Do Direct Payments and Crop Insurance Influence Commercial Farm Survival and Decisions to Expand?

Christopher B. Burns and Daniel L. Prager[1]

Selected paper presented for presentation at the 2016 Agricultural & Applied Economics Association, Boston, MA, July 31-August 2, 2016.

[1] Economic Research Service, U.S. Department of Agriculture. The views expressed are those of the authors and do not necessarily correspond to the views or policies of ERS, or the U.S. Department of Agriculture. Direct correspondence to: Christopher Burns, christopher.burns@ers.usda.gov.

Abstract

This paper seeks to understand the effect of crop insurance and direct payments on farm survival and growth, and how this effect differs by the economic size of the farm. Using data from the Agricultural Censuses of 2007 and 2012, along with additional county-level data, we estimate a three stage model that accounts for sample selection bias and the endogeneity of the choice to purchase crop insurance. We also control for characteristics of the principal operator, farm household, and farm operation. Our preliminary results show that government policies in place over the period from 2007 to 2012 played a small but important role in the survival and growth of US commercial farms.

Introduction

The effects of government policies on farm structure and agricultural production has been a longstanding area of interest to economists and policy makers. With the expansion of the crop insurance program and ending of direct payments in the latest Farm Bill (the Agricultural Act of 2014), there has been renewed attention on how this policy shift will affect farm-level production decisions. As the suite of farm programs funded by the federal government becomes more focused on risk management and less on income support, understanding how direct payments and crop insurance affected historical farm production decisions and farm survival is important to future policy considerations. In addition, examination of whether these programs have differing benefits for small, midsize, and large commercial farms could allow policymakers to target interventions more effectively.

Since the decoupling of government payments in 1996, two of the largest federal agricultural commodity programs were fixed direct payments and crop insurance. Over this period, fixed direct payments were a broad-based commodity program that provided income support based on a farm's historical production. They represented about $4.5 billion in payments annually. The Agricultural Act of 2014 ended fixed direct payments to producers based on historical production and created new programs tied to annual or multi-year fluctuations in prices, yields or revenues. These programs include those that pay producers when prices fall below a reference price (Price Loss Coverage (PLC)), when revenue falls below a benchmark (Agricultural Risk Coverage (ARC)), as well as programs aimed at providing support for shallow revenue or yield losses (Supplemental Coverage Option (SCO) and Stacked Income Protection Plan (STAX)).

This paper seeks to understand the effect of crop insurance and direct payments on farm survival and growth, and whether this effect differs by farm size (type). Both of these programs were designed to be decoupled from production decisions, but whether this is actually the case has been the subject of much academic debate (Goodwin and Mishra 2006, Young and Westcott 2000). Both crop insurance and direct payments may help farms survive by providing some guaranteed source of income. We also examine whether this affects small and large farm survival and production decisions differently. For example, it is possible that crop insurance and direct payments help smaller farms expand production more because they are more likely to be credit constrained. Using the ERS farm typology (Hoppe and MacDonald 2013) we also examine whether these government programs have differing effects for small, midsize and large commercial farms specializing in the three largest cash grains. Using data from the 2007 and 2012 Census of Agriculture, along with yield data from the U.S. Department of Agriculture's National Agricultural Statistics Service (NASS) and Risk Management Agency (RMA), we estimate a three stage model that accounts for sample selection bias and the endogeneity of crop insurance. We also control for characteristics of the principal operator, and farm operation. Our preliminary results show that well-designed government policies may play a small but important role for farm survival and growth.

U.S. Crop Insurance Program Participation

The federal crop insurance program began with the Agricultural Act of 1938, but only in the last 20 years have enrollment levels become high enough to become a main pillar of the farm safety net. Prior to 1994, the program suffered from low participation (less than 25 percent of eligible area was enrolled). This changed when Congress passed the Crop Insurance Reform Act of 1994. This legislation ensured that producers of eligible crops could receive a basic level of coverage, known as catastrophic risk protection (CAT), which covered 50 percent of a producer's approved yield and 60 percent of the expected market price. The act also provided additional subsidies for coverage levels greater than 50 percent (buy-up levels). Legislation enacted in 2000 further increased premium subsidies to participating farmers.

Federal crop and revenue insurance programs are delivered through private insurance companies with the USDA's Risk Management Agency (RMA) subsidizing insurance premiums and administrative costs. Over the last two decades there have been striking grains in acres enrolled, policies issued, and coverage levels. From 1998 to 2011 enrolled acres increased from 182 to 265 million, with more than 70 percent of enrolled acres having at least 70 percent insurance coverage. Between 2007 and 2011 total premiums for crop insurance rose from $6.5 billion to $12 billion and premium subsidies increased from $3.8 billion to $7.3 billion. Revenue policies such as ARC totaled more than 173 million acres in 2011, while yield policies accounted for less than 20 percent of insured acres (Glauber 2013). In 2012, 80 percent of planted acreage of corn, cotton, soybeans and wheat were covered by crop insurance. Between 2011 and 2013 average insurance payouts to farmers net of premiums rose from $2.5 billion to $9.1 billion, exceeding direct payments in each year (Orden and Zulauf 2014). In 2014, total premium subsidies declined to about $6 billion, reflecting the recent drop in crop prices, while direct payments decreased substantially, as part of the planned phase-out from the Farm Bill of that same year (USDA-ERS 2016).

Direct Payments

Established in 1996 Farm Bill, direct payments were designed to replace a set of farm programs that supported a number of crop commodities at above market levels. Commodity-related payments[2], such as direct payments, are tied to land and to the production of specific commodities – mostly field crops, such as barley, corn, soybeans, peanuts, cotton and wheat. Payments were based on historical yields and the number of enrolled acres and therefore were designed to be "decoupled" from current production decisions. The goal of the direct payments programs was to establish farm income support, and stabilize production, without distorting production markets.

Farm Typology

In addition to exploring the effect of direct payments and crop insurance on farm survival and expansion, this paper also seeks to understand the differing effects of each government policy by farm size. Based on the updated ERS farm typology, we use gross cash farm income (GCFI) to define farm size. GCFI is the gross revenue received by a farm business in a year[3]. It is defined as the sum of the farm's cash and market contract revenues from

[2] Examples of commodity-related payments include direct payments, loan deficiency payments, marketing loan gains, net value of commodity certificates, milk income loss contract payments, agricultural disaster payments, and other miscellaneous State, Federal, and local payments.

