Effects of Crop Insurance on Farm Disinvestment and Exit Decisions

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Motivations and Research Questions

1. Crop insurance is expanding in the U.S. and in the Europe and also in many developing countries.

2. Crop insurance is a government program and heavily subsidized - yet, little is known about the effects on farm disinvestment and exit decisions.

Does subsidized crop insurance affect disinvestment and exit decisions of farms?

Crop Insurance and Farm Disinvestment/Exit

Real option theory (Dixit 1989) suggests...

1. A reduction in the variability of revenues leads to higher thresholds of revenues for farm disinvestment/exit, and
2. An increase in the expected value of revenues leads to lower thresholds of revenues for farm disinvestment/exit.

Subsidized crop insurance **reduces the volatility of revenues** and **increases the expected value of revenues**.

Contributions

This study...

1. Mitigates endogeneity issues of purchasing crop insurance decision, and
2. Provides empirical evidence on negative effects of crop insurance on the likelihoods of farm disinvestment and exit decisions.

Data

1. Kansas Farm Management Association (KFMA) - provides a farm-level dataset.
2. KFMA collects accounting and production information from its members.
3. Crop insurance data exist from 1993.

Summary Statistics (1993 -2016)

VARIABLES	Overall N	Overall mean (SD)	1998 N	1998 mean (SD)	2016 N	2016 mean (SD)
Total crop acres	42,364	1,223 (1,132)	2,199	1,059 (923.2)	1,024	1,655 (1,779)
Operator age	42,364	54.03 (20.93)	2,199	51.86 (13.55)	1,024	58.50 (12.90)
Crop labor ratio	42,364	0.756 (0.275)	2,199	0.751 (0.279)	1,024	0.790 (0.244)
Years operated	42,364	15.85 (10.76)	2,199	13.22 (8.818)	1,024	21.29 (13.83)
Machinery and equipment value	42,364	51,354 (62,178)	2,199	44,810 (57,866)	1,024	93,251 (112,116)
Value of farm production	42,364	206,836 (232,718)	2,199	147,409 (162,037)	1,024	299,789 (365,147)
Non-farm income	42,364	16,606 (40,047)	2,199	16,447 (24,577)	1,024	19,329 (35,125)
Total farm capital	42,364	1.352e+06 (1.620e+06)	2,199	974,492 (797,363)	1,024	3.344e+06 (3.367e+06)
Debt-to-asset ratio	42,356	0.368 (1.474)	2,198	0.398 (0.385)	1,024	0.257 (0.269)
Owned land/total land	41,393	0.377 (0.345)	2,133	0.383 (0.485)	1,008	0.345 (0.312)
Number of insured years within the last 5 years	20,886	4.000 (1.670)	1,372	3.336 (1.719)	654	4.543 (1.269)

Defining Farm Survival

	2013	2014	2015	2016	Type
Farm 1	Observed	Observed	Observed	Observed	Stayer
Farm 2	Observed	Observed	Observed	Not Observed	Stayer
Farm 3	Observed	Observed	Not Observed	Not Observed	Stayer
Farm 4	Observed	Not Observed	Not Observed	Not Observed	Exitor
Farm 5	Not Observed	Not Observed	Not Observed	Not Observed	Exitor

Duration Analysis

1. Cox proportional hazard model: For a farm that survived until time t, the conditional probability of exiting after time t is called a hazard function and is displayed as follows:

$$h(t; D_i, X_i) = h_0(t) \exp(\gamma D_i + \Gamma X_i) \tag{1}$$

where $h_0(t)$ is the baseline hazard function, D_i is a variable equal to one if farm i is in the treatment group and equal to zero otherwise, X_i is a vector of control variables.

2. Treated if farm i had purchased crop insurance consecutively for five years since 1996.

Estimating Farm Disinvestment

The estimation equation is specified as

$$y_i = \beta_0 + \beta_1 D_i + BX_i + \epsilon_i \tag{2}$$

where y_i is the disinvestment measure for farm i, D_i is a treatment status for farm i, X_i is a vector of control variables.

Defining Farm Disinvestment

For farm i in year t, we define disinvestment as

$$y_i = \frac{\sum_t \frac{investment_{it-1} - investment_{it}}{investment_{it-1}}}{n}, \quad t \in \{1, ..., T\} \tag{3}$$

where investment is defined as the amount of the value of machinery and equipment, t is an element of set of observed years, with T is the last survived year before a farm goes out of business, and n is the number of elements in the set.

The Crop Insurance Reform Act of 1994

1. Documents mandatory crop insurance provision - farms need to be insured by crop insurance to receive farm subsidies.
2. The mandatory provision was repealed in 1996.
3. We use Year 1996 as the base year and estimate the survival and disinvestment rates of the treated and the control groups.

