THE RISK PREFERENCES OF INDIVIDUAL INVESTORS[*]

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Abstract

Risk preferences of individual investors are studied by asking experimental questions to 2,226 members of a consumer panel. We find that most investors use more than one risk measure. For those investors who systematically choose one risk measure, semi-variance is most popular. Stock investors have a preference for semi-variance as a risk measure, while bond investors favor probability of loss. Investors state that they consider the original investment to be the most important benchmark, followed by the risk-free rate of return, and the market return. However, their choices in the experiment reveal that the market return is the most important benchmark.

In the last five years there has been an increasing attention in the investment profession for the risk attitudes of individual investors. This attention is partly caused by declining stock prices around the turn of the millennium. In the context of investment advice to individual investors, financial institutions all over the world have started to use so-called risk profiles of their clients. These risk profiles are standard questionnaires that are completed by potential clients. Risk profiles used by different banks in different countries all have in common that they contain questions on both the time horizon of the investors and on their risk preferences.[1] The idea behind the questions on the time horizon is that investors with a longer time horizon would generally be better off investing in stocks compared to investors with shorter time horizons.[2] The questions on the risk preferences include questions such as "Assume that over the last year your diversified portfolio of stocks declined by 20%. How would you react"? The possible answers generally vary between "I would sell my stocks immediately" to "I would hold on to my portfolio for at least another year". The obvious idea behind the questions on the risk preferences is that investors who are more risk tolerant would benefit from relatively larger investments in stocks. The combined score on the time horizon and the risk preference questions leads to an investment advice on the asset allocation for the potential client. In the Netherlands, financial institutions are legally obliged to construct such risk profiles. In other countries, they are generally not compulsory.

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[1] This is for example the case for risk profiles used by financial institutions in Canada, the Netherlands, New Zealand, and the United States.

[2] The concept that a longer time horizon should lead to a larger allocation to shares has long been disputed by finance theorists. This was based on the idea of Merton [1969] that if asset returns are i.i.d., an investor with power utility who rebalances her portfolio optimally, should choose the same asset allocation, regardless of investment horizon. However, research by Barberis [2000] shows that investors with longer time horizons should invest more in equity than investors with short time horizons. This is based on the finding that stock returns exhibit mean-reversion, which lowers the variance of cumulative returns over long horizons.

An interesting question in this context is how risk should be measured. Standard textbooks in finance and investment generally teach that risk is measured as the variance of (portfolio) returns.[3] This is a symmetric risk measure in which upwards deviations from the mean are given as much weight as downwards ones. However, there is also some limited evidence that in reality investors tend to find downside risk to be more important. For example, Unser [2000] finds that measures of shortfall risk are more important than the variance of returns. In line with this we see that in the behavioral finance literature it is documented that investors are more sensitive to losses than to gains. This feature stems from prospect theory and was documented by Kahneman and Tversky [1979] among others.

In this paper we study how individual investors perceive risk by asking experimental questions to members of a Dutch investor panel. We consider three asymmetric risk measures. The first one is the semi-variance. This risk measure is similar to the variance, but it only takes the deviations below the target return into account. The second and third risk measures are the probability of loss, and the expected value of loss. All these asymmetric risk measures are special cases of the α,t model of Fishburn [1977]. The fourth risk measure that we test is the variance of returns, which is a symmetric risk measure.

The choices for risk preferences are studied by submitting a questionnaire to members of the CentERpanel of CentERdata, which is associated with Tilburg University in the Netherlands. This consumer panel contains approximately 3,000 members of 2,000 representative Dutch households. We ask them direct questions on a number of topics that are related to their investments. For example, we ask them which financial

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[3] See e.g. Bodie, Kane, and Marcus [2002], or Ross, Westerfield, and Jaffe [2005].

instruments they hold, what their investment horizon is, and what their benchmark is. The second part of the questionnaire contains experimental questions in the form of pairwise comparisons. In these questions we ask the respondents to choose between two ways to invest 1,000 euro that both have the same expected return, but that are different with regard to risk. The questions are constructed in such a way that the first alternative is less risky according to one risk measure, and the second alternative is less risky according to the other three risk measures. We find that in three out of four questions, most respondents have a preference for the alternative that is less risky according to the three risk measures.[4] Our results show that the respondents base their decisions on more than one risk measure. A subgroup of respondents systematically chooses the same risk measure. Within this group, semi-variance is the most popular risk measure, preferred by 48% of the respondents. Semi-variance is followed by probability of loss (20%), variance (18%), and expected value of loss (14%). The results also show that stock investors have a preference for semi-variance as a risk measure, while bond investors prefer probability of loss.