[3]While gross sales produce similar estimates, gross cash farm income is a preferred metric because it better accounts for production and marketing contracts, where the gross income from contracting farms is well below sales.

the sale of livestock and crops, Government payments, and other farm-related income[4], including fees from production contracts.

Over the past two decades, the share of production on large farms (defined as those with at least $1,000,000 in gross cash farm income) has increased, however significant production still occurs on midsize farms (those with between $350,000 and $1,000,000 in gross cash farm income) In 2014, midsize farms represented almost 21 percent of total U.S. agricultural production. We also include small commercial farms (those with between $10,000 and $350,000 in GCFI) in our analysis. They represent the smallest farms (using GCFI), but are the greatest in number. Small farms (those with less than $10,000 in GCFI) are excluded because they are owned by households which typically derive the majority of their income from off-farm sources and consequently less affected by government programs like crop insurance and direct payments.

The distributions of farm size and total agricultural production in U.S. agriculture are skewed. According to the 2014 Agricultural Resource Management Survey (ARMS), midsize and large farms accounted for only 10 percent of all U.S. farms (approximately 2.08 million in 2014), but represented 78 percent of total production. Midsize farms alone numbered about 128 thousand farms, or 6 percent of all farms, and accounted for 21 percent of total production. Large farms comprise 4 percent of farms and 57 percent of total output. In contrast, small and small commercial farms together total 90 percent of U.S. farming operations but only produce around 22 percent of total agricultural output.

Literature Review

Previous work on farm survival has identified several factors influencing farm exits with operator age and farm profitability emerging as the two most important factors (Kimhi and Bollman 1999, Hoppe and Korb 2006). Farms often are opened, expand, and close along

---

[4] Other farm-related income could include receipts from custom work, machine hire, livestock grazing fees, timber sales, and outdoor recreation.

with the lifecycle of the principal operator. All else equal, older operators are much more likely exit; however, in many cases, the operation may be sold or passed down to the next generation of farmers. Farm size is another important factor in farm survival, with larger farms more likely to continue operation. Past studies find beginning and retired farmers also more likely to exit farming altogether. Finally, the supply of off-farm labor and the household's dependence on off-farm income tend to negatively affect farm survival (Ahearn, Yee and Korb 2009).

Outside of profitability and operator characteristics, government policy also plays an important role in farm survival. Goetz and Debertin (2001) use county-level data from 1987-1997 to examine factors that affect net farm exits. They find that farmers quit farming at faster rates as the transaction costs of moving into full-time off-farm employment decrease. They also find that farmers who own higher values of land or buildings, receive more government payments, or live in or adjacent to a county with high population density were more likely to quit. Using annual data from 1983-2012 Goetz and Davlasheridze (2016) found that agricultural extension services not only provide substantial benefits to farmers, but are a cost effective way to keep farmers from exiting. Storm et al. (2014) used a spatial probit analysis of Norwegian farm survival and show that spatial interdependence and government policy plays an important role. They find that farm survival is influenced by the effects of neighboring farm's level of direct payments and that survival rates of smaller farms were more influenced by direct payments.

Young and Westcott (2000) distinguish three channels through which direct payments may influence production decisions. First, lenders are more willing to make loans to farmers with guaranteed levels of income because they have a lower risk of default. Second, payments allow a farmer to more easily invest in the operation if they are credit constrained and have liquidity issues. The addition of the payments may allow these farms to expand more or to make commodity-specific capital purchases, potentially leading to increased specialization. Third, the guaranteed income provided by direct payments may allow farms to increase their level of absolute risk, due to a wealth effect. For instance, Hennessy (1998) argued that direct payments are not completely decoupled from production decisions because they reduce farmer's absolute level of risk aversion, assuming they induce no changes in production. However, farmers may shift towards riskier crops or riskier production strategies, or take out more debt in a "risk balancing" theory.

A number of previous studies in the last decade from researchers affiliated with the Economic Research Service at USDA have examined the impact of direct payments on farm-level production and household decisions. A pair of papers by Key and Roberts (2006; 2007) used Census of Agriculture data and found that per-acre government payments have small, positive effects on farm business survival and expansion, after controlling for spurious correlation. The effect was shown to be stronger for crop farms that operated more acreage. Mishra and Goodwin (2006) explored the effect of marketing loans assistance payments (MLA) and Agricultural Market Transition Act payments (direct payments) on both farm-level production and county-level acreage using multiple years of ARMS data. They also found a significant but modest positive effect on agricultural production. Finally, Weber and Key (2011) estimate the effect of the change in zip-code level direct payments on total acres harvest and value of production using Census data from 2002 and 2007. They make use of a natural experiment originating from the 2002 Farm Bill that allowed soybean and oilseed producers to be eligible for direct payments based on historical yields between 1997 and 2002. Using the average value of oilseed production from 1997-2002 to instrument for changes in total government payments from 2002 to 2007, they find that changes in direct payments from 2002 to 2007 had no significant effect on total acres harvested or value of production in 2007.

Other studies have examined the effect of direct payments on household labor decisions. Key and Roberts (2009) used an agricultural household model to show that lump-sum payments (e.g. direct payments) increase the supply of farm labor and decrease off-farm labor given farmers have a decreasing marginal utility of income. The results also assume that farmers have preferences for farm versus off-farm work. Ahearn and El-Osta (2005) found that an observed increase in off-farm participation was not the result of the 1996 policy change to "decoupled payments", but a reflection of the long-run trend toward greater reliance on off-farm sources of income. Using data from the 1996 and 1999 ARMS data, they conclude that government payments have a negative effect on off-farm labor participation.

Previous studies on the effect of crop insurance participation on production decisions have examined similar issues as direct payments. Young and Westcott (2000) note that crop insurance can change the expected revenues by reducing the financial risk associated with crop production variability. Thus, government policies that make crop insurance more affordable, through subsidies, are likely to distort production decisions because they represent a net benefit to farmers. An increase in the expected returns per acre from subsidized crop insurance may lead to more crop production occurring on marginal land. Second, because subsidies vary by crop and farm in response to loss ratios, they reflect the associated risks of each insurable crop. This subsidy structure may encourage more production on land with higher yield variability. Finally, because the Federal crop insurance program is delivered to farmers by private insurance companies, this has likely increased its availability in remote parts of the country.

