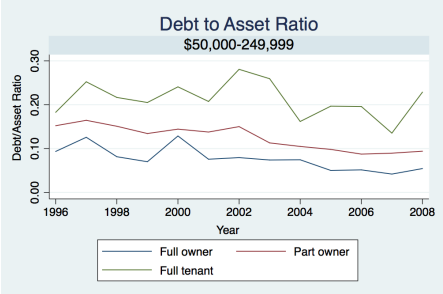
Borrowing money is one way farmers can recover after having been hit



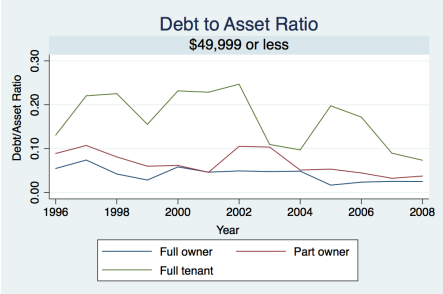
(a) Debt-Asset Ratio by Tenure, Sales¿$500,000



(b) Debt-Asset Ratio by Tenure, Sales=$250,000-$500,000



(c) Debt-Asset Ratio by Tenure, Sales=$50,000-$250,000



(d) Debt-Asset Ratio by Tenure, Sales¡$50,000

Figure 2: Comparison of the evolution of the debt-to-asset ratio by tenure across sales classes from 2000-2011

by a negative shock. Crop insurance is another way. The following sections overview the riskiness of farming and the details of the Federal Crop Insurance program.

Agricultural Risks

Risk and uncertainty are inherent to agriculture. Producers confront various risks; Table 1 below describes some key agricultural risks faced by producers.

These risks greatly affect farmer livelihood through their effect on yield and price. Weather, diseases, and labor and health risks could result in lower yield and cause loss of production; at the same time, price risks originating from the nature of agricultural supply and demand might create wide fluctuations in the market prices of agricultural products. Figure 3 and Figure 4 respectively

Table 1: Major Agricultural Risks

Risk	Examples/Factors
Weather Risks	Rainfall or temperature variability or extreme events
Biological Risks	Pests, disease, contamination
Price Risks	Low prices, market supply and demand, volatility
Labor and Health Risks	Illness, death, injury
Policy and Political Risks	Regulatory changes, political upheaval, disruption of markets, unrest

Source: Agriculture Risk Management Team (ARMT) of The World Bank

exhibit the price trends and monthly price changes for the three largest U.S. field cropscorn, soybean, and wheatover the previous decade. Prices for the three commodities have been volatile, especially for the period starting in late 2006 (Figure 4), when prices for major field crops began to rise. Corn, soybean and wheat prices peaked in 2008, with each more than doubling its value in late 2005 (corn at $5.47 per bushel in June, soybeans at $13.30 per bushel in July, and wheat at $10.50 per bushel in March). Prices then fell substantially from their peaks, and rose again in late 2010 (Figure 3). Grain markets appear to have entered a new era beginning about late 2006, with higher price levels and wider swings (Irwin and Good 2010; Abbot, Hurt, and Tyner 2011).

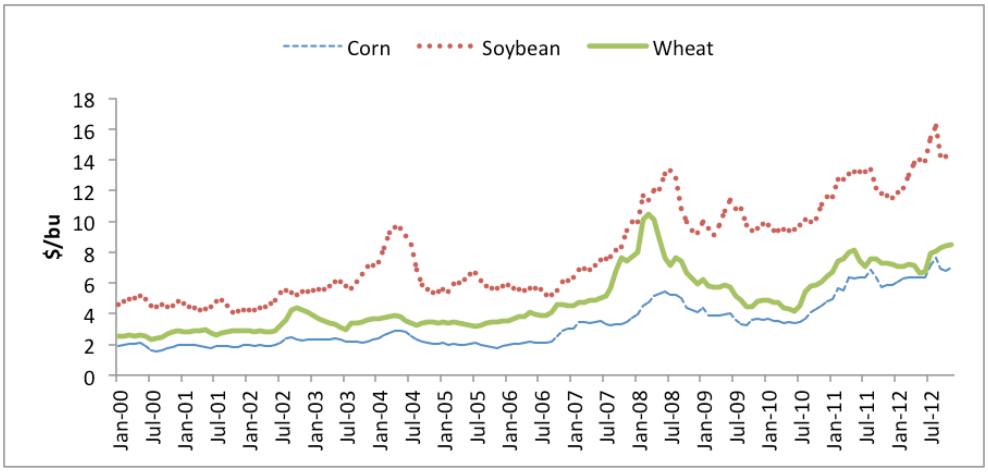


Figure 3: Price Trends for Corn, Soybean and Wheat, 2000-2012

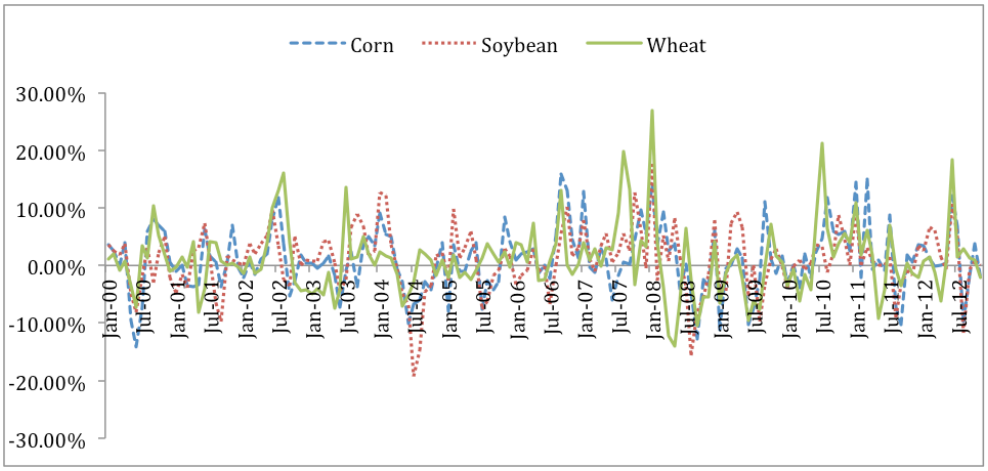


Figure 4: Monthly Price Changes, Corn, Soybean, Wheat, 2000-2012

Federal Crop Insurance

Crop Insurance History and Program Basics

The federal crop insurance program began in 1938; it is currently administered by the Risk Management Agency (RMA), USDA. Crop insurance provides producers with risk management tools to address crop yield and/or revenue risks. Shields provided a brief description on the program basics (Shields 2010):