Another remarkable result is that there seems to be a large divergence between the benchmark that investors indicate themselves and the benchmark that implicitly results from their choices. When asked directly, investors indicate that they consider the original investment to be the most important benchmark (59%), followed by the risk-free rate of return (28%), and the market return (7%). If, on the other hand, their choices in the experimental questions are analyzed, a completely different picture emerges. In this case

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[4] The only exception is for the question in which the respondents are asked to choose between the alternative with the lower semi-variance, and the alternative that is less risky according to the other three risk measures. Here the answers are equally divided between the two alternatives.

the market return is the most popular benchmark (40%), followed by the initial investment (29%), and the risk-free rate of return (18%).

We have also tested whether the answers to the experimental questions are related to demographics of the respondents. The only systematic pattern that we find is that respondents in a number of demographic categories are more likely to answer that they are indifferent or that the question is not clear for them. More specifically, respondents that are younger, male, have followed university or college education, or who earn more than 2,000 euro per month, are more likely to make a choice between the investment alternatives rather than indicating that they are indifferent or that the question is not clear for them. These differences largely disappear when we only look at the sub-sample of investors. In that case only the gender difference holds.

Finally, we have also used a questionnaire that was identical to the first, except that all amounts are multiplied by 20. The results from this questionnaire are generally the same as the results from the first questionnaire. The only differences are the fact that investors now choose in all four questionnaires for the alternative that is less risky according to the three risk measures, and that the zero return is slightly favored as a benchmark (33%), over the market return (32%), and the risk-free rate or return (14%).

These results are potentially very useful for financial institutions that use questionnaires in order to measure the risk preferences of their customers.

The remainder of this paper is organized as follows. Section I describes risk preference theories. The experiment is described in Section II. The results of the experiment are described in Section III. The paper is concluded in Section IV.

I. Risk preference theories

A large part of the modern investment theory is based on the mean-variance framework. In this framework the variance of the investor's portfolio returns is the most important risk measure.[5] The advantage of this approach is that investment decisions are only based on the mean and the variance of returns. An important disadvantage of this approach is that the variance is symmetrical. This means that it assigns the same weight to positive and to negative deviations from the expected value. In other words, variance does not capture the common notion of risk as a negative, undesired risk.

There is also a strand of literature that uses measures of risk that only look at the downside of risk. The first paper in this field is by Roy [1952] who proposes a safety-first model in which return is traded off against the risk of earning less than a target or minimum acceptable return. Fishburn [1977] develops a mean-risk dominance model with risk associated with below target returns. These are measures of downside or shortfall risk in the sense that only negative deviations from a target are taken into consideration. Applications of such models are the model of Bodie [1991], who uses shortfall risk measures in the context of pension fund management, Leibowitz and Kogelman [1991], who develop a simple shortfall methodology to determine the division between risky and riskless assets in a portfolio, and the model of Milevsky, Ho, and Robinson [1997], who study the optimal consumption in retirement.

Closely related to this literature are the studies on loss aversion. Loss aversion refers to the phenomenon that decision makers are more sensitive to losses than to gains.

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[5] It should be emphasized that the variance is the relevant risk measure for the entire *portfolio*. The relevant risk measure for an individual asset is different. For example, in the Capital Asset Pricing Model, which is based on mean-variance analysis, the relevant risk measure of an individual asset is the beta. This is the covariance of the asset return with the return on the market portfolio divided by the variance of the returns on the market portfolio.

This feature stems from prospect theory, and was first documented by e.g. Kahneman and Tversky [1979]. Empirical research by Kahneman, Knetsch, and Thaler [1990] and Tversky and Kahneman [1992] shows that losses are weighted about twice as strongly as gains. The disutility of losing $100 is roughly twice the utility of gaining $100.[6] A well-studied case of loss aversion is myopic loss aversion. This combines loss aversion, and a tendency to evaluate outcomes frequently. Investors who display myopic loss aversion are less willing to invest a greater portion of their wealth into risky assets if they evaluate their investments more frequently.[7] Even though the literature on shortfall theory is hardly ever combined with the literature on loss aversion, it can be noticed that loss aversion is similar to shortfall with a target return of zero.

In this paper we consider four risk measures. The first risk measure is the well-known variance of returns, which is a symmetric risk measure. We also consider three asymmetric risk measures. These are all special versions of the α,t model of Fishburn [1977]. The first and second asymmetric risk measures are the probability of loss and the expected value of loss. The third asymmetric risk measure is the semi-variance. This risk measure is similar to the variance, but it only takes the deviation below the target return into account.

