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Volume 5 No. 1
December 1987

WAITE MEMORIAL BOOK COLLECTION
DEPARTMENT OF AGRICULTURAL AND APPLIED ECONOMICS
232 CLASSROOM OFFICE BLDG.
1994 BUFORD AVENUE, UNIVERSITY OF MINNESOTA
ST. PAUL, MINNESOTA 55108

RISK ATTITUDES MEASURED BY THE INTERVAL APPROACH: A CASE STUDY OF KANSAS FARMERS

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ABSTRACT

Risk attitudes of farmers are of major importance to agricultural economists today. Recently, many studies concerning decision making and risk attitudes have used the Pratt-Arrow absolute risk aversion coefficient as a base. This study includes the development of a questionnaire designed to determine risk aversion levels. The method involves the elicitation of risk aversion intervals using generalized stochastic dominance given specified upper and lower bounds on absolute risk aversion. The risk aversion levels of 30 north-eastern Kansas farmers are elicited in order to investigate the relationship between age and level of risk aversion, the consistency of risk aversion over five income ranges, and the accuracy with which farmers can assess their own levels of risk aversion.

The results of the study indicate that no statistically significant difference is present between the risk aversion levels of younger and older farmers. The majority of farmers expressed fairly consistent patterns in their risk attitudes over different income ranges. Finally, and perhaps of most interest, is the fact that farmers show some ability to assess their own risk attitudes. This has significant implications for future research in risk.

INTRODUCTION

Farmers' attitudes toward taking risks are of major importance to agriculture today. Results from many research projects depend on the researchers' assumptions regarding farmers' risk attitudes. In the past, risk research results frequently displayed a range of income alternatives involving risk which allowed farmers to choose among the alternatives. More recently, research methods have been developed which directly select utility maximizing alternatives based on assumptions about risk aversion levels of farmers. Stochastic dominance techniques, in particular, make assumptions about risk aversion levels and then eliminate from consideration alternatives or strategies which are not optimal for the assumed risk aversion level. These selection criteria depend directly on the assumed risk aversion levels; and, therefore, researchers definitely need accurate information concerning farmers' risk attitudes. Raskin and Cochran have summarized the studies that have been performed in this particular area.

One method that is commonly used to investigate risk attitudes is the method developed by Meyer. Using the Pratt-Arrow absolute risk aversion coefficient

as a base, Meyer developed criteria for generalized stochastic dominance given specified upper and lower bounds on absolute risk aversion. These criteria enable one to elicit risk aversion intervals for a decision maker. As a result of past studies in eliciting risk aversion intervals, many economists have assumed the previously elicited intervals to be correct for the general farm populus (Raskin and Cochran). However, little effort has been made to measure risk aversion levels of specific groups of farmers (for example, different ages) or different ranges of incomes for the farmers. Also, little effort has been made to relate the results of the elicitation to the perceived attitudes which farmers feel that they have towards risk. Consequently, economists should concern themselves with these areas when they use previously elicited risk aversion intervals as secondary information in their research work.

The principle objectives of this research project are: a) to investigate the relationship between age of farmers and risk aversion, b) to investigate consistency in elicited risk aversion intervals over different income ranges, and c) assess the ability of farmers to evaluate their own risk preferences. With these objectives in mind, a case study was conducted to elicit 30 north-eastern Kansas farmers' risk aversion intervals.

PROCEDURE

A questionnaire was developed to meet the objectives outlined above. The procedure used to develop the questionnaire involved the use of a computer program to create random distributions of farm income[1]. Each distribution contains six observations representing possible farm incomes. The program then orders the income distributions into intervals stochastic dominance with respect to a function criteria given specified upper or lower bounds on absolute risk aversion.

These specified upper or lower bounds of absolute risk aversion are given by:

$$r(x) = -u''(x)/u'(x)$$

where: $r(x)$ is the risk aversion coefficient; $u'(x)$ is the first derivative of the utility function; and $u''(x)$ is the second derivative of the utility function. Simply stated, the risk aversion coefficients are merely measures of the concavity or convexity at a specified point on the decision maker's utility function. If the utility function is concave at that point, a person is said to be risk averse. On the other hand, if the utility function is convex at that point, a person is said to be risk loving.

