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# Empirical Comparison of Direct Techniques for Measuring Attitudes Toward Risk

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## ABSTRACT

**The purpose of this study was to compare various direct techniques of measuring attitudes toward risk. The Equally Likely Certainty Equivalent with a Purely Hypothetical Risky prospect (ELCE-PH), The Equally Likely Certainty Equivalent with a Hypothetical but Realistic Risky prospect (ELCE-R) and Probability of Winning Demanded (PWD) models were used to elicit the risk attitude of a sample of farmers. These methods were then compared and evaluated. The criteria employed were (1) sample respondent capability in answering questions, (2) means and corresponding risk attitudes classification and (3) distribution of risk attitudes. According to the first criterion, the results showed PWD technique is the best one. While there are no differences among the three direct techniques on the basis of the second criterion. Also, the findings indicate that respondent education and age, family education, level of hypothetical income and a greater explanation by other people during interview have an influence on respondent capability in answering questions. These characteristics should therefore be considered when choosing the appropriate technique.**

**Keyword:** Attitudes toward risk, Certainty equivalent, Probability of winning demanded.

## INTRODUCTION

Attitudes toward risk are major determinants of the rate of diffusion of new technologies among peasant farmers and of the outcome of rural development programs [10]. If they are going to be effective, new technologies and rural development programs need to be tailored to the attitudes toward risk of particular categories of peasant farmers. For this purpose, it is important to identify the specific determinants of behavior toward risk and to quantify their impacts on decision making [10, 11].

There are different approaches for measuring attitudes toward risk [2, 9]. For example Moscardi and de Janvry (11) classified these approaches into direct and indirect approaches. They believed that the direct method, developed by von Neumann and Morgenstern, has serious difficulties resulting from the fact that the subjects have different levels of tolerance or intolerance for gambling (the method used to reveal their preferences) and that the concepts of probability are by no means intuitively obvious. Also, it is a time consuming method. For these reasons, they proposed and used an indirect approach in their study. In their model, risk was introduced into a model of economic decision making as a safety-first rule. Dillon and Scandizzo [5] classified the methods of measuring risk behaviors under the headings of: (a) economic anthropology, (b) econometrics, (c) farm risk programming, (d) sectoral risk programming, (e) expected utility and safety-first theory. They used the expected utility and safety-first theory methods to measure the risk attitudes of subsistence farmers in northeast Brazil. Binswanger [3] measured attitudes toward risk using two methods, an interview method eliciting certainty equivalents and an ex-

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perimental gambling approach with real payoffs. He believed the interview method is subject to interviewer bias, and his study showed that the interview results were totally inconsistent with the experimental measures of risk aversion. Feinerman and Finkelshtain [6] developed a theoretical framework to study the effects of socioeconomic factors on farmers' attitudes towards risk and production decisions. In their method, no maintained assumptions about the individual's utility are required. A key element in this framework is the categorization of socioeconomic factors by their effect on the farmers' attitudes towards risk. A simple methodology for this categorization, based on the equivalent between the Arrow-Pratt measure of risk aversion and the probability of winning demanded, is proposed by Feinerman and Finkelshtain [6]. Anderson *et al*. [1] introduced several techniques for designing interviews to elicit the preference functions of farmers. They are: (a) the von Neumann-Morgenstern (N-M) model, (b) a modified version of the N-M model or the Equally Likely Certainty Equivalent (ELCE) method, and (c) the Ramsey or the Equally Likely but Risky Outcome (ELRO) method.

In the light of above discussion, there are, in the main, two approaches for measuring attitudes toward risk. These are: (1) direct approaches based on von Neumann-Morgenstern method and (2) indirect approaches. Furthermore, attitudes toward risk based on direct approaches can be measured by means of both interview and experimental methods. In this paper, the interview method of the direct approach is discussed and various techniques that are usually used in the interview method are then empirically compared. These techniques are: (1) the Equally Likely Certainty Equivalent with a Purely Hypothetical Risky prospect (ELCE-PH), (2) the Equally Likely Certainty Equivalent with a Hypothetical but Realistic Risky prospect (ECLE-R), and (3) Probability of Winning Demanded (PWD).