Crop insurance may also allow credit constrained producers to expand production. By guaranteeing a certain level of revenue to a producer, this may make lenders more willing to lend and allow the farm to expand more quickly. Ifft, Kuethe, and Morehart (2014) examined short-term and long-term debt use by farms that enroll in crop insurance using ARMS data. They find that Federal Crop Insurance participation is associated with an increase in short-term, but not long-term, debt use. Goodwin, Vandever and Deal (2004) examined the impact of crop insurance on acreage decisions for corn and soybean and wheat and barley farms in the Corn Belt and Northern Great Plains using pooled cross-sectional and time series county-level data from 1985-1993. They use a multiequation structural model of acreage response, insurance participation, Conservation Reserve Program (CRP) enrollment and input usage. They find that increased insurance program participation provokes a statistically significant acreage response in some cases, but the effect is rather modest. They also found that producers with higher than average historical loss ratios[5] (measured at county-level) are less responsive to change in insurance premium rates.

Studies on the effects of crop insurance on production have also looked an input usage and land conversion. Goodwin and Smith (1996) examine chemical input use and insurance purchase decisions for Kansas dryland wheat farmers. They find that moral hazard incentives lead farmers who purchase crop insurance to use fewer chemical inputs. Wu (1999) estimated the effect of crop insurance on crop mix and the resulting change in chemical use in the Central Nebraska Basin. He found that crop insurance participation resulted in an increase in total chemical use. It also shifted production from hay and pasture to corn, leading to an increase in chemical use at the extensive margin. Classeen et al. (2011) modeled the combined impact of Federal disaster payments, crop insurance, and commodity program support on land use changes, specifically grassland to cropland conversion in North and South Dakota. They found that these programs increased the returns to cultivation by about 2.9 percent between 1998 and 2007. The effect of crop insurance participation alone was about 1 percent.

Previous studies have examine whether crop insurance encourages farms to become more specialized. With lower income risks farmers may make more commodity-specific investments. O'Donoghue, Roberts and Key (2009) examined how the 1994 Federal Crop Insurance Reform Act, which substantially increases insurance subsidies, impacted farm-level decisions about diversification. They found that farms that expanded crop insurance coverage reduced their levels of commodity diversification slightly (became more specialized) as greater insurance subsidies were made available. Previous studies have also examined the effect of crop insurance on household labor decisions. Key, Roberts and O'Donoghue (2006) examined the off-farm labor response of higher crop insurance premium subsidies in the 1994 Federal Crop Insurance Reform Act (FCIRA). They found that large farms worked fewer hours off-farm after the 1994 legislation was passed while small farms increased off-farm hours worked.

[5] The Loss Ratio is the claims paid by an insurer (total indemnities) divided by the total premiums collected for a given period.

Studies on crop insurance participation have found that the most consistent predictors include business and yield risk, operator age, farm size, level of wealth and leverage. A study by Sherrick et al. (2004) proposed a two-stage model for a farmer's decision to participate in crop insurance when selecting among several risk management options. They found that the likelihood of crop insurance usage is higher for larger, older, less tenured, more highly leveraged farms with higher perceived yield risks. Velandia et al. (2008) used a simultaneous multivariate probit approach to model the decision to adopt risk management tools, such as crop insurance, forward-contracting and sales spreading. The find factors that were significant in the adoption of these tools included the proportion of owned acres, off-farm income, education, age and level of business risk. Mishra and Goodwin (2006) found that cash grain farmers will tend to self-insure rather than purchase revenue insurance with higher wealth, off-farm income, or participate in production and marketing contracts.

The role that government policy has played in the shift towards more production occurring on large farms over the last few decades remains an area of research. Ahearn, Yee and Korb (2005) examined the impact of government payments on U.S. farm structure. They find that farmers use government payments to expand their farms, and that government payments may have increased the share of large farms between 1982 and 1997. Roberts and Key (2008) examine the impact of per acre government payments on cropland consolidation (i.e. cropland becoming concentrated on fewer farms) using zip code data from the Census of Agriculture from 1987-2002. They find government payments are strongly associated with growth in cropland concentration.

One of the other main drivers in cropland consolidation is advances in labor-saving technologies and economies of scale. Certain crop farms may especially benefit from economies of scale. A study by MacDonald, Korb and Hoppe (2013) found that cropland midpoint acreage – where half of cropland is on larger farms and half on smaller-- was 600 acres in 1982, but grew to 1,100 acres in 2007. They also show that the number of midsize crop farms has declined while farm numbers at the extremes (small and large) have grown.

They find that large crop farms typically have better financial returns than smaller crop farms.

Data

We use the 2007 and 2012 Censuses of Agriculture to understand how factors such as demographics, aspects of the farm enterprise, and government programs affect farm survival and growth. The Census of Agriculture surveys the entire U.S. farm sector every five years and contains data on U.S. farm holdings (acres and agricultural products produced), operator demographics, production inputs and outputs, and government payments. Improvements in the methodology used to track operations in the Census beginning in 2007 allow estimation of farm exits for this portion of the farm sector better than in previous studies.[6]

We combine the 2007 and 2012 Census data with several auxiliary sources of information. From the 2007 Census, we use a full slate of farm and operator characteristics, including location and operator demographics, along with program participation. We combine this with 2012 data on farm existence and acres operated. In order to look at the effects of crop insurance on farm exit and expansion, we focus on major cash grains, limiting the sample to corn, soybean and wheat operations. In 2007, this included 105,429 farms, of which 77,314 were corn farms, 19,167 were soybean farms, and 8,948 were wheat farms. Seventy-four percent of these farms had acres enrolled in the Federal Crop Insurance program. 75,875 (72%) of these cash grain farms were observed again in 2012.

We use three additional sources of county-level information in order to better model the situations facing individual farms. First, to account for crop insurance payments and

[6] The National Agricultural Statistical Service (NASS) is responsible for maintaining a list frame that contains a record of all current U.S. farm operations. This list frame is maintained and updated for each Census of Agriculture to reflect operations that exit and enter. Starting in 2007, NASS created a variable called the Operation_ID (OID), based on a state-level variable called state_OID (State Operation_ID), in order to track operations in each succeeding census period. This change in the operation identifier resulted from a need for a more standardized method for tracking farms longitudinally. Ideally, it will improve the quality of inter-census links over time.

premiums, we include 2007 data from the Summary of Business files produced by the USDA's Risk Management Agency (RMA).[7] We include average premiums paid per acre for both yield and revenue-based programs at the county-level. Second, we use soil data from the National Commodity Crop Productivity Index (NCCPI), produced by the USDA's National Resources Conservation Service (NCRS). This index evaluates soils according to their inherent capacity to produce dryland (nonirrigated) commodity crops. Most of the NCCPI criteria relate directly to the ability of soils, landscapes, and climates to foster crop productivity. A few criteria relate to factors that can limit use of the land (e.g., surface boulders). Finally, we combine this information with county-level yield data available from the National Agricultural Statistical Service (NASS) QuickStats database.[8] NASS produces county-level estimates of the acreage, production, and yield of most crop commodities grown in the United States based on quarterly production surveys of individual crop growers. In this analysis, we use county-level yield (bushels per acre).

