Measuring Risk Attitude and Relation to Marketing Behavior

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Abstract

Researchers employ various measures of risk attitudes to investigate their relation to market behavior with mixed results. We find that a higher-order global risk attitude construct, developed using survey scales and experiments based on expected utility theory, is related to several marketing alternatives, but does not exhibit substantially greater explanatory power than underlying measures. With few exceptions, scales yield greater significance of risk attitudes for these choices, but experimental measures reveal other insights, e.g., differential attitudes in gain and loss domains. Given recent concerns with experimental measures in the literature, we suggest studies include scales as a low cost supplemental measure.

Keywords: risk behavior, risk attitude, futures and options, forward contracts, marketing contracts.

Measuring Risk Attitude and Relation to Marketing Behavior

Various measures of risk attitudes are employed in studies dealing with risk preferences and market behavior. The evidence on whether risk preferences influence behavior is mixed, which may reflect measurement issues as well as the decision contexts in which they have been measured. Main approaches consist of measures derived from experiments conducted under the expected utility framework and measures derived from multi-item scales (Antle 1987; Chavas and Holt 1990; Goodwin and Schroeder 1994; Smidts 1997; Pennings and Smidts 2000). Despite the popularity of experimental risk-preference elicitation in the early 1980s (e.g., Binswanger 1981), there have been few applications in the agricultural economics literature since (the dialogue surrounding) Grisley and Kellog (1983, 1985). As an exception, Pennings and Garcia (2001) utilize common variance among measures from both approaches to develop a higher-order or global risk attitude construct (GRAC) and demonstrate, using factor analytic methods (Bollen 1989; Hair, et al. 1995; Thompson 2004), a statistically significant relation with producers' intent to use futures markets. Still, few agricultural economists have used experiments to elicit risk-preferences since Pennings and Garcia (2001), as "simple questions and Likert scale questions are often preferred by applied researchers because of their ease of inclusion in mail surveys and/or their relative low cost ..." (Hudson, Lusk and Coble 2005, p.41).[1] Further, several limitations of the expected utility framework have recently been identified (e.g., Just and Peterson 2010; Just, Khantachavana, and Just 2010; Just 2011).

Here, following Pennings and Garcia (2001), we develop a GRAC from measures derived from certainty equivalents obtained through computerized lottery experiments (i.e., expected utility theory) and from multi-item scales obtained through personal administration of a survey. We demonstrate the validity of this measure and its ability to predict market behavior for a sample of hog producers and crop producers, who keep accounting records through the Farm Business Farm Management (FBFM) program at the University of Illinois. In contrast to prior studies that investigate the influence of risk attitudes on the use of an individual marketing tool, we examine relations between risk attitudes and the adoption and proportional use of several distinct marketing alternatives (i.e., spot markets, futures and options, forward contracts, and marketing contracts).

In this study, producers' risk preferences are elicited directly (Roe 1982) and are represented by three measures that comprise a higher-order construct. Two measures are derived from responses to multi-item scales, and one is derived from the expected utility framework using the certainty equivalence technique for assessing the utility function. Negative exponential functions (EXP) and inverse power transformation (IPT) functions, respectively, are fit to certainty equivalents to determine if the curvature of the utility functions are globally concave (risk averse) or convex (risk seeking) as in the Pratt (1964) and Arrow (1971) framework or if the utility function exhibits an inflection point consistent with Prospect Theory (Kahneman and Tversky 1979).

Several studies evaluate the consistency of various measures of risk attitudes and/or their ability to predict behavior with mixed results (Pennings and Smidts 2000; Dohmen, Falk, Huffman, Sunde,Schupp, and Wagner 2005; Fausti and Gillespie 2006;

Fellner and Maciejovsky 2007; Anderson and Mellor 2009). Here, we evaluate the validity of a combined measure and its usefulness in predicting actual risk behavior, while controlling for other factors with accounting data. That is, various risk attitude measures are tested for convergent validity (i.e., positive correlation) using factor analytic methods (Bollen 1989; Hair, et al. 1995; Thompson 2004) to assess whether they reflect the same construct and for nomological validity (i.e., meaningful relation to other constructs, like measures of behavior) using hurdle model regression analysis (Cragg 1971; Katchova and Miranda 2004).[2] Hurdle models are utilized, since decisions regarding adoption of a particular marketing method and how much to sell using that method may be made separately or sequentially and may be influenced differently by the same variables (Katchova and Miranda 2004). Like Pennings and Garcia (2001), we find that different risk attitude measures used by researchers can be accounted for by a GRAC. We extend Pennings and Garcia's (2001) framework by relating GRAC to several marketing alternatives (i.e., adoption and proportional use of marketing contracts, forward contracts, futures and options and spot market sales) and accounting for factors, other than risk preferences, that have been identified as (partly) driving marketing decisions (i.e., experience or age and education of the producer, size of the operation, and degree of leverage). By doing so, we obtain a more complete conceptual and empirical framework than Pennings and Garcia (2001), allowing us to better understand the role of GRAC and its components in producers' decision making processes.

We proceed by reviewing various measures of risk attitude used by researchers and describing the elicitation process used in our research context. We then report the empirical risk attitude measurements and classifications for the producers in the sample and relate their risk attitudes to actual market behavior. We conclude with a brief discussion of our findings and suggestions for future research.

