# Producers' Complex Risk Management Choices

**Joost M.E. Pennings**
*Department of Marketing, Department of Finance, Maastricht University, Tongersestraat 53, 6211 LM, Maastricht, The Netherlands; University of Illinois at Urbana-Champaign, Department of Agricultural and Consumer Economics, 326 Mumford Hall, MC-710, 1301 West Gregory Drive, Urbana, Illinois 61801; and Marketing & Consumer Behavior Group, Wageningen University, Hollandseweg 1, 6706 KN Wageningen, The Netherlands. E-mail: JME.Pennings@mw.unimaas.nl*

**Olga Isengildina-Massa**
*Department of Applied Economics and Statistics, Clemson University, 295 Barre Hall, Box 340313, Clemson, SC 29634-0313. E-mail: olga123@clemson.edu*

**Scott H. Irwin**
*Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, 326 Mumford Hall, MC-710, 1301 West Gregory Drive, Urbana, Illinois 61801. E-mail: sirwin@uiuc.edu*

**Philip Garcia**
*Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, 326 Mumford Hall, MC-710, 1301 West Gregory Drive, Urbana, Illinois 61801. E-mail: p-garcia@uiuc.edu*

**Darrel L. Good**
*Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, 326 Mumford Hall, MC-710, 1301 West Gregory Drive, Urbana, Illinois 61801. E-mail: d-good@uiuc.edu*

## ABSTRACT

Producers have a wide variety of risk management instruments available, making their choice(s) complex. The way producers deal with this complexity can vary and may influence the impact that the determinants, such as risk aversion, have on their choices. A recently developed choice bracketing framework recognizes that producers are unable to evaluate all alternatives simultaneously and that to manage a complex task, they often group or bracket individual alternatives and their consequences together in choice sets. Data on 1,105 U.S. producers show that producers do not use all available combinations of risk management tools and that the influence of the determinants of producer's risk management decisions are not necessarily the same across risk management strategies within and across bracketing levels. The findings may help resolve puzzling results on the role that well-known determinants of risk management behavior have on producers' choices, extending knowledge on producers' risk management behavior. Further, the findings have managerial implications for policy makers and agribusiness companies that provide risk management services. [EconLit citations: M000, G1000, Q130] © 2008 Wiley-Liss, Inc.

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## 1. INTRODUCTION

The literature on the determinants of risk management behavior has produced relevant, but sometimes puzzling results. For instance, the role of risk aversion in management behavior appears ambiguous; with some researchers, finding a strong relationship between risk aversion and the use of risk management instruments while others do not (e.g., Pennings & Garcia, 2001; Rabin & Thaler, 2001). Most work on the determinants of risk management behavior has focused on relatively simple choices—whether to use futures or options contracts (Pennings & Leuthold, 2000) or crop insurance (Knight & Coble, 1997)—and has demonstrated that decisions regarding forward pricing and crop insurance use are driven to a certain extent by similar factors. Recent studies have examined the combination of forward pricing tools and crop insurance. Coble, Heifner, and Zuniga (2000) examine the impact of hedging on the use of crop insurance, and Katchova and Miranda (2004) analyze the impact of futures, crop insurance and advisory services on the use of cash marketing contracts. These studies have focused on one particular tool (e.g., crop insurance in Coble et al. and marketing contracts in Katchova and Miranda) with the use of alternative tools serving as factors in their analyses. In reality producers have many risk management instruments from which they can choose, including futures and options contracts, forward contracts and insurance products, and the availability of the instruments allows producers to combine specific tools into strategies that fit their risk management needs. When risk management decisions are viewed in terms of combinations of tools, the number of alternatives in a producer's decision set quickly becomes very large. For example, with six price risk management instruments and six crop insurance products, producers face a total of 4,096 ($2^6 \times 2^6$) combinations of instruments. The following questions emerge: How do producers make decisions in this complex environment and does the structure of the choices influence our understanding of the role of the determinants of behavior?

Recent advances in the behavioral economics and psychological literature may improve our understanding of how producers deal with complex choices and how the determinants of behavior in risky and complex situations affect choice. Here, we use a choice bracketing framework to examine the factors that determine the combinations of risk management tools used by producers. This framework seems particularly useful because it recognizes that decision makers are unable to evaluate all alternatives simultaneously and that to manage a complex task, they often group or bracket individual choices together in sets. Final choice is made by considering only the consequences of the alternatives within a set. In the risk management context, choice of one risk management instrument is likely to influence the choice of another instrument, and inaccurate identification of the brackets may cloud our understanding of the determinants of behavior and their effect on choice.

The research may help resolve puzzling results on the role that well-known determinants of risk management behavior have on producers' choices, extending the knowledge of producer behavior. Further, the bracketing framework may permit us to better understand why some alternatives are attractive for one producer but not another. We expect that observed differences may emerge when seemingly similar producers bracket their choices differently. For example, while alternative A may not seem to be attractive when considered in isolation (e.g., narrow bracket), it may be attractive when considered with other alternatives (e.g. broad bracket). This

"adding-up" effect may be of interest as presenting alternatives in isolation or together may yield different behavior.

We examine the combinations of risk management instruments used by U.S. crop producers based on data from 1,105 U.S. corn, cotton, soybean, and wheat producers. The usefulness of the bracketing framework is illustrated by a number of multinomial logit models in which the dependent variables are risk management strategies (i.e., combination of tools used) at different bracketing levels and the independent variables are the determinants of risk management behavior as identified in the agricultural economics literature.

The findings may be of interest to producers, policy makers, and agribusiness companies providing risk management services. Producers may not be aware how to approach complex decisions because they use a "routine" or heuristic approach. For policy makers, this research may help when trying to understand policy to help producers with risk management. For example, answers to the questions—do producers consider the adoption of an insurance plan simultaneously with their decisions regarding futures contracts? Or are producers evaluating the offered insurance in isolation?—may assist policy better predict adoption of new insurance programs. In addition, policy makers may have tools available (e.g., education and product design) to induce a particular bracketing that could influence desired outcomes. Similarly, companies may design products in such a way to fit or complement other products and then communicate complementary when marketing to producers.

## 2. COMPLEX DECISIONS

In the economic literature, it is often assumed that a decision maker evaluates all available information and alternatives and selects the alternatives that maximize utility. Various authors have reported that this approach is not able to describe actual behavior (McFadden, 1999; Rabin, 1998; Thaler, 2000). Rabin and Thaler provide an extensive discussion on how human behavior differs from that predicted by normative economic models. The psychological literature offers explanations for the existence of these anomalies arguing that humans have limited capacity to process information. Miller (1956) showed that there are physiological limitations to the pace at which humans can process information. Experiments have shown that decision makers may in some cases simply fail to consider the entire choice set.

Choice bracketing proposed by Read, Loewenstein, and Rabin (1999) can be helpful when explaining producers' complex risk management choices. Bracketing can be used to describe how producers process information and deal with complex choices. Formally, bracketing refers to the grouping of individual alternatives in sets and the consequences of the groupings. Some producers may make decisions based on narrow choice sets that contain only a few alternatives which implies, for example, that they assess using futures or options without taking into account the consequences of other alternatives. Other producers may make decisions by processing information on broad choice sets containing multiple alternatives and consider the consequences of these risk management instruments simultaneously.

Read et al. (1999) argue that broad bracketing allows decision makers to consider all consequences of their actions and therefore generally leads to choices yielding higher utility. An important aspect of bracketing is the adding-up effect, which is

defined by "alternatives that are chosen repeatedly have trivial or even non-noticeable costs or benefits when considered individually. When choices are bracketed together, however, the aggregate costs or benefits can exceed a threshold so that they play a greater role in choice" (Read et al., p.176). The intuition that expanding the choice set permits decision makers to see valuable complementary or conflicting relationships may be particularly relevant in the context of this study. For instance, high yield variability decreases hedging effectiveness, but if yield insurance is purchased at the same time, hedging effectiveness may increase. The adding-up effect may also decrease (or eliminate) the combined use of certain instruments if their functions or consequences of their use are overlapping. The notion that broad bracketing generates higher utility is consistent with the traditional assumption in the economic literature that a decision-maker evaluates all available information and alternatives and is able to select the alternatives that maximize utility.