To limit the geographical elements affecting farm exits and expansion, in this paper we focus on crop farms located in the Heartland and Northern Great Plains[9] specializing in corn, wheat and soybeans. This group represented 72% of total value of production for corn, wheat and soybeans in 2012.

[Insert Table 1]

Empirical Model

With the ultimate goal of understanding how farm characteristics and government programs affect the decision to expand acreage, our empirical model is estimated in three stages. The first stage uses a Heckman selection model (Heckman 1976) to control for

[7] County-level data on the number and total cost of policies purchased for individual commodities and coverage levels are available at: http://www.rma.usda.gov/data/sob/scc/index.html.
[8] A wealth of county and state-level data on agricultural production, yields and prices is available through the National Agricultural Statistical Service at: http://quickstats.nass.usda.gov/
[9] These two regions include the states of Illinois, Indiana, Iowa, Minnesota, Missouri, Montana, Nebraska, North Dakota, and South Dakota.

factors that affect farm exits between 2007 and 2012. Without controlling for these factors, we run the risk of sample selection bias in the model for decisions to expand acreage by 2012.

The first stage probit model is

$$(1)\ \Pr(y_i = 1) = \Phi(\boldsymbol{X_i}^{\boldsymbol{T}}\theta\ \boldsymbol{)} + e_{\boldsymbol{i}} \qquad (1)$$

where i indexes farm, y_i equals 1 if farm exits between 2007 and 2012 and 0 otherwise, Φ is the standard normal cumulative density link function, $\boldsymbol{X_i}$ is a matrix of controls of operator and farm characteristics including an intercept, θ is a vector of regression parameters to be estimated, and e_i ~N(0,1) .

The matrix of control variables ($\boldsymbol{X}_i$) for the selection model include operator age, beginning farmer status, operator retired status, acres operated in 2007, ratio of acres owned to operated, legal organization, commodity specialization (e.g. corn, soybeans or wheat), new tractors purchased in last 5 years, direct payments per acre, an interaction term for direct payments per acre interaction and farm typology, county-level soil productivity index, operating expense ratio dummy variable (indicates whether farm is in red zone (FFSC 2016)), an interaction term between the operating expense ratio and land renter/owner status, farm typology (i.e., small commercial, midsize, or large), and state-level fixed effects.

For the selection model to be identified we require an exclusion restriction on at least one variable in the first stage model, which is not used in subsequent stages. We use a dummy variable which is equal to 1 if the operator is over the age of 65. An analysis of the data shows that operators over 65 are nearly twice as likely to exit. However, farmers under 65 were about as likely to expand as farmers over 65, which makes this variable suitable as an exclusion restriction.

Once the probit model is estimated, the inverse Mills ratio can be calculated as

$$\hat{\lambda}_i = \frac{\phi(\mathbf{X}_i\hat{\beta})}{\Phi(\mathbf{X}_i\hat{\beta})}$$

where ϕ is the probability density function for a standard normal distribution and Φ is the cumulative density of a standard normal distribution. The inverse Mills ratio then used to control for sample selection bias in the two-stage least squares portion of our model.

Model for Farm Expansion 2007-2012

Before modeling the decision to expand acreage we need to account for possible spurious correlation between direct payments and farm size. Although direct payments are based on a farm's "base acreage" and should be decoupled from future production decisions, farms with more productive land or that operated more acreage would be expected to receive different amounts of payments. As noted in Key and Roberts (2006), there has been historical variation in enrollment, so similar farms may receive different levels of payments. To account for variation in the level of payments received by farms in 2007, we divide total direct payments received by acres operated to get an estimate for direct payments per acre in 2007. We also control for acres operated in 2007, commodity specialization (i.e. corn, wheat or soybeans), and a county-level soil productivity index, in addition to operator characteristics.

Endogeneity of Crop Insurance Premiums

We use a two-stage least squares (2SLS) approach to deal with the endogenous decision to purchase in crop insurance, measured in total premiums paid. 2SLS has been shown to be equivalent to a control function approach (Woolridge 2015). To identify the causal effect of premiums on production, we instrument using the coefficient of variation (C.V.) of county-level yields (yield risk) for corn, wheat or soybean between 2002 and 2006. All else equal, we would expect that farmers who experience more variability in yields between 2002 and 2006 to pay higher crop insurance premiums in 2007. We would not expect lagged county and crop-level yield risks to be strongly related to acreage decisions between 2007 and 2012. In examining changes in production decisions over this time period we also assume farmers are price takers in both input and output markets and that prices are homogenous.

Instrumenting for Total Premiums

In the second stage of the model, we regress total crop insurance premiums paid on an instrumental variable, the coefficient of variation of yields (yield risk) from 2002-2006. Included in the regression are the control variables used equation (1), and the estimated inverse Mills ratio (lambda). Assuming our instrument is valid, the residuals will be exogenous to the disturbance term in our model for acreage expansion, after controlling for farm and operator characteristics. This should allow us to get a consistent estimate of the effect of insurance premiums on decisions to expand acreage.

The instrument for total premiums (*Prem)* in 2007 using the reduced form equation

$$(2)\ Prem_{i,c,2007} = \alpha_0 + \beta_1\, Yield\ Risk_{2002-2006,c(i)} + \boldsymbol{X_i}^{\boldsymbol{T}}\alpha + \hat{\lambda}_i + r_i$$

where i indexes farm, c indexes county, α is a vector of regression parameters for operator and farm characteristics including an intercept, and r_i is a disturbance term. In the 2SLS framework, the fitted values from equation (2) are then used in the last stage of our model as the policy variable for crop insurance premiums. Assuming the instrument is strongly related to crop insurance premiums and not expansion, the fitted values from the IV regression will be exogenous to decisions to expand in the last stage.