The specific boundaries of absolute risk aversion used in this study -.0005, -.0001, 0.0000, .0001, .0003, .0006, .0010, and .0050. These boundaries range from being extremely risk loving at -.0005 to being extremely risk averse at .0050. Past studies have typically used risk aversion intervals of -.0001 to .0001 as being almost risk neutral and .0002 to .02 as being strongly risk averse (Raskin and Cochran).

When ordering the income distributions, using stochastic dominance with respect to a function given the upper and lower bounds of absolute risk aversion, the program must calculate the utility levels of the different income elements with the given risk aversion coefficient. The

utility function used by the program is:

$$u(x) = -\exp(-rk) \text{ if } r(x) > 0$$
$$u(x) = x \text{ if } r(x) = 0$$
$$u(x) = \exp(-rx) \text{ if } r(x) < 0$$

where u(x) is the utility of the specified income level, r is the risk aversion coefficient, and x is the level of income.

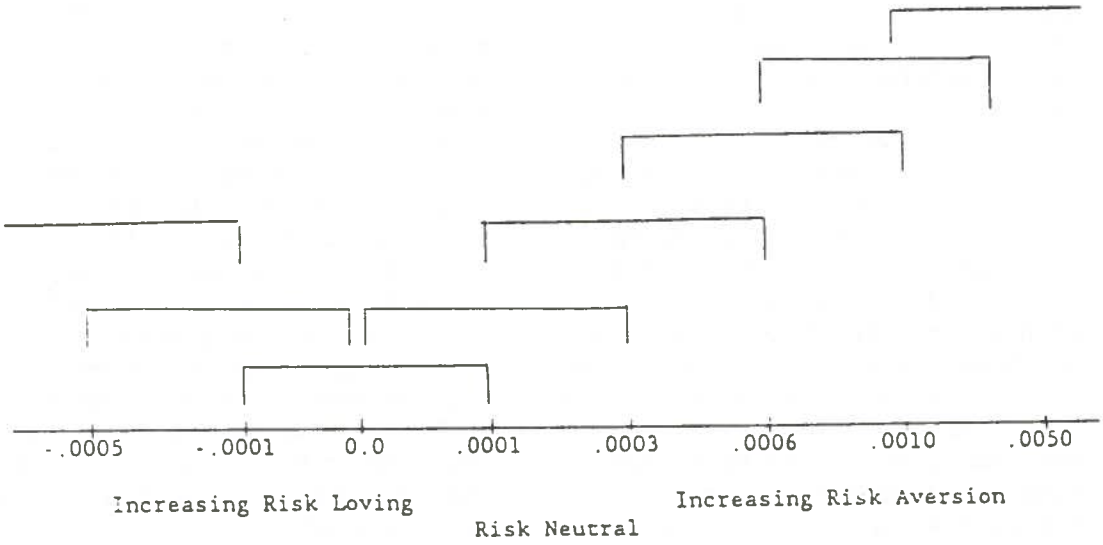
A major reason for using this utility function is the ease of calculations o utility levels. The theorem developed by Meyer and used to order the distributions integrates the following problem to determine the upper and lower bounds of risk aversion.

$\int[G(x)-F(x)]\, u'(x)\, dx$ over a specified interval, where G(x) and F(x) are cumulative distributions and u'(x) is the first derivative of the utility function. Since a large number of calculations of utility levels must be made, this particular form provides both simplicity and efficiency. (For more detailed information on the technique, see Meyer).

Once the income distributions have been generated and ordered using stochastic dominance with respect to a function, those income distributions must be formatted into a questionnaire. Since eight risk aversion coefficients were used to order the distributions, eight different intervals in risk aversion space may be identified. These intervals are [.0010, ∞), [.006, .0050], [.003, .0010], [.0001, .0006], [0.0000, .0003], [-.0001, .0001], [-.0005, 0.0000], and ($-\infty$, -.0001]. They are classified according to level of risk aversion in the following diagram.