> In purchasing a policy, a producer growing an insurable crop selects a level of coverage and pays a portion of the premiumor none of it in the case of catastrophic coveragewhich increases as the level of coverage rises (averaging about 60% of the total). The federal government pays the rest of the premium. Insurance policies are sold and completely serviced through 16 approved private insurance companies. The insurance companies losses are reinsured by the USDA, and their administrative and operating costs are reimbursed by the federal government.

For the first 40 years after its authorization, federal crop insurance was only available for limited crops and counties. By 1980, only 26 crops and about half of the counties across the nation were eligible for insurance coverage (Glauber 2013). The modern era of federal crop insurance began with passage of the

Federal Crop Insurance Act of 1980, which expanded the program to 9,618 crop-county combinations by 1982. Crop insurance policies were consistently structured from 1980 until 1994 when, to encourage greater participation, Congress passed the Crop Insurance Reform Act of 1994. The Agricultural Risk Protection Act of 2000 further enhanced the crop insurance program (Shields 2010). In response, enrollment has grown sharply, increasing from 101 million acres in 1990 to more than 282 million in 2012. (Figure 5)

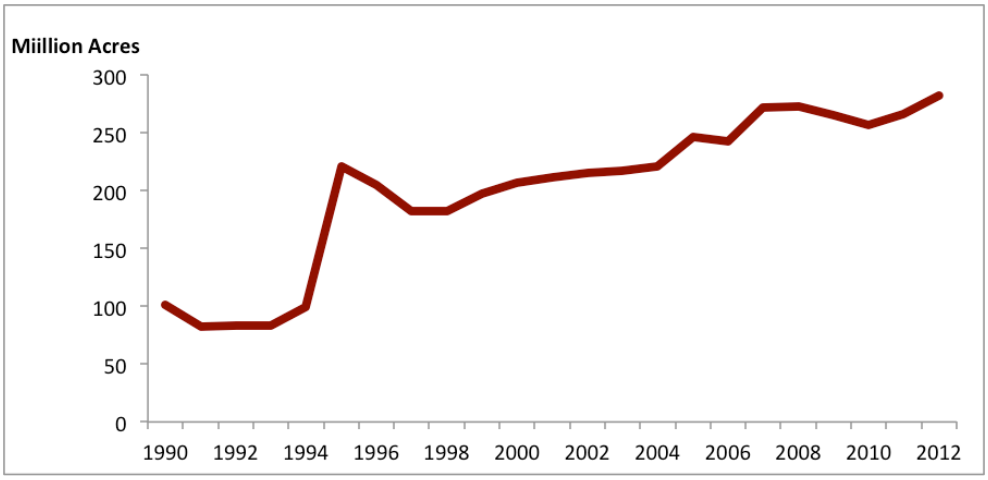


Figure 5: Net Insured Acres, 1990-2012

The rise in crop insurance participation is partly attributed to the increases in premium subsidies, which made crop insurance increasingly affordable over time, thus boosting participation (Bulut, Collins, and Zacharias 2012).[1] Prior to the 1980 Act, farmers paid the full premium; the 1980 Act provided subsidies up to 30% of the premium costs. Under the 1994 Crop Insurance Reform Act, producers were eligible to receive a basic level of coveragecatastrophic risk protection (CAT)for free (except for a sign-up fee equal to $50 per crop per county). Additionally, subsidies were also provided for buy-up levels. The 2000 Agricultural Risk Protection Act further raised the subsidy rates for most buy-up levels, which brought increases in both enrolled acres and coverage levels . The most recent Farm Bill in 2008 raised the subsidy rate for enterprise units, while leaving the subsidy levels for basic and optional units unchanged. This resulted in significant increase in enterprise units and use of

[1]Other USDA programs required farmers to have crop insurance, which contributed to the increased use of crop insurance.

higher coverage levels (Murphy 2011). Figure 6 exhibits the subsidy rates for crop insurance premium from 1990 to 2012.