II. The experiment

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[6] The impact of loss aversion on optimal portfolio choice is studied, for example, by Berkelaar, Kouwenberg, and Post [2004].
[7] See Thaler, Tversky, Kahneman, and Schwartz [1997], Gneezy and Potters [1997], Gneezy, Kapteyn, and Potters [2003], and Bellemare, Krause, Kröger, and Zhang [2005].

The experiment in this paper is based on a questionnaire submitted to the panel of CentERdata at Tilburg University in the Netherlands.[8] This internet-based panel consists of approximately 3,000 members from approximately 2,000 households. However, there is no need to have a personal computer with an Internet connection. Households that do not have access to the Internet are provided with a so-called NetBox with which a connection to the Internet can be established via a telephone line and a television set. All households can call a helpdesk or ask for technical support from home. The panel is recruited by telephone, so the recruiting of the panel is independent of whether or not households have Internet access. The panel is kept representative of the Dutch population with respect to a number of demographics. In other words, the average panel member has the same experiences and knowledge as the average person living in the Netherlands. The members of the panel are interviewed each week on a number of issues that mostly deal with financial matters. Clients of the panel are businesses and university researchers.[9] An important advantage of the use of the panel is that it has a number of demographic variables available for all participants. These may be linked to the answers that the respondents give.

We originally created the questionnaire in English, but the version sent to the respondents was translated in Dutch by one of the authors of this paper.[10] The final version of the questionnaire was *not* pre-tested on a separate sample. However, we have held a number of discussions with the staff at CentERdata to make sure that the questions

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[8] CentERdata is a survey research institute, specializing in Internet-based surveys. These surveys are carried out through the CentERpanel. CentERdata is located at Tilburg University in the Netherlands. Information about CentERdata and the CentERpanel can be found at http://www.centerdata.nl

[9] The panel has been used for previous finance research. For example, Dong, Robinson, and Veld [2005] study preferences of individual investors on dividend payments, and Guiso, Sapienza, and Zingales [2005] investigate the relationship between trust and stock market participation.

[10] The Dutch version of the questionnaire is, on request, available from the authors.

would be clear for the members of the panel. Appendix A contains an accurate translation of the version that was submitted by internet to the respondents.

The members of the CentERpanel are first asked to make several sequential choices between two possible investment alternatives. The alternatives all have the same expected returns, but they are different in their volatility and/or downside risk. Therefore, the investors optimize their utility by choosing the alternative with the lowest perceived risk. The use of pairwise comparisons is standard in economic experiments and is frequently used to test expected utility and its generalizations.[11]

The first four questions are set up in such a way that Alternative 1 minimizes one risk measure and Alternative 2 minimizes the other three risk measures. This can be illustrated with Question 1. This question reads:

"Suppose that you plan to invest 1,000 euro of your own money in an investment fund. You can choose between 2 investment funds. Both funds will be liquidated after 1 year and on average they pay out 1,100 euro (this is a return of 10%, which is equal to the average return on the stock market). The payment at the end of the year is unknown. You have the following probabilities of receiving different payments from the funds. What do you choose?

1. Fund A: 10% chance of 200 euro, and 90% chance of 1,200 euro
2. Fund B: 40% chance of 920 euro, and 60% chance of 1,220 euro
3. Both choices are equally attractive (or unattractive) to me
4. The question is not clear for me"

In Appendix B it is demonstrated that Alternative 1 will be chosen by respondents who are mostly concerned about the probability of loss. This probability is only 10 percent in Alternative 1 and it is 40 percent in Alternative 2. According to the other three

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[11] The many examples include Harless and Camerer [1994] and Hey and Orme [1994]. See Camerer [1995] for an overview.

risk measures, Alternative 2 is less risky than Alternative 1. In Questions 2 to 4, Alternative 1 will be chosen by respondents who are mostly concerned about respectively, semi-variance, the expected value of loss, and variance.

The question states that stocks earn an average return of 10 percent per year. This is based on the fact that the real return on U.S. stocks over the period 1926-1999 was 10 percent (see Chapter 5 of Bodie, Kane, and Marcus [2002]).[12] Furthermore the alternatives are calibrated in such a way that the standard deviation lies between 14 and 26 percent. This range is based on the fact that the standard deviation of (nominal) returns for U.S. stocks was 20 percent over the same period (see also Bodie, Kane, and Marcus [2002]). In order to avoid alternatives with odd numbers, we have rounded off numbers in such a way that the expected return is always between 9.9 and 10.1 percent and the standard deviation is always between 14 and 30 percent.