Model for Acreage Decisions in 2012

The third stage of our model estimates a regression for acers operated in 2012 as a function of the same operator and farm characteristics used in equations (1) and (2), the inverse Mills ratio (λ_i) , and the fitted values from the control function estimated in equation (2). We define DP_acre as the vector of interactions between per-acre direct payments and the farm typology dummy variables.

The reduced form model for decisions to expand acreage in 2012 is

$$(3)\ \log(Acres_{i,2012}) = \delta_0 + \gamma Prem_{\boldsymbol{i}} + \mu DP\_acre_i + \mathbf{X}_{\boldsymbol{i}}{}^{\boldsymbol{T}}\delta + \hat{\lambda}_i + \varepsilon_i$$

where γ is the coefficient for the effect of crop insurance premiums on expansion, μ is (3x1) vector of coefficients for the effect of per-acre direct payments at different farm typologies, $\boldsymbol{X_i}$ is a matrix of the control variables used in equations (1) and (2) minus per-acre direct payments (DP_acre), δ is a vector of population regression coefficients of farm operation controls to be estimated, and ε_i is a disturbance term. Woolridge (2015) showed that a heteroskedastic robust Hausman test for endogeneity is equivalent to a t-test for $\gamma = 0$. This will tell us whether yield risk is a weak instrument for total crop insurance premiums.

Results

We examine the effects of government programs and farm characteristics on the propensity of farm businesses to exit farming or expand their operations. In order to control for the selection bias of expansion, we use a Heckman selection model. In the second stage, we use an instrumental variable approach to control for the endogenous decision to purchase crop insurance. In the third and final stage, we use the fitted values from the second stage to estimate the determinants of acres operated in 2012, including the effects of per-acre direct payments and total crop insurance premiums.

Table 2 shows the main results. The first stage, in Column 1, presents the results of the probit regression (selection model) of farm exit on farm characteristics. The marginal effects (at the mean of the data) are presented in Table 3. As expected, larger farms are less likely to exit. Those with an operating expense ratio in the red zone (OER_RED) are slightly more likely to be observed again in 2012; these farms may be taking on additional debt for expansion. We find a negative effect on exits for farms renting some or all of their land. Our exclusion restriction, a binary variable equal to one if the principal operator is over the age of 65 is positive and significant, with a p-value of less than 0.001. Beginning farmers are 3.5% more likely to cease operations. As compared with Corn farmers (the omitted category), soybean and wheat farms are more likely to exit, with the probability increasing by 0.5% and 3.1%, respectively. Direct Payments do not appear to have a significant effect on farm exit, except for large commercial farms, where payments make the probability of exit marginally less likely. Older and beginning farmers are found to be more likely to exit. We also see significant effects for days worked off-farm. As compared with operators who did not work off-farm, operators who worked between 1 and 49 days, or more than 100 days off-farm were 1.3-1.4% more likely to exit. We also find significant interaction effects with farm size.

In the second stage of our model, the instrumental variable equation, we regress the total amount of crop insurance premiums paid on our instrumental variable (the coefficient of variation of crop yields), the inverse mills ratio from our first stage selection model, and farm and operator characteristics. The hypothesis test for weak instruments is rejected with an F statistic of 64.40.[10] We find that full owners of land operating with operating expense ratios in the "Red Zone" are less likely to buy crop insurance, while those who rent in at least some of their land are more likely to buy crop insurance. Farmers at either end of their career—either beginning or retired—are more likely to buy crop insurance. Finally, farms in areas with poor soil quality made greater use of crop insurance.

The third stage of our model uses the fitted values from the IV regression to control for the endogenous choice of purchasing crop insurance. Doing so allows us to isolate the effects of crop insurance on acres operated in 2012. Standard errors are reported using the Eicker-Huber-White heteroscedastic consistent covariance estimator. We find that roughly 76% of the variation in acres operated in 2012 can be explained by the number of acres operated in 2007. Consistent with previous studies (Goodwin, Vandever and Deal 2004) we find a small but modest positive effect of owning crop insurance on expanding the number of acres operated. We find that for each $1 increase in premiums paid in 2007 cash grain farms expanded their acres operated by 0.002% from 2007 to 2012, holding all else constant. We also find positive effects of direct payments per acre on acres operated in

[10] The general rule of thumb is that the F-statistic for a valid instrument should be greater than 10 (Staiger and Stock 1997).

2012. The effect of direct payments is found to be much larger for corn, soybean or wheat farms with over $1 million in gross cash revenue.

Consistent with the literature (Ahearn, Korb and Yee 2009) we also see effects for operators working off farm full-time. Those operators working 200 days or more operated 4.4% less land in 2012. We also see a negative and significant coefficient on lambda, which suggests that an increased probability of exit is negatively correlated with acreage expansion. This seems consistent with theoretical predictions that operations preparing to exit would be less likely to expand acreage.

Finally, results from an OLS regression (not shown) find the marginal effect of crop insurance on acres operated in 2002 is positive and significant, but biased downwards by several orders of magnitude.

Results for midsize farms only

Lastly, we estimate the same model using the subset of corn, wheat and soybean farms that were classified as a midsize farm in 2007. This included 18,264 corn farms, 1,801 soybean farms, and 2,118 wheat farms. Eighty-six percent of these farms had acres enrolled in the Federal Crop Insurance program in 2007 and they paid an average of $22,741 in crop insurance premiums. As in the main results, we instrument using the coefficient of variation of crop yields. A Hausman test for this instrument has an F-statistic of 40, rejecting the null hypothesis of a weak instrument.

These results are displayed in Table 4. In the first stage selection model we find similar to the full dataset. We find that operators over 65 years old and older operators in general are more likely to exit. Beginning midsize farms are also found to exit at significantly higher rates. Finally, we find no significant effect of per-acre direct payments on midsize cash grain farm survival.

While the model for acreage expansion has fewer significant coefficients than the full dataset, but we do see some similarities. While, per-acre direct payments are not found to have a significant effect on expansion, the marginal effect of crop insurance premiums is found to be very similar to the full dataset. Similarly, we find a $1 increase in 2007 premiums paid causes a 0.002% increase in acres operated from 2007-2012, holding all else constant. Midsize soybean and wheat farms were more likely to expand between 2007 and 2012 when compared with corn farms. Older operators are found to expand less than younger operators.