Here, we investigate the effect of the determinants of producer risk management choice using different bracketing schemes to gain insight into producer behavior and shed light on conflicting findings in the literature. Bracketing may explain behavior that does not seem to correspond to the choices predicted by current risk management models. The next section describes the data used in the analysis.

## 3. EMPIRICAL SETTING: COMBINATIONS OF RISK MANAGEMENT TOOLS USED BY PRODUCERS

The data used to examine producers' use of various risk management tools were generated from a survey of U.S. crop producers conducted in January/February 2000. The sample was drawn from directories kept by a U.S. firm that delivers agricultural market information and advisory services via satellite. Background information on producer age, size of farm, and crops grown was also obtained. In general, the customers of the firm represent relatively large-scale commercial farmers. To increase the response rate and the quality of the data collected, we pretested the survey with a group of 15 farmers to identify any ambiguity or difficulty in responding to the questions. Based on the feedback, questions were eliminated, others were modified, and additional questions were developed. The cover letter indicated that the information provided would remain strictly confidential and that respondents could call one of the researchers if they had any questions about the survey. Further details of the survey development and execution are discussed in Pennings, Irwin, and Good (2002). The survey instrument was sent to 3,990 producers in the Midwest, Great Plains, and Southeast.[1] A total of 1,105 usable questionnaires were returned for this research.

The demographic characteristics of respondents reported in Table 1 suggest that they can be classified as relatively large commercial producers.

The scale of the farm operation was about four times the national average (as reported by the 2002 Census of Agriculture) if measured by total acreage and about five times the national average if measured by gross annual sales. On average,

[1]The Midwest is represented by Illinois, Iowa, Minnesota, Missouri, Nebraska, Ohio, and Wisconsin. The Great Plains include Colorado, Kansas, Montana, North Dakota, Oklahoma, South Dakota, and Texas. The Southeast includes Alabama, Arkansas, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, South Carolina, and Virginia.

TABLE 1. Descriptive Statistics of the Sample

| Percentage of crop producers that used one of the following price risk management instruments in 1999/2000 | | Insurance | | Age | | Gross annual farm sales | |
|---|---|---|---|---|---|---|---|
| Cash forward contract | 82.2% | Catastrophic coverage | 42.1% | Younger than 25 years | 0.7% | Over $ 1,000,0000 | 16.5% |
| Basis contracts | 42.2% | Crop revenue coverage | 49.6% | 25–29 years | 4.4% | $ 999,999–$ 500,000 | 25.9% |
| Futures contracts | 40.4% | Only hail insurance | 21.4% | 30–34 years | 12.8% | $ 499,999–$ 400,000 | 13.7% |
| Put options | 37.0% | Group risk plan (GRP) | 8.9% | 35–39 years | 21.2% | $ 399,999–$ 300,000 | 15.4% |
| Hedge-to-arrive contracts | 20.6% | Income protection (IP) | 5.8% | 40–44 years | 20.0% | $ 299,999–$ 200,000 | 17.3% |
| Minimum price contracts | 13.2% | Revenue assurance (RA) | 5.3% | 45–49 years | 18.0% | $ 199,999–$ 100,000 | 9.9% |
| | | | | 50–59 years | 18.8% | $ 99,999–$ 50,000 | 1.1% |
| | | | | 60–64 years | 2.7% | Less than $ 50,000 | 0.1% |
| | | | | 65 years and older | 1.4% | | |

| Crop acreage (planted annually) | Corn | Sorghum | Soybean | Wheat | Cotton | Rice | Hay |
|---|---|---|---|---|---|---|---|
| Over 2,000 acres | 4.5% | 1.1% | 2.9% | 9.1% | 2.2% | .4% | 5.2% |
| 1,999–1,500 acres | 16.3% | 1.5% | 10.9% | 14.7% | 3.7% | 1.3% | 3.1% |
| 1,499–1,000 acres | 42.3% | 3.0% | 34.2% | 16.3% | 4.7% | 1.8% | 5.4% |
| 999–500 acres | 7.9% | 5.1% | 14.4% | 8.0% | 1.5% | 1.1% | 7.1% |
| 499–300 acres | 6.9% | 8.3% | 9.9% | 13.3% | .6% | .8% | 14.9% |
| Under 300 acres | 2.9% | 6.6% | 4.6% | 12.4% | .4% | .1% | 21.3% |
| No acres | 19.3% | 74.5% | 23.1% | 26.2% | 87.0% | 94.6% | 42.9% |

*Note*. The sample consists of 1,105 U.S. crop producers in the Midwest, Southeast, and Great Plains. The crop producers' age, gross annual farm sales, and crop acreage were obtained from accounting data. Data on price risk management instruments and insurance products were measured during the survey and reflects usage during 1999 and 2000.

respondents were somewhat younger than the overall population of U.S. producers: 44 versus 54 years of age. The highest concentration (57%) of respondents was in the Midwest, followed by the Great Plains (35%), and the Southeast (8%). Their principal crops were corn, soybeans, and wheat. Fifty-six percent reported that they also had livestock in their farm operation. Overall, the group of producers appears to be similar to commercial producers described in previous surveys in terms of age (43 years in Schroeder, Parcell, Kastens, & Dhuyvetter, 1998) and farm size (an average of 1,572 acres in Goodwin & Schroeder, 1994 and $473,850 average gross income in Coble, Heifner, & Zuniga, 1999).

Similar to the findings from previous research, producers used a variety of risk management tools, including *forward pricing instruments* (cash forward contracts, futures, options, hedge-to-arrive contracts, minimum price contracts, and basis contracts) and *crop insurance products* (catastrophic coverage [CAT], crop revenue coverage [CRC], income protection [IP], revenue assurance [RA], group risk plan [GRP], and hail insurance).[2] Cash forward contracts were the most popular forward pricing instrument (used by 80.7% of the crop producers during the two-year period 1999–2000), followed by basis contracts (41.8%), futures contracts (40.1%) and (put) options (36%). Hedge-to-arrive contracts and minimum price contracts were less popular (19.9% and 13.6% respectively). Crop revenue coverage (49.6%) and catastrophic coverage (42.1%) were the most popular insurance products. Insurance products directly related to income, such as the income protection, revenue assurance, and group-risk plans, were less popular among the respondents.

Table 2 presents producers' use of *forward pricing strategies* (combinations of instruments) in 1999–2000. Crop producers have 64 ($2^6$) possible combinations of six available forward pricing instruments, but producers reported using only 54 different strategies.

The most popular strategy used, by nearly 20% of crop producers, was cash forward contracts only. The second most popular strategy used, by about 8% of producers, combined cash forward contracts, futures, and options contracts. Seven percent of producers used a combination of forward contracts and basis contracts. Another 7% of producers reported that they did not use any forward pricing tools. Twenty-three price risk management strategies accounted for 88.5% of all combinations used by producers.

Table 3 reports various *crop insurance strategies* used by crop producers in 1999–2000. The six relevant insurance products provide 64 ($2^6$) possible combinations.[3]

Out of the 64 possible combinations, 41 strategies were actually used. The distribution of the insurance strategies is less flat than that of the forward pricing

[2]We did not include all risk management instruments and insurance products (e.g., APH insurance) that existed at the time of the survey (2000) because that would have made the survey instrument too long and too complicated for producers.

[3]RMA regulations limit the number of insurance products a farmer can use. The rules are that a farmer can select one crop insurance product per unit. Depending on the product, each crop in a county can be divided into enterprise units (all of one crop in a county), basic units (all crop with same revenue percent from crop), and optional units (all of a crop within a township section). So, if a farmer grows corn and soybeans in one county and they use enterprise units, they could use two different products. If the same farmer had three products in two counties, they could have up to six products.