## MATERIALS AND METHODS

In this section, the research methodology used for eliciting the risk attitudes in each technique is presented.

### ELCE -PH Technique

The ELCE-PH model is designed to avoid bias caused by probability preferences through the use of ethically neutral probabilities (i.e., P=(1-P) = 0.5). The subject is confronted with two-state risky prospects having an equal probability of 0.5 for each state. This method overcomes the criticism of bias owing to probability preference. However, it still has the difficulty that the subject is forced to select between a certainty and a lottery. Nevertheless, this problem may be minimized by presenting the questions as practical decision making problems [1].

In this study, each farmer was asked to indicate the certain income that he or she would need to be indifferent between receiving this certain amount and a lottery with the highest possible win of 100 million Rials and the lowest of 10 million Rials, each with a probability of 0.5. The expected value of the above lottery is 55 million Rials. So depending on whether the certain amount is greater than, equal to, or less than the expected value of the risky prospect, each farmer in the sample can be classified as risk preferring, risk neutral or risk averse. To compare the various techniques, the farmers were classified according to his or her choice into three groups. They are

- risk averse: certain amount <55 000 000
- risk neutral: certain amount = 55 000 000
- risk preferring: 55 000 000< certain amount

### ELCE-R Technique

With the ELCE-R technique, the farmers' risk attitudes are appraised according to their choices between hypothetical but realistic farm alternatives involving risky versus sure outcomes [5]. These choices form the basis





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for the analysis and were geared towards finding the certainty equivalents of risky prospects involving stated probabilities. Risky prospects involved only two possible outcomes whose probabilities were 0.5. The certain prospect was progressively changed until the subject expressed indifference between the risky and the sure prospect at which the sure prospect is the certainty equivalent of the risky prospect.

In this study, the actual questions concerned pistachio prices because all of the farmers under investigation grew only pistachio nuts. In this way, the pistachio price variability can be regarded as an index for income variability and production risk.

The farmers in the sample were asked the following questions: Suppose that in the month of Mordad (two months before harvesting) your preferred pistachio buyer is offering you a contract under which they guarantee to pay a fixed price for your pistachios at harvest. The offer is that you declare your total final harvest of pistachios and they guarantee to pay you the agreed contract price for the harvest. There is no penalty for production being above or below your current expectations. In other words, if your pistachio crop doesn't yield as expected, there will be no penalty for you in this contract since the deal is not based on a set tonnage. Also, the timing and method of the contract payment can be arranged as you wish. The harvest which you have not committed to contract will be sold by your preferred buyer at harvest (in Mehr) at the going market price. But now (in Mordad) experts can only guess what the prices are likely to be at harvest. Their forecast of possible gross prices for pistachios covers the following range:

- 50% chance of 10000 Rials / kilogram,
- 50% chance of 40000 Rials / kilogram,

Now, which would you prefer, (A) to sell your pistachios at the uncertain going market price of harvest, or (B) to accept a contract price of 15000 Rials per kilogram?

If B was preferred to A, the price in B was reduced by decrements of 1000 Rials until indifference or a switch to A was established. If A was preferred to B, the same procedure was repeated but with the price in B increased by increments of 1000 Rials. The expected value of selling pistachio at the going market price was 25000 Rials per kilogram and the farmers' certainty equivalent was the last contract price. Depending on whether his certainty equivalent is greater than, equal to, or less than the expected value of the market price (25000), each farmer was classified as risk preferring, risk neutral, or risk averse in the following groups:

- risk averse : contract price < 25000
- risk neutral : contract price = 25000
- risk preferring : 25 000< contract price

**PWD Technique**

Since farmers would be classified on the basis of their attitudes toward risk, the concept of probability of winning demand (PWD) was used. PWD can be defined as below (7).

Denote using [P, $E^1$ , $E^2$] a lottery with two possible prizes $E^1$ and $E^2$ ($E^1 > E^2$) in which P is the probability of winning the larger prize. Suppose that an individual is facing the choice between such a lottery and a fixed amount of money E , such that $E^1 > E > E^2$. The PWD, P, is defined as Pu ($E^1$) + (1-P)u ($E^2$)= u (E).