The next step is to find out what the benchmark is for the respondents who choose one of the asymmetric risk measures. This benchmark can either be the initial investment, the risk-free rate of return, or the market rate of return. The choice for the benchmark is examined in Questions 5-8. For example, Questions 5 and 6 have to be answered by all respondents who answered "1" to either Question 1 or Question 3. By giving this answer they indicate a preference for the probability of loss (Question 1) and/or the expected value of loss (Question 3). Question 5 reads:

"Suppose that you plan to invest 1,000 euro of your own money in an investment fund. You can choose again between two funds. Both funds will be liquidated after 1 year, and on average they pay out 1,100 euro (this is a return of 10%). This average

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return is higher than the interest on a savings account. A savings account would have paid 1,040 euro with certainty (this is a return of 4%). You can use the interest on the savings account in order to make a comparison. It is *not* possible to put the 1,000 euro in a savings account. What do you choose?

1. Fund A: 10% chance of 680 euro, 5% chance of 1,050 euro, and 85% chance of 1,150 euro
2. Fund B: 5% chance of 730 euro, 70% chance of 1,050 euro, and 25% chance of 1,310 euro
3. Both choices are equally attractive (or unattractive) to me
4. The question is not clear for me"

In Appendix B it is demonstrated that Alternative 1 is preferable if the market return is the benchmark, and Alternative 2 is preferable if the initial investment or the risk-free rate of return is the benchmark. Question 6 is set up in such a way that Alternative 1 is given by respondents who have a preference for the risk-free rate of return or the market return as the benchmark, and Alternative 2 is for investors who have the initial investment as a benchmark. Based on the combination of these responses it is possible for us to determine their benchmark. Questions 7 and 8 have to be answered by the respondents who answered "1" as an answer to Question 2. By answering "1" they indicate a preference for the semi-variance as a risk measure. Questions 7 and 8 are set up in a similar way to Questions 5 and 6. Based on the answers to these questions we can determine whether the investors consider the semi-variance relative to zero, the risk-free rate, or the market return.

The experiment is *not* incentive-induced. Even though there are arguments in favor of financially rewarding the subjects, in the sense that a financial stimulus will motivate them to think more deeply about their choices, there are important reasons not to reward them. The first reason is that we want people to consider the alternatives as if

they were investing their own money. By awarding people for their choices, we create an endowment effect.[13] Besides that, we want people to think in terms of substantial amounts of money. This is virtually impossible in an incentive-induced experiment, simply because it would get too costly. A solution that is often chosen for the second problem is to give all the participants a chance to win their choice. In such a case, one person would be allowed to play the game of her choice. Rabin [2000] argues that this lottery procedure is known to only be sufficient when the expected-utility hypothesis is maintained. Since in this paper we are testing the implications from this hypothesis against competing hypotheses, this procedure would not be useful for our purpose.[14] In addition, Camerer [1995] argues that persons with well-formed preferences are likely to express these truthfully, whether they are paid or not.[15]

In the second part of the experiment we ask questions similar to the first part. We only multiply all the amounts by 20. The first experiment carries the risk that investors consider the 1,000 euro mentioned in that experiment as a marginal investment. Since they might take different decisions when their whole capital is at stake, we have added this second part. The questions in this second part are phrased in the following way: "You are planning to allocate 20,000 euro of your own money in a stock investment fund. This is all the money you want to invest in stocks. You are planning to keep the rest of your savings on a savings account. You are considering two funds that offer the following payouts after one year (...)".

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[13] See Kahneman, Knetsch, and Thaler [1990] for a discussion of the endowment effect.
[14] Rabin [2000] also argues that if expected-utility theory holds, these procedures are at best redundant, and are probably harmful.
[15] Harless and Camerer [1994] find that the main effect of paying subjects is a reduction in the variance of their responses. This bias is avoided by not paying the subjects.

The third part of the experiment consists of Questions 9 to 17 from Appendix A. These are questions in which background information on the investors is acquired. In this part we ask questions on the type of financial instruments that they hold, on their time horizon, and on their benchmark.

III. Results

The first and the third part of the questionnaire were presented to the 2,943 members of the panel of CentERdata on the weekend of November 28, 2003.[16] These members had the opportunity to fill out the questionnaire from 17.00 hours on Friday November 28, 2003 to 24.00 hours on Tuesday December 2. In total 2,226 respondents filled out the questionnaire (75.6%). This makes the number of non-respondents equal to 717. The second part of the questionnaire was presented to the panel from 17.00 hours on Friday December 5, 2003 to 24.00 hours on Tuesday December 9. This part of the questionnaire was answered by 2,126 of a total of 2,962 respondents (71.8%).[17]

We first present the results on the financial products that the respondents own or have owned in the prior three years. These results are presented in Table I.