TABLE 2. Forward Pricing Strategies Used by Crop Producers in 1999–2000

| Strategy | Cash Forward Contract | Hedge using futures | Buy put option | Hedge-to-arrive contract | Minimum price contract | Basis contract | Percentage | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | % | Σ% |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 19.6 | 19.6 |
| 2 | 1 | 1 | 1 | 0 | 0 | 0 | 7.6 | 27.1 |
| 3 | 1 | 0 | 0 | 0 | 0 | 1 | 6.9 | 34.1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 6.8 | 40.8 |
| 5 | 1 | 1 | 0 | 0 | 0 | 0 | 6.3 | 47.2 |
| 6 | 1 | 1 | 1 | 0 | 0 | 1 | 6.0 | 53.2 |
| 7 | 1 | 0 | 1 | 0 | 0 | 0 | 4.0 | 57.2 |
| 8 | 1 | 1 | 0 | 0 | 0 | 1 | 3.5 | 60.7 |
| 9 | 1 | 0 | 0 | 1 | 0 | 1 | 3.4 | 64.1 |
| 10 | 1 | 0 | 1 | 0 | 0 | 1 | 2.9 | 67.0 |
| 11 | 1 | 1 | 1 | 1 | 0 | 1 | 2.9 | 69.9 |
| 12 | 0 | 0 | 0 | 0 | 0 | 1 | 2.4 | 72.3 |
| 13 | 1 | 1 | 0 | 1 | 0 | 1 | 2.3 | 74.7 |
| 14 | 1 | 1 | 1 | 1 | 1 | 1 | 2.2 | 76.8 |
| 15 | 1 | 1 | 1 | 1 | 0 | 0 | 1.5 | 78.4 |
| 16 | 1 | 0 | 0 | 0 | 1 | 0 | 1.4 | 79.8 |
| 17 | 1 | 0 | 0 | 0 | 1 | 1 | 1.4 | 81.2 |
| 18 | 1 | 0 | 1 | 0 | 1 | 1 | 1.4 | 82.7 |
| 19 | 0 | 1 | 1 | 0 | 0 | 0 | 1.4 | 84.0 |
| 20 | 0 | 1 | 0 | 0 | 0 | 0 | 1.2 | 85.2 |
| 21 | 0 | 0 | 1 | 0 | 0 | 0 | 1.1 | 86.3 |
| 22 | 1 | 0 | 0 | 1 | 0 | 0 | 1.1 | 87.4 |
| 23 | 1 | 0 | 1 | 1 | 0 | 1 | 1.1 | 88.5 |

*Note*. N = 1,105: 1 = use, 0 = do not use.

instrument combinations. The dominant strategy used by 26% of producers was crop revenue coverage insurance only. Fourteen percent of producers did not use any crop insurance. Another 14% used only catastrophic coverage. Overall, 13 strategies accounted for 91% of all crop insurance strategies used.

When considering both forward pricing instruments and insurance products, crop producers are faced with 4,096 ($2^6 \times 2^6$) possible combinations. The crop producers in the sample used 375 different *risk management strategies* in 1999–2000. Thus, only 9.15% (375) of the 4,096 total alternatives were actually used by crop producers. The distribution of these 375 strategies is flat as no dominant strategy emerged. Table 4 displays strategies used by more than 1% of the crop producers.

Fourteen strategies meet this criterion, accounting for 28% of all strategies used. The most popular risk management strategy included a combination of cash forward contracts and crop revenue coverage insurance which was used by 5% of producers in the sample. Three percent of producers reported using cash forward contracts and catastrophic coverage insurance. Only 1% of respondents did not use any risk management tools. The following section describes how the choice bracketing

TABLE 3. Crop Insurance Strategies Used by Crop Producers in 1999–2000

| Strategy | Catastrophic coverage | Crop revenue coverage (CRC) | Income protection (IP) | Revenue assurance (RA) | GRP area yield insurance | Only hail insurance purchased | Percentage | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | % | Σ% |
| 1 | 0 | 1 | 0 | 0 | 0 | 0 | 25.7 | 25.7 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 14.1 | 39.8 |
| 3 | 1 | 0 | 0 | 0 | 0 | 0 | 13.6 | 53.4 |
| 4 | 1 | 1 | 0 | 0 | 0 | 0 | 10.5 | 63.8 |
| 5 | 1 | 0 | 0 | 0 | 0 | 1 | 7.5 | 71.3 |
| 6 | 1 | 1 | 0 | 0 | 0 | 1 | 4.1 | 75.5 |
| 7 | 0 | 1 | 0 | 0 | 0 | 1 | 3.1 | 78.5 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 3.0 | 81.5 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 2.8 | 84.3 |
| 10 | 0 | 0 | 1 | 0 | 0 | 0 | 1.7 | 86.0 |
| 11 | 0 | 0 | 0 | 1 | 0 | 0 | 1.6 | 87.6 |
| 12 | 1 | 0 | 0 | 0 | 1 | 0 | 1.5 | 89.2 |
| 13 | 0 | 1 | 0 | 0 | 1 | 0 | 1.4 | 90.6 |

*Note.* $N = 1{,}105$: 1 = use, 0 = do not use.

framework is used to increase our understanding of producers' complex risk management behavior and describes the research design to illustrate the merits of using a bracketing framework.

## 4. CHOICE BRACKETING AND PRODUCERS' RISK MANAGEMENT STRATEGIES

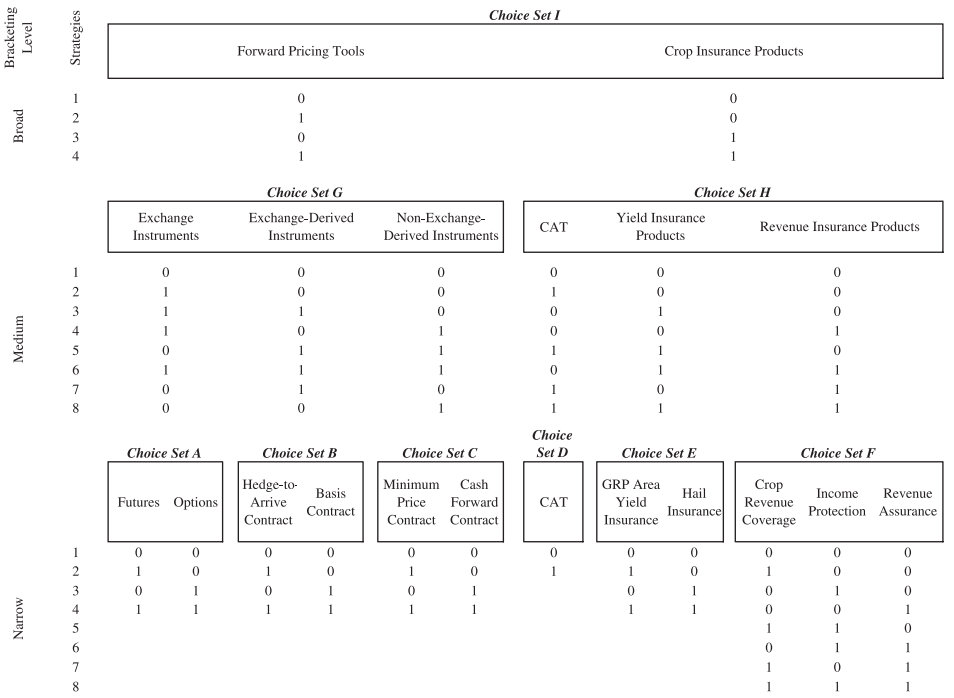
Choice bracketing suggests that individual choices may differ depending on the number of alternatives considered within choice sets. A hierarchy of bracketing levels is portrayed in Figure 1.

Some producers may bracket broadly (*Choice Set I*) and have only one choice set that includes all alternatives (e.g., all risk management instruments) while producers who bracket narrowly have many choices sets, where each choice set contains only a few alternatives (e.g., futures or options). In the context of risk management decisions the broadest bracketing level includes the entire space of 4,096 ($2^6 \times 2^6$) available combinations of risk management instruments (six forward pricing tools and six crop insurance products). In this case, a choice of risk management strategy would consist of a single decision that includes all available information. However, most producers may find it difficult to process such a large information set and will therefore group relevant alternatives into smaller choice sets. There may be various intermediate bracketing levels depending on individual's preference to process information and the characteristics of the risk management instruments. For example, producers may combine all forward pricing tools into one choice set (*Choice Set G* with $2^6 = 64$ alternatives) and all crop insurance products into another