The questionnaire contains five sections with questions asking a farmer to choose between possible income distributions. To illustrate the format of the questionnaire, a copy of the questionnaire used to determine the risk interval for an income level of $50,000 is given in Appendix A. Question one requires a choice between income distribution A and distribution B. The probability of one of the income elements occurring in distribution A or B is one-sixth. The questions are arranged in such an order that a farmer only needs to answer three of the seven questions and, as a result, can be classified into one of the eight possible risk aversion intervals.

A farmer is placed into one of the eight risk aversion intervlas in the following manner. If a farmer chooses distribution A over distribution B in question one then his risk aversion space is narrowed from ($-\infty$, ∞) to [.0001,∞). The computer program ordered the distributions so that distribution A is preferred above the risk aversion coefficient of .0003 and distribution B is preferred below the risk aversion coefficient of .0001. Therefore, if a farmer prefers distribution A, his interval has been narrowed to [.0001, ∞). Likewise, if a farmer prefers distribution B, his risk aversion interval has been narrowed to ($-\infty$, .0003]. He is then instructed to answer a second question according to his response in question one. By answering his second question, his risk aversion interval is further narrowed until upon the completion of his third question his risk aversion interval has been narrowed to one of the eight final risk averson interval classifications. The skeletal model in Table 1 illustrates the process by which the questions and responses narrow a farmer's risk aversion interval from ($-\infty$, ∞) to one of the eight final intervals.


-.0005
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Increasing Risk Loving
Risk Neutral
Increasing Risk Aversion