Conclusions and Discussion

In this paper, we analyze two Federal agricultural policies, direct payments and subsidized crop insurance, both of which affected cash grain farm survival and expansion between 2007 and 2012. Using improved Agricultural Census data, which better tracks operations through time, we account for sample selection bias in the model. We also address issues of endogeneity in both direct payments and crop insurance premiums. We condition on factors that affect per-acre direct payments and instrument for decisions to purchase crop insurance using a measure of crop yield risk.

Consistent with previous literature, we find a small but significant effect of crop insurance premiums on decisions to expand acreage. This effect is also found with direct payments, but is slightly larger for large farms (those with gross cash farm income over $1 million). Direct payments are also found to have a small effect on cash grain farm survival. Our results for farm survival are also consistent with the literature. We find that the lifecycle of the operator plays an important role in farm exits, with beginning farmers and older farmers (those over 65) are more likely to exit, and farmers who are in the middle more likely to survive. Crop insurance is found to have a small but significant effect on midsize cash grain farms production decisions. However, we do not find evidence that higher per-acre direct payments lead to increases in acres operated.

In future research we plan to examine whether the decisions to purchase crop insurance have an impact on acres enrolled in the Conservation Reserve Program (CRP), specifically whether farms that purchase more crop insurance are more likely to convert CRP land back into production. Another area for future research is whether decisions to purchase crop insurance lead to more grassland and pastureland being brought into crop production.

References

Ahearn, Mary C. and Hisham El-Osta. "The Impact of Coupled and Decoupled Government Subsidies on Off-Farm Labor Participation of U.S. Farm Operators," *American Journal of Agricultural Economics* 88(2):393-408, 2005.

Ahearn, M., Yee, J., and Penni Korb. "Producer Dynamics in Agriculture: Empirical Evidence." *Producer Dynamics: New Evidence from Micro Data*. Timothy, Dunne, K. Bradford Jensen, and Mark J. Roberts. Chicago: University of Chicago Press, 369-391, 2009.

Ahearn, M., Yee, J., and Penni Korb. "Effects of Differing Farm Policies on Farm Structure and Dynamics," *American Journal of Agricultural Economics* 87(5): 1182-1189, 2005.

Classen, Roger, Fernando Carriazo, Joseph C. Cooper, Daniel Hellerstein, and Kohei Udea. Grassland to Cropland Conversion in the Northern Plains: The Role of Crop Insurance, Commodity, and Disaster Programs, ERR-120, U.S. Dept. of Agri., Econ. Res. Serv. June 2011.

FFSC (2016), Farm Financial Ratios and Guidelines, Farm Financial Standards Council, Menomonee Falls, WI, available at: www.ffsc.org/Files/FarmFinancialGuidelinesRatios.pdf (accessed 18 April 2016).

Glauber, Joesph W. "The Growth Of The Federal Crop Insurance Program, 1990-2011," *American Journal of Agricultural Economics* 95(2): 482-488, 2013.

Goetz, Stephan J. and David L. Debertin. "Why Farmers Quit: A County-Level Analysis," *American Journal of Agricultural Economics* 83(4): 1010-1023, 2001.

Goetz, Stephan J. and Meri Davlasheridze. “State-Level Cooperative Extension Spending and Farmer Exits,” *Applied Economic Perspectives and Policy*. First published online April 19, 2016 doi:10.1093/aepp/ppw007

Goodwin, Barry K. and Vincent H. Smith. “Crop Insurance, Moral Hazard, and Agricultural Chemical Use,” *American Journal of Agricultural Economics* 78(2): 428-438, 2006.

Goodwin, Barry K., Vandeveer M.L., and John L. Deal. “An Empirical Analysis of Acreage Effects of Participation in the Federal Crop Insurance Program,” *American Journal of Agricultural Economics* 86(4): 1058-1077, 2004.

Heckman, James J. "The common structure of statistical models of truncation, sample selection and limited dependent variables and a simple estimator for such models." *Annals of Economic and Social Measurement* NBER 5(4): 475-492, 1976.

Hennessy, David A. "The production effects of agricultural income support policies under uncertainty." *American Journal of Agricultural Economics* 80(1): 46-57, 1998.

Hoppe, Robert A. and James MacDonald. *Updating the ERS Farm Typology*, Economic Information Bulletin, No. 110, U.S. Department of Agriculture, Economic Research Service, April 2013.

Hoppe, Robert A., and Penni Korb. *Understanding U.S. Farm Exits*, Economic Research Report No. 21, U.S. Department of Agriculture, Economic Research Service, June 2006.

Ifft, Jennifer E., Todd Kuethe, and Mitch Morehart. "Does federal crop insurance lead to higher farm debt use? Evidence from the Agricultural Resource Management Survey (ARMS)." *Agricultural Finance Review* 75(3): 349-367, 2015.

Key, Nigel D. and Michael J. Roberts. “Government Payments and Farm Business Survival,” *American Journal of Agricultural Economics* 88(2): 382-392, 2006.

Key, Nigel D. and Michael J. Roberts. “Do Government Payments Influence Farm Size and Survival,” *Journal of Agricultural and Resource Economics* 32(2): 330-348, 2007.

Key, Nigel D. and Michael J. Roberts. "Nonpecuniary benefits to farming: Implications for supply response to decoupled payments." *American Journal of Agricultural Economics* 91(1): 1-18, 2009.

Key, Nigel D., Michael J. Roberts, and Erik O'Donoghue. "Risk and Farm Operator Labor Supply." *Applied Economics* 38(5): 573-586, 2006.

Kimhi, Ayal and Ray Bollman. “Family Farm Dynamics in Canada and Israel: The Case of Farm Exits,” *Agricultural Economics* 21(1): 69-79, 1999.

MacDonald, J., Korb, P., and Robert A. Hoppe. *Farm Size and the Organization of U.S. Crop Farming*. Economic Research Report No. 152, U.S. Department of Agriculture, Economic Research Service, August 2013.

Mishra, Ashok K., and Barry K. Goodwin. "Revenue insurance purchase decisions of farmers." *Applied Economics* 38(2): 149-159, 2006.

O’Donoghue, Erik, Michael J. Roberts, and Nigel D. Key. “Did the Federal Crop Insurance Reform Act Alter Farm Enterprise Diversification?” *Journal of Agricultural Economics* 60(1):80-104, 2009

Orden, David and Carl Zulauf. “Political Economy of the 2014 Farm Bill,” *American Journal of Agricultural Economics* 97(5):1298-1311, 2014.