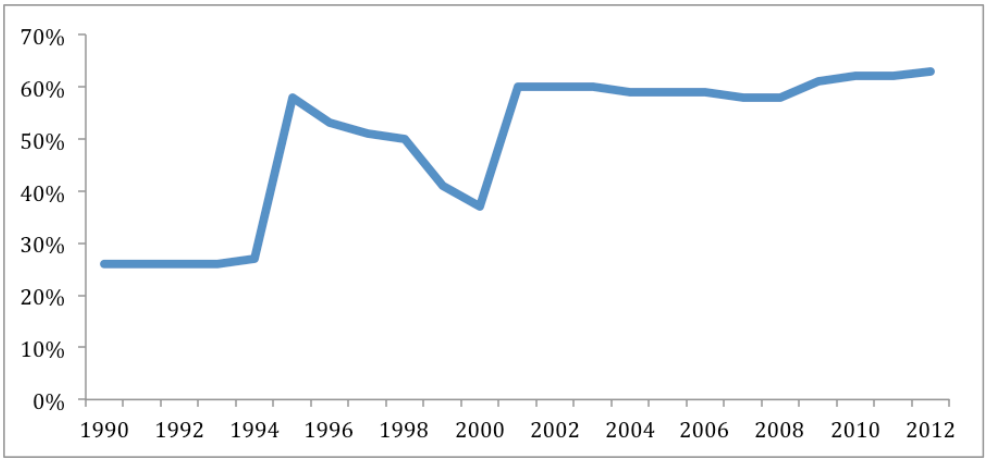


Figure 6: Premium Subsidy Rates, 1990-2012

Crop insurance policies generally fall into two categories: yield-based and revenue-based. For yield-based insurance, a producer can receive an indemnity if the realized yield falls below a certain percentage (coverage level) of his/her normal yield (based on the producers actual production history). Revenue-based insurance combines the production guarantee of yield-based policies and a price guarantee to create an instrument to protect against revenue loss resulting from yield loss, price decline, or both. Revenue-based insurance was first introduced in 1996 for corn and soybean producers in Nebraska and Iowa; by 2003, it was offered nationwide, and was very popular among producers: acreage under revenue policies (113.5 million) exceeded acreage covered by yield policies (90 million) (Glauber 2013; Shields 2010). Of the total 2.11 million crop insurance policies sold in 2012, revenue-based policies account for 61% (1.29 million), with the remainder being yield-based policies. (Figure 7)

Program Costs and the 2013 Farm Bill Debate

Corresponding with the increase in crop insurance participation and coverage level, the costs of the program have risen; Table 2 displays government costs of the federal crop insurance program and ad hoc disaster payments for the last decade. Government costs increased substantially in the 2008 and 2009 fiscal years, driven by the rising crop prices during that period. Costs fell to 3.7 billion in FY2010, then rose again in FY2011 and FY2012, following climbing

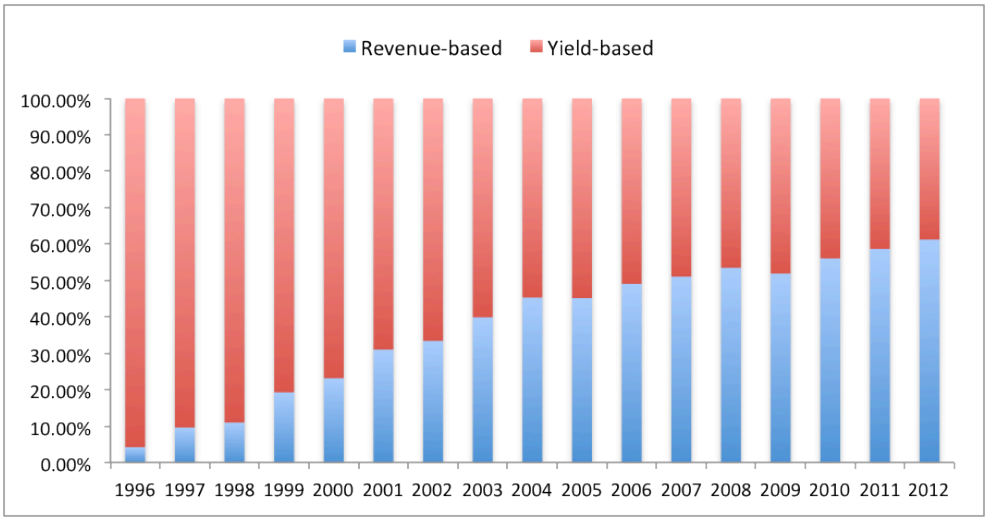


Figure 7: Types of Crop Insurance Policies, 1996-2012

crop prices. The crop insurance program is now the largest cost program in the farm safety net, and the premium subsidy is the largest cost component in crop insurance, which alone totaled $14.1 billion in 2012 (Zulauf, Schnitkey, and Barnaby 2011). Subsidies have been justified as a way to decrease ad hoc disaster payments. As the last column in Table 2 attests, disaster payments have generally declined over the decade, but not at the rate at which subsidies have increased.

The sheer size of program costs has aroused increasing discussions about it; currently the program is being debated in Congress for the new 2013 Farm Bill. Under extreme pressure to cut federal spending, a variety of options have been proposed to reduce program costs; one alternative is to raise the share of premium paid by farms, that is, to lower subsidy rates (Zulauf, Schnitkey, and Barnaby 2011).

Critics of crop insurance subsidization contend that heavy governmental subsidization leads to production distortion and disturbs the private risk market (Goodwin and Smith 2013; Shields, Monke, and Schnepf 2010). Furthermore, distortions could occur throughout the economy as the crop insurance subsidization represents a form of budgetary transfers from taxpayers to farmers and private crop insurance companies (Goodwin and Smith 2013).

On the other hand, proponents of the program argue that adequate premium subsidies are necessary to sustain farmers participation—cutting or eliminating insurance subsidies would likely result in a reduction in program

Table 2: Government Cost of Federal Crop Insurance (Dollars in millions)

Fiscal Year	Program Losses or (Gains)[1]	Premium subsidy	A&O Expense Reimbursements[2]	Other Costs	Total Government Costs	Federal Agricultural Disaster Payments
2003	822	1,874	743	149	3,588	3,077
2004	(305)	2,387	900	143	3,125	867
2005	(293)	2,070	783	139	2,699	2,899
2006	(32)	2,517	960	125	3,570	446
2007	(1,068)	3,544	1,341	123	3,940	113
2008	(1,717)	5,301	2,016	137	5,737	2,331
2009	108	5,198	1,602	131	7,039	194
2010	(2,523)	4,680	1,371	143	3,671	2,057
2011	2,392	7,376	1,383	144	11,295	1,257
2012	5,370	7,149	1,411	141	14,071	NA

Data source: USDA, RMA and FSA

1. Program Losses or (Gains if negative) = Loss claims paid in excess of premiums and other income.
2. A&O = Administrative and operating.

enrollment and coverage levels, exposing producers to higher level of risks (Schnitkey 2011), which could trigger governmental ad hoc payments in the event of a widespread disaster (Collins and Bulut 2011). Besides, crop insurance could serve as collateral and allow producers to secure credit; it also facilitates forward contracting by providing resources to meet delivery obligations in the event of a production loss (Collins and Bulut 2011). Therefore, a likely decline in participation and coverage levels that arises from a loss of subsidies would in turn limit producers ability to acquire operating loans from banks or participate in forward marketing, thus adding to risk exposure.

