Risk Attitudes of US Agricultural Producers

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Rosch is an economist with the USDA Economic Research Service. Disclaimer: The view are the author's own and do not necessarily represent those of the Economic Research Service or the USDA.

1. Intro

We characterize risk attitudes among US farmers, and show how these attitudes correlate with use of risk management options including insurance and savings; farm management decisions including crop specialization, capital investment, and land tenure arrangements; and participation in USDA programs. We also explore how risk attitudes correlate with demographic characteristics and measures of risk exposure. These results are useful in understanding how changes in Federal risk management programs may impact participation decisions.

Our data on risk attitudes and farm and household characteristics comes from the 2014 Agricultural Resource Management Survey (ARMS) survey. While many studies have tried to infer farmers' risk attitudes from production decisions (e.g. Antle, 1987; Bar-Shira, 1997) or participation in crop insurance programs (Babcock, 2015; Du et al., 2016), few studies have attempted to directly measure risk attitudes. Previous studies that directly measured US farmer risk attitudes involved convenience samples (Fausti and Gillespie, 2006) or representative but small samples of US farmers (Roe, 2015). The 2014 ARMS survey data is a representative sample of almost 30,000 farm enterprises, and includes information on a wide range of farm practices, Federal program participation, and household characteristics. Thus our study provides the most detailed and comprehensive view of US farmers' risk attitudes to date.

This topic is a policy-relevant issue as expenditures on farm risk management programs – in particular on Federal crop insurance (FCI) and price support programs – are major budgetary items for the USDA. Understanding how risk attitudes impact program participation is essential for predicting how changes in these programs will impact future participation rates and government expenditures under the next Farm bill.

2. Data and Empirical Procedures

All data comes from the 2014 Costs and Returns Report version of the Agricultural Resource Management Survey (ARMS). ARMS is the USDA's primary source of information on the financial condition, production practices, and resource use of US farm households. The survey is designed to be representative for the continental US and to support State-level estimates for 15 key agricultural States. The 2014 sample included 29,747 farm households, of which 28,057 (94.3%) chose to provide information about their risk attitudes.

Risk attitude is measured following the format proposed by Dohmen et al (2011). The ARMS survey included the question "Are you generally a person willing to take risks or do you try to avoid taking risks?" Respondents indicated their response on an 11-point scale where 0 indicated "Not at all willing to take risks" and 10 indicated "Fully willing to take risks." Roe (2015) used the same question for a smaller, representative sample of US farmers and found the answers correlated well with crop specialization and demographic characteristics. In addition to the raw responses, we also define dummy variables for the category risk averse (willingness to accept risk between 0-3), risk neutral (willingness to accept risk between 4-6), and risk seeking (willingness to accept risk between 7-10).

Sample results were weighted to estimate nationally representative statistics following the procedure described by Dubman (2000). For county average statistics, we restrict the sample to only counties with

more than 3 respondents per county. This reduces the number of counties from 3,235 in the full sample to 2,804 counties for analysis.

3. Results

3.1 Descriptive Statistics

Figure 1 presents a histogram of willingness to accept risk for the sample of farmers who completed the 2014 ARMS survey. The modal response was 5. Approximately 24% of the farmers sampled were risk averse, 41% of the sample was risk neutral, and 35% of the sample was risk seeking (see Figure 1).
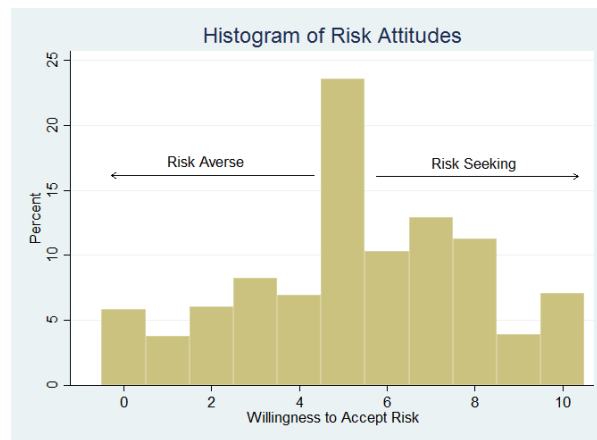

Figure 1: Distribution of Risk Attitudes for US Farmers in 2014 ARMS sample

For the full population, US farmers are on average close to risk neutral when it comes to willingness to accept risk. The estimated mean willingness to accept risk for the full population is 4.81 with 95% CI (4.71, 4.90). This estimate is very similar to the population estimate from Roe (2015)[1]. On average, 32% of farmers are risk averse, and 8.9% maximally risk averse (willingness to accept risk = 0). Risk seeking farmers make up 28% of the population, with 5.3% of farmers maximally risk seeking (willingness to accept risk = 10).