Literature Review

The literature is mixed regarding the relative explanatory power of risk attitude measures derived from experiments and survey scales. Pennings and Smidts (2000) find that Likert scale survey items show some agreement with intentions to reduce risk, while lottery based measures are better predictors of actual market behavior. Dohmen, et al. (2005) find a general 11-point Likert scale explains a broad spectrum of risk behavior contexts, whereas a lottery measure does not. In their study, the best predictor of risk behavior in any particular context is a context-specific survey item. Based on comparisons of the consistency of numerous survey measures of risk attitude, Fausti and Gillespie (2006) recommend using relatively simple elicitation procedures framed according to the situational construct in question. Fellner and Maciejovsky (2007) find that only lotteries explain market behavior. Anderson and Mellor (2009) observe limited consistency across measures of risk attitudes derived from experiments with monetary rewards and survey questions with hypothetical gambles. Abdellaoui, Bleichrodt, and Paraschiv (2007) find that both nonparametric and parametric approaches to eliciting utility functions and quantifying loss aversion (and gain seeking) yield similar support for prospect theory. Pennings and Garcia (2001) demonstrate that a global risk attitude construct (GRAC) utilizing common variance among scale and lottery based measures is statistically related to agricultural producers' intent to use futures markets.

However, recent studies call into question the applicability of theories commonly underlying experimental elicitation of risk preferences. For instance, Just and Peterson (2010) and Just (2011) employ a method to assess the empirical adequacy of expected utility theory (EUT) by calibrating a utility function to revealed behavior. In empirical applications, both studies find limited applicability of EUT. Just and Peterson (2010, p. 16) identify, "EUT is ... applicable only when expected payoffs of gambles are similar or when more than half of wealth is at risk." Similarly, Just (2011) concludes that large wealth transfers are necessary to justify large changes in risk aversion under EUT and that prospect theory also seems an inappropriate representation of risk preferences given his results. Just and Lybbert (2012, p. 1) investigate aversion to marginal changes in risk as opposed to standard measures of (average) risk aversion and suggest, "While a high degree of correspondence can be found between these experimental results and real world response to risk (see e.g., Pennings and Garcia 2001), framing risk as static gambles in isolation may be too restrictive a frame."

Overall, the literature suggests that measurement of risk preferences should be framed in a situation that reflects the decision making context. However, it is also clear that risk measurement is complex as alternative measures can provide different views of how individuals' respond. In this context, we examine the value of combining risk measures, each of which may not be entirely consistent, to explain behavior. Following Pennings and Garcia (2001), we develop a combined GRAC measure using scale and lottery based measures and relate it to actual behavior. Specifically, we investigate the relation between GRAC and agricultural producers' adoption and proportional use of marketing contracts, forward contracts, and futures and options contracts in addition to spot market sales. Furthermore, we consider other factors such as age, education level and leverage in order to better understand the role of GRAC in real marketing decisions.

Research Measures and Methods

The Risk Context

MacCrimmon and Wehrung (1990) and Shapira (1997) have demonstrated that risk attitude is context or situation specific. We examine Illinois agricultural producers' attitudes toward price risk for hogs and corn. Price risk is substantial in production agriculture, and producers have numerous marketing tools available to help them manage this risk. Hence, we elicit risk attitudes in the context of commodity price fluctuations and relate these measures to producers' actual use of cash transactions, forward contracts, futures and options contracts, and marketing contracts.[3]

A unique dataset was assembled by interviewing a sample of 50 hog producers and 49 corn producers in 2006. Annual accounting and production records are kept for these producers through the Farm Business Farm Management (FBFM) program at the University of Illinois, eliminating the need for producers to consult records to provide accurate estimates of such data during interviews (Pennings, Irwin, and Good 2002). FBFM is a cooperative educational-service available to all agricultural producers in Illinois for a fee (Lattz, Cagley, and Raab 2005). Presently, about one out of five Illinois commercial farms with over 500 acres or over $100,000 total farm sales participate. Interviewed FBFM producers are generally representative of larger commercial producers (Table 1). The program assists producers with management decisions by providing business analysis through computerized processing of records for income tax management. Secondary production and accounting data are collected annually by 58 full time field staff specialists serving nine FBFM associations or regions. The resulting dataset provides extensive information on the cost and debt structure of the farm operations, as well as the source of revenues (i.e., grain or livestock production).

Four rounds of pretests – two with FBFM personnel on campus and two with ten producers at their residences – were performed in October 2006. Using a personal interview process in pretests is more likely to yield improvements to the questionnaire than impersonal administration (Reynolds and Diamantopoulos 1998). In each case, survey items were modified, eliminated, and added based on comments regarding any ambiguity or other difficulty experienced with responding to the questionnaire. When possible, items that require ratings or checking boxes were employed in place of open-ended questions, based on reports from the survey literature that respondents prefer the former over the latter (Pennings, Irwin, and Good 2002). Consequently, pretest participants sometimes noted omission of potentially relevant response alternatives, one of the most common errors detected via survey pretesting (Hunt, Sparkman, and Wilcox 1982).

One hundred fifty producers were contacted and as encouragement for their participation in interviews were offered a chance at one of ten $100 lottery prizes.

Balakrishnan et al. (1992) found that using a lottery prize giveaway significantly increases willingness to respond to surveys. Personal interviews, averaging just over an hour, limited the sample size but enhanced the reliability of survey responses and enabled collection of risk attitude measures via computerized lottery experiments. Interviews were conducted from November 20, 2006 through April 2, 2007 at the producers' farms or privately at Illinois Extension offices. This lengthy interview period reflects the time intensive nature of driving to visit with individual producers and the greater availability of crop producers in January and February (Pennings, Irwin, and Good 2002).

The Certainty Equivalence Technique

Producers were asked to "put themselves in the situation of selling their commodity" when completing a computerized experiment where they faced two alternatives – one with a 50%/50% lottery (representing spot price risk) in which initial upper and lower bounds were set by researchers based on historical price ranges and one with a fixed price randomly generated by the computer within the initial price range. Prices for corn were in dollars per bushel and for hogs were in dollars per hundredweight. Hog producer experiments were available on either a live hog or lean hog (carcass) price basis, whichever producers were more familiar with. Based on producers' choices, the computer updates the fixed price and lottery price options, and does so for five iterations for each of seven utility points and three consistency checks, entailing a total of 50 decisions (five iterations per utility point for 10 total utility points). On average, the experiment took 11 minutes to complete or about 13 seconds per decision.