Data

The Agricultural Resource Management Survey (ARMS)

This study primarily uses the Agricultural Resource Management Survey (ARMS) data. The ARMS is an annual survey sponsored jointly by the National Agricultural Statistics Service (NASS) and the Economic Research Service (ERS) of USDA. It is the only nationally representative survey that provides information on the production practices and financial condition of the farm business and the characteristics of farm operators and their households. ARMS collects data from a stratified random sample of U.S. farms. Each observation has a different weight that reflects its probability of selection

ARMS consists of three phases; detailed contracting information is drawn from Phase III, Cost and Returns Report (CRR) survey, which is conducted in the spring of the year following the reference year (USDA, ERS). Limited information on federal crop insurance for each farm is also available from the survey, but only for limited years. For the survey from 2000 to 2011, farmers were asked how much they spend for federal crop insurance. Starting in 2003, farmers were asked for the number of acres covered under a federal crop insurance policy.

The ARMS data are not longitudinal; to allow for the examination of variations in farmers behavior over time, I follow Cole and Kirwan (2009) and pool 12 cross-sectional data sets from 2000 to 2011 to create a pseudo-panel, which contains 154,539 farms. I limit the sample to farms that have a positive value of crop production or are classified as a crop farm by the USDA. I further limit the sample to farms with gross sales greater than $50,000; smaller farms are included in the sample if the primary operator reports farming as the main occupation. The final dataset consists of 86,490 farms. In the analysis below I control for expenditure on non-crop insurance, total assets, the age and age^2, experience and experience^2, and education of the primary operator. I also control for the previous year's revenue.

Despite its national representativeness and comprehensiveness, the ARMS data have several limitations. First, the survey does not collect data on the same farms over time. Second, questions asked are not completely consistent for each year. Finally, the ARMS data do not contain details about farmers use of crop insurance: information such as the types of insurance or crops covered under insurance is not available. The first two limitations prevent me from controlling for some of the farmer's characteristics before purchasing crop insurance. This might introduce bias into the estimation if any of the control variables were influenced by the crop insurance decision. For this reason I

report the results with and without control variables to get a sense of possible bias. Since the dataset is not a panel I cannot account for time-invariant farm characteristics. Since the sample was stratified at the state level the data are statistically reliable at the state level, and I include a state fixed effect to account for unique state-level characteristics that don't change over time.[2]

The Summary of Business Data

Another dataset used in this study is the county-level summary of business (SOB) data from 1995 to 2010. It is an annual data containing information on crop insurance business. The SOB data is available from the Risk Management Agency (RMA), the main variables include crop insured, insurance plan type, coverage category/level, number of policies sold, net acres, liability, total premium, subsidy, indemnity and loss ratio.

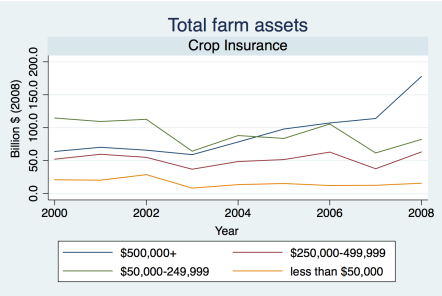
The SOB data provides important details on crop insurance on a county-level basis. It is utilized to construct a "loss-risk" term that measures the probability for an individual county to collect indemnities in excess of the total premiums. This is simply the average of the countys previous ten years normalized loss ratios (more details will be discussed later). This loss-risk term will be used as an instrumental variable in the subsequent regression analysis to address the potential endogeneity problem of crop insurance adoption.

Crop Insurance and Other Farm and Household Characteristics

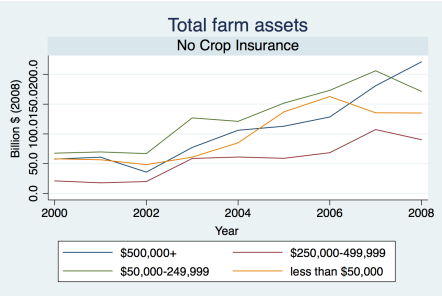
Establishing the causal effect of crop insurance on farm debt requires more than simply comparing farms with insurance to those without. Figure 8 illustrates such a comparison by showing the evolution of farm assets and debt separately for those with crop insurance and those without. Figure 8 illustrates total farm financial debt and assets stratified by sales class. The top two panels reveal the difference between asset growth for farms with and without crop insurance. Farms without crop insurance—panel b—experienced a higher growth rate, but started from a lower level. The second row of panels shows debt. Again illustrating faster debt growth for uninsured farms. Panel c shows that large farms' debt grew over the decade, while smaller farms seem to have remained basically steady.

Panels 8e and 8f of Figure 8 provide a glimpse of the challenge of deducing the causal relationship between crop insurance and debt.The bottom row illus-

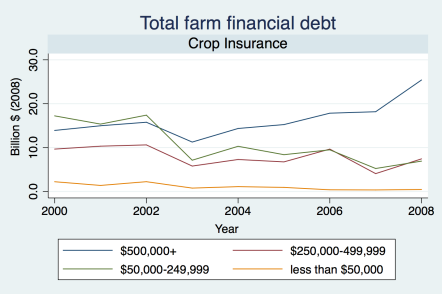
[2]Including county fixed effects in these data introduces bias and statistical inefficiency.