TABLE 4. Risk Management Strategies Used by at Least 1% of the Crop Producers in 1999–2000

| Strategy | Cash forward contr. | Hedge using futures | Buy put option | Hedge-to-arrive contr. | Min. price contr. | Basis contr. | Catastrophic coverage | CRC | IP | RA | GRP | Hail insurance | Percentage % | Percentage Σ% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5.0 | 5.0 |
| 2 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3.1 | 8.0 |
| 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.5 | 10.6 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2.2 | 12.7 |
| 5 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2.2 | 14.9 |
| 6 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 2.0 | 16.9 |
| 7 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1.9 | 18.8 |
| 8 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1.5 | 20.3 |
| 9 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1.5 | 21.8 |
| 10 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1.4 | 23.3 |
| 11 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1.3 | 24.5 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.1 | 25.6 |
| 13 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1.1 | 26.7 |
| 14 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1.1 | 27.8 |

*Note.* A total of 375 different strategies (e.g., combinations of risk management instruments) were used by crop producers. $N = 1{,}105$: 1 = use, 0 = do not use.



| Bracketing Level | Strategies | Choice Set I: Forward Pricing Tools | Choice Set I: Crop Insurance Products |
|---|---|---|---|
| Broad | 1 | 0 | 0 |
| | 2 | 1 | 0 |
| | 3 | 0 | 1 |
| | 4 | 1 | 1 |

| Bracketing Level | Strategies | Choice Set G: Exchange Instruments | Choice Set G: Exchange-Derived Instruments | Choice Set G: Non-Exchange-Derived Instruments | Choice Set H: CAT | Choice Set H: Yield Insurance Products | Choice Set H: Revenue Insurance Products |
|---|---|---|---|---|---|---|---|
| Medium | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2 | 1 | 0 | 0 | 1 | 0 | 0 |
| | 3 | 1 | 1 | 0 | 0 | 1 | 0 |
| | 4 | 1 | 0 | 1 | 0 | 0 | 1 |
| | 5 | 0 | 1 | 1 | 1 | 1 | 0 |
| | 6 | 1 | 1 | 1 | 0 | 1 | 1 |
| | 7 | 0 | 1 | 0 | 1 | 0 | 1 |
| | 8 | 0 | 0 | 1 | 1 | 1 | 1 |

| Bracketing Level | Strategies | Choice Set A: Futures | Choice Set A: Options | Choice Set B: Hedge-to-Arrive Contract | Choice Set B: Basis Contract | Choice Set C: Minimum Price Contract | Choice Set C: Cash Forward Contract | Choice Set D: CAT | Choice Set E: GRP Area Yield Insurance | Choice Set E: Hail Insurance | Choice Set F: Crop Revenue Coverage | Choice Set F: Income Protection | Choice Set F: Revenue Assurance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Narrow | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| | 3 | 0 | 1 | 0 | 1 | 0 | 1 | | 0 | 1 | 0 | 1 | 0 |
| | 4 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 0 | 0 | 1 |
| | 5 | | | | | | | | | | 1 | 1 | 0 |
| | 6 | | | | | | | | | | 0 | 1 | 1 |
| | 7 | | | | | | | | | | 1 | 0 | 1 |
| | 8 | | | | | | | | | | 1 | 1 | 1 |

Figure 1 Crop producer risk management strategies. *Notes*. 1 = use; 0 = not use.

choice set (*Choice Set H* with $2^6 = 64$ alternatives), thus making two separate decisions (Figure 1). Alternatively, an outcome of the crop insurance choice set (e.g., one product) may be included in the forward pricing choice set ($2^7 = 128$ alternatives) or otherwise. Various other choice sets may also be formed on an intermediate bracketing level. Larger choice sets result in decisions that are more likely to maximize utility than smaller choice sets because they are based on more information when disregarding the cost of making complex decisions. Finally, some producers prefer to narrow their choice sets to very few alternatives. Making risk management decisions on a narrow bracketing level implies that producers make separate decisions on each individual tool or a small combination of closely related tools. As an example, Figure 1 describes a narrow bracketing in which risk management decisions are broken down into six choice sets: three choice sets related to forward pricing tools (exchange—*Choice Set A*, exchange-derived—*Choice Set B*, and nonexchange derived—*Choice Set C*—tools) and three choice sets related to crop insurance decisions (catastrophic coverage—*Choice Set D*, yield insurance—*Choice Set E*, and revenue insurance—*Choice Set F*). The exchange set of forward pricing instruments includes futures and options, the exchange-derived set includes hedge-to-arrive and basis contracts, and the nonexchange-derived set includes minimum price contracts and cash forward contracts. The catastrophic coverage set includes only one insurance product, CAT coverage. The yield insurance set includes GRP and hail insurance and the revenue insurance set includes CRC coverage, income protection, and revenue assurance.

### 4.1. Research Design: Choice Bracketing Levels

We examine the determinants that drive the use of risk management strategies by producers at different bracketing levels, assuming three bracketing levels as shown in Figure 1. At the broad bracketing level, we assume that the decision includes all forward pricing and crop insurance products, i.e., there is one choice set. We assume that at this broad bracketing level all forward pricing tools are grouped in one group and all crop insurance products are grouped in another group, which creates four implicit strategies. Figure 1 shows these four strategies by means of 0s and 1s, where a 0 indicates nonuse and a 1 indicates use of an alternative. At the medium bracketing level, we assume that producers have two choice sets. The first choice set, *Choice set G*, has three alternatives: exchange instruments, exchange derived instruments and nonexchange-derived instruments. The second choice set, *Choice set H*, also has three alternatives: catastrophic, yield, and revenue insurance products. At this bracketing level there are eight implicit strategies (e.g., combinations of risk management instruments) in each choice set. The narrow bracketing level consists of six choice sets, each choice set consisting of two to eight explicit strategies (Figure 1). These explicit strategies are the specific combinations of risk management instruments identified in Tables 2 and 3. The explicit strategies are grouped together to form implicit strategies at the medium bracketing level, which, in turn, are grouped together to form implicit strategies at the broad bracketing level. For example, if a producer does not use any futures or options, it is described by strategy 1 in *Choice Set A* on the narrow bracketing level, by 0 use of exchange instruments in *Choice Set G* on the medium bracketing level, and (when combined with 0 use of exchange-derived and nonexchange-derived instruments) by 0 use of forward pricing tools in *Choice Set I* on the broad bracketing level. Thus, six *explicit* choice sets at the narrow bracketing level are embedded into two *implicit* choice sets at the medium bracketing level, which, in turn, are nested into one choice set at the broad bracketing level. The eight strategies in each of the two choice sets on the medium bracketing level implicitly contain 64 combinations of risk management tools. Similarly, the four strategies in the single choice set on the broad bracketing level implicitly contain 4,096 ($2^6 \times 2^6$) combinations of risk management tools. The list of bracketing levels is by no means inclusive and serves as an illustration of how the choice bracketing framework may be used to explain producer's complex decisions.

In this context, we are interested in identifying which determinants drive the choice in each choice set. In particular, we are interested in finding out whether the determinants that have been identified in previous studies of the use of risk management instruments have the same influence at different bracketing levels and for different choices. Specifically, are broad and narrow bracketed choices driven by the same determinants? Differences may provide insight into why a particular determinant may drive behavior for some producers and not for others.

## 5. RESEARCH METHOD

To examine the effect of the determinants of the risk management choices, we estimate multinomial logit models for each choice set in Figure 1, where producer's choice of risk management strategy is explained by the determinants of risk management behavior. The multinomial logit models estimate the probability of

producer $n$ choosing strategy $J$:

$$P_{ni} = \text{Prob}\,(Y_{ni} = j) = \exp\,(X_n' b_i) / \left[\sum_{j=1}^{J} \exp(X_n' b_j)\right], \qquad j = 1, \ldots, J \quad (1)$$

where $X$ is the matrix of regressors as described in Table 5 and the dependent variable, $J$, reflects the risk management strategies as defined in Figure 1. For