Following Pennings and Smidts (2003), the resulting certainty equivalents are fit to negative exponential (EXP) and inverse power transformation (IPT) functions to determine the shape of producers' utility functions *u(x)*. The EXP function implies constant absolute risk attitude and increasing proportional risk attitude and is expressed as

(1) $$u(x_i) = \frac{1-e^{-c(x_i-x_L)}}{1-e^{-c(x_H-x_L)}},$$

where x_L and x_H are lower and upper bounds of the outcome range of the 50%/50% lottery, x_i is the assessed certainty equivalent, and c is the risk attitude coefficient. A risk attitude coefficient $c > 0$ implies concavity (risk aversion), $c < 0$ implies convexity (risk seeking), and $c = 0$ implies linearity (risk neutral). The IPT function is given by

(2) $$u(x_i) = \frac{1}{1-e^{[-\alpha-\beta(1/\gamma)\log(1+\gamma X_i)]}},$$

where x_i is again the certainty equivalent and α, β, and γ are coefficients characterizing the shape of *u(x).* Here, S-shaped utility functions (concave, i.e., risk-averse, in gains and convex, i.e., risk-seeking in losses) described in Kahneman and Tversky's (1979) prospect theory may be observed, where the inflection point may be given by $u(x) = 1/2\times(1-\gamma/\beta)$. Since certainty equivalents, and not utility points, are elicited with error by experiments, the inverses of EXP and IPT functions are estimated. The inverse of the EXP function is

(3) $$x_i = \frac{\ln(0.5(e^{-cx_l}+e^{-cx_h}))}{-c} + e_i,$$

where x_l and x_h, respectively, represent the low and high outcomes of the 50%/50% lottery, and e_i is a residual error term. The inverse of the IPT function is given by

(4) $$x_i = \frac{1}{\gamma} e^{-\frac{\gamma}{\beta}\left(\log\left(\frac{1}{u(x_i)}-1\right)+\alpha\right)} - 1 + \varepsilon_i,$$

where ε_i is a residual error term.

The Risk-Attitude Scales

We follow the iterative procedure proposed by Churchill (1995) to obtain reliable and valid scales.[4] First, a pool of survey items (i.e., potential indicators) was accumulated. Specifically, we start with items previously validated in agricultural marketing contexts (e.g., Pennings and Garcia 2001). The clarity and appropriateness of the items was evaluated through pretests with producers of hogs and corn. Producers completed the questionnaire and indicated any ambiguity or difficulty experienced in responding to items. Their feedback suggested the need to only modify a few items in the interest of clarity, which is not surprising given the use of these items in previous research. The survey items used to measure risk attitude are listed in Table 2.

Measurement of Control Variables

Prior research commonly controls for the effects of age or experience and education of the producer, size of the operation, and degree of leverage (i.e., debt) on marketing decisions. Studies find that age is negatively related the percentage of crops forward priced (Musser, Patrick, and Eckman 1996) and to contract production of hogs (Key and McBride 2003), and experience is negatively related to the proportion of crop sales made with futures and options contracts (Shapiro and Brorsen 1988; Sartwelle, O'Brien, Tierney, and Eggers 2000). Hence, we expect producer's AGE in years to be positively related to cash sales and negatively related to contract use.

College education is expected to lead to greater use of forward pricing with tools such as futures and options contracts, but the evidence is mixed (Shapiro and Brorsen 1988; Goodwin and Schroeder 1994; Musser, Patrick, and Eckman 1996), and education appears to be negatively related to contract production of hogs (Key and McBride 2003). Thus, we anticipate COLLEGE, which equals one if the producer has a college education and zero otherwise, is positively related to forward pricing tools (i.e., forward contracts and futures and options) and negatively related to production contracting. Forward pricing is also significantly associated with larger acreage crop farms (Shapiro and Brorsen 1988; Goodwin and Schroeder 1994; Sartwelle, O'Brien, Tierney, and Eggers 2000), and contract hog production is generally greater among operations raising larger numbers of hogs. Hence, we expect positive relationships between use of these contracts and size as approximated by SALES (in $1000).

Typically, contract use is expected to be greater among producers bearing more debt, as lenders may extend additional loans to operations with stable cash flows. While the DEBT/ASSET ratio is expected to reflect this effect, we note that existing evidence using this measure is quite mixed (Shapiro and Brorsen 1988; Goodwin and Schroeder 1994; Musser, Patrick, and Eckman 1996; Key and McBride 2003; Katchova and Miranda 2004; Davis and Gillespie 2007). Finally, we include HOGS, which equals one for hog producers and zero otherwise (i.e., crop producers), to control for industry effects with no *a priori* expectations as to the direction of these effects.

Modeling Marketing Behavior

Several studies investigating determinants of the proportion of a crop contracted have employed Tobit procedures (e.g., Shapiro and Brorsen 1988; Goodwin and Schroeder 1994; Musser, Patrick and Eckman 1996). The log-likelihood for the Tobit model contains probabilities of nonuse of contracts from a Probit regression in the first term and a classical regression for positive amounts contracted in the second term:

$$\ln L = \sum_{\alpha_i=0} \ln \Phi\left(-\frac{\beta'_\alpha x_i}{\sigma}\right) + \sum_{\alpha_i>0} \ln\left[\frac{1}{\sigma}\phi\left(\frac{\alpha_i - \beta'_\alpha x_i}{\sigma}\right)\right], \tag{5}$$