Feinerman and Finkelshtain (6) proved that PWD can measure the degree of risk aversion. They showed that, when risk aversion increases, PWD also increases and *vice versa*.

In this study, the farmers were asked about investing in the Karoon Water Transfer Project (KWTP). This is a project that will transfer Karoon water to Rafsanjan in future. Each farmer was asked to choose the minimum probability for success (or PWD) at which he would be prepared to invest in KWTP. Investment in KWTP was presented as a two-prize lottery in which the farmer might win or lose a fixed amount of money. The level of prize (investment) was considered 5000000 Rials. Farmers were classified





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**Table 1**: The number and percentage of respondents who could answer questions completely in each technique.

| Rspondents | ELCE-PH technique | ELCE-R technique | PWD technique | All of [a] them |
|---|---|---|---|---|
| Number | 31 | 34 | 38 | 25 |
| Percentage | 62 | 68 | 76 | 50 |

[a] The number and percentage of respondents who could answer for all three techniques.

based on their PWD choices into three groups as follows:

- risk averse: 50% < PWD
- risk neutral: PWD = 50%
- risk preferring: PWD < 50%

## Factors Affecting the Utility of Study Techniques

Three criteria were established for comparing of the utility techniques for measuring attitudes toward risk. These are: (1) respondent capability in answering questions, (2) sample means and corresponding risk attitudes classification, and (3) distribution of risk attitudes.

Respondent capability in answering questions is measured by the number of respondents who can answer questions about a special technique.

For measuring the impact of socioeconomic characteristics on respondent capability in answering questions, a dummy dependent variable was defined. If a respondent answered the question, the dummy dependent variable would equal one, otherwise it would be zero. The independent variables are respondent socioeconomic characteristics.

Three statistical models that are available for analyzing binary choice problems such as whether or not to adopt adopt a technology are the linear probability, logit, and probit models. Logit analysis is employed in this study for the following reasons. With a linear probability model, the predicted probability of adoption can lie outside the 0 to 1 boundary imposed on probabilities. Such a result then forces the arbitrary defining of outcomes which are less than 0 or greater than 1 (4). Both the logit and probit models are transformations whereby a cumulative distribution is estimated, thus eliminating the 0-1 problem associated with the linear probability model. Empirical evidence suggests that neither logit nor probit has any advantage over the other (4). However, logit models are easier to apply.

The logit model is based on the logistic cumulative probability function represented by:

$P_i = F(z_i) = 1/(1+e^{-Zi})$

where $P_i$ is the probability that the ith decision maker selects the first alternative, $z_i = X_iB$ where $X_i$ is the vector of attributes associated with the ith decision maker, B is a vector of the parameters to be estimated, and e represents the natural logarithmic base [8]. In this equation, $z_i$ can range from positive infinity to negative infinity. The probability of adoption ($P_i$), however, lies between 0 and 1. Maximum likelihood procedures were used to estimate the parameters.

Evaluating a logit model requires examining both goodness of fit measures and the

**Table 2**: Sample means and corresponding risk attitudes classification for respondents who could answer for all of the three techniques.

| Technique | Sample mean | Sample standard deviation | Risk attitude class |
|---|---|---|---|
| ELCE-PH | 43200 000 | 19142013 | risk averse |
| ELCE-R | 21400 | 5824 | risk averse |
| PWD | 0.62 | 0.18 | risk averse |





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**Table 3**: Distribution of risk attitudes of sample farmers by methods of elicitation.

| Technique | Risk averse | Risk neutral | Risk preferring |
|---|---|---|---|
| ELCE-PH | 10 | 11 | 4 |
| ELCE-R | 14 | 5 | 6 |
| PWD | 13 | 8 | 4 |

estimated coefficients. One goodness of fit measure is Mcfadden's $R^2$, calculated as follows:

Mcfadden's $R^2 = 1-\{\log L (B_{ML})/\log (L_0)\}$, where $L(B_{ML})$ denotes the maximum value of the log-likelihood function and $L_0$ is the value of the log-likelihood function when all coefficients, except the intercept, are set equal to 0. Empirical evidence suggests Mcfadden's $R^2$ typically lies between 0.2 and 0.4 (8).