TABLE 5. Independent Variable Definitions and Descriptive Statistics[a]

| Variable | Definition | Mean | Std. dev. |
|---|---|---|---|
| Farm characteristics: | | | |
| Farm size | Total acres (owned and rented): 6 = over 2,000 acres, 5 = 1,999 to 1,5000, 4 = 1,499 to 1,000, 3 = 999 to 500, 2 = 499 to 300, 1 = under 300 | 5.12 | 1.01 |
| Diversification | 1 if a crop farm included a livestock operation, 0 otherwise | 0.43 | 0.50 |
| Decision makers | Number of individuals with access to your DTN unit | 2.70 | 1.38 |
| External decision makers | 1 if hire someone to market any or all of your crops, 0 otherwise | 0.15 | 0.36 |
| Producer characteristics: | | | |
| Age | approximate age of primary subscriber: 1 = less than 25 yrs, 2 = 25 to 29, 3 = 30 to 34, 4 = 35 to 39, 5 = 40 to 44, 6 = 45 to 49, 7 = 50 to 59, 8 = 60 to 64, 9 = 65 and older | 5.06 | 1.62 |
| Innovativeness | 1 if and producer owns or leases a computer, 0 otherwise | 0.66 | 0.47 |
| Risk aversion | See scale developed in Pennings and Smidts (2000; where 1 indicates relatively risk averse and 9 relatively risk seeking) | 6.44 | 1.48 |
| Risk perception | See scale developed in Pennings and Smidts (2000; where 1 is not at all risky and 9 is very risky) | 5.98 | 1.87 |
| Market orientation | See scale developed in Pennings and Leuthold (2000; where 1 indicates relatively less market oriented and 9 relatively more market oriented) | 7.28 | 1.23 |
| Involvement | "How often do you follow cash or futures market prices?" 1 = several times a day, 2 = once a day, 3 = once to several times a week, 4 = once to several times a month, 5 = never | 1.31 | 0.61 |
| External sources of information: | | | |
| Extension | "How much do you rely on the following sources of market information?" 1 = do not rely, 9 = rely heavily | 3.90 | 2.33 |
| MAS | | 5.85 | 2.50 |
| Satellite | | 7.83 | 1.55 |
| USDA | | 5.48 | 2.25 |
| Elevator | | 5.06 | 2.54 |
| Internet | | 3.14 | 2.56 |
| Geographic heterogeneity: | | | |
| MIDWEST | 1 if producer is from the Midwest, 0 otherwise | 0.57 | 0.49 |
| GPLAINS | 1 if producer is from the Great Planes, 0 otherwise | 0.34 | 0.48 |
| SEAST | 1 if producer is from the Southeast, 0 otherwise | 0.08 | 0.28 |

[a] $N = 1{,}105$.

example, for Choice Set A, $j = 1, 2, 3, 4$, where $j = 1$ is defined as 0 (do not use) futures and 0 options, $j = 2$ is defined as 1 (use) futures and 0 options, $j = 3$ is defined as 0 futures and 1 options, $j = 4$ is defined as 1 futures and 1 options. Estimation of the parameters $b_j$ in the multinomial logit model (Equation 1) is described in detail in Greene and Srinivasan (2003, pp. 721–722). The multinomial logit framework is attractive because of the discrete nature of the dependent variables and its ease of application and interpretation. However, this approach assumes that the covariance of errors is a diagonal matrix for each respondent $n$ (independence of irrelevant alternatives [IIA] assumption). This assumption was tested for each model using the Hausman test and the null hypothesis that odds (e.g., choice of strategy 1 versus strategy 2) are independent of other alternatives was not rejected in any of the models.[4] A total of nine models are estimated (one for each choice set: six at the narrow brackets, two at the medium brackets and one at the broad bracket).

### 5.1. Determinants of Risk Management Behavior

The producer choice of a particular risk management strategy is explained by the determinants of risk management behavior. Because we do not have a priori knowledge about whether the determinants that influence risk management behavior have different influence on different bracketing levels, we hypothesize that they play a similar role on all bracketing levels. We hypothesize that the choice of risk management tools is influenced by farm characteristics, producer characteristics, external sources of information, and location. Table 5 shows the determinants of risk management behavior examined in this study.

Previous studies identified farm size, diversification, and decision unit composition as *farm characteristics* relevant for risk management decisions. *Farm size* is hypothesized to have a positive effect on the use of risk management tools. The costs of learning and implementing such tools every year can be more easily spread with high production so that their usage is more easily justified in large-scale farms than in small farms. *Livestock diversification* has been shown to have negative and significant effect on crop insurance participation (Barnett, Skees, & Hourigan, 1990; Cannon & Barnett, 1995). Pennings and Leuthold (2000) and Pennings and Garcia (2001) showed that the opinions of the members of the producers' decision-making unit, such as spouse, partner, and advisors, may influence producers' choices. Here, we specify the concept of the decision-making unit by (a) *internal decision makers*, the number of individuals that have access to the producers' satellite delivered information system (DTN), and (b) *external decision makers*, whether or not the producer hires someone to market the crops.

The producer characteristics considered here are age, innovativeness, risk aversion, risk perception, and market orientation. Musser, Patrick, and Eckman (1996) argued that younger producers have a longer planning horizon to recover the learning and adjustment costs associated with risk management instruments, and hence *age* may be negatively related with the use of risk management instruments. Goodwin and Schroeder (1994) examined the adoption of forward pricing methods. In that context, *innovativeness* becomes an important factor as more innovative producers are more likely to adopt new risk management tools. Based on the findings of

[4]The results of the Hausman test on the IIA assumption are available from the authors upon request.

Huffman and Mercier (1991) and Putler and Zilberman (1988), this study uses possession of a computer as a proxy for producer innovativeness. Pennings and Leuthold (2000) showed a positive relationship between *risk attitude*, *risk perception*, and *market orientation* and producers' use of risk management instruments. We used the scale developed by Pennings and Smidts (2000) to measure risk attitude and risk perception, and we used the work by Jaworski and Kohli (1993) for measuring producers' market orientation.[5] In addition to market orientation, producer *involvement in marketing* their crops may play a significant role in the use of risk management instruments. Producers involved in marketing crops are likely to be more aware of the risks in the market place and prone to use marketing instruments. We hypothesize a positive relationship between involvement and the use of risk management tools.

Davis and Patrick (2000), Pennings, Isengildina, Irwin, and Good (2004), and Isengildina, Pennings, Irwin, and Good (2005) demonstrate that the use of external sources of information affects the use of forward pricing by producers. We hypothesize that *university extension service*, *market advisory services*, *satellite delivery systems* (such as DTN), *USDA reports*, *local elevator*, and the *Internet* may affect producer use of risk management tools. The direction of the relationship depends on the informational content of these sources.

Pennings and Leuthold (2000) showed that producers are heterogeneous with respect to the use of risk management tools. Part of this heterogeneity may be attributed to *geographic location*, which is associated with particular crops and natural hedge conditions.

Table 5 presents the definitions, measurements and descriptive statistics of the determinants discussed in this section. These determinants were used as independent variables in the multinomial logit models. The models were estimated using LIMDEP econometric software. The purpose of this analysis is to identify the factors driving choice on various bracketing levels.

## 6. RESULTS

The results are presented in Tables 6, 7, and 8. The estimated coefficients describe the likelihood of choosing an alternative strategy relative to strategy 1 which does not include any risk management instruments. The particular strategies are described in Figure 1. All nine models perform reasonably well. The predictive ability at the broad bracketing level was 81%, at the medium bracketing level it ranged from 33% to 37%, and at the narrow bracketing level it ranged from 53% to 72%.[6]

Consistent with the descriptive statistics on strategies used presented in Tables 2 through 4, the models predicted that the most popular strategy on the broad bracketing level was strategy 4, which included both forward pricing and crop

[5]Confirmatory factor analysis was used to assess the psychometric measurement quality of the latent variables: producers' risk attitude, risk perception, and market orientation (Hair, Anderson, Tanham, & Black, 1995).

[6]The predictive ability is calculated as the number of producers that were correctly classified by the model with respect to their risk management strategy to the total number of producers. For example, at the broad bracketing level, a total of 892 (1+1+4+ 886) producers were correctly classified out of 1,105 (12 +142+63+888) producers (e.g., Table 6).