where $\Phi(\bullet)$ is the standard normal probability density function, $\mathbf{x}_i$ and β_α are vectors of independent variables and coefficients, σ is the standard deviation, and α_i denotes the proportion contracted.[5] Following Katchova and Miranda (2004), α_i is not constrained from above since a producer conceivably may contract more than his actual *ex post* production. Under the Tobit formulation, the independent variables and associated coefficients are constrained to be the same for the contract adoption and proportion contracted decisions. Cragg's (1971) less restrictive hurdle or two-step model does not require the variables and coefficients for both decisions to be the same. The log-likelihood is the sum of the log-likelihood of a Probit regression (the first two terms) and the log-likelihood of a truncated regression (the second two terms) and is given by

$$\ln L = \sum_{c_i=0} \ln \Phi(-\gamma' z_i) + \sum_{\alpha_i>0} \left\{ \ln \Phi(\gamma' z_i) + \ln\left[\frac{1}{\sigma}\phi\left(\frac{\alpha_i - \beta'_\alpha x_i}{\sigma}\right)\right] - \ln \Phi\left(\frac{\beta'_\alpha x_i}{\sigma}\right) \right\}, \tag{6}$$

where $\mathbf{z}_i$ and γ are vectors of independent variables and coefficients pertaining to contract adoption and, and as before, $\mathbf{x}_i$ and β_i are vectors of independent variables and coefficients pertaining to the proportion contracted. When $\mathbf{z}_i = \mathbf{x}_i$ and $\gamma = \beta_\alpha/\sigma$, equations (5) and (6) are equivalent.

Results of Risk-Attitude Measurements

Expected Utility Framework

Ten certainty equivalents were assessed for seven utility levels between $u(x) = 0$ and $u(x) = 1$ with two certainty equivalents measured at $u(x) = 0.25$, $u(x) = 0.50$, and $u(x) = 0.75$ as checks of internal consistency.[6] If producers respond in accordance with expected utility theory, certainty equivalents for a given utility level should differ only by random response error. Pairwise t-tests indicate no statistically significant difference between assessed certainty equivalents for each of the consistency checks ($p > 0.23$). This result implies that producers' decisions are consistent and substantiates the experiment design's resemblance to the real business context, thereby limiting response mode effects (Payne1997; Shapira 1997).

Certainty equivalents are fit to inverses of EXP and IPT functions to determine the global shape of producers' utility functions. A producer is assigned to the EXP group if EXP estimation fits the data as well as or better than IPT estimation. However, if the mean squared error from IPT estimation is significantly lower than that from EXP estimation, based on pairwise t-tests, then the producer is assigned to the IPT group. Thus, on average, IPT estimation yields statistically higher R-squares and lower root mean squared errors for the IPT group, but there is not a statistical difference between the two estimation techniques for the EXP group (Table 3). That is, if EXP fit the data equally or better than IPT, then the producer is classified as EXP. For the EXP group, the risk attitude coefficient *c* indicates that the median producer is risk-neutral and the mean producer is risk-seeking. For the IPT group, producers, on average, have an S-shaped (convex, concave) function (i.e., $\beta > \gamma$). Table 4 summarizes the classifications of utility function shape for the whole sample and by hog and corn producers. Across samples, a smaller proportion of the producers are risk-averse than risk-neutral and risk-seeking, and nearly a quarter possess S-shaped utilities.

Estimates of the IPT function also allow derivation of inflection points for IPT group utility functions, which closely correspond to 2006 production costs. The slope coefficient from an OLS regression of inflection points on average costs of production is not statistically different from one (Table 5). Simpler pairwise *t*-tests of mean differences corroborate this finding for the full sample but also reveal how closely infection points correspond to average production costs for hog and corn producer subgroups (Table 6). For hog producers the difference is not statistically significant, but for grain producers the average inflection overestimates average production costs. This is consistent with hog producers thinking about both costs and revenues (i.e., prices) on a per hog basis. Crop producers, due to yield variation, typically think of average production costs per acre instead of dollars per bushel as crop prices are quoted. Since yield variation makes it difficult to accurately convert production costs from a per acre to a per bushel basis, crop producers tend to overestimate production costs to arrive at a conservative break-even price as a reference point when thinking in terms of gains and losses in lottery experiments.

Scaling Framework

Exploratory factor analysis of items in Table 2 for the hogs and corn group (hogs and soybeans group) yielded eigenvalues for the first two factors of 2.87 and 1.11 (2.85 and 1.11), supporting a two factor model of risk aversion where the first and second factors, respectively, explained 47.90% and 18.50% (47.57% and 18.43%) of the variation in the data. The first two items in Table 2 comprise Scale 1 and the last four comprise Scale 2. All of the factor loadings of the items exceeded 0.50, and Cronbach's (1951) alphas between 0.70 and 0.90 indicate high reliability for the construct measurement (Streiner and Norman 1995).

Based on average sum scores for these risk attitude factors or scales, producers are classified as risk-averse (positive scores), risk-neutral (zero scores), or risk-seeking (negative scores) in Table 7. Note that some of the scale's items required recoding so that negative scores imply risk-seeking and positive scores imply risk aversion. By these measures, the proportion of risk-averse producers is notably higher than indicated by measures rooted in the expected utility approach (i.e., comparing classifications in Tables 4 and 7). It may be that Table 4 statistics underestimate the percentage of risk-averse producers, as producers with S-shaped utility functions may exhibit risk-aversion for prices ranging in the domain of gains, and IPT estimates do not provide a risk attitude coefficient as is provided by EXP estimates.[7] It is worth noting that average sum scores of risk attitude scales 1 and 2 indicate greater proportions of risk averse producers in the IPT (S-shaped) utility function group (84% and 56%, respectively) than among those in the EXP group (69% and 51%, respectively), and also that a large percentage of IPT group producers use contracts that may limit their exposure to price risk (Tables 7 and 8).