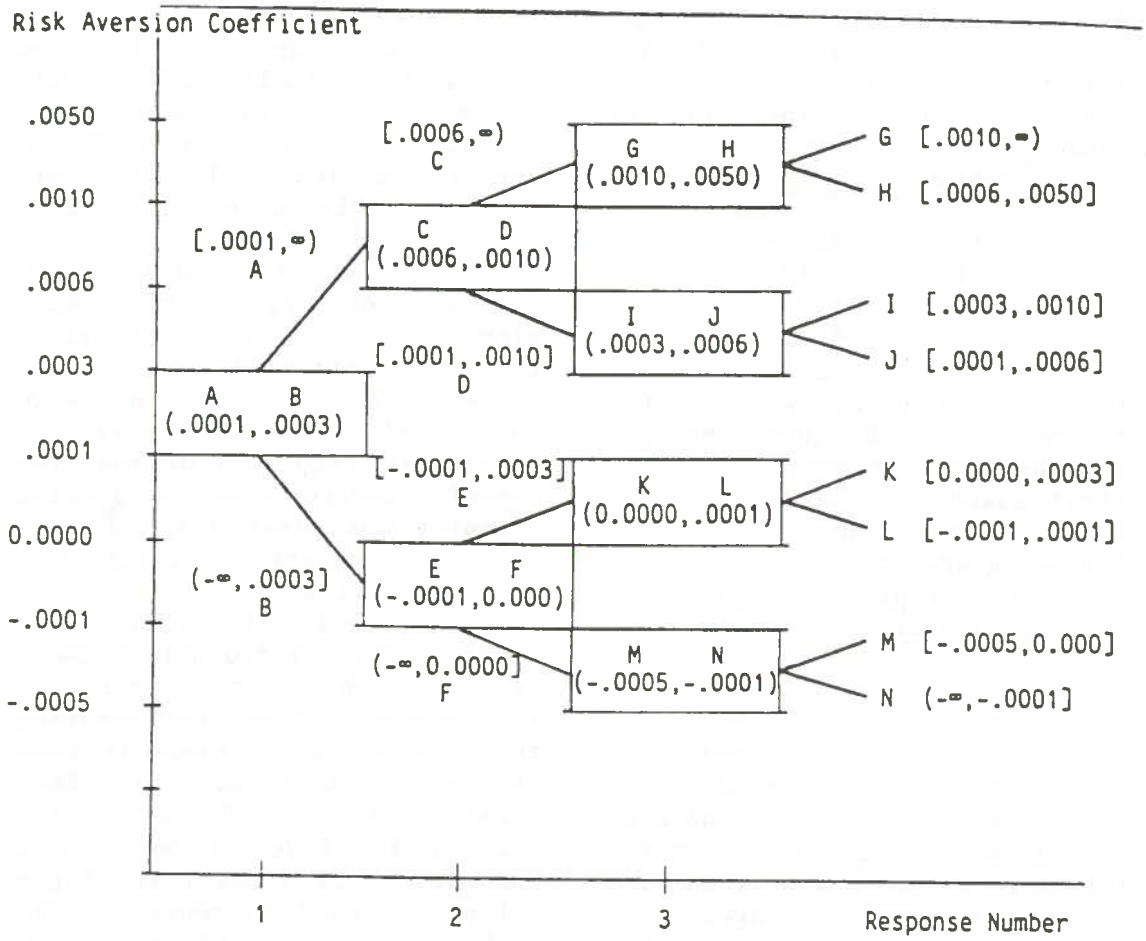

Table 1.
Skeletal Breakdown of Risk Aversion Intervals

In order to fulfill one of the objectives set forth in this paper, the questionnaire contained five sections, each identifying a farmer's risk aversion interval for a different income range. Each of these sections had distributions centered about income levels according to the following schedule:

Section	Farm Income
I	$50,000
II	$25,000
III	$0
IV	-$25,000
V	-$50,000

To fulfill the other objectives, a final page was attached to the end of the questionnaire. It contained two questions. The first asked the farmer to categorize himself into one of the following age groups:

Id Number Assigned to the Category	Age Group
1	20-29
2	30-39
3	40-49
4	50-59
5	60-69
6	70 and over

The age groups were used to investigate relationships between risk aversion intervals and age.

The second question asked the farmer the following question:

> How well do you like taking risks in general? Rate yourself on a scale of one to eight with one being an extreme dislike and eight being an extreme like?

This information was collected to investigate the extent to which farmers can assess their own risk preferences.

RESULTS

Once the questionnaire was completed, 30 north-eastern Kansas farmers were interviewed. The survey was conducted in the local community where the interviewer grew up. The farmers were primarily row crop, cattle, and hog farmers. This process was very time consuming, but the enumeration process assured that the information elicited was a result of careful thought and thorough understanding on the part of the farmers questioned. The responses to the questionnaire are presented in Appendix B.

In order to evaluate the data more easily, the risk aversion intervals were converted from the intervals to single values. These single values were calculated by taking the average of the two endpoints of the risk aversion intervals after positive infinity was given the value of .009, and negative infinity was given the value of -.0009.

The first relationship analyzed is the relationship between age and level of risk aversion. The single values representing the risk aversion intervals were utilized in this analysis. Each farmer had a single value for each of the five income ranges. The average of these five single values was used to represent the risk aversion level for each farmer. The farmers were then divided into two groups as evenly as possible. The "young" farmer category included individuals who were younger than 50 years of age, and the "older" farmer category included those who were 50 years of age or older. The younger group consisted of 17 farmers, and the older group had 13 farmers. In averaging the risk aversion coefficients from the farmers in both groups, it was found that the younger farmers had an average risk aversion level of .000567, and the older farmers had an average level of .000422. This suggests that the

older farmers, on average, were less risk averse than the younger farmers. However, this difference was not statistically significant (F=.19 with corresponding significance level equal to .66). Therefore, no definite conclusion can be drawn concerning the relationship between age and level of risk aversion.