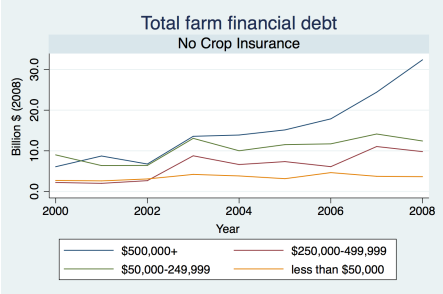
(a) Assets—Insured



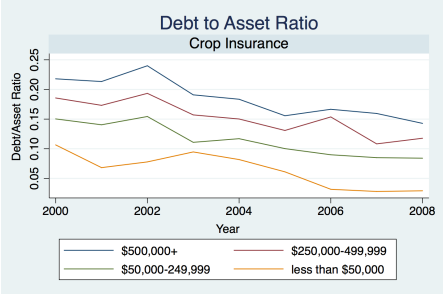
(b) Assets—Uninsured



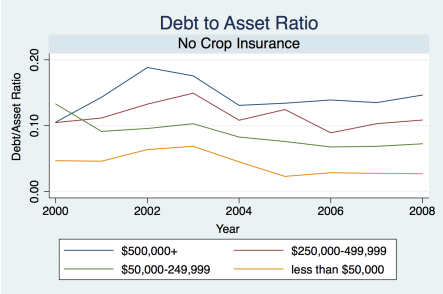
(c) Debt—Insured



(d) Debt—Uninsured



(e) Debt-Asset Ratio—Insured



(f) Debt-Asset Ratio—Uninsured

Figure 8: Comparison of the evolution of assets and debt between the insured and uninsured from 2000-2011

trates the debt-to-asset ratios. While debt-to-asset values fell for crop-insured farms, it remained relatively steady for those without crop insurance. This graphical evidence seems to portray a negative relationship between crop insurance and debt—farms with crop insurance reduced their debt load relative to assets. This relationship may not illustrate the causal relationship. Consider a world with just two types of farmers, risk-averse and risk-neutral. Risk averse farmers would purchase crop insurance and reduce their debt load, while the risk-neutral farmers might not find it profitable to pursue such a course. The result would look like panels 8e and 8f of Figure 8. In other words, it's possible that the relationship we observe is driven by something we cannot easily observe.

We can, however, observe a great deal about the farmers in the data. Table 3 provides the summary statistics of farm and personal/household characteristics by insurance status for both samples. In each table, the first pair of columns gives the mean and standard deviation of each characteristic for farms with crop insurance. The second pair of columns gives the same information on farms with no crop insurance. The summary statistics suggest that farms with crop insurance are systematically different from uninsured farms based on most of the observable characteristics. On average, insured farms are larger farms with higher farm revenues. They are also more leveraged. In addition, the operators of insured farms are slightly younger and are more likely to have higher education levels. These comparisons based on observable characteristics suggest that the insured and uninsured farms might be different in un-observable ways also.

Empirical Strategy

This paper seeks to estimate the way increased crop insurance coverage causes credit demand to change. As the previous section illustrated, the simply-observed relationship might not be causal. This section outlines a strategy to overcome the challenges and illuminate the causal relationship.

Identifying the Effect of Crop Insurance on Credit Demand

Since farmers with crop insurance are clearly different than those without, one must exercise caution when drawing conclusions between observable relationships. Physicists establish causality by directly manipulating just one part of the system and observing the reaction. Physicians determine the effectiveness of drugs by randomly giving the medication to some patients and not others. Like the physicists, physicians manipulate one part of the system—who gets

Table 3: Characteristics of Farms by Insurance Status, All Farms

	Farms Insured		Farms Uninsured	
	Mean	SD	Mean	SD
Farm Characteristics				
Acres Operated	1,132.49	2,060.41	474.53	3,489.72
Acres Owned	484.55	1,258.51	275.17	1,896.37
Gross Cash Farm Income	363,669	698,181	157,793	720,055
Net Farm Income	104,971	351,284	41,641	284,969
Share of total farm income from crops	0.86	0.53	0.86	0.61
Number of Commodities Produced	2.72	1.26	2.47	1.25
Entropy[1]	0.25	0.13	0.23	0.14
Primary crop revenue share	0.69	0.20	0.76	0.21
Debt dummy	0.77	0.42	0.56	0.50
Debt-to-asset ratio	0.16	3.22	0.09	0.25
Personal and Household Characteristics				
Age	55	13.07	57	13.72
Experience	30	14.58	29	15.95
Education				
Less than high school	0.05	0.22	0.12	0.32
High school and some college	0.71	0.46	0.70	0.46
College and beyond	0.24	0.43	0.19	0.39
Off-farm income to Total income	0.58	2.04	0.70	1.84
Non-farm Asset	270,546	390,418	261,498	427,655
Observations	41,202		16,647	

Note: Data from pooled ARMS data, 2005-2011. Sample includes all farms with cropland or self-reported as crop farms. 1. Entropy is an index between zero and one measuring the equality of the value of production among commodities produced by the farm. A value of 1 indicates perfect equality of commodity production value. It is calculated by the USDA.

the medication—and observe the results. Why do physicians randomize? Because it's a simple way to ensure taking the medication is unrelated to other characteristics that might also influence the outcome. While it is not possible to randomize crop insurance, it is possible to find a reason to adopt/adjust crop insurance that is not related to characteristics that determine credit demand.

Farmers adjust crop insurance coverage for a variety of reasons. Sometimes, the rules that determine the price of crop insurance result in mis-priced crop insurance. When the price does not accurately represent the farmers' expected loss, the farmer has incentive to adjust his coverage. RMA rules that systematically adjust the price without considering farmers' expected loss may alter farmers' behavior. I exploit these rules in the analysis below to identify the causal relationship between crop insurance and credit demand. Since these rules alter farmers' behavior in a way unrelated to characteristics that determine credit demand, the behavior is as good for our purposes as if it were random.