Roberts, Michael J. and Nigel Key. “Agricultural Payments and Land Concerntration: A Semiparametric Spatial Regression Analysis,” *American Journal of Agricultural Economics* 90(3):627-643, 2008.

Sherrick, Bruce J., Barry, P.J., Ellinger, P.N., and Gary D. Schnitkey. “Factors Influencing Farmer’s Crop Insurance Decisions,” *American Journal of Agricultural Economics* 86(1):103-114, 2004.

Staiger, D., and Stock, J.H. “Instrumental variables regression with weak instruments,” *Econometrica*, 65(3), 557-586, 1997.

Storm, Hugo, Mittenzwei, K. and Thomas Heckelei. “Direct Payments, Spatial Competition, and Farm Survival in Norway,” *American Journal of Agricultural Economics* 97(4):1192-1205, 2014.

USDA-ERS (2016). Projected Spending under the 2014 Farm Bill. Available at: http://www.ers.usda.gov/topics/farm-economy/farm-commodity-policy/projected-spending-under-the-2014-farm-bill.aspx

Velandia, Margarita, et al. "Factors affecting farmers' utilization of agricultural risk management tools: the case of crop insurance, forward contracting, and spreading sales." *Journal of Agricultural and Applied Economics* 41(1): 107-123, 2009.

Weber, Jeremy G. and Key D. Key. “How much Do Decoupled Payments Affect Production? An Instrumental Variable Approach with Panel Data,” *American Journal of Agricultural Economics* 94(1): 52-66, 2011.

Wooldridge, Jeffrey M. "Control function methods in applied econometrics." *Journal of Human Resources* 50(2): 420-445, 2015.

Wu, JunJie. "Crop Insurance, Acreage Decisions, and Nonpoint-Source Pollution." *American Journal of Agricultural Economics* 81(May 1999):305-320

Young, C. Edwin and Paul C. Westcott. "How Decoupled Is U.S. Agricultural Support for Major Crops?" *American Journal of Agricultural Economics* 82(August 2000): 762-767, 2000.

Table 1 – Summary Statistics

VARIABLE	N	mean	sd
Farm Exit (=1 if exited between 2007 and 2012)	105429	0.09	0.28
Acres Operated (2007)	105429	876.14	1423.70
Acres Operated (2012)	75875	961.04	1616.63
Operating Expense Ratio (operating expenses/gross revenue X 100)	105429	69.61	39.02
Land Tenure (1- full owner, 2- partial owner, 3- full renter)	105429	1.82	0.66
Midsize	105429	0.21	0.41
Large	105429	0.05	0.21
Efficiency (gross cash farm income per acre)	105415	517.20	1714.85
Direct Payments ($ per acre)	99485	14.77	33.78
Corn Farm	105429	0.73	0.44
Soybean Farm	105429	0.18	0.39
Wheat Farm	105429	0.08	0.28
New Tractors (< 5 yrs old)	105429	0.32	0.82
Organization_Partnership	105429	0.09	0.29
Organization_Corporation	105429	0.08	0.27
Organization_Other	105429	0.01	0.10
Age of Principal Operator	105429	56.09	13.47
Beginning Farmer	105429	0.15	0.36
Retired Farmer	105429	0.13	0.34
Off-farm Work Days	105429	76.48	88.41

Table 2 – Main Results

	Pr(Exit=1)	Premiums Paid	Ln(Land in 2012)
Ln(Land in 2007)	-0.098667	3,357.1	0.7632264
	(-9.85)**	(26.16)**	(22.09)**
OER_RED	-0.114398	-705.37	0.011044
	(-4.22)**	(-4.62)**	(0.60)
Tenure_Partial	-0.285500	-3,572.4	0.0848479
	(-14.29)**	(-10.32)**	(2.19)*
Tenure_Renter	-0.051368	30.138	0.0377911
	(-1.98)*	(0.22)	(2.68)**
OER_RED*Tenure_Partial	0.087615	2,327.0	-0.0298848
	(2.37)*	(12.62)**	(-1.31)
OER_RED*Tenure_Renter	0.164030	2,165.7	-0.0203459
	(3.33)**	(7.72)**	(-0.65)
Age>65	0.106160		
	(4.22)**		
Midsize Farm	-0.014725	8,842.0	-0.0953253
	(-0.42)	(32.46)**	(-1.48)
Large Farm	0.125197	46,479.1	-0.8284025
	(1.35)	(25.89)**	(-2.51)*
Revenue Efficiency	0.000006	0.15715	8.93e-06
	(1.82)	(7.25)**	(1.96)*
Direct Payments per Acre	-0.000125	6.9177	0.0012615
	(-0.46)	(3.21)**	(3.26)**
Direct Payments * Midsize	0.000636	-66.087	0.0008404
	(0.45)	(-5.42)**	(0.90)
Direct Payments * Large	-0.013279	-730.78	0.013642
	(-2.41)*	(-7.15)**	(2.42)*
Soybean	0.039879	-2,953.76	0.0565468
	(2.09)*	(-34.57)**	(2.23)*
Wheat	0.211282	-4,297.92	0.15505
	(5.78)**	(-11.93)**	(3.17)**
New Tractors	0.012971	1,898.97	-0.0254947
	(1.29)	(10.62)**	(-1.59)
Organization_Partnership	0.168562	3,983.82	-0.0858706
	(7.23)**	(14.14)**	(-2.40)*
Organization_Corporation	0.111816	505.53	0.0288027
	(3.93)**	(2.40)*	(1.71)
Organization_Other	0.212655	3,132.2	-0.0866439
	(3.57)**	(4.13)**	(-1.68)
Age of Principal Operator	0.015450	160.68	-0.0130506
	(15.38)**	(7.81)**	(-6.17)**
Beginning Farmer	0.245953	2,889.9	-0.0573928
	(11.17)**	(9.16)**	(-1.66)
Retired Farmer	0.014041	672.01	-0.045354
	(0.66)	(7.05)**	(-3.29)**
Days Worked Off-farm (1 49)	-0.096294	-688.54	-0.0051845
	(-3.59)**	(-4.93)**	(-0.31)
Days Worked Off-farm (50 to 99)	-0.056204	-587.37	0.0057129
	(-1.54)	(-5.05)**	(0.33)
Days Worked Off-farm (100 to 199)	-0.105601	-1,362.19	0.0192569