Willingness to accept risk is dispersed around the country (see Figure 2). There is no clear spatial pattern for estimate of county average willingness to accept risk. Each state has both counties with high densities of risk averse farmers and counties with high densities of risk seeking farmers.

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[1] The metric of risk preferences used in Roe (2015) scaled from 1-11 instead of 0-10. Therefore Roe's estimate for average risk tolerance is equivalent to 4.89, within the bounds of our 95% CI.
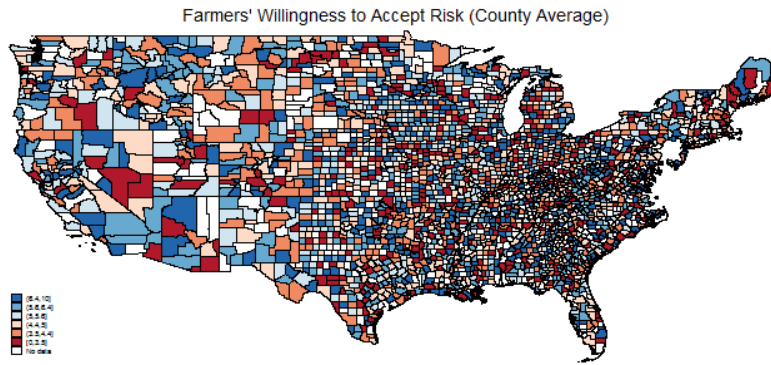
Figure 2: Average Willingness to Accept Risk for all sampled farmers per county

3.2 Individual Characteristics and Risk Aversion

Table 1 shows the results of an ordered probit regression of farmer characteristics on willingness to accept risk. Age and gender both have significant negative correlations with farmers' risk preferences. Older farmers are more likely to be risk averse than younger farmers, and women are more likely to be risk averse than men. These findings agree with previous studies on farmers (Roe, 2015) and also with other populations (Dohmen et al, 2011). Education, farming experience and being retired are all positively correlated with risk attitudes. Race and ethnicity as a category, however, is not correlated with risk attitudes after controlling for other factors.

Table 1: Ordered Probit Regression of Farmer Characteristics on Risk Preferences

	Coefficient	Std Err	P-value
Age	-0.0139	0.0014	0.000
Education	0.1887	0.0150	0.000
Gender	-0.3408	0.0471	0.000
Retired	0.2036	0.0261	0.000
Farming Experience	0.0050	0.0011	0.000
Race/Ethnicity	-0.0133	0.0195	0.497
Cut 1	-1.4961	0.1404	0.000
Cut 2	-1.1941	0.1391	0.000
Cut 3	-0.8463	0.1375	0.000
Cut 4	-0.5236	0.1371	0.000
Cut 5	-0.3119	0.1369	0.023
Cut 6	0.3331	0.1366	0.015
Cut 7	0.6052	0.1367	0.000
Cut 8	0.9805	0.1377	0.000
Cut 9	1.4463	0.1388	0.000
Cut 10	1.6819	0.1411	0.000
Number of Observations			25,493

3.3 Risk Aversion as a Predictor of Farm Characteristics and Decision-making

As shown in Table 2, willingness to accept risk is correlated with land tenure and rental decisions. Risk averse farmers are more likely to be full owners than more risk tolerant types. 80% of highly risk averse

farmers are full owners of their operations, as compared to 53-56% of highly risk seeking operators. Likewise, only 4% of highly risk averse farmers are purely tenant farmers, compared to 9% of highly risk seeking producers. Risk seeking farmers are also more likely to rent in land for their operations than risk averse farmers, although all types are about equally likely to rent out land to another operator.