TABLE 6. Results of the Multinomial Logit Estimation for Broad Bracketing Level ($N = 1{,}105$)

| | Choice set I—risk management tools | | | |
|---|---|---|---|---|
| Strategy* | 1 | 2 | 3 | 4 |
| Constant | | 14.185** | 9.362* | 14.003** |
| Farm size | | 0.700** | 0.434 | 0.750** |
| Diversification | | −1.355 | −1.206 | −2.700** |
| Decision makers | | −0.315 | −0.382* | −0.259 |
| External decision makers | | −1.339* | −2.426** | −0.811 |
| Age | | −0.423* | −0.240 | −0.490** |
| Innovativeness | | −0.140 | −0.207 | −0.148 |
| Risk aversion | | 0.141 | 0.190 | 0.163 |
| Risk Perception | | −0.276 | −0.149 | −0.136 |
| Market orientation | | 0.251 | 0.372 | 0.305 |
| Involvement | | −0.024 | 0.480 | −0.149 |
| Extension | | 0.113 | 0.119 | 0.128 |
| MAS | | 0.158 | −0.092 | 0.168 |
| Satellite | | −0.902* | −0.893 | −0.837* |
| USDA | | 0.025 | 0.010 | −0.020 |
| Elevator | | −0.194* | −0.079 | −0.131 |
| Internet | | 0.146 | 0.073 | 0.148 |
| GPLAINS | | −1.071 | 0.779 | −0.422 |
| SEAST | | 15.360** | 14.807 | 15.018 |
| Actual use | 12 | 142 | 63 | 888 |
| Predicted use | 1 | 1 | 6 | 1097 |
| Correctly predicted | 1 | 1 | 4 | 886 |

*Note*. Strategies correspond to broad level bracketing strategies described in Figure 2. Single and double asterisks (*) denote statistical significance at the 10% and 5% levels, respectively.

insurance products. On the medium bracketing level in *Choice Set G* (forward pricing tools), strategy 6 was most often used, which included all types of instruments, followed by strategy 8, which included nonexchange-derived instruments only. On the narrow bracketing level in *Choice Set A* strategy 1 (no tools used) was most often used followed by strategy 4, which included both futures and options.

### 6.1. What Factors Determine Producers' Risk Management Decisions on Different Bracketing Levels?

When the influence of the determinants of producer's risk management decisions are compared across bracketing levels, we see that more general characteristics (farm size, age) are relevant in all brackets, while more specific characteristics (innovativeness, risk aversion, and market orientation) are significant mainly in narrow brackets.

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TABLE 7. Results of the Multinomial Logit Estimations for Medium Bracketing Level ($N = 1{,}105$)

| | Choice set G—forward pricing tools | | | | | | | | Choice set H—crop insurance products | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strategy* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Constant | | 3.180 | 5.558** | 3.913** | 2.559 | 4.058** | 0.153 | 3.683** | | −1.854 | −2.385 | −0.450 | −1.970 | −1.161 | −2.890** | −3.208** |
| Farm size | | 0.337 | 0.703* | 0.290* | 0.325** | 0.578** | 0.445* | 0.294** | | 0.148 | 0.025 | 0.074 | 0.112 | 0.332** | 0.063 | 0.132** |
| Diversification | | 0.030 | −0.219 | −2.051** | −30.903 | −1.911** | −30.931 | −1.134 | | −0.504 | −1.404 | −2.024** | −30.708 | −30.607 | −1.872* | −0.165 |
| Decision makers | | −0.094 | 0.208 | 0.081 | 0.042 | −0.040 | −0.063 | 0.079 | | −0.048 | −0.034 | 0.030 | −0.020 | −0.183 | 0.173** | −0.090 |
| External decision makers | | 1.097 | 1.898** | 1.141** | 0.340 | 1.257 | 0.803 | 0.336 | | 0.210 | −0.067 | 0.500 | 0.795** | 0.746* | 0.289 | −0.160 |
| Age | | −0.273** | −0.588** | −0.303** | −0.336** | −0.309** | 0.036** | −0.201** | | 0.056 | −0.212** | −0.063 | −0.026 | −0.219** | −0.125* | −0.215** |
| Innovativeness | | 0.230 | −0.294 | 0.152 | 0.102 | 0.158 | 0.122 | 0.014 | | 0.016 | −0.031 | 0.022 | 0.198 | −0.360 | −0.006 | −0.045 |
| Risk aversion | | −0.123 | −0.012 | −0.113 | 0.027 | −0.051 | −0.049 | 0.135 | | 0.001 | −0.078 | 0.055 | −0.001 | −0.012 | −0.004 | 0.233** |
| Risk perception | | −0.076 | −0.336* | −0.025 | −0.120 | −0.133 | 0.152 | 0.018 | | 0.114 | 0.036 | 0.111 | 0.184* | 0.210* | 0.182* | −0.084 |
| Market orientation | | 0.031 | −0.045 | 0.024 | 0.084 | 0.103 | −0.122 | −0.127 | | 0.048 | 0.196 | 0.001 | 0.036 | 0.234* | 0.148 | 0.156 |
| Involvement | | −0.528* | −0.876* | −0.819** | −0.342* | −0.794** | −0.473 | −0.468** | | −0.074 | 0.123 | 0.013 | −0.119 | −0.403 | −0.069 | −0.168 |
| Extension | | 0.135 | −0.143 | −0.023 | 0.061 | −0.022 | −0.031 | 0.069 | | 0.086 | −0.052 | 0.024 | 0.091 | −0.038 | −0.071 | 0.075 |
| MAS | | 0.268** | 0.175* | 0.352** | 0.207** | 0.378** | 0.170** | 0.125** | | −0.032 | −0.019 | 0.049 | −0.062 | 0.000 | 0.003 | 0.034 |
| Satellite | | −0.066 | −0.072 | 0.005 | 0.058 | 0.029 | 0.075 | −0.055 | | 0.035 | 0.271** | −0.033 | 0.082 | −0.053 | 0.065 | 0.066 |
| USDA | | −0.157 | 0.262* | −0.009 | −0.020 | 0.065 | −0.146 | −0.054 | | 0.020 | −0.155** | −0.012 | −0.096 | −0.020 | −0.073 | 0.023 |
| Elevator | | −0.205** | −0.030 | −0.138** | −0.046 | −0.114* | −0.018 | −0.030 | | −0.002 | 0.119** | 0.061 | 0.019 | 0.054 | 0.121** | 0.048 |
| Internet | | 0.133 | −0.009 | 0.084 | 0.095 | 0.126** | 0.156** | 0.030 | | −0.005 | −0.040 | −0.019 | −0.008 | 0.059 | 0.000 | 0.099* |
| GPLAINS | | 0.164 | −0.728 | −0.987** | −1.255** | −1.620** | −0.860* | −1.158** | | 0.634** | 0.256 | 0.531** | 0.328 | 0.660* | 0.650** | 1.049** |
| SEAST | | 0.929 | 1.815* | −0.462 | 1.163 | 0.535 | 1.185 | 0.136 | | 0.578 | −0.874 | −1.775** | −0.073 | −2.224** | 0.463 | 0.058 |
| Actual use | 75 | 40 | 23 | 217 | 161 | 312 | 38 | 239 | 155 | 150 | 74 | 344 | 108 | 68 | 143 | 63 |
| Predicted use | 34 | 6 | 2 | 135 | 34 | 529 | 1 | 364 | 30 | 70 | 6 | 958 | 5 | 3 | 32 | 1 |
| Corr predicted | 12 | 4 | 1 | 35 | 11 | 221 | 0 | 129 | 11 | 23 | 0 | 320 | 0 | 1 | 6 | 0 |

*Note.* Strategies correspond to medium level bracketing strategies described in Figure 2. Single and double asterisks (*) denote statistical significance at the 10% and 5% levels, respectively.