The estimated coefficients were also examined. Besides the sign and significance of the estimated coefficients, the way in which a change in an attribute will affect the probability of adoption is also important (8).

The second and third criteria are explained in the results and discussion section.

### Data Source

A farmer survey was conducted in the summer of 1999 in order to collect data. Farm level data were collected from a sample of 50 farmers who were selected by two stage cluster sampling from Rafsanjan district, Kerman province, Iran. First, a cluster of 25 villages was selected randomly. Second, two farmers were chosen randomly from each village. The sample size is sufficiently large as both quantitative and qualitative information were collected through the interview. In the similar studies, Vandeveer and Loehman (1994) and Zuhair *et al*. (1992) have used samples of 55 and 30, respectively. Data were then collected using specifically designed questionnaires. Each farmer was asked to answer risk-attitude questions using the PWD, ELCE-PH and ELCE-R techniques. In addition, the questionnaires elicited information about various characteristics of and the socioeconomic factors affecting the farm and its operator.

## RESULTS AND DISCUSSION

As Table 1 shows, according to the respondents capability of answering questions, PWD is the most efficient technique and the ELCE-PH is the least.

The ELCE-PH technique asked the respondent hypothetical questions while PWD asked real questions. This shows that the respondents could answer the real questions better than the hypothetical questions.

As Table 2 shows, all three techniques classify the sample farmers on average as risk averse. Thus, on the basis of the sample means and corresponding risk attitudes classification, there is no difference between

**Table 4**: Logit estimates for respondent capability of answering[a] (total sample)

| | ELCE-PH technique | | ELCE-R technique | | PWD technique | |
|---|---|---|---|---|---|---|
| Variable | Coefficient | t-test | Coefficient | t-test | Coefficient | t-test |
| Intercept | -2.78 | -1.75** | 0.86 | 1.41* | -25.44 | -2.16*** |
| Adj | 0.23 | 2.53*** | 0.12 | 1.60* | 0.50 | 2.14** |
| Hoadj | 0.31 | 1.54* | - | - | - | - |
| Hozoor | 0.95 | 0.99 | - | - | 1.49 | 1.15 |
| Trind | -1.4E-9 | -0.85 | - | - | - | - |
| Parpesf | - | - | -1.32 | -1.96** | - | - |
| Sen | - | - | - | - | 1.03 | 2.36*** |
| Sen2 | - | - | - | - | -0.01 | -2.46*** |
| Mcfadden's $R^2$ | 0.22 | | 0.20 | | 0.40 | |

A single asterisk indicates significance at a P value of 0.10, a double asterisk indicates significance at a P value of 0.05, and a triple asterisk indicates significance at a P value of 0.01.





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these techniques.

Table 3 presents the distribution of risk attitudes according to the different techniques for those 25 farmers who were able to respond to all three methods of elicitation.

According to the distribution of risk attitudes, these techniques cannot be clearly distinguished.

More complete appraisal about respondent capability in answering is given by a regression model. To investigate the influence of socioeconomic characteristics on their capability in answering, a logit model was used, in which a dummy variable was used as the dependent variable. If a respondent answered the questions, the dummy dependent variable would be equal to 1, otherwise it would be zero.

Table 4 includes the estimated logit model, significance tests and goodness of fit measures of each technique. Independent variables were defined as follows:

Adj: Respondent education except respondent (schooling years).

Hoadj: Family education (schooling years).

Hozoor:Participation of other people besides the respondent in the interview (yes=1, no = 0).

Trind: The difference between respondent total income and the expected value of the risky prospect (Rials).

Parpesf:Where did you sell your product last year (Rafsanjan Pistachio Producers Cooperative, (RPPC) = 1, Otherwise = 0).

Sen: Respondent age.

Sen2: Respondent age squared.