[Please insert Table I here]

In total 1,629 respondents indicate that they own investment products. We find that 17.5% of these panel members own stocks of exchange-listed companies other than investment funds. Stocks of investment funds are held by 36.4% of the panel members. Besides that, a relatively large part of this panel holds indirect investment in stocks. The

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[16] For this purpose all panel members of 16 years and older were selected. This allows the possibility that multiple persons from one household answer the questionnaire. This does not cause a problem for our research since we ask for risk attitudes. These can be different among household members.

[17] A complete draft of the questionnaire is, on request, available from the authors.

most common indirect investments in stocks are stocks in life annuities (17.2%), and investment mortgages (12.0%). In a life annuity the individual pays part of her income to a life insurance company. The contribution is deducted from income for tax purposes in the year it is paid to the insurance company. The contribution is invested by the insurance company. At the end of the maturity the individual is obliged to use the proceeds in order to buy a life annuity in order to supplement her pension. The payments from the life annuity are taxable. The investment mortgage is a combination of a mortgage loan and an investment. Individuals pay interest on the mortgage loan, but do not repay this loan until the end of the maturity (usually 30 years). Instead they contribute to a life insurance. This contribution is invested in stocks, bonds, and/or stocks in investment funds. At the maturity, the proceeds of the life insurance are used to pay off the principal amount of the mortgage. This system is very popular for tax reasons.

Not surprisingly, 88.5% of the panel members who indicate that they hold investment products, state that they have at least one savings account. The remaining investment products are only held by a small part of the panel members who indicate that they have invested in financial products.

In the remainder of this paper we distinguish between "investors" and "non-investors". With regard to investors we want to limit ourselves to persons who actively invest in risky assets. For this reason we do not count persons who only have investments in life annuities and/or in investment mortgages as investors. We also do not count individuals who only have savings accounts as investors.

The summary results of the first part of the experiment are included in Table II. These results are for the investors in our sample.[18]

[Please insert Table II here]

For each question we document the number of answers. Alternative 1 corresponds to Answer 1. Alternative 2 corresponds to Answer 2, and Answers 3 and 4 correspond to respectively "equally (un)attractive", and "the question is not clear". In the second part of the table we exclude Answers 3 and 4, and we calculate means and medians.

The results for the investment of 1,000 euro, from now on to be referred to as the marginal investment, are presented in Panel A of Table II. In Question 1 we find that 28.64% of the respondents find the probability of loss to be more important than the other three risk measures. If Alternatives "3" and "4" are eliminated, this percentage increases to 36.51%. Both the mean and the median are significantly different from 1.5, thereby indicating that the majority of the respondents find other risk measures to be more important than the probability of loss. The answers to Questions 3 and 4 also indicate that Alternative "2" is significantly more popular than Alternative "1". In each of the Questions 1-4, between 30 and 51 percent of the respondents choose a specific risk measure. The remaining 49 to 70 percent prefer an alternative that is minimizing the other three risk measures. In 3 out of 4 questions, this proportion is significantly different from 50%. The answers are, therefore, not random. This evidence also suggests that there is no single risk measure that is preferred by the majority of investors. Rather, all four risk measures are important, with semi-variance being chosen by about 50 percent of respondents. We can also look at the total percentage of respondents who choose a single

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[18] We also have results for the whole sample. Since these are virtually the same as the results for the investors, we restrict ourselves to presenting the results for the investors. The results for the whole sample are, on request, available from the authors.

risk measure against the other three. If every investor had one and only one risk measure, we would expect the percentage of investors in the first four rows of column (7) to add up to 100. However, the actual number it adds up to is 156%. This indicates that a single investor considers a number of important risk characteristics. A preliminary conclusion that can be drawn from these results is that investors use several risk measures. However, the semi-variance is more popular than the other three risk measures.

The answers to Question 5 indicate that 48.20% of the respondents, who are concerned with either the probability of a loss or the expected value of a loss, consider underperformance relative to the market return. The remaining 51.80% relate this underperformance to either the risk-free rate of return or the initial investment (zero return). Question 6 shows that 51.27% of the respondents find the risk-free rate of return or the market return to be more important than the initial investment (zero return).