TABLE 8. Results of the Multinomial Logit Estimations for Narrow Bracketing Level ($N = 1{,}105$)

| | Choice set A—exchange | | | | Choice set B—exchange-derived | | | | Choice set C—non-exchange-derived | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strategy* | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| Panel A: Forward pricing tools | | | | | | | | | | | | |
| Constant | | 0.065 | −1.336 | 0.859 | | −2.331 | −0.996 | −0.930 | | −3.736 | 1.930** | −1.124 |
| Farm size | | 0.209** | 0.107 | 0.200** | | 0.039 | 0.200** | 0.357** | | 0.330 | 0.096 | 0.097 |
| Diversification | | 0.228 | 0.031 | −0.572 | | −0.454 | −0.827 | −29.272 | | 0.258 | −1.475** | −31.955 |
| Decision makers | | −0.004 | −0.080 | −0.011 | | −0.052 | −0.066 | −0.054 | | −0.117 | 0.042 | 0.057 |
| External decision makers | | 0.516 | 1.299** | 0.757** | | 0.019 | 0.160 | 0.393 | | 1.426** | −0.090 | −0.113 |
| Age | | −0.033 | −0.068 | −0.194** | | −0.152* | −0.029 | −0.126** | | −0.245 | −0.128** | −0.163** |
| Innovativeness | | −0.136 | 0.069 | 0.340* | | 0.206 | 0.025 | −0.027 | | 1.355* | 0.011 | 0.142 |
| Risk aversion | | −0.231** | 0.119 | −0.235** | | −0.064 | −0.031 | 0.034 | | 0.134 | 0.049 | 0.030 |
| Risk perception | | 0.020 | −0.123 | −0.087 | | −0.120 | −0.111* | −0.094 | | −0.020 | −0.005 | −0.025 |
| Market orientation | | 0.142* | −0.066 | 0.194** | | 0.186 | 0.109* | 0.067 | | −0.274 | 0.024 | 0.044 |
| Involvement | | −0.592** | 0.082 | −0.948** | | −0.280 | 0.051 | −0.362* | | 0.101 | −0.356** | −0.039 |
| Extension | | −0.113** | −0.035 | −0.049 | | −0.023 | −0.025 | −0.030 | | −0.013 | 0.017 | 0.048 |
| MAS | | 0.233** | 0.110** | 0.290** | | 0.147** | 0.054* | 0.142** | | 0.155 | 0.134** | 0.147** |
| Satellite | | −0.052 | 0.046 | 0.031 | | 0.066 | 0.071 | 0.038 | | −0.182 | 0.011 | 0.029 |
| USDA | | 0.069 | 0.053 | 0.073* | | 0.000 | 0.053 | 0.108* | | −0.110 | 0.023 | 0.093 |
| Elevator | | −0.087** | −0.022 | −0.155** | | 0.030 | 0.001 | −0.006 | | 0.596** | −0.042 | 0.020 |
| Internet | | 0.061* | 0.032 | 0.046 | | 0.064 | 0.064** | 0.035 | | 0.189* | 0.012 | 0.011 |
| GPLAINS | | −0.164 | 0.008 | −0.333 | | −0.944** | −0.318* | −0.770** | | −0.307 | −1.002** | −1.145** |
| SEAST | | −0.561 | −0.022 | −0.594* | | −0.275 | 1.103** | 0.646* | | −29.508 | −0.485 | −0.647 |
| Actual use | 513 | 183 | 145 | 265 | 571 | 68 | 306 | 160 | 176 | 18 | 785 | 127 |
| Predicted use | 770 | 24 | 24 | 288 | 960 | 0 | 119 | 26 | 24 | 1 | 1081 | 0 |
| Corr predicted | 437 | 11 | 10 | 132 | 528 | 0 | 53 | 5 | 11 | 1 | 774 | 0 |

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TABLE 8. Continued

| | Choice set D—CAT | | Choice set E—yield insurance | | | | Choice set F—revenue insurance | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strategy | 1 | 2 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Panel B: Crop insurance products | | | | | | | | | | | | | | |
| Constant | | −1.600** | | −2.123 | −4.419* | −1.295 | | −0.418 | −1.681 | −6.936** | −3.459 | 488.587 | −6.301** | −9.739* |
| Farm size | | 0.042 | | 0.051 | 0.858** | 0.023 | | 0.031 | 0.096 | −0.198 | 0.300 | 0.307 | −0.037 | −0.342 |
| Diversification | | 0.089 | | 0.254 | −27.340 | −1.192 | | −1.037 | −37.410 | −37.394 | −37.646 | −34.666 | 0.918 | −36.267 |
| Decision makers | | 0.031 | | −0.145 | −0.009 | −0.107* | | 0.029 | 0.238** | 0.212 | 0.085 | −16.199 | 0.128 | 0.146 |
| External decision makers | | 0.006 | | −0.386 | 0.519 | 0.231 | | 0.256 | −0.591 | 0.378 | 0.076 | −159.546 | −1.560 | −34.394 |
| Age | | 0.022 | | −0.131* | 0.033 | −0.119** | | −0.101** | −0.005 | 0.004 | −0.184 | −30.767 | 0.137 | 0.061 |
| Innovativeness | | 0.066 | | −0.324 | 1.167* | −0.031 | | −0.007 | −0.155 | −0.357 | −1.068** | −280.721 | 0.110 | −0.620 |
| Risk aversion | | 0.017 | | −0.147* | −0.150 | 0.084 | | 0.058 | 0.202 | −0.052 | −0.123 | −39.294 | 0.089 | 0.002 |
| Risk perception | | 0.033 | | 0.030 | 0.057 | −0.024 | | 0.061 | 0.041 | 0.076 | −0.182 | −34.606 | −0.148 | −0.288 |
| Market orientation | | 0.044 | | 0.211** | 0.137 | 0.053 | | −0.009 | −0.145 | 0.495** | 0.328 | 17.969 | 0.151 | 0.374 |
| Involvement | | −0.072 | | 0.045 | −0.386 | −0.120 | | −0.058 | −0.231 | 0.358 | −0.051 | −139.663 | 0.254 | 0.940 |
| Extension | | 0.034 | | 0.069 | −0.108 | 0.006 | | −0.029 | −0.138* | −0.017 | −0.050 | 16.837 | −0.197* | −0.222 |
| MAS | | −0.041 | | −0.069 | −0.105 | −0.012 | | 0.065** | 0.059 | 0.041 | −0.009 | −6.756 | 0.042 | 0.059 |
| Satellite | | 0.059 | | 0.073 | 0.166 | 0.074 | | −0.065 | −0.184** | −0.222** | 0.031 | −31.231 | 0.193 | 0.046 |
| USDA | | −0.010 | | −0.075 | −0.008 | −0.056 | | 0.035 | 0.015 | −0.064 | −0.064 | 16.270 | −0.124 | 0.153 |
| Elevator | | −0.005 | | −0.042 | 0.131 | 0.015 | | 0.047* | 0.015 | 0.083 | 0.174 | 10.485 | 0.067 | −0.102 |
| Internet | | 0.019 | | 0.072 | 0.056 | 0.015 | | −0.004 | −0.048 | 0.088 | 0.170* | −3.561 | 0.207** | 0.183 |
| GPLAINS | | 0.221 | | 0.379 | −0.119 | −0.068 | | 0.309** | 0.717* | −0.057 | 0.960 | 227.537 | −0.646 | 1.017 |
| SEAST | | 1.320** | | −0.052 | −1.005 | −0.238 | | −0.895** | −37.531 | −1.375 | 0.913 | 38.801 | −1.008 | 2.993** |
| Actual use | 641 | 464 | 794 | 76 | 23 | 212 | 487 | 503 | 41 | 27 | 16 | 2 | 25 | 4 |
| Predicted use | 977 | 128 | 1105 | 0 | 0 | 0 | 458 | 645 | 0 | 0 | 0 | 2 | 0 | 0 |
| Corr predicted | 594 | 82 | 794 | 0 | 0 | 0 | 253 | 344 | 0 | 0 | 0 | 2 | 0 | 0 |

*Note*. Strategies correspond to narrow level bracketing strategies described in Figure 2. Single and double asterisks (*) denote statistical significance at the 10% and 5% levels, respectively.

Several variables were significant on the medium and narrow levels but not on the broad bracketing level (e.g., risk aversion, risk perception, market orientation, and producer involvement). Some sources of information affected decisions on all three bracketing levels (satellite services and elevators), while others were relevant on medium and narrow levels (market advisory services, USDA, Internet) or only in narrow brackets (university extension service). Most variables were relevant for both types of risk management tools (forward pricing instruments and insurance products), with some exceptions. The number of decision makers in the decision-making unit was important only for crop insurance decisions but not for forward pricing decisions. Producer involvement in marketing their products was important for forward pricing decisions but not for crop insurance choices.