Global Risk Attitude Construct

Figure 1 shows the results of confirmatory factor analysis to investigate the presence of a higher order measure of risk attitude or a global risk attitude construct (GRAC), which is comprised of risk aversion coefficients computed from the certainty equivalent measure given by equation (1) and the two scale measures.[8] The analysis was conducted on the subsample of 74 producers for which certainty equivalents fit the EXP function better than the IPT function, as risk attitude coefficient may be ascertained from EXP estimates but not IPT estimates (see footnote 7). The analysis differs from exploratory factor analysis in that items 3 through 6, for instance, are permitted to influence only Scale 2. This second-order model quantifies the presence of a common, higher order, latent factor based on correlations across the three latent risk attitude measures. Each of the three latent risk attitude measures is significantly related to the GRAC at the 10 percent level or better. The model exhibits good adherence to the data with χ^2/df of 1.22 (p = 0.262), root mean squared error (RMSE) of 0.047, and Tucker Lewis Index (TLI) of 0.962 supporting the presence of a GRAC.[9] Asterisks in Figure 1 reflect the significance of GRAC components. Interestingly, in contrast to Pennings and Garcia (2001), where the GRAC was driven by measures derived from experiments, here scales have a relatively greater influence on GRAC composition. This point is reflective of the relative ability of individual components of the GRAC to explain behavior, as discussed in the next section.

Global Risk Attitude Construct and Marketing Behavior

Marginal effects from regressions for adoption (i.e., binary probit) and proportional use (i.e., truncated least squares) of various marketing alternatives are presented in Table 9 for hog and corn sales.[10] In particular, we examine producers' usage of marketing contracts, forward contracts, futures and options, and spot sales.

Findings for several producer characteristics are consistent with prior findings. For instance, age is positively related to spot market use and negatively related to contract use (Table 9). Producers with larger operations, as indicated by level of sales (in $100,000) and those with college education are more likely to use futures and options. Of the producers using futures and options, those with college education use these marketing tools proportionally less. Such interesting subtleties are observable due to the hurdle model approach used here (Cragg 1971; Katchova and Miranda 2004) and may be masked in prior studies using Tobit regressions. Producers with higher DEBT/ASSET ratios use spot markets less and forward contracts more. Relative to crop producers, there is lower use of forward contracts and futures and options by hog producers, but greater use of marketing contracts.

Notably, risk aversion (GRAC) decreases proportional use of spot markets and increases proportional use of forward contracts but not futures and options. Clearly, finding that producers with relatively greater aversion to risk make greater use of forward contracts to limit their exposure to cash price variation is an intuitive result. The finding for futures and options is unexpected, however. It may be that futures and options are also used for reasons other than risk abatement. During interviews, some producers noted that they at times utilize futures markets in a more speculative manner, and the fact that futures and options usage was not distinguished by motives (i.e., hedging vs. speculation) in data collection may contribute to confounding effects. Another unexpected result is that risk aversion significantly decreases proportional use of marketing contracts for hog and corn sales (Table 9). However, this finding is particularly sensitive to model specification. Replacing the debt-to-asset ratio by an alternative measure (i.e., capital replacement and term debt repayment margin) or using soybean sales in place of corn sales yields alternative results. Under these specifications, adoption of marketing contracts significantly increases with risk aversion (respective *p*-values of 0.104 and 0.016) but indicates no significant effects on proportional usage. Similarly, adoption of marketing contracts is significantly greater among producers with S-shaped utility functions, as measured by a binary dummy variable (*p*-value = 0.082) in probit regressions using the alternative debt measure but not the debt-to-asset ratio.[11] This finding may reflect loss-averse producers' willingness to sign contracts offering price floors or premiums over cash prices that help to ensure profitability.

Table 10 compares R^2 values from alternative regressions using each of the measures of risk attitude to assess their relative explanatory contribution. The GRAC is the best predictor in only two of these regressions, but is a close second in many of the others. In light of the relative importance of the scale measures in the GRAC formulation, it is not be too surprising that these measures provide somewhat similar or even modestly better explanatory power than the more sophisticated construct. Examination of the importance of the individual risk coefficients (not shown) also is supportive of the scale measures. For the regressions, the measures derived from scales typically are at least as significant as the GRAC and more significant than the measure derived from experiments alone. Only for the binary probit models related to forward contract adoption did the experimentally derived measure provide a significant and a more intuitively positive relationship than the scale measures. This relationship also is not implied by the heavily scale influenced GRAC measure.

These findings contrast Pennings and Garcia's (2001) results in which the GRAC is more heavily influenced by two experimental measures than by scales, and is superior to the underlying components as a predictor of producers' intended behavior. In addition, Pennings and Garcia's (2001) GRAC has a significantly positive influence on producers' *intended* futures market usage, while we find no such relationship between actual futures market usage and any of the risk attitude measures. Notably, Pennings and Garcia's (2001) structural equation model accounts for measurement and modeling error but does not distinguish between adoption and proportional use of marketing methods and does not control for other producer characteristics as we do here.

Conclusions

This paper builds on previous research by Pennings and Garcia (2001) that relates producers' intention to use futures contracts to a global risk attitude construct (GRAC) comprised of multi-item scale and expected utility theory (EUT) based measures of risk attitude. Here, the relation between a GRAC and several distinct alternative marketing methods is investigated for hog producers and corn producers for which production and accounting data are available through the Farm Business Farm Management (FBFM) program at the University of Illinois.