Questions 7 and 8 are for respondents who indicated earlier that they are concerned about the semi-variance. The answers to Question 7 show that significantly more of these respondents relate the semi-variance of returns to the market return than to the risk-free rate of return or the zero return. Apparently this group of investors sees the market return as an important benchmark. This result is confirmed, or in any case not contradicted, in Question 8 where 63.74% of the respondents indicate that they find the market rate of return and the risk-free rate of return to be more important than the zero return.

A further analysis of the answers to Questions 1-4 is presented in Figure I. In this figure we left out all the results for respondents who answered at least once "3" or "4" in

Questions 1 to 4. This means that we kept only the 449 respondents who made a choice in all four questions for one of the investment alternatives (Alternative 1 or 2).

[Please insert Figure I here]

Figure I starts with the answer to Question 4 in Panel A of Table I. Respondents, who answered "1" here, implicitly see the variance as their most important risk measure. Those who choose "2" implicitly choose one or more of the other risk measures. The reason that we start with the answers to Question 4 is that the variance is the only symmetric risk measure in our research. All the other risk measures are asymmetric. As can be seen in Figure I, in total 42.09% of the respondents choose variance, the remaining 57.91% chooses for the other (asymmetric) risk measures.[19] In the next nod we check whether the investors who choose variance as a risk measure in Question 4, have also chosen one of the asymmetric risk measures in any of the other questions. This turns out to be the case for 85.19% of the respondents. Of these investors, semi-variance is most popular, followed by probability of loss. With regard to the investors who do not consider the variance to be the most important risk measure, 84.62% has chosen for an asymmetric risk measure in one of the preceding questions. Also for these investors, semi-variance is the most important risk measure, now followed by expected value of loss.

An important conclusion that can be drawn from Figure I is that almost 58% of the investors do not consider the variance to be the most important risk measure. This is remarkable, since a large part of the investment theory is based on the variance as the only risk measure. Even among the investors who do choose variance, more than 85% also finds at least one of the asymmetric risk measures to be important. This means that

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[19] The results from Figure 1 do not exactly match those of Question 4 in Panel A of Table 1. The reason for this is that in Figure 1 we left out all the respondents who answered at least once "3" or "4" in one of the Questions 1-4.

only 28 out of 449 investors (6%) systematically choose the variance as the most important risk measure. Finally, both classes of investors who choose the variance and those that do not choose the variance tend to find the semi-variance to be the most important asymmetric risk measure.

As mentioned before, we have asked the same questions for a much larger investment (20,000 euro instead of 1,000 euro). These results are labeled as the results for the total investment. The answers to these questions are presented in Panel B of Table I. The results for Questions 1, 3, and 4 are not noticeably different between Panel A and Panel B. There is a difference however between the results of Question 2. In Panel A we find an almost equal number of investors answering "1" as answering "2", indicating an equal preference for semi-variance as for the other risk measures. This preference has mostly disappeared in Panel B. The result for semi-variance considered in isolation is still better than that of the other risk measures (42.83% versus 36.05% for probability of loss, which is the second most popular risk measure considered in isolation), but it is significantly less popular than the other three risk measures combined. This indicates that here we have even stronger evidence than in Panel A that there is no single risk measure that is preferred by the majority of investors to all other risk measures. It should be kept in mind that all the alternatives have the same expected return. The answers to Question 5 in Panel B indicate that 54.85% of the respondents, who are concerned with either the probability of a loss or the expected value of a loss, are more concerned about the underperformance relative to the market return than relative to the initial investment or the risk-free rate of return. Question 6 looks at the same respondents, but asks whether they are more concerned about underperformance with regard to the market or the risk-

free rate combined (Answer 1) or with regard to the initial investment (Answer 2). In Panel B we find that 41.87% is more concerned about underperformance with regard to the market or the risk-free rate than with regard to a return of zero. Questions 7 and 8 are for the respondents who indicated earlier that they find the semi-variance to be the most important risk measure. On both Questions 7 and 8 their responses are almost equally divided between Answers 1 and 2.

We can now set up Figure II which is similar to Figure I, except that we now look at the total investment instead of the marginal investment.