The influence (a positive or negative effect) of most variables was not always the same across strategies within a bracketing level. The use of risk management tools across bracketing levels was positively influenced by farm size, market orientation, producer involvement in marketing their crops, and use of market advisory services and the Internet as sources of information. Age, diversification, and use of university extension service advice had a negative relationship with the use of risk management tools. Some coefficients had different signs for different strategies, that is, some variables were positively associated with a risk management strategy in a particular choice set but negatively related with a risk management strategy at a different choice set. Examples are as follows: risk perception had a negative effect on the use of forward pricing tools but a positive effect on the use of crop insurance (on the medium bracketing level); the use of satellite sources of information discouraged the use of revenue insurance (on the narrow level) but encouraged the use of yield insurance (on the medium bracketing level); the use of USDA reports encouraged the use of forward pricing tools (exchange and exchange-derived tools, in particular) and the use of revenue insurance but discouraged the use of yield insurance (on the medium bracketing level); and the use of the elevator as an information source discouraged the use of forward pricing tools but encouraged the use of minimum price contracts and revenue insurance. Consistent with previous findings, the results also demonstrated geographic heterogeneity in the way producers make their marketing decisions. For example, producers from the Great Plains were less likely to use risk management tools (forward pricing tools in particular) than producers from the Midwest. However, these producers were more likely to use crop insurance (catastrophic coverage and revenue insurance in particular) than Midwestern producers. On the other hand, producers in the Southeast were more likely to use forward pricing tools (exchange-derived instruments in particular) and less likely to use crop insurance.

Several determinants (e.g., external decision makers, risk aversion) had different effects on different bracketing levels. These sign reversions illustrate the adding-up effect. For example, risk aversion had a positive impact on the use of crop insurance products on the medium bracketing level, but a negative impact on the use of yield insurance on the narrow bracketing level. This finding suggests that yield insurance becomes attractive to risk-averse producers only in combination with other products. Use of external decision makers (hiring somebody to market crops) has a negative impact on the use of risk management tools on the broad bracketing level but a positive impact on the use of tools on the medium and narrow levels. These findings may help explain the puzzling results that

have been found in previous research on the role of these variables in producers' decision making.

These results seem to suggest that variables that have been associated with producers risk management behavior may not have the same influence for all producers. That is, the assumption of homogeneity regarding the factors that influence producers risk management behavior does not hold across different segments of producers. This study suggests that observed heterogeneity in risk management behavior is not only driven by observable variables such as farm size (e.g., Pennings & Garcia, 2004) but may also be driven by the bracketing level of producers. That is, the influence of the factors associated with producers risk management behavior may be different for narrow bracketers versus broad bracketers. Understanding the extent of bracketing of producers may help further explain and understand the heterogeneity that we observe in producers' risk management behavior.

## 7. CONCLUSIONS AND DISCUSSION

Previous studies examining producers' risk management decisions often dealt with the relatively simple choice whether producers used a particular risk management instrument. In practice, producers are confronted with a much more complex decision context. For example, if producers are faced with six forward pricing instruments and six insurance products their decision space consists of 4,096 possible alternatives. While economic theory assumes that decision makers evaluate all available information and hence all available alternatives, the behavioral economics and psychology literature have shown that cognitive limitations make it difficult for humans to make such "full information" choices. Read et al. (1999) introduced the concept of choice bracketing that helps explain how producers may process large spaces of choice alternatives. This concept suggests that decision makers "bracket" their choices into sets so that the consequence of each choice in the set is taken into account on all other choices in the set but not between choice sets. Here, we use the choice bracketing concept to better understand the determinants of risk management behavior and their impact on complex risk management choices.

The analysis illustrates the concept using three bracketing levels of risk management choices: broad, medium, and narrow. The determinants of producer risk management choices on each bracketing level are evaluated using multinomial logit models. The results show that different strategies are selected on different bracketing levels. The findings show the presence of the adding-up effect: the phenomena that risk management tools that are less attractive on one bracketing level become more attractive on another bracketing level. Further, when comparing the determinants of producer's risk management decisions across bracketing levels it appears that more general characteristics (farm size, age) are important drivers on all bracketing levels, while more specific characteristics (innovativeness, risk aversion) are significant only on the narrow bracketing level. The impact of most of the variables was similar across brackets. However, several variables (external decision makers, risk aversion) had a different impact on different bracketing levels. More specifically, the results showed that yield insurance becomes attractive to risk-averse producers only in combination with other products. Use of external decision makers (hiring somebody to market crops) has a negative impact on the use of risk

management tools on the broad bracketing level but a positive impact on the use of tools on the medium and narrow levels. These findings may help explain the puzzling results that have been found in previous research on the role of these variables in producers' decision making.

In this study, we used three bracketing levels and developed various choice sets at each bracket level. While such classification of price risk management instruments seems intuitive, we did not validate whether this classification reflects the actual way producers think when they make choices. Further research is needed to identify producers' bracketing levels. One way to elicit such information is through a conjoint framework in which producers have to evaluate (rank) different combinations of risk management instruments. Conjoint analysis allows the researcher to investigate the interrelatedness of individuals' choices by checking whether there is nonlinearity in the producer's value function (Green & Srinivasan, 1990). This nonlinearity is reflected in the extent to which the interactions between attributes of the risk management instruments are significant in the producer's value function, which is obtained by the conjoint task. The extent to which they are significant is a measure of the extent to which producers bracket broadly.

The results have implications for financial institutions that provide risk management instruments and for policy makers dealing with risk management programs. The results indicate that it may be valuable for exchanges and brokerage firms to know whether a producer is a broad or narrow bracketer because of the adding-up effect described above. For example, a broad bracketer will evaluate the consequences of a variety of risk management instruments simultaneously and include interactions between them. Hence, for a broad bracketer, complementarity among instruments becomes an important issue when designing new risk management instruments. For exchanges, it may be beneficial to work in conjunction with other risk management service providers (e.g., firms that offer crop insurance) when designing new contracts. Such cooperation would help the exchange to create the optimal palette of products such that cannibalism is minimized and reinforcement is maximized (Pennings & Leuthold, 2001). As mentioned before, a conjoint analysis research design may allow companies to gain insight in the extent of bracketing. Companies that develop risk management instruments often use conjoint analyses to gain insight into how to design their product. By extending the choice task by including alternative risk management products and paying special attention to the interactions between products, agribusiness companies may be able to identify bracketing levels. The potential payoff of better understanding the extent to which producers bracket may be substantial.

For policy makers it is important to understand how their programs may enter producers' choice sets. Producers who bracket narrowly may fail to see the complementary between the new program and, for example, existing risk management tools and may decide not to participate in the program. Knowledge about the size of the segments of producers with respect to bracketing levels and how these segments can be identified is crucial for successful risk management policy. Failure to understand bracketing and its implications can lead policy makers to formulate inappropriate production and marketing strategies. Finally, the findings also may be of interest to producers. Producers may not be aware how to approach complex decision because they use a "routine" or heuristic approach. Making producers aware about how different bracketing

levels can result in different choices may be helpful and can improve the quality of their choices.

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**Joost M.E. Pennings** *is a professor in the Department of Marketing and the Department of Finance at Maastricht University in the Netherlands, a professor in the Department of Agricultural & Consumer Economics at the University of Illinois at Urbana-Champaign, and the AST professor of marketing at Wageningen University in the Netherlands. His current research deals with understanding revealed economic behavior by studying the decision-making behavior of real decision-makers (market participants, consumers, managers etc).*

**Olga Isengildina-Massa** *holds a PhD in Agricultural Economics and an MS in Agricultural Economics from Mississippi State University. She is also an assistant professor in the Department of Applied Economics and Statistics at Clemson University. Her current research interests are agricultural marketing, forecasting analysis, finance, and futures and options markets.*

**Scott H. Irwin** *holds a PhD in Philosophy in Agricultural Economics and an MS in Agricultural Economics from Purdue University, and a BS in Agricultural Business from Iowa State University. He is the Laurence J. Norton Professor of Agricultural Marketing, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign. His current research interests are agricultural price analysis, forecasting, risk management, and futures and options markets.*

**Philip Garcia** *holds a PhD in Agricultural Economics and an MS in Agricultural Economics from Cornell University as well a BA in Economics from Occidental College. He is the Professor, Thomas A. Hieronymus Distinguished Chair in Futures Markets, and Director of the Office of Futures and Options Research (OFOR), Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign. His current research interests are agricultural price analysis, futures and options markets, risk management, and behavior under risk.*

**Darrel L. Good** *holds a PhD in Agricultural Economics from Michigan State University and an MS in Agricultural Economics and a BS in Agricultural Education from Southern Illinois University. He is a professor in the Department of Agricultural and Consumer Economics, University of Illinois. His research interests are performance of market advisory services, marketing performance of crop producers, and the accuracy and price impact of USDA crop and livestock reports.*