Table 2: Risk Preferences, Farm Ownership, and Land Rental Decisions

Risk Preference Category	Ownership			Proportion who Rent Land In	Proportion who Rent Land out
	Full Owner	Partial Owner	Tenant Only		
0	0.8095	0.1554	0.0351	0.1952	0.1065
1	0.8053	0.1467	0.0480	0.2129	0.1620
2	0.7877	0.1738	0.0385	0.2223	0.1147
3	0.6914	0.2669	0.0417	0.3251	0.1388
4	0.7089	0.2337	0.0573	0.3132	0.1459
5	0.6533	0.2765	0.0702	0.3584	0.1212
6	0.5815	0.3358	0.0827	0.4400	0.1522
7	0.5952	0.3290	0.0758	0.4230	0.1273
8	0.5610	0.3393	0.0997	0.4598	0.1438
9	0.5356	0.3774	0.0869	0.4800	0.1214
10	0.5608	0.3483	0.0909	0.4637	0.1423
Overall	0.6640	0.2703	0.0657	0.3517	0.1315
Number of Obs	28,057			28,057	28,057
Pearson Chi-Squared	14.38***			28.11***	1.90**

The relationship between tenancy and risk attitudes may be related to beginning farmers. Table 1 shows that younger farmers are more likely to be risk seeking than older farmers, and younger farmers are more likely to rent a larger portion of their operation than older farmers (Bigelow et al, 2016). Bigelow et al also note that small family farms are less likely to rent in land than larger scale operations, and larger operations tend to be organized most often as part-owner operations. If access to land is a major barrier for beginning farmers (Ahearn and Newton, 2009) and younger farmers are more risk seeking, then we would expect to see risk seeking farmers engaging in more tenancy and partial ownership operations than risk averse producers.

Table 3 displays the correlations between willingness to accept risk and different types of farm management decisions. Risk averse farmers are likely to have fewer co-operators and smaller size operations than risk seeking farmers. These findings are consistent with the results on land tenancy shown in Table 2.

Table 3: Risk Preferences, Farm-Management Practices, and Outcomes

	Number of Observations	Risk Preferences	Risk Averse	Risk Neutral	Risk Seeking

	Number of Observations	Risk Preferences	Risk Averse	Risk Neutral	Risk Seeking
Number of Co-Operators	28,057	0.0097***	-0.0528**	0.0167	0.0366
		(0.0022)	(0.0195)	0.0321	(0.0253)
Operated Acres	28,057	56.77***	-232.70***	-26.66	281.62***
		(7.42)	(78.96)	(72.28)	(39.71)
Total Operator Capital Expenses as a share of Total Production Value	25,229	-0.0367	-0.1955	0.2879	-0.1386
		(0.0563)	(0.3631)	(0.4624)	(0.3359)
Total Variable Expenses as a share of Total Production Value	25,229	-0.0926	0.4653	-0.1011	-0.3471
		(0.0561)	(0.5521)	(0.5634)	(0.4009)
Total Household Income	27,467	13,904***	-54,950***	-13,450	75,090***
		(2723)	(6720)	(8343)	(15,040)
Net Farm Income	28,057	6927***	-28,570***	-6268	38,160***
		(907.6)	(4302)	(5015)	(6438)
Ratio of Farm Income to Total Household Income	24,959	0.0418	-0.2501	0.0671	0.1923
		(0.0302)	(0.2708)	(0.1860)	(0.1182)

Risk attitudes are uncorrelated with either capital investment or expenses on variable inputs. This parallels findings from Baumgart-Getz et al (2012) that risk attitudes do not influence adoption of farm best management practices. Risk attitudes are strongly correlated with farm income and total household income. Risk seeking farmers have higher farm and household incomes than risk averse farmers, although the ratio of farm income to total household income does not vary with willingness to accept risk. Risk seeking farmers operate larger size farms, which could explain the differences in farm incomes.

Risk attitudes also correlate with the use of different risk management strategies, however the effect may be counter-intuitive for some strategies. As shown in Table 4, risk averse operators grow a smaller number of crops and engage less in forward contracting than risk seeking farmers. Typically, crop diversification and forward contracting as assumed to be risk-reducing, and should therefore be more appealing to risk averse individuals. Overall, risk averse farmers maintain a higher share of working capital than risk seeking farmers, although aggregate differences between risk averse, risk neutral, and risk seeking farmers are not statistically significant. However, risk seeking operators have higher levels of retirement and non-retirement savings and total financial assets.