Identification Strategy

Specifically, rules determining county base rates provide variation that can affect credit demand only through their effect on crop insurance coverage. Some of these rules are designed to enhance fairness rather than achieve actuarially-fair prices. For instance, the RMA uses "credibility" weighting to smooth rates among adjoining counties. Catastrophic losses in a single county or region of a state are also redistributed over the rest of the state. In addition to these rules, Woodard, Sherrick, and Schnitkey (2011) have demonstrated the mispricing due to failure to trend-adjust the rates for continually increasing productivity. I capture these discrepancies in the following variables: the previous year's loss-cost ratio, the expected return to crop insurance, the lagged net cost of insurance, the likelihood of collecting indemnities in excess of premiums. Each of these variables are computed at the county level using the RMA's Summary of Business data. These variables are computed as follows:

The Loss-Cost Ratio

The loss-cost ratio is a county's indemnity divided by its liability in a specific year. In the equations below, the subscript i represent the county, t represents the year.

$$LCR_{i,t-1} = \frac{indemnity_{i,t-1}}{liability_{i,t-1}} \tag{1}$$

It forms the backbone of the RMA's rate-making calculations (Coble et al. 2010). I use the previous years' loss-cost ratio to capture changes in the base rate due to short-term weather fluctuations.

Expected Return to Crop Insurance

The expected return to crop insurance incorporates the crop insurance premium subsidies to measure the gain from subsidized insurance.

$$\frac{1}{10}\sum_{s=t-1}^{t-10}\frac{indemnity_{is}+subsidy_{is}-premium_{is}}{premium_{is}-subsidy_{is}} \tag{2}$$

Farmers who expect to earn a profit from crop insurance will be more likely to purchase crop insurance or expand coverage.

Lagged Net Price of Insurance

The lagged net price of insurance measures the net cost of insurance to the farmer relative to the amount insured. The lower the net price, the more likely the farmer will be to purchase insurance.

$$LNPI_{i,t-1}=\frac{premium_{i,t-1}-subsidy_{i,t-1}-indemnity_{i,t-1}}{liability_{i,t-1}} \tag{3}$$

A County's Likelihood of Collecting Indemnities in Excess of its Premium

The crop insurance loss ratio is the ratio of insurance payments (indemnity) to total premiums; if the premium rate is actuarially fair, on average the indemnities should be equal to the total premiums, which results in a loss ratio of 1. A higher loss ratio indicates higher return to crop insurance, hence increasing the likelihood a farmer will purchase crop insurance. Goodwin (1993) suggested averaging a county's loss ratio relative to the state-average loss ratio over ten years. This variable, which Goodwin calls the "loss-risk", measures an individual countys likelihood of collecting indemnities in excess of its total premiums.

$$LossRisk_{it}=\frac{1}{10}\sum_{s=t-1}^{t-10}\frac{\frac{indemnity_{is}}{premium_{is}}}{\frac{1}{N}\sum_{j=1}^{N}\frac{indemnity_{js}}{premium_{js}}} \tag{4}$$

where N represents the number of counties in the state.

Combined, these four variables measure county-level variation in insurance price caused by features of the crop insurance program, which are not related to hidden characteristics, like risk aversion.

The next section explains in greater detail how I combine the four variables introduced in this section to isolate variation in crop insurance coverage that is "as good as random."

Estimation Framework

I examine the relationship between crop insurance and debt financing from three perspectives. First, I look at the decision to take up crop insurance—I call this the "extensive effect." This perspective focuses on the "yes"/"no" answer to the following question: Does the farmer participate in the Federal Crop Insurance program? This first perspective ignores the amount of coverage the farmer has.

The second perspective I use to examine the crop insurance/debt financing question focuses squarely on the impact the amount of crop insurance purchased has debt financing. By restricting the sample to only those farms with some crop insurance coverage, I separate the extensive effect (the effect of having any FCI coverage) from the "intensive effect"—the effect of having *more* FCI coverage if the farm already has some FCI coverage.

Finally, I explore the net effect of crop insurance on debt financing by examining the amount of FCI coverage including no FCI coverage. In contrast to the intensive effect analysis, this perspective is not limited to farms with crop insurance. In essence, it combines both the extensive and intensive effects to get a net effect of crop insurance.

Each of these three approaches answers a different facet of the policy question. The first approach—intensive effect—answers the question, "How will debt change, on average, if farm policy causes an uninsured farmer to purchase crop insurance?" The second approach—extensive effect—answers the question, "What will happen to debt, on average, for those who already have crop insurance and farm policy causes them to buy greater coverage?" Finally, the "net effect" approach answers the question, "How will debt change, on average, due to a policy that promotes more crop insurance for all farmers, both the currently insured and uninsured?"

Technical Summary

To estimate the causal effect of crop insurance on credit demand, I employ an instrumental variables (IV) strategy. The instrumental variables were intro-

duced in the Identification Strategy section above. I implement this strategy with two-stage least squares. In the first stage, I regress the (natural log of the) farmer's crop insurance expenditure in year t on the instrumental variables along with the variables included in the second stage. This procedure has the effect of isolating the variation in farmers' crop insurance expenditures that is correlated with the instrumental variables. In other words, it isolates variation in crop insurance expenditures caused by miscalculation of the county base rate (relative to the farmer's actuarial fair rate).

Once I have isolated the "random" variation in crop insurance expenditures, I substitute it for the actual crop insurance expenditures in the second stage, which regresses the (natural log of the) farmer's debt on the instrumented crop insurance expenditure.