The second objective was to investigate the consistency of risk aversion intervals over the five income ranges. Once again, the single values assigned to the risk aversion intervals were used. The average for all farmers over each of the five income ranges was then calculated. These averages are:

Income Range	Ave. Risk Aversion Coefficient
$50,000	.000288
$25,000	.000000
$0	.001106
-$25,000	.000675
-$50,000	.000451

As can be seen, the average risk aversion level at the $0 income range was the greatest. Descriptively speaking, this difference at the $0 income range is significantly different and shows a relatively high level of risk aversion.

The consistency with which individual farmers expressed their attitudes towards risk over the five income ranges should also be noted. Of the 30 farmers interviewed, 10 were consistently either risk averse to risk neutral or risk loving to risk neutral. The remaining 20 farmers were mixed in their degree of risk aversion. Of those farmers with mixed attitudes, five farmers were consistently risk averse to risk neutral at the $0, -$25,000, and -$50,000 income ranges. Also, of those farmers with mixed attitudes towards taking risk, 10 farmers were only inconsistent in one of the income ranges. This left five farmers remaining whose attitudes were unexplainably varied over the five income ranges. This information concerning consistency of risk attitudes over income ranges is, therefore, useful because it can be used to generalize farmers into one of four categories. The first is those who were consistently risk averse to risk neutral or risk loving to risk neutral over the income ranges. The second is those who were risk loving at high income ranges and risk averse to risk neutral in the lower income ranges. The third is the same as the first with the exception of one inconsistency in the income ranges. The fourth is those farmers whose attitudes inconsistently varied over the income ranges.

The third objective was to explore the relationship between the elicited risk aversion intervals and the farmers' responses on the self-ranking question. In investigating this relationship, the farmers were categorized into two groups. Those ranking themselves as one through four were assigned to the risk averse group. Conversely, those ranking themselves as five through eight were assigned to the risk loving group. The average risk aversion values were then compared for the two groups. The risk averse group had an average risk aversion value of .000827, and the risk loving group had an average risk aversion value of .000182. This implies that the farmers who responded in a risk averse fashion on the questionnaire rated themselves as being risk averse. Likewise, it implies that those who responded in a risk loving manner on the questionnaire rated themselves as being risk loving. This, in fact, was strongly the

case. The means for the two groups were significantly different at the five percent level (F=4.52). This offers some hope to researchers involved in the study of risk attitudes because some of the farmers apparently were capable of assessing their own risk attitudes.

QUESTIONNAIRE EVALUATION

A common comment received from farmers while completing the questionnaire was that they really did not see much difference between the two distributions facing them. The response to this comment was that there is a difference, and they were instructed to answer the questions as well as they possibly could. It should be noted, however, that most farmers found it easier to distinguish the differences between the distributions at the $0 income range. One possible explanation for this is that the average standard deviations of all income ranges except the $0 range were equal to five percent of the income range. For example, the standard deviation for the $50,000 range was $2500. At the $0 range, however, this standard deviation assignment could not be used. Therefore, $500 was given as the standard deviation for the $0 income range. This standard deviation may have been slightly higher for that income range in comparison to the standard deviations of the other income ranges. Another possible explanation as to why farmers could more distinguish differences in the income elements at the $0 range is that the distributions contained both positive and negative income observations. This could be the reason why farmers had little trouble in noting differences because large positive or negative numbers tended to be more easily observed.

Another interesting observation was made while administering the questionnaire. When the farmers were answering the self-ranking question, there were several occasions in which a farmer would respond to the income decisions in a very risk loving or extremely risk averse manner, but the farmer would rarely respond with an "8" or "1" on the self-ranking question. It is intriguing from both a psychological and economic standpoint to observe this. Does he not know the degree of risks he is taking, or does he not wish to reveal to others that he is extremely risk loving or risk averse? If a farmer was extremely risk averse, a common justification for marking the answer with a "4" or above (risk loving) was, "Well, I guess you've got to like taking some risks to be in this business."

Yet another observation concerning the format of the questionnaire was made while surveying farmers. A few individuals seemed to acquire the pattern in which the questions were arranged and gave the same responses on nearly every section. This did not occur often, but questions should be rearranged from section to section for future projects involving this technique of eliciting risk preferences.