Risk attitudes are uncorrelated with enrollment in ARC or PLC commodity support programs, and also uncorrelated with participation in the Conservation Reserve Program (CRP). However, risk seeking operators also spend more on crop insurance in aggregate and as a share of the value of production. Federal crop insurance is heavily subsidized to make the program more attractive to producers (Glauber, 2013). Our findings suggest that those subsidies are accruing more to risk seeking producers than to risk averse farmers. However, our analysis does not control for household-level risk exposure which has been shown to impact farmers' purchases of Federal Crop Insurance (Sherrick et al, 2004).

Table 4: Risk Preferences and Risk Management Decision-Making

	Number of Observations	Risk Preferences	Risk Averse	Risk Neutral	Risk Seeking

Number of Crops Produced	28,057	0.0773*** (0.0065)	-0.4009*** (0.0214)	0.0861* (0.0438)	0.3271*** (0.0557)
Share of production under contract	25,229	0.0074*** (0.0009)	-0.0357*** (0.0064)	-0.0043 (0.0075)	0.0406*** (0.0079)
Ratio of Working Capital to Total Expenses	28,057	-19.00** (8.17)	52.57 (47.20)	32.33 (72.09)	-95.10 (57.80)
Non-retirement Savings	20,525	11,186*** (3357)	-44,967*** (15,013)	-23,861 (15753)	76,841** (31239)
Retirement Savings	27,467	4366*** (1475)	-16,733* (8860)	-9914 (11,557)	29,835** (13,953)
Total Farm Financial Assets	28,057	124,200*** (8404)	-549,000*** (41,960)	-68,230 (64,810)	670,800*** (65,620)
Insurance Expenses	28,057	982.0*** (45.86)	-4224*** (210.5)	-729.9** (299.4)	5407*** (388.9)
Federal Crop Insurance Expenses	28,057	462.5*** (23.21)	-1967*** (111.6)	-366.5*** (118.3)	2549*** (182.9)
Federal Crop Insurance as a Share of Total Value of Production	25,229	0.0009*** (0.0001)	-0.0041*** (0.0006)	-0.0007 (0.0007)	0.0049*** (0.0008)
Enrollment in ARC or PLC	28,057	0.0012 (0.0011)	-0.0048 (0.0057)	0.0010 0.0062	0.0040 (0.0067)
Enrollment in CRP	28,057	-0.0003 (0.0013)	0.0006 (0.0089)	0.0018 (0.0109)	-0.0028 (0.0082)

To summarize, we find that compared to risk seeking farmers, risk averse farmers are more likely to be full owners, less likely to rent-in land, farm smaller operations, share responsibilities with fewer co-operators, and have lower farm and household incomes. Risk averse farmers are also less likely to diversify production, use contract production, invest in crop insurance, or invest in savings. Risk averse producers do, however, maintain higher levels of working capital. We find no difference in propensity to rent out land, participation in commodity support programs or CRP, expenditure on capital or variable inputs, or ratio of farm income to household income across risk types. These results suggest that US farmers may not be using crop diversification, contracted production, crop insurance, or commodity support programs specifically as a means to mitigate risk exposure.

4. Discussion

These results raise a few interesting questions. First, are the correlations measured in this study indicative of differences in risk aversion or some other factors correlated with both risk aversion and farm outcomes? Our results show that risk seeking farmers have significantly more co-operators on average than risk averse farmers. Several experimental studies have shown that teams tend to make decisions that reflect more risk aversion than decisions made by individuals alone (Rockenbach et. al, 2007; Sutter, 2007; Shupp and Williams, 2008). If risk averse producers are making farm and investment decisions individually on average and risk seeking producers making the same decisions within teams on

average, then both sets of decisions should reflect risk averse attitudes. That would suggest that the correlations we measure reflect differences across farmers beyond their attitudes towards risk.

Second, are relationships between farmers' risk attitudes and outcomes stable over time? Using the 2014 ARMS sample, we observe that risk seeking and risk averse farmers tend to have similar shares of total income from farm income. That indicates a positive correlation between on-farm revenues and off-farm household income within in this sample. However, research using the 2004 ARMS sample found that operators of smaller farms had higher off-farm incomes than larger-scale operators (Fernandez-Cornejo et al, 2007). The 2004 ARMS questionnaire did not include any measures of attitudes towards risk, so it is not possible to verify if smaller farms in 2004 were more likely to have risk averse operators. It is possible that either the correlation between risk attitude and farm size or risk attitude and dependency on off-farm income has shifted over time. On the other hand, the decade between 2004 and 2014 saw significant changes in commodity prices and farm incomes (Key et al. 2017). Larger scale producers have been shown to have higher income volatility than retiree and lifestyle farms (Poon and Weersink, 2011; Key et al. 2017), and farm households tend to have more off-farm income in response to farm income volatility (Mishra and Goodwin, 1997). It is also plausible that large scale producers adjusted to the changes in farm income volatility during 2004-2014 by shifting to have more off-farm household income independently of their willingness to accept risk, again suggesting that observed correlation patterns stem from something besides risk attitudes.