Propensity Score Matching

1. Estimate propensity scores ($\hat{Prob}(D = 1|X)$): Logit estimation
2. Use the nearest neighbor matching algorithm - sampling with replacement
3. Our goal is to achieve "conditional independence".

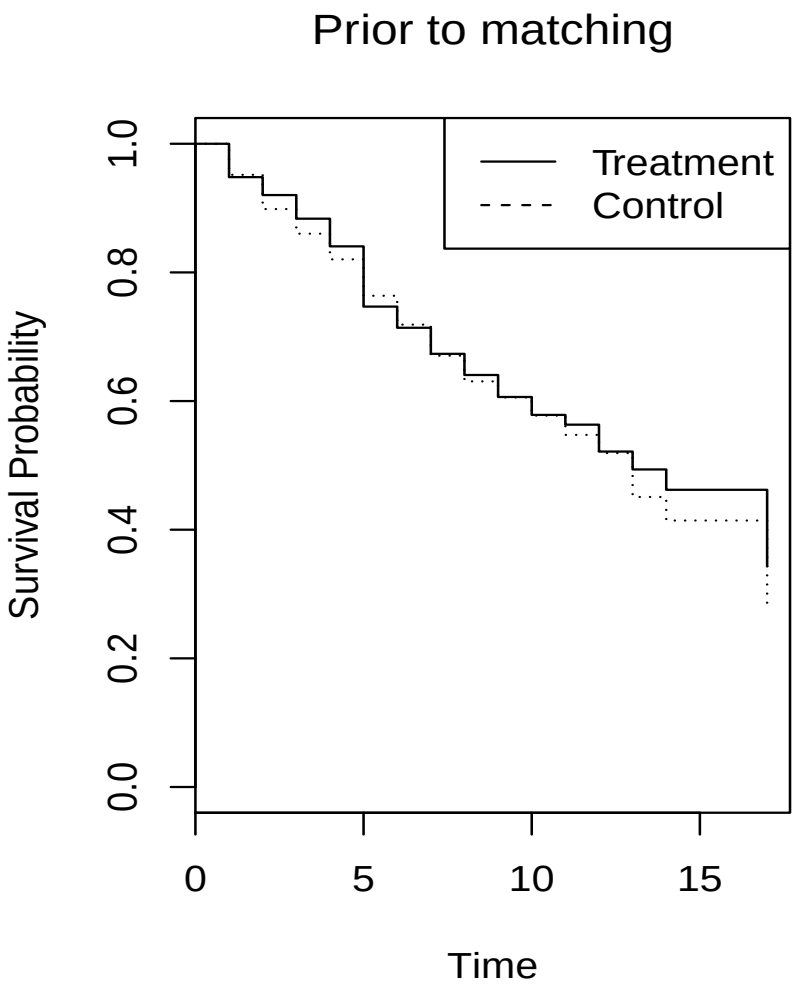
$$y_0, y_1 \perp D|X \Longrightarrow y_0, y_1 \perp D|p(X) \tag{4}$$

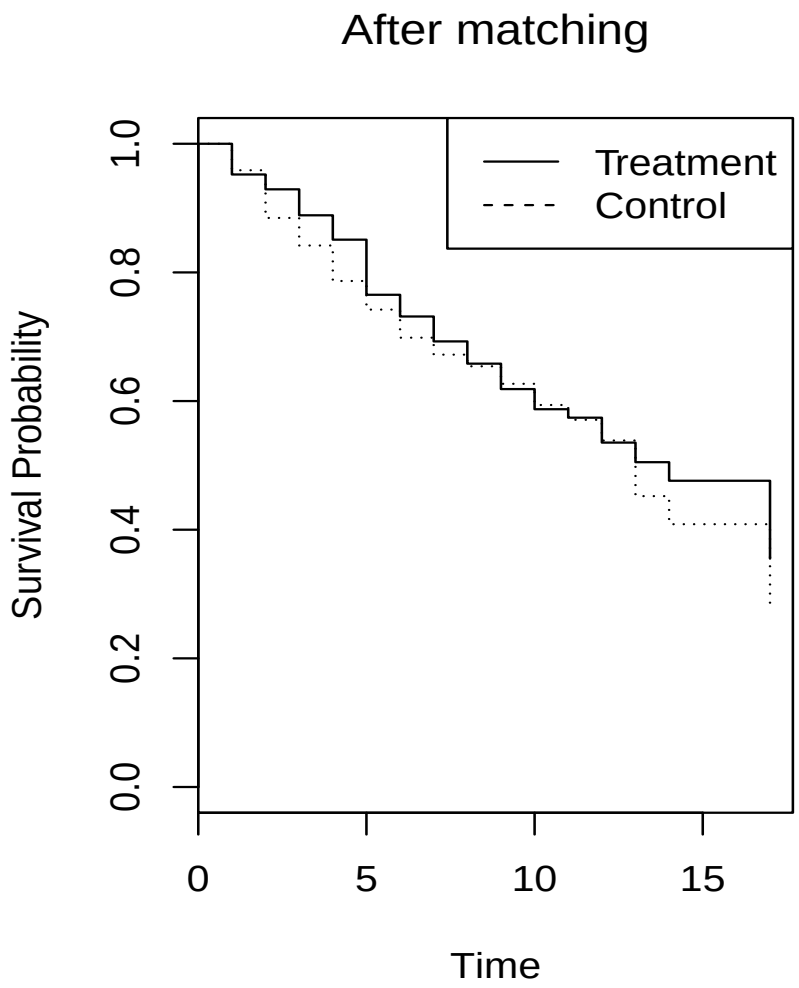
where y_0 is outcome for the control group, and y_1 is outcome for the treatment group, $p(X)$ is the propensity score, X represents observable characteristics, and D denotes treatment.