The reliability and validity of the risk attitude measures underlying the GRAC is established first. As indicated by EUT measures derived from experiments, most of the interviewed producers possess globally concave (risk-averse) or convex (risk-seeking) utility functions, from which risk aversion coefficients could easily be inferred for development of the GRAC. Interestingly, average costs of production seem to drive the occurrence of inflection points for a quarter of the sample, which exhibit S-shaped utility functions corresponding to Prospect Theory (Kahneman and Tversky 1979). This group of producers may be risk averse for prices ranging above their production cost (i.e., gains) and risk seeking for lower price ranges (i.e., losses). For hog producers, production costs do not differ significantly from inflection points, but corn producers' inflection points are statistically higher than average costs of production. Corn producers normally view production costs on a per acre basis due to yield variation and appear to error on the side of caution when converting production costs to a per bushel basis for comparison to per bushel prices.

Regression analyses reveal that increasing risk aversion is statistically associated with lower use of spot transactions and greater use of forward contracts. Here, using the GRAC measure of risk attitude offers similar or better explanatory power than its underlying measures. However in other cases, the scale measures provide modestly better explanatory power and significant findings—a result consistent with their relative importance in the GRAC formulation. Despite the conceptual attractiveness of combining various risk measures, the overall findings suggest that their use may yield little relative gain in explaining behavior.

In the context of the literature our findings are mixed. Our results highlight the importance of the Likert scales, but do not signal the superiority over lottery measures found by Dohmen, et al (2005). They also contrast with Fellner and Maciejovsky (2007) who find that only lotteries explain market behavior, and with Anderson and Mellor (2009) who observe little consistency across survey and experimental measures of risk attitudes. Our findings are somewhat similar to Pennings and Garcia (2001) who demonstrate that a GRAC utilizing common variance among scale and lottery based measures is statistically related to producers' intended use of futures markets. However, the superiority of their GRAC measure relative to its underlying components, and the relatively greater contribution of the EUT measure to its formulation, is not observed in our results. One possible explanation for these differences is our focus on actual marketing behavior, rather than intentions. Our finding of relatively lower significance and explanatory power of the EUT measure in comparison to alternative measures seems consistent with recent work raising questions about the adequacy of risk attitude measures derived from experiments based on EUT (e.g., Just and Peterson 2010; Just, Khantachavana, and Just 2010; Just 2011). Clearly, these concerns imply that further work is needed to improve risk attitude measures derived from experiments. Our findings also suggests that including survey items on risk attitudes may be a low cost supplement to experiments as they allow for checks of consistency and accuracy of EUT measures and permit comparative analysis of risk-related behavior.

Further, future research may investigate under which circumstances simpler rather than more sophisticated risk measures are needed. One advantage of lottery-based experiments is that they yield measures that allow insights into whether risk attitudes differ in the domains of gains and losses, as suggested by prospect theory (Kahneman and Tversky 1979). Typical use of simpler scale survey items does not permit identification of such effects. However, a challenge with S-shaped utility functions is that it becomes more problematic to identify effects of risk attitudes on behavior, unless data are collected for several utility points in both gain and loss domains. Pennings and Smidts (2003) find that S-shaped utility functions are related to operational or organizational decisions to buy rather than make (raise) weaner pigs, whereas we find some evidence that producers with S-shaped utility functions are more likely to use marketing contracts. Future research can investigate whether asking producers to answer scale survey items under alternative scenarios of higher and lower price ranges yield similar insights. Finally, the results presented here indicate that much of the unexplained variance in marketing behavior reflects factors other than error in measuring risk attitude. This suggests the importance of proper specification of the surrounding situation to accurately identify the effect of risk on behavior.

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Footnotes

[1] Papers citing Pennings and Garcia (2001) typically acknowledge the comprehensive approach combining scale and experimental measures of risk attitude and proceed to use one or the other measure individually in their own work (e.g., Lusk and Coble 2005; Hudson, Lusk and Coble 2005; Franken, Pennings, and Garcia 2012) or reference the use of factor analysis to combine measures (e.g., Tonsor, Schroeder, and Pennings 2009; Pope, Schroeder, Langemeier,and Herbel 2011).

[2]Convergent validity (i.e., positive correlation) refers to whether variables reflect the same construct and for nomological validity reflects meaningful relation to other constructs, e.g., measures of behavior (Churchill 1995).

[3] While specialty crop (e.g., seed, non-genetically modified, or identity preservation) contracts could be distinguished as production contracts, since producers may not take ownership of the seed or crop in some cases, they are categorized here as specialty marketing contracts following Katchova and Miranda (2003).

[4] Reliability pertains to whether variables are consistent with the concept they are intended to measure, and validity pertains to the extent that a set of measures correctly represent the concept.

[5] The proportion contracted α_i equals the latent variable α_i^* for $\alpha_i^* = \beta_\alpha' X_i + \varepsilon_{\alpha i} > 0$ and equals zero otherwise, where $\varepsilon_{\alpha i}$ are independently and normally distributed residuals with mean zero and variance σ^2.

[6] Except for the first lottery, in which outcomes were set based on historical prices, outcomes depend on producers' prior choices between lotteries and certain prices. Thus, outcome ranges and expected values of lotteries vary across producers.

[7] Since elicited certainty equivalents span both domains of losses and gains, there exist insufficient numbers of certainty equivalents to detect statistically positive risk attitude coefficients (i.e., risk aversion) for just the gains domain.

[8] Estimated relationships can be expressed as $y = \Lambda_y\eta + \varepsilon$ between observed variables y and first-order factors η and $\eta = \Gamma\xi + \zeta$ between first-order factors and second-order factors ξ, where Λ_y and Γ are matrices of partial regression coefficients commonly referred to as factor loadings and ε and ζ are residual errors. See Pennings and Garcia (2001) for a more detailed account of the measurement model for the second order factor.

[9] For RMSE, a value below 0.08 indicates a close fit (Browne and Cudeck 1986). For TLI, a value greater than 0.90 is recommended (Hair et al. 1995).