Third, is this metric of willingness to accept risk a good construct for measuring farmers' risk preferences? Experimental risk elicitation instruments are considered to be the gold standard for measuring risk preferences (Charness et al, 2013). This survey metric has been shown to be correlated with real-world outcomes including investment in stock markets, tendency toward self-employment over salaried labor, and smoking (Dohmen et al, 2011). It has also been shown to have better test-retest stability and correlation with within-experiment decision-making than one of the most commonly used experimental approaches (Lönnqvist et al, 2015). However, it was not well correlated with actual crop insurance purchases for a non-representative sample of Italian farmers (Menapace et al, 2016).

Our results show risk seeking farmers are more likely to purchase crop insurance, which agrees with the findings of Hellerstein et al (2013) who measured risk attitudes for a small sample of US farmers using standard experimental elicitation techniques. Previous research has suggested that farmers treat crop insurance less as a risk management strategy and more as a stand-alone risky investment (Babcock, 2015), which would therefore be more attractive to risk seeking individuals. We also observe in the sample that risk seeking individuals are more likely to invest in retirement and non-retirement savings. Therefore from the vantage point of risky investments, the survey question yields consistent results.

The survey question also capture correlations with land tenure and rental decisions, and these correlations have signs which match with our *a priori* expectations. Einav et al. (2012) demonstrate that risk attitudes can vary substantially within the same individual across different types of financial risks. If farmers do assess risk differently for land tenure, farm management, and risk management decisions, then it is plausible that this survey metric is suitable to capture at least some of those aspects of risky-decision making.

Lastly, assuming our metric captures true correlations between risk attitudes and decision-making, do risk attitudes matter for policy, and if so, for which policies? Our results show no aggregate differences in enrollment in commodity support programs or CRP for different risk types. Risk attitudes are

correlated with participation in Federal Crop Insurance programs, and participation patterns suggest that crop insurance is less attractive for risk averse types. Therefore policymakers who want to increase participation in the crop insurance program may want to target changes in existing crop insurance programs to better suit the preferences of risk averse types.

5. Conclusion

We characterize risk attitudes among US farmers, and show how these attitudes correlate with use of risk management options including insurance and savings; farm management decisions including crop specialization, capital investment, and land tenure arrangements; and participation in USDA programs. Our data on risk attitudes and farm and household characteristics comes from the 2014 Agricultural Resource Management Survey (ARMS) survey, a nationally-representative survey of nearly 30,000 farmers. Thus our study provides the most detailed and comprehensive view of US farmers' risk attitudes to date.

We find that compared to risk seeking farmers, risk averse farmers are more likely to be full owners, less likely to rent-in land, farm smaller operations, share responsibilities with fewer co-operators, and have lower farm and household incomes. Risk averse farmers are also less likely to diversify production, use contract production, invest in crop insurance, or invest in savings. Risk averse producers do, however, maintain higher levels of working capital. We find no difference in propensity to rent out land, participation in commodity support programs or CRP, expenditure on capital or variable inputs, or ratio of farm income to household income across risk types. These results suggest that US farmers may not be using crop diversification, contracted production, crop insurance, or commodity support programs specifically as a means to mitigate risk exposure. Our findings may be useful in understanding how changes in Federal risk management programs may impact farmers' participation decisions.

References

Ahearn, Mary, and Doris Newton (2009). Beginning Farmers and Ranchers, EIB-53, U.S. Department of Agriculture, Economic Research Service, May.

Antle, John M. "Econometric estimation of producers' risk attitudes." *American Journal of Agricultural Economics* 69, no. 3 (1987): 509-522.

Babcock, B. A. (2015). Using Cumulative Prospect Theory to Explain Anomalous Crop Insurance Coverage Choice. American Journal of Agricultural Economics, 97 (5): 1371-1384.