Balance Tests

	Unmatched			Matched		
VARIABLES	Treatment	Control	P-value	Treatment	Control	P-value
operator age	49.07	52.16	0.002	49.07	49.83	0.212
operator age^2	2,556	2,769	0.002	2,555	2,623	0.272
years operated	12.04	12.66	0.141	12.05	11.44	0.120
years operated^2	202.22	218.75	0.117	202.78	189.37	0.164
crop labor fraction	0.791	0.644	0.000	0.788	0.807	0.056
owned land/total land	0.304	0.416	0.000	0.307	0.315	0.556
ln(non-farm income)	7.62	7.27	0.125	7.61	7.44	0.441
ln(total crop acre)	6.86	6.38	0.000	6.85	6.89	0.171
ln(value of farm production)	11.64	11.59	0.271	11.64	11.68	0.340
ln(total farm capital)	13.50	13.44	0.078	13.50	13.53	0.309
ln(machinery and equipment value)	9.96	9.98	0.854	9.98	10.17	0.025
ln(debt-to-asset ratio)	0.447	0.348	0.000	0.430	0.424	0.649
Number of observations	566	779	-	1,214	1,214	-

Kaplan-Meier Survival Curves





Cox Estimation Results: Impact on Farm Survival

	(1)	(2)	(3)	(4)	(5)	(6)
	(Unmatched)		(Caliper size of 0.1)		(Caliper size of 0.01)	
Dependent Variable: Hazard Rate						
Panel A: Treatment						
Treated	-0.122	-0.147*	-0.156***	-0.163***	-0.145***	-0.176***
	(0.079)	(0.087)	(0.046)	(0.056)	(0.047)	(0.049)
Covariates		Y		Y		Y
Number of observations	1,345	1,345	2,428	2,428	2,270	2,270

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

OLS Estimation Results: Impact on Farm Disinvestment

	(1)	(2)	(3)	(4)	(5)	(6)
	(Unmatched)		(Caliper size of 0.1)		(Caliper size of 0.01)	
Dependent Variable: Disinvestment measure						
Treated	-0.040	-0.057**	-0.058***	-0.061***	-0.055***	-0.057***
	(0.027)	(0.027)	(0.018)	(0.018)	(0.019)	(0.019)
Covariates		Y		Y		Y
Number of observations	1,341	1,341	2,423	2,423	2,266	2,266

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Concluding Remarks

1. We find that crop insurance deters farm disinvestment or farm exits.

2. Remaining Challenges:

    1. Some doubts related to PSM - have we really achieved "conditional independence"?
    2. Estimating heterogenous effects - do farms with poor finance performances benefit more from crop insurance?

Appendix: Propensity Score Estimation Results

VARIABLES	Coefficients
constant	5.597***
	(1.797)
operator age	-0.046
	(0.033)
operator age^2	-0.000
	(0.000)
years operated	0.009
	(0.037)
years operated^2	-0.000
	(0.001)
crop labor fraction	0.451
	(0.304)
owned land/total land	-0.250
	(0.228)
ln(non-farm income)	0.036**
	(0.016)
ln(total crop acre)	1.396***
	(0.167)
ln(value of farm production)	-0.167
	(0.129)
ln(total farm capital)	-0.897***
	(0.199)
ln(machinery and equipment value)	-0.019
	(0.036)
ln(debt-to-asset ratio)	0.603***
	(0.218)
Number of observations	1,345
Log likelihood	-803.189
Pseudo R-squared	0.123

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix: Placebo Test Results

	(1)	(2)	(3)	(4)	(5)	(6)
	(Unmatched)		(Caliper size of 0.1)		(Caliper size of 0.01)	
Dependent Variable: Hazard Rate						
Panel B: Pseudo-treatment						
(Pseudo) treated	-0.010	-0.039	-0.047	-0.021	-0.037	-0.046
	(0.045)	(0.050)	(0.032)	(0.034)	(0.033)	(0.035)
Covariates		Y		Y		Y
Number of observations	1,345	1,345	2,490	2,490	2,442	2,442

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1