[10] To examine the sensitivity of our results, the analysis was conducted using the capital replacement and term debt repayment margin in place of the debt-to-asset ratio or using soybean sales in place of corn sales. Except as otherwise noted herein, the results are largely similar to those presented here.

[11] Such findings of sensitivity to specification can emerge when the correlation between different measures of the financial situation and risk attitudes are non-zero.

Table 1. Comparison of Size Distribution for Sample and Industry

Distribution of Hog Producers by Size				Distribution of Crop Producers by Size		
	FBFM Surveyed Producers	IL	US		FBFM Surveyed Producers	U.S. Harvested Cropland
>5,000 head	33.33%	17.70%	10.68%	> 2,000 acres	8.33%	4.98%
2,000-4,999 head	37.50%	12.47%	6.78%	1,000 to 1,999 acres	35.42%	5.94%
1,000-1,999 head	12.50%	10.81%	4.66%	500 to 999 acres	35.42%	9.12%
500-999 head	6.25%	8.33%	4.49%	< 499 acres	20.83%	79.96%
200-499 head	10.42%	9.76%	5.69%			
< 200 head	0.00%	40.94%	67.70%			

[a]2007 Census of Agriculture, available at

http://www.agcensus.usda.gov/Publications/2007/Full_Report/usv1.pdf

Table 2. Scale Items Representing Farmers' Risk Attitude and Results of Factor Analysis

	Hog and Corn Data	
Risk Attitude Item:	Factor 1	Factor 2
1. I usually like "playing it safe" (for instance, "locking in a price") instead of taking risks for market prices for my commodity.	***0.916***	0.209
2. When selling/marketing my commodity, I prefer financial certainty to financial uncertainty.	***0.745***	0.202
3. When selling/marketing my commodity, I am willing to take higher financial risks in order to realize higher average returns.	0.032	***0.573***
4. I like taking financial risks with my commodity farm business.	0.450	***0.609***
5. I accept more risk in my commodity farm than other commodity farmers.	0.188	***0.562***
6. With respect to the conduct of business, I dislike risk.	0.304	***0.512***
Reliability:		
Cronbach's Alpha	0.839	0.700
Cronbach's Alpha Based on Standardized Items	0.841	0.700

Note: Scaling was from -4 for strongly risk seeking to 4 for strongly risk averse. For hog farmers *hogs* was used in place of *commodity*. For grain farmers *grain* was used in place of *commodity*.

Table 3. Comparing Average Fit of EXP and IPT Functions for EXP and IPT Groups

	EXP (N = 74)			IPT (N= 25)				
	Adj R^2	RMSE	*c*	Adj R^2	RMSE	gamma	beta	Alpha
Median	0.9990	0.2485	0.0000	0.9992	0.1212	13.6667	126.0721	-72.9669
Mean								
EXP	0.9981	0.8698	-0.1891	0.9931	1.963	63.6363	758.0779	-89.0266
	(0.0003)	(0.1130)		(0.0010)	(0.3962)			
IPT	0.9846	0.9791		0.999	0.6951			
	(0.0135)	(0.1505)		(0.0002)	(0.1559)			
Difference	0.0135	-0.1093		-0.0059***	1.2680***			
	(0.0135)	(0.1312)		(0.0010)	(0.3269)			

Table 4. Shape of Utility Functions Elicited from Lottery Task

	All Producers	Hogs Producers	Corn Producers
N	99	50	49
Risk Averse	14%	12%	16%
Risk Neutral	28%	28%	29%
Risk Seeking	32%	34%	31%
S-Shaped	25%	26%	24%
	100%	100%	100%

Table 5. Results from Regressions of Inflection Points on Average Production Costs

	Coefficient	Adjusted R^2	Joint H_0: $\beta_1 = 1$ and $\beta_0 = 0$.
Average Production Cost (β_1)	0.9934***	0.9605	F(2, 23) = 0.8400
	(0.0411)		Prob> F = 0.4425
Constant (β_0)	1.2127		
	(1.2382)		

Note: N = 25. Triple asterisk (***) denotes statistical significance at the 1% level.

Table 6. Pairwise T-Test of Mean Differences between Inflection Points and Average Production Costs

Producer Type	Mean		Mean Difference
	Inflection Point	Average Production Cost	
All Producers	23.5000	22.4344	1.0656
	(4.1535)	(4.1009)	(0.8090)
Hog Producers	42.7669	41.5192	1.2477
	(1.3781)	(1.1984)	(1.5774)
Grain Producers	2.6275	1.7592	0.8683***
	(0.0818)	(0.1190)	(0.1665)

Note: N = 13 for hog producers, 12 for grain producers, and 25 for all producers. Triple asterisk (***) denotes statistical significance at the 1% level.

Table 7. Classification of Respondents Based on Average Sum Scores of Risk Attitude Scales

	All Producers		Hog Producers		Corn Producers	
	Factor 1	Factor 2	Factor 1	Factor 2	Factor 1	Factor 2
Risk Averse	69%	51%	58%	52%	80%	49%
Risk Neutral	11%	5%	12%	10%	10%	0%
Risk Seeking	20%	44%	30%	38%	10%	51%

Note: $N = 99$

Table 8. Contract Use and Risk Attitude Scales for Producers with S-Shaped Utility Functions

Percentage of Producers with S-Shaped Utility Functions Using		
Futures & Options	Forward Contracts	Marketing Contracts
35%	74%	39%
Risk Preference:	Factor 1	Factor 2
Risk Averse	84%	56%
Risk Neutral	4%	12%
Risk Seeking	12%	32%