- First-Stage Regression In the first-stage regression, the potential endogenous variable CI_{it}—crop insurance participation or the natural log of crop insurance expenditure—is regressed on the instrumental variables outlined above. I control for characteristics of the primary farm operator that can influence the crop insurance decision but cannot be influenced by it. These are age and age^2, experience and experience^2, and education. As a proxy measure of the farmer's risk aversion, I control for expenditure on non-crop insurance. To account for farm size and debt capacity, I control for total assets. I include year fixed effects to account for events that affect all producers, such as price fluctuation. I include state fixed effects to account for time-invariant state characteristics and, due to the sampling design, the state is the lowest geographical level at which fixed effects can be included without introducing bias. The empirical specification is

$$CI_{it} = \alpha + \beta Z_{ct} + \gamma X_{it} + \delta_t + \delta_s + \varepsilon_{it}. \tag{5}$$

  Z_{ct} represents a matrix containing the instrumental variables for county c in year t. X_{it} represents a matrix containing all of the farm and operator control variables. δ_t is a fixed effect for year t, and δ_s is a fixed effect for state s.

- Second-Stage Regression The predicted value of CI_{it} is obtained from the first-stage regression and used as an independent variable in the second stage regressions. The remaining variables right-hand side variables are the same as in the first-stage regressions (excluding the instrumental variables, which are embodied in the predicted CI_{it}). The dependent

variable is the natural log of the amount of debt held by the farm. The empirical specification for the second stage is

$$Debt_{it} = \alpha + \beta CI_{it} + \gamma X_{it} + \delta_t + \delta_s + \varepsilon_{it}. \tag{6}$$

The next section presents the results from estimating these empirical specifications.

Results

Table 4–6 report the results of the main analysis. The tables report the coefficient on the crop insurance variable either from the un-instrumented fixed effect model or from the instrumental variables model (β in equation (6) above). Each table reports the results for three different outcomes. The first outcome is the total financial debt. The second and third rows of each table break the total debt into total current liabilities and total non-current liabilities. This way it is possible to get a better sense of how crop insurance affects debt. Each table reports the results from one of the three different approaches outlined in the Estimation Framework section: the extensive effect, the intensive effect, and the net effect. The columns of each table show the different specifications that were used to estimate the effect. Since the data are not longitudinal, it is impossible to control for the pre-insured state of some characteristics that might also be affected by crop insurance, e.g., assets and income. To investigate the possible bias this introduces, I report the results both with control variables and without extra control variables.

Columns 1 and 3 report the estimates without extra control variables—the specifications includes only state and year fixed effects as controls. Columns 2 and 4 of the tables show the relationship between crop insurance expenditures and financial debt after controlling for farm and farmer observable characteristics. It controls for assets and the amount spent on other insurance as a proxy for risk tolerance. In addition to assets and non-crop insurance expenditures, this specification includes the primary operator's age, age^2, experience, experience^2, education level. It also the value of beginning-of-year crop inventory.

The first two columns of the tables report the un-instrumented results. Columns 3 and 4 reports the same specifications, but this time using the instruments to isolate the "as-good-as-random" variation in crop insurance expenditures. The bottom row of the table reports the F-stat for the excluded instruments from the first stage. A value greater than 10 is generally considered to indicate sufficient correlation between the instruments and the

instrumented variable. Values less than 10 indicate low correlation between the instruments and the instrumented variable and indicate possible bias in the estimation.

Table 4: The effect of crop insurance on farm financial debt—Net effect

Outcome	(1)	(2)	(3)	(4)
Total financial farm debt	0.235***	0.078***	0.267***	0.130
	(0.006)	(0.006)	(0.085)	(0.083)
Total current farm liability	0.213***	0.071***	0.240***	0.112*
	(0.005)	(0.005)	(0.070)	(0.066)
Total Non-current farm liability	0.306***	0.107***	0.259	0.069
	(0.012)	(0.012)	(0.171)	(0.189)
Observations	86,490	80,860	84,998	79,446
F-statistic	.	.	34.382	30.415

Significance levels: * 10 percent, ** 5 percent, *** 1 percent. Robust standard errors are in parentheses. All regressions have state and year fixed effects.

In the top row of Table 4, the first column reports an elasticity of 0.235; that is, a 10-percent increase in expenditure on crop insurance results in a 2.35-percent increase in total farm debt. After using the instruments to isolate the causal effect, column 2 reports an elasticity of 0.078—a 10-percent increase in crop-insurance expenditure causes farm debt to increase by 0.78 percent.

Columns 3 and 4 show the instrumented, causal effect of crop insurance expenditure on the outcome variable. Contrast columns 1 and 2 with 3 and 4, and it is clear that the easily observable ,un-instrumented, correlation suffers a downward bias, perhaps caused by the negative correlation due to risk aversion. The instrumented estimates for both specifications are higher, although for column 4 the impact on total financial farm debt is statistically noisy. Column 4, the instrumented specification including control variables, reports an elasticity of 0.13; a 10-percent increase in crop-insurance expenditure will result in total debt expanding by 1.3 percent. At the mean, this translates into an increase in debt of $3,042.60 due to spending $236.15 on crop insurance, which, at current subsidy rates, translates into total premiums expanding by $377.84.

The second and third rows of the tables break down the total-debt effect by looking at the effect on current and non-current liabilities. Across the specification in columns 1-3 the non-current liability effect is larger. In column 4, the preferred specification, the non-current liability estimate is smaller and statistically noisy. Column 4 reports that a 10-percent increase in crop insurance expenditure will cause current farm liability to increase by 1.12 percent

($938.00 at the mean). The (noisy) estimate on non-current liability suggests the result of such a change in crop insurance expenditure would result in 0.69 percent higher non-current liability ($1,023.1).