Bar-Shira, Ziv, Richard E. Just, and David Zilberman. "Estimation of farmers' risk attitude: an econometric approach." *Agricultural Economics* 17, no. 2 (1997): 211-222.

Baumgart-Getz, A., Prokopy, L. S., & Floress, K. (2012). Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature. *Journal of environmental management*, *96*(1), 17-25.

Bigelow, Daniel, Allison Borchers, and Todd Hubbs (2016). "US Farmland Ownership, Tenure, and Transfer." USDA Economic Research Service, Economic Information Bulletin 161, August.

Charness, G., Gneezy, U., & Imas, A. (2013). Experimental methods: Eliciting risk preferences. *Journal of Economic Behavior & Organization*, *87*, 43–51.

Dohmen, Thomas, Armin Falk, David Huffman, Uwe Sunde, Jürgen Schupp, and Gert G. Wagner (2011). "Individual risk attitudes: Measurement, determinants, and behavioral consequences." *Journal of the European Economic Association* 9, no. 3: 522-550.

Du, X., Feng, H., & Hennessy, D. A. (2016). Rationality of Choices in Subsidized Crop Insurance Markets. *American Journal of Agricultural Economics*.

Dubman, R.W (2000). Variance Estimation with USDA's Farm Costs and Returns Surveys and Agricultural Resource Management Study Surveys. USDA-ERS Staff Paper No. AGES 00-01.

Einav, L., Finkelstein, A., Pascu, I., & Cullen, M. R. (2012). How General are Risk Preferences? Choices under Uncertainty in Different Domains. *The American Economic Review*, *102*(6), 2606–2038.

Fausti, Scott, and Jeffrey Gillespie. "Measuring risk attitude of agricultural producers using a mail survey: how consistent are the methods?." *Australian Journal of Agricultural and Resource Economics* 50, no. 2 (2006): 171-188.

Fernandez-Cornejo, J., Mishra, A. K., Nehring, R. F., Hendricks, C., Southern, M., & Gregory, A. (2007). *Off-farm income, technology adoption, and farm economic performance* (No. 7234). United States Department of Agriculture, Economic Research Service.

Glauber, J. W. (2013). The growth of the federal crop insurance program, 1990–2011. *American Journal of Agricultural Economics*, *95*(2), 482-488.

Hellerstein, Daniel, Nathaniel Higgins, and John Horowitz (2013). "The predictive power of risk preference measures for farming decisions." *European Review of Agricultural Economics*.

Key, N., Prager, D., & Burns, C. (2017). Farm Household Income Volatility: An Analysis Using Panel Data from a National Survey. USDA Economic Research Service, Economic Research Report 226, February.

Lönnqvist, J.-E., Verkasalo, M., Walkowitz, G., & Wichardt, P. C. (2015). Measuring individual risk attitudes in the lab: Task or ask? An empirical comparison. *Journal of Economic Behavior & Organization*, *119*, 254–266.

Menapace, L., Colson, G., & Raffaelli, R. (2016). A comparison of hypothetical risk attitude elicitation instruments for explaining farmer crop insurance purchases. *European Review of Agricultural Economics*, *43*(1), 113–135.

Mishra, A. K., & Goodwin, B. K. (1997). Farm income variability and the supply of off-farm labor. *American Journal of Agricultural Economics*, *79*(3), 880-887.

Poon, K., & Weersink, A. (2011). Factors affecting variability in farm and off-farm income. *Agricultural finance review*, *71*(3), 379-397.

Rockenbach, B., Sadrieh, A., & Mathauschek, B. (2007). Teams take the better risks. *Journal of Economic Behavior & Organization*, *63*(3), 412-422.

Roe, B. E. (2015). The risk attitudes of US farmers. *Applied Economic Perspectives and Policy*, *37*(4), 553–574.

Sherrick, B. J., Barry, P. J., Ellinger, P. N., & Schnitkey, G. D. (2004). Factors influencing farmers' crop insurance decisions. American Journal of Agricultural Economics, 86(1), 103-114.

Shupp, R. S., & Williams, A. W. (2008). Risk preference differentials of small groups and individuals. *The Economic Journal*, *118*(525), 258-283.

Sutter, M. (2007). Are teams prone to myopic loss aversion? An experimental study on individual versus team investment behavior. *Economics Letters*, *97*(2), 128-132.