SUMMARY AND CONCLUSIONS

In summary, the importance of understanding the risk attitudes of farmers can be a valuable aid to decision making research. Much current research depends on information concerning risk aversion levels. Of the farmers that were given the

questionnaire, their extreme level of risk aversion at the $0 range of farm income indicates that farmers tend to be very conservative in their decisions when they are at break even levels, possibly in order to ensure that they do not make decisions that could be detrimental to their operations. Also, the majority of farmers followed a fairly consistent pattern in their risk attitudes, which could enable researchers to generalize farmers risk attitudes over several different outcome ranges. Older farmers had slightly smaller risk aversion values than younger farmers, but the difference was not statistically significant.

The indication that farmers have some ability to assess their own risk attitudes has tremendous implications for future decision making research. Perhaps farmers themselves can be asked to generalize their attitudes in such a way that the eliciting process could be made much simpler without sacrificing a great deal of accuracy. Research results could be reported for several different risk aversion levels, and farmers may be able to select from them. This capability needs to be explored further to evaluate farmers' accuracy in ranking themselves. However, farmers failure to respond as strongly risk averse or risk loving is interesting from both a psychological and economic standpoint.

The information presented in this paper is evidence that additional study in eliciting risk aversion intervals is needed.

ENDNOTE

[1]This program was originally developed by King and Robison in FORTRAN programming language. It was later converted to BASIC programming language by the author. This was done in order to make the program more accessible to users of personal computers.

SECTION I

1. Compare the following two distributions and circle the one you prefer.

A	B
45500	45000
48300	48650
50250	49450
50550	52450
52450	53550
53200	55200

If you prefer A, go to question 2. If you prefer B, go to question 3.

2. Compare the following two distributions and circle the one you prefer.

C	D
47600	46900
47800	49250
48750	51300
50000	51400
51900	52900
52050	53950

If you prefer C, go to question 4. If you prefer D, go to question 5.

3. Compare the following two distributions and circle the one you prefer.

E	F
51150	49350
52100	49750
52300	50500
53150	53250
53450	54100
53900	57100

If you prefer E, go to question 6. If you prefer F, go to question 7.

4. Compare the following two distributions and circle the one you prefer.

G	H
47700	47650
48000	47900
48850	49050
50050	53750
51600	54400
52400	54400

Go to the next section.

SECTION I (cont.)

5. Compare the following two distributions and circle the one you prefer.

I	J
47600	47300
48300	47450
48500	48100
49150	50750
50100	53100
50350	59900

Go to the next section.

6. Compare the following two distributions and circle the one you prefer.

K	L
44000	43400
47450	46450
48650	47750
49950	50700
51500	51200
52850	55900

Go to the next section.

7. Compare the following two distributions and circle the one you prefer.

M	N
46300	44600
48500	49100
50400	49400
50600	49950
51100	51050
51400	52800

Go to the next section.