Extensive Margin

The extensive margin effect measures the change in debt when a farm moves from having no crop insurance to having some crop insurance. Table 5 reports the estimates from regressing the natural log of the outcome variable on an indicator variable that equals one if the farm has crop insurance and zero otherwise. The specifications from columns 1-4 are the same as in Table 4. Column 4, the preferred specification, reports that total financial farm debt increases by 1.2 percent when a farm takes up crop insurance. An increase in debt of $2,808.55 at the mean. The result is statistically significant at the 10-percent level.

Looking at the components of farm debt, the table reports a 1.036 percent increase in current farm liability and 0.67 percent increase in non-current liability when a farm takes up crop insurance. At the mean this translates into a $868 more current liability and $993.45 non-current liability.

Table 5: The effect of crop insurance on farm financial debt—Extensive effect

Outcome	(1)	(2)	(3)	(4)
Total financial farm debt	1.533***	0.484***	2.294***	1.205*
	(0.052)	(0.046)	(0.744)	(0.721)
Total current farm liability	1.370***	0.423***	2.066***	1.036*
	(0.042)	(0.038)	(0.613)	(0.575)
Total Non-current farm liability	1.984***	0.654***	2.152	0.669
	(0.101)	(0.098)	(1.482)	(1.625)
Observations	86,490	80,860	84,998	79,446
F-statistic	.	.	24.671	21.951

Significance levels: * 10 percent, ** 5 percent, *** 1 percent. Robust standard errors are in parentheses. All regressions have state and year fixed effects.

Intensive Margin

Table 6: The effect of crop insurance on farm financial debt—Intensive effect

Outcome	(1)	(2)	(3)	(4)
Total financial farm debt	0.682***	0.287***	0.288	0.166
	(0.022)	(0.020)	(0.245)	(0.191)
Total current farm liability	0.645***	0.292***	0.124	0.063
	(0.017)	(0.017)	(0.213)	(0.170)
Total Non-current farm liability	0.884***	0.323***	0.776	0.300
	(0.044)	(0.046)	(0.525)	(0.467)
Observations	34,463	32,547	34,277	32,365
F-statistic	.	.	17.358	19.512

Significance levels: * 10 percent, ** 5 percent, *** 1 percent. Robust standard errors are in parentheses. All regressions have state and year fixed effects.

The intensive margin effect focuses on the debt response of crop-insurance expansion among only farms with crop insurance. In other words, how much would currently insured farms respond to expanding crop insurance? Table 6 reports the results of this analysis. The results of this analysis are statistically noisy, but they provide an idea of the potential response.

As would be expected, the effects on the intensive margin are larger than the net effects reported in Table 4. Column 4 of Table 6, the preferred specification, reports that already-insured farms increase debt by 1.66 percent in response to a 10-percent increase in premium expenditure. At the mean, that translates into $5,523.72 more total debt in response to $941.84 increase in premium expenditure. Non-current liabilities will increase by 0.63 percent ($804.45), and current liabilities will increase by 3 percent ($6,081).[3]

Conclusions

This paper demonstrates that federal farm policy will increase farm financial debt if it causes farmers to increase crop-insurance coverage. Overall farm financial debt will increase by 1.3 percent in response to a policy that provides expanded crop-insurance coverage equivalent to the coverage expansion achieved by a 10-percent increase in premium spending. At the mean values of insurance spending and total debt, this translates into an increase in debt

[3]Keep in mind that these are statistically-noisy estimates. They give an idea of the effect, but aren't precise and won't add up.

of $3,042.60 due to spending $236.15 on crop insurance, which, at current subsidy rates, translates into total premiums expanding by $377.84.

Whether the agricultural sector benefits from increased debt depends on how the money is invested. For example, increased debt will benefit the agricultural sector if it increases productive investment and removes barriers to entry for young farmers. If, however, the debt is used to cover operating losses by unproductive farmers, or if non-farm investors use it to accumulate land then the increased debt will not benefit the agricultural sector.

This paper introduced innovative methods to identify the causal effect of crop insurance on credit demand. Simple correlations are not enough to establish the effect of crop insurance coverage on total debt. Unobservable risk attitudes confounds relationship. Farmers who are risk-averse will both purchase crop insurance and have relatively low debt. Farmers who eschew crop insurance tolerate risk, which leads to greater debt and leverage. Observable correlations between these two groups of farmers—the insured and the uninsured—suggest a negative relationship between crop insurance and debt; in other words, crop insurance appears to be a substitute for financial debt.

This paper established the causal effect of crop-insurance coverage on farm financial debt by focusing on behavior induced by RMA rate-making rules. The rate-making rules are simply bureaucratic and unrelated to farmer characteristics such as risk aversion. Thus, crop-insurance coverage decisions caused by RMA rules are unrelated to the unobserved farmer characteristics that would otherwise confound the relationship.

Ultimately, I find a positive relationship between farm financial debt and crop insurance coverage. When looking at the *extensive* margin—a farm that moves from having no crop insurance to having some crop insurance—I find total financial farm debt increases by 1.2 percent, which, at the average debt level, translates into an increase in debt of $2,808.55. I estimate that a farm that already has some crop-insurance coverage (the *intensive* margin) will increase their financial debt by 1.66 percent when induced to increase spending on crop-insurance premiums by 10 percent. At the mean, that translates into $5,523.72 more total debt in response to $941.84 increase in premium expenditure.

Whether this crop-insurance induced debt enhances efficiency or not remains an open question. Overall efficiency will increase if farmers previously were unable to completely manage risk and borrow as much as they want at the prevailing interest rates. In this case, expanded crop insurance provides the means for profitable investment and productivity growth. Economic efficiency does not increase if expanding crop insurance crowds out other risk management strategies and causes farmers to take on more financial risk and

shift that risk onto the tax payer.

Regardless of the efficiency question, we should expect farm financial debt to increase as the farm bill shifts emphasis to crop-insurance-type risk management.

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