[Please insert Figure II here]

The first conclusion that can be drawn from Figure II is that the variance is even less popular as a risk measure for the total investment than it is for the marginal investment. The number of respondents choosing for variance as the risk measure decreases from 42.09% in Figure I to 33.33% in Figure II. Moreover we see that no less than 81.48% of the respondents that choose variance as a risk measure, have chosen for at least one asymmetric risk measure. This means that only 20 out of 324 respondents (6%) systematically choose variance as the only risk measure. When we look at the choice of the asymmetric risk measures, we see similar results with a smaller popularity of the semi-variance than in Figure I. Given the difference in results between Panel A and Panel B in Table II this result is not surprising. Furthermore we can see that the expected value of loss has become more popular as a risk measure for those respondents that did choose variance in Question 4. It is not surprising that investors become more concerned about the expected value of a loss when an investment of 20,000 euro is considered instead of an investment of 1,000 euro.

In line with Figures I and II we investigate how many respondents systematically choose one risk measure. With "systematically choosing" we mean selecting an alternative that minimizes this risk measure in all four questions. In Figure I we find that 28 out of 449 respondents systematically choose the variance as the most important risk measure. We also investigate this for the other risk measures. The results of this analysis are presented in Table III.

[Please insert Table III here]

Panel A presents the results for the marginal investment. We find that in total 155 respondents systematically choose one risk measure: 31 investors go for probability of loss, 74 investors for semi-variance, 22 for expected value of loss, and the earlier reported 28 for variance. If we express this as a percentage, we find that 47.74% of the investors, which systematically choose one risk measure, choose semi-variance as that risk measure. The χ^2 test, which tests for the non-randomness of the distribution of answers, is significant at the 1%-level. From Figure I we conclude that approximately 6% of the investors systematically choose the variance as a risk measure. Table III shows that more than 16% systematically chooses for the semi-variance. The results for the total investment are not dramatically different. In this case 41.04% of those investors who systematically choose the same risk measure choose the semi-variance. This can be compared to 14.93% for the variance, 26.12% for the probability of loss, and 17.91% for the expected value of loss. Thus, although we find that all four risk measures play a role in investment decisions, semi-variance is by far the most important measure.

Table IV shows how the individuals' answers to Questions 1 to 8 for the amounts of 1,000 are related to their answers to the same questions for the amount of 20,000 euro.

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[Please insert Table IV here]

Separately for every question we report Pearson's χ^2 statistics and Phi coefficients. Pearson's χ^2 statistics is used to test the null hypothesis that the responses to each pair of questions are independent. For all four risk measure questions the null hypothesis is rejected at the one percent level, suggesting that people tend to make the same choice, irrelevant of the amount of money at stake. Similar result holds for the benchmark questions, although the significance levels for these questions vary from one to ten percent. In order to assess how closely the answers between the small- and large-amount questions are related, we also calculate Phi coefficients, calculated as $\sqrt{\chi^2 / N}$, where N is the number of observations. Similarly to the correlation coefficient, Phi coefficients measure the association between two groups of responses, but are robust to nonlinearity. They can vary from 0 to 1, with a high number indicating a stronger relation between the two series. The values of the Phi coefficients, reported in Table IV, suggest a strong association between the two series. This is especially the case for the risk measure questions, where they all lie between 0.4 and 0.5. Respondents tend to vary their answers slightly more with regard to the benchmark, especially those who selected probability and expected value of loss as their main risk concern.

In addition to the experimental questions on the benchmark, we also explicitly ask respondents how they evaluate the performance of their stocks. We only ask this question to respondents with investments in stocks and/or investment funds. These results are included in Table V.

[Please insert Table V here]

From Table V it can be concluded that most investors consider the initial investment to be the most important benchmark (58.95%). This is followed by the risk-free rate of return (28.09%) and the stock market return (7.13%). The finding that investors strongly rely on the initial value is also documented in the behavioral finance literature. De Bondt [1998] argues that, next to the market return, the original purchase price is a "highly salient reference point". He argues (page 837): "*How many people can bring themselves to sell off a house at a price that is lower than what they paid for it?*" The reliance on the initial value is also an important element of the disposition effect, first documented by Shefrin and Statman [1985]. This is the effect that investors are reluctant to sell assets trading at a loss relative to the price at which they were purchased.

The investors' benchmarks can also be derived from our experimental questions. This analysis is presented in Table VI.