FARMER'S ID NUMBER	RISK AVERSION INTERVAL (Income Range) $50,000	$25,000	$0	-$25,000	-$50,000	AGE CATEGORY	SELF-RANKING QUESTION
1	[.0006,.0050]	(- ∞ ,-.0001]	[.0003,.0010]	[.0001,.0006]	[.0001,.0006]	2	3
2	[.0006,.0050]	[-.0001,.0001]	[.0001,.0006]	[-.0001,.0001]	[0.0000,.0003]	3	5
3	(- ∞ ,-.0001]	[-.0001,.0001]	(- ∞ ,-.0001]	[.0003,.0010]	(- ∞ ,-.0001]	5	8
4	(- ∞ ,-.0001]	(- ∞ ,-.0001]	[.0001,.0006]	(- ∞ ,-.0001]	(- ∞ ,-.0001]	1	4
5	[.0006,.0050]	(- ∞ ,-.0001]	[.0001,.0006]	[.0010, ∞)	[0.0000,.0003]	4	7
6	[.0001,.0006]	[-.0005,0.0000]	[.0006,.0050]	[-.0005,0.0000]	[.0001,.0006]	3	1
7	[-.0001,.0001]	[.0001,.0006]	[-.0005,0.0000]	(- ∞ ,-.0001]	(- ∞ ,-.0001]	1	4
8	(- ∞ ,-.0001]	(- ∞ ,-.0001]	[.0001,.0006]	[.0001,.0006]	[.0001,.0006]	4	5
9	(- ∞ ,-.0001]	[-.0005,0.000]	[.0006,.0050]	(- ∞ ,-.0001]	[-.0005,0.0000]	1	6
10	(- ∞ ,-.0001]	(- ∞ ,-.0001]	(- ∞ ,-.0001]	(- ∞ ,-.0001]	[-.0005,0.0000]	4	6
11	(- ∞ ,-.0001]	(- ∞ ,-.0001]	(- ∞ ,-.0001]	(- ∞ ,-.0001]	[-.0005,0.0000]	4	6
12	[-.0005,0.0000]	(- ∞ ,-.0001]	(- ∞ ,-.0001]	[-.0005,0.0000]	[-.0005,0.0000]	3	6
13	[-.0005,0.0000]	[.0006,.0050]	[.0010, ∞)	[.0010, ∞)	[.0010, ∞)	1	4
14	[0.000,.0003]	[0.000,.0003]	[.0003,.0010]	[.0001,.0006]	[0.000,.0003]	2	2
15	(- ∞ ,-.0001]	(- ∞ ,-.0001]	[.0006,.0050]	[-.0001,.0001]	[-.0005,0.0000]	2	4
16	[0.0000,.0003]	[.0001,.0006]	[.0003,.0010]	[-.0001,.0001]	[-.0001,.0001]	4	7
17	(- ∞ ,-.0001]	(- ∞ ,-.0001]	[.0010, ∞)	[0.0000,.0003]	[.0010, ∞)	3	3
18	[0.0000,.0003]	[.0001,.0006]	[.0003,.0010]	[.0001,.0006]	(- ∞ ,-.0001]	4	2
19	[.0006,.0050]	[-.0001,.0001]	[.0010, ∞)	[-.0001,.0001]	[.0001,.0006]	4	3
20	[-.0001,.0001]	(- ∞ ,-.0001]	[.0006,.0050]	[.0010, ∞)	[-.0005,0.0000]	2	6
21	[-.0005,0.0000]	(- ∞ ,-.0001]	[.0003,.0010]	[-.0001,.0001]	[.0001,.0006]	2	5
22	[-.0005,0.0000]	[-.0001,.0001]	[.0003,.0010]	[.0001,.0006	[.0001,.0006	5	4
23	[.0006,.0050]	[0.0000,.0003]	[.0003,.0010]	[.0003,.0010]	[-.0005,0.0000]	2	3
24	[-.0001,.0001]	[-.0001,.0001]	[.0003,.0010]	[-.0001,.0001]	[-.0001,.0001]	3	6
25	[-.0005,0.0000]	[0.0000,.0003]	[.0001,.0006]	[-.0005,0.0000]	[-.0005,0.0000]	6	6
26	[-.0005,0.0000]	(- ∞ ,-.0001]	[-.0001,.0001]	[0.0000,.0003]	[-.0005,0.0000]	3	6
27	[-.0005,0.0000]	[-.0005,0.0000]	[.0003,.0010]	[-.0001,.0001]	[0.0000,.0003]	4	7
28	[-.0005,0.0000]	[0.0000,.0003]	[.0003,.0010]	[0.0000,.0003]	[-.0005,0.0000]	3	4
29	(- ∞ ,-.0001]	(- ∞ ,-.0001]	[.0001,.0006]	[.0010, ∞)	[.0010, ∞)	4	4
30	[.0001,.0006]	[.0006,.0050]	[.0003,.0010]	[-.0001,.0001]	[.0001,.0006]	5	2

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