Note: $N = 25$

Table 9. Marginal Effects for Hog and Corn Sales Regressions

	Spot Sales		Marketing Contract		Futures & Options		Forward Contract	
	Binary Probit	Truncated OLS	Binary Probit	Truncated OLS	Binary Probit	Truncated OLS	Binary Probit	Truncated OLS
AGE	0.0079**	0.0108***	-0.0124**	0.0172***	-0.0248***	-0.0143	-0.0053	-0.0008
	(0.0040)	(0.0041)	(0.0050)	(0.0037)	(0.0091)	(0.0101)	(0.0051)	(0.0062)
COLLEGE	0.0240	-0.0357	-0.0122	-0.4058***	0.2675*	-0.4622**	0.0496	0.1334
(1=Yes, 0=No)	(0.0724)	(0.0652)	(0.0700)	(0.1007)	(0.1449)	(0.2140)	(0.0898)	(0.1051)
SALES	-0.0005	-0.0006	0.0004	-0.0065**	0.0105***	0.0008	-0.0006	0.0041
($100,000)	(0.0016)	(0.0013)	(0.0014)	(0.0029)	(0.0037)	(0.0039)	(0.0017)	(0.0043)
HOG	-0.0577	0.3989***	0.1694*	0.6874***	-0.4475***	-0.4251	-0.5449***	-0.5932***
(1=Yes, 0=No)	(0.0867)	(0.0795)	(0.0917)	(0.1618)	(0.1497)	(0.2787)	(0.1056)	(0.2218)
DEBT/ASSET	-0.0007	-0.0047***	0.0019	0.0008	0.0024	0.0055	0.0029	0.0051**
	(0.0015)	(0.0016)	(0.0014)	(0.0015)	(0.0031)	(0.0047)	(0.0023)	(0.0025)
GRAC	-0.0081	-0.0147**	0.0087	-0.0344*	0.0157	-0.0211	0.0115	0.0188*
	(0.0078)	(0.0068)	(0.0073)	(0.0198)	(0.0146)	(0.0181)	(0.0102)	(0.0109)
Sigma	–	0.2269***	–	0.1023***	–	0.2584***	–	0.2641***
		(0.0242)		(0.0209)		(0.0622)		(0.0428)
Observations	71	62	71	12	71	29	71	51
Censored	–	9 truncated	–	59 truncated	–	42 truncated	–	20 truncated
Log Likelihood	-23.1162	11.2832	-21.7598	10.3281	-36.3233	15.5511	-25.4614	15.1886
Pseudo R^2	0.1436	0.3645	0.3254	0.0071	0.2435	0.1305	0.3968	0.3984

Note: Asterisk (*), double asterisk (**), and triple asterisk (***) denote significance at 10%, 5%, and 1%, respectively.

Table 10. R^2 for Models of Marketing Methods for Hog Producers and Corn Producers using Alternative Measures of Risk Attitude

	Spot		Marketing Contract		Futures & Options		Forward Contracts	
	Probit	Truncated	Probit	Truncated	Probit	Truncated	Probit	Truncated
Scale 1	0.1299	**0.3725**	**0.3343**	0.0090	**0.2522**	0.0989	0.3924	0.3960
Scale 2	0.1338	0.3134	0.3051	0.0251	0.2315	0.1619	0.3899	0.3652
u(x)	0.1245	0.3148	0.3333	**0.0475**	0.2459	**0.1862**	**0.4099**	0.3554
GRAC	**0.1436**	0.3645	0.3254	0.0071	0.2435	0.1305	0.3968	**0.3984**

Note: Best R^2 is bolded.

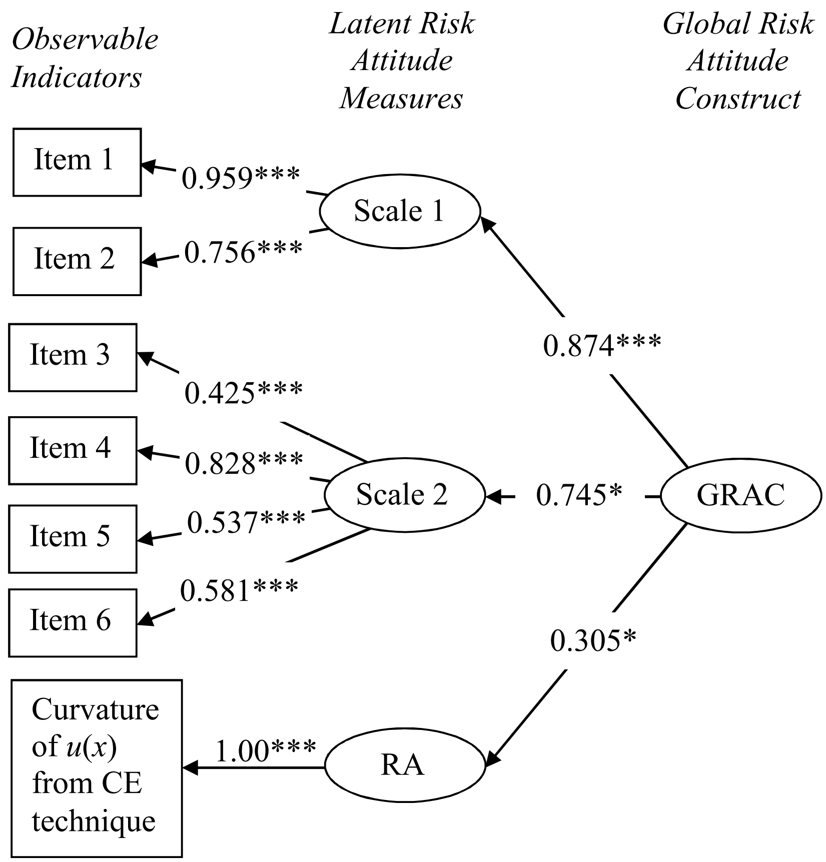

Figure 1. Second-order confirmatory factor model

Note: Asterisk (*), double asterisk (**), and triple asterisk (***) denote significance at 10%, 5%, and 1%, respectively.