	(3.59)**	(-8.98)**	(1.08)
Days Worked Off-farm (200 or more)	-0.106854	-999.40	-0.0440489
	(-5.05)**	(-6.66)**	(-2.75)**
25 Days * Midsize	-0.040234	-994.79	0.0369819
	(-0.70)	(-3.30)**	(1.81)
25 Days * Large	0.171574	-2,491.45	0.1312547
	(1.32)	(-1.05)	(1.83)
75 Days * Midsize	0.010387	-782.15	-0.0025382
	(0.11)	(-1.69)	(-0.07)
75 Days * Large	0.003647	-957.51	0.029759
	(0.01)	(-0.26)	(0.29)
150 Days * Midsize	0.025682	-1,566.39	0.0532687
	(0.33)	(-4.10)**	(1.99)*
150 Days * Large	0.350365	2,884.43	-0.0521083
	(2.12)*	(0.43)	(-0.26)
200 Days * Midsize	0.089846	-860.72	0.0461806
	(1.44)	(-2.76)**	(1.68)
200 Days * Large	0.334250	2,609.95	0.062013
	(2.69)**	(1.13)	(0.80)
Soil Quality Index	-0.188831	-3,027.07	-0.0339001
	(-2.40)*	(-5.73)**	(-0.77)
Yield Risk	0.023312	5,814.00	
	(0.21)	(8.27)**	
Lambda		12,485.9	-0.2654401
		(9.08)**	(-1.85)
Premiums Paid			0.0000236
			(3.19)**
Constant	-1.556289	-43,813.9	2.400711
	(-14.47)**	(-15.02)**	(6.22)**
R^2		0.54	0.72
State Fixed Effects	Yes	Yes	Yes
N	98,154	98,134	71,767

Note: * indicates p<0.05, ** indicates p<0.01. T-value is displayed in parentheses.

Table 3 – Marginal Effects of the Probit Regression for Exit

Variable	Marginal Effect
Ln(Land in 2007)	*-0.01434*
	(0.0014634)**
OER_RED	-0.00764
	(0.0024094)**
Tenure_Partial	-0.03823
	(0.0027132)**
Tenure_Renter	-0.00184
	(0.0038542)
Age>65	0.015424
	(0.0036599)**
Midsize Farm	-0.00214
	(0.0051233)
Large Farm	0.01819
	(0.0134618)
Efficiency	9.41E-07
	(0.000000516)
Direct Payments per Acre	-1.8E-05
	(0.0000393)
Direct Payments * Midsize	9.24E-05
	(0.0002052)
Direct Payments * Large	-0.00193
	(0.0008011)*
Soybean	0.005794
	(0.002767)*
Wheat	0.030697
	(0.0053059)**
New Tractors	0.001885
	(0.0014653)
Organization_Partnership	0.02449
	(0.0033872)**
Organization_Corporation	0.016246
	(0.0041357)**
Organization_Other	0.030896
	(0.0086443)**
Age of Principal Operator	0.002245
	(0.0001449)**
Beginning Farmer	0.035734
	(0.0032013)**
Retired Farmer	0.00204

	(0.003074)**
Days Worked Off-farm (1 to 49)	-0.01408
	(0.0033828)**
Days Worked Off-farm (50 to 99)	-0.0082
	(0.0048833)
Days Worked Off-farm (100 to 199)	-0.01345
	(0.0038217)**
Days Worked Off-farm (200 or more)	-0.01255
	(0.0029022)**
Soil Quality Index	-0.02743
	(0.0114502)*
Yield Coef. Of Variation	0.003387
	(0.0161161)
N	98,154

Note: * indicates $p<0.05$, ** indicates $p<0.01$. T-value is displayed in parentheses.

Table 4 – Midsize Farms Only

	Pr(Exit=1)	Ln(Land in 2012)
Ln(Land in 2007)	-0.1463134	0.4084811
	(-2.81)**	(2.79)**
OER_RED	-0.0459355	-0.0002252
	(-0.31)	(0.00)
Tenure_Partial	-0.3858745	-0.0735731
	(-6.23)**	(-1.08)
Tenure_Renter	-0.2130808	-0.0668287
	(-2.58)**	(-1.33)
OER_RED*Tenure_Partial	0.1342149	0.0160711
	(0.87)	(0.17)
OER_RED*Tenure_Renter	0.2792995	0.0221063
	(1.54)	(0.21)
Age>65	0.1792926	
	(2.80)**	
Revenue Efficiency	0.0000257	-0.000071
	(0.45)	(-1.21)
Direct Payments per Acre	-0.0007717	-0.0006446
	(0.34)	(-0.81)
Soybean	0.090441	0.292463
	(1.31)	(3.06)**
Wheat	0.0476918	0.599906
	(0.46)	(4.11)**
New Tractors	0.0080213	0.0104206
	(0.40)	(1.66)
Organization_Partnership	0.2200246	0.0378991
	(4.39)**	(0.99)
Organization_Corporation	0.0436404	0.0251788
	(0.87)	(1.53)
Organization_Other	0.3436608	0.0748724
	(1.99)*	(0.79)
Age of Principal Operator	0.0124362	-0.0054091
	(4.78)**	(-2.11)*
Beginning Farmer	0.3608939	0.0748724
	(5.26)**	(1.16)
Retired Farmer	0.0423033	-0.0373677
	(0.47)	(-0.75)
Days Worked Off-farm (1 to 49)	-0.1484117	-0.0380337
	(-2.88)**	(-1.31)
Days Worked Off-farm (50 to 99)	-0.0737863	-0.0533364
	(-0.83)	(-1.50)
Days Worked Off-farm (100 to 199)	-0.1172622	-0.0155345
	(-1.60)	(-0.58)
Days Worked Off-farm (200 or more)	-0.0498941	-0.0379714
	(-0.86)	(-1.70)
Soil Quality Index	-0.3696513	-0.022084
	(-1.79)	(-0.26)
Yield Risk	0.0532916	
	(0.16)	
Lambda		0.2213991
		(1.22)
Premiums Paid		0.0000237
		(3.25)**

Constant	-0.8308058	3.510833
	(-1.86)	(4.13)**
R^2		0.36
State Fixed Effects	Yes	Yes
N	20,811	16,684

Note: * indicates p<0.05, ** indicates p<0.01. T-value is displayed in parentheses.