In Table 4, the overall fit of the equations is recorded. Mcfadden's $R^2$ equals 0.22, 0.20, 0.40 for ELCE-PH, ELCE-R and PWD respectively, all of which lie within the expected 0.2 to 0.4 range. Overall, the goodness - of - fit measures indicate that these models fit the data reasonably well.

Next, the estimated coefficient is examined. Respondent education (Adj) was significant in all of the techniques. Consistent with expectations, as respondent education increases, the probability of answering increases. Family education(Hoadj) was only significant for the ELCE-PH technique while the Parpesf variable was only significant for the ELCE-R technique. Those respondents who sold their product only to RPPC couldn't answer ELCE-R questions very well. Respondent age was only significant for the PWD technique. As respondent age increases, the probability of answering increases initially and then decreases.

Finally, Trind was important only for the ELCE-PH technique. As the difference between respondent total income and the expected value of the risky prospect increases, the probability of answering decreases. In the ELCE-PH and PWD techniques, the Hozoor variable was also important. If other people were talking during the interview, the probability of answering increased. This implies that the ELCE-PH and PWD techniques are more complicated than ELCE-R technique.

The results of this study demonstrated that answering ELCE-PH questions is more difficult than the other techniques. It needs more education, more explanation and more care in determining the level of hypothetical income. Although the ELCE-R approach (with the pistachio price) was easier than the other techniques, it was an efficient technique if and only if the respondent did not have a contract with any permanent buyer. Thus, according to these results, the PWD approach is the most efficient technique. Since it is not so complicated and is based on real questions.

The broad conclusions drawn from an empirical comparison of the three direct techniques for measuring attitudes toward risk can be briefly summarized as follows. First, according to respondent capability of answering questions, PWD is the most efficient technique and the ELCE-PH technique is the least efficient. Second, there is no difference between the three techniques according to sample means and corresponding risk-attitude classification. Third, according to the distribution of risk attitudes, these techniques cannot be clearly compared. Fourth, respondent and family education, level of hypothetical income and greater explanation





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by other people during the interview influence respondent capability in answering with the ELCE-PH technique. Fifth, respondent education and product selling place have an influence on respondent capability in answering with the ELCE-R technique. Finally, respondent education and age, and more explanation by other people during interview have an influence on respondent capability in answering with the PWD technique. So it is important to consider the a forementioned characteristics when choosing an efficient technique.

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## مقایسه عملی روشهای مستقیم اندازه‌گیری دیدگاههای ریسکی

**ج. ترکمانی و م. عبداللهی**

## چکیده

هدف از این مطالعه مقایسه عملی روشهای مستقیم اندازه گیری دیدگاههای ریسکی بود. بدین منظور، ابتدا از روشهای معادل مطمئن برابر با فعالیت فرضی ، معادل مطمئن برابر با فعالیت واقعی ، و احتمال پیروزی تقاضا شده جهت اندازه گیری دیدگاههای ریسکی نمونه‌ای از کشاورزان استفاده شد. سپس این روشها با یکدیگر مقایسه شده و مورد ارزیابی قرار گرفتند. معیارهای استفاده شده جهت مقایسه شامل (۱)





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توانایی پاسخگو در جواب دادن به سئوالات مربوط به هر روش، (۲) میانگین ریسک گریزی نمونه مورد مطالعه، (۳) توزیع دیدگاههای ریسکی نمونه مورد مطالعه بود. نتایج حاصل از این مطالعه نشان داد که با توجه به معیار اول، احتمال پیروزی تقاضا شده مناسب‌ترین روش است. بر اساس معیار دوم، هیچ اختلاف معنی داری بین سه روش فوق مشاهده نشد. همچنین، نتایج نشان داد که سواد وسن پاسخگو، سطح درآمد و توضیحات اضافی ارائه شده توسط افرادی غیر از مصاحبه گر در حین مصاحبه بر روی توانایی اعضاء نمونه در پاسخ دادن به سئوالات مؤثر است. لذا برای انتخاب روش مناسب بایستی ویژگیهای فوق مورد توجه قرار گیرد.



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