[Please insert Table VI here]

The results in Table VI are again only for investors. This table only includes those respondents who indicated a preference for one or more of the asymmetric risk measures in Questions 1-4. Based on the answers to Questions 5-8 it is possible to derive which benchmark investors implicitly choose. From this table it can be concluded that the market return is the most important benchmark for all investors (39.66%), followed by the zero return (28.65%) and the risk-free rate of return (17.65%). The market return is an even more important benchmark for the investors who choose the semi-variance of returns. The subjects who choose one of the other asymmetric risk measures find the initial investment to be the most important benchmark. Finally, it is possible that respondents give inconsistent results. For example, the choice of Answer 1 on Question 5

would imply that the respondent finds the market return a more important benchmark than either the risk-free rate of return or zero. If the same respondent would Answer 2 to Question 6 it would mean that this respondent finds a zero return to be a more important benchmark than either the market return or the risk-free rate of return. This sequence of choices is obviously inconsistent. Similarly, it is inconsistent to Answer 1 to Question 7 followed by 2 on Question 8. If all the respondents would have filled out the questionnaire randomly, this would have been the case for an expected 25% of the respondents. In reality 14.04% of the respondents showed this inconsistency. This number is different from the earlier mentioned 25% on the 1%-significance level. It should be noticed that inconsistencies are common in the literature on experimental economics and experimental finance. For example, Loomes, Starmer, and Sugden [1991] find that a large number of subjects prefer a 60% chance of £ 8 over a 30% chance of £ 18. The same subjects also prefer a certain amount of £ 4 over a 60% chance of £ 8 and they prefer a 30% chance of £ 18 over a certain £ 4. This clear violation of the transitivity rule accounted for approximately 17 percent of the patterns resulting from pairwise choices in their study. The questions and the choices in our study are very complicated. For this reason it is highly unlikely that any of the respondents was aware of the fact that they gave inconsistent answers. Furthermore, the respondents were not informed in any way that they could give inconsistent answers. In this context it is not surprising that a relatively large number of respondents gave inconsistent answers.

The results for the total investment show some interesting differences compared to the results for the marginal investment. First we see that the number of inconsistent responses goes up to 20.95%. This result is still significantly different at the 5%-level

from the 25%-score that would have resulted if the questionnaire were filled out randomly. We also see that the risk-free rate of return is still not very popular as a benchmark (13.79% compared to 17.65% for the marginal investment). However, we now see that the initial investment is more popular as a benchmark than the market return (33.42% versus 31.83%). Apparently, as the stakes get higher, investors focus more on the initial investment than on the market return, or put in terms of popular investment books, "greed" is overcome by "fear".

Reviewing the results for both the marginal and the total investments it can be concluded that there is still a large divergence between the respondents' answers to a direct question with regard to their benchmarks and their (implicit) choices. Table III shows an overwhelming preference for the initial investment (58.95%) over the market return (7.13%) as an anchor. However, looking at Table V we find that there is a marginal support for the initial investment as an anchor when we look at the total investment (33.42% versus 31.83%). When looking at the marginal investments, we even see a reversal, in the sense that the market return is more popular than the zero return.

In Table VII we test whether a preference for a particular risk measure can explain in which risky assets people tend to invest.

[Please insert Table VII here]

This is tested by estimating a logit model, where the dependent variable is equal to 1 when the respondent has invested money in a particular risky asset, and 0 otherwise. This analysis is only carried out for the most common investment categories: stocks, investment funds, and corporate bonds. A comparison of stock and bond investments is interesting for our purposes, since these two categories not only have different amount of

risk associated with them, but also differ in their risk profile. We use the preferences for the particular risk measure, derived from the answers to the Experimental Questions 1 to 4, as explanatory variables in the regressions. We find that respondents with a preference for the semi-variance as a risk measure are more likely to hold individual stocks. This is the only risk measure in this category that is significantly different from zero (on the one percent level). The only significant risk measure for corporate bond investors is the probability of a loss. It is in line with intuition that bond investors have different preferences than stock investors. Bond investors are a priori expected to be more concerned about the probability of losing part of their initial investment compared to stock investors, since they invest in an instrument that limits this probability. We find that investors in investment funds have a preference for two risk measures, i.e. the semi-variance, and the probability of a loss. This could be expected because investment funds may combine both equity and fixed income assets. Consequently, these investors share the preferences of both stock and bond investors. Overall, results of these regressions show that the different types of risk attitudes among individual investors, found in the previous parts of the paper, directly translate into their investment behavior. Individuals tend to choose their investments into risky assets according to their risk preferences and the risk profile of the different assets, thereby displaying a clear clientele effect.

We also test whether the answers to the experimental questions are related to respondents' demographics. We distinguish the following demographic categories: age (below 55 versus 55 and older), gender, education (university or college versus other), and monthly gross income (below 2,000 euro versus above 2,000 euro). We do not find any systematic relationship between answering "1" or "2" (in other words, particular risk

preferences), and demographics. For this reason we do not present these results here.[20]

However, we do find interesting differences in the frequency of answering "3" ("indifferent") and "4" ("question is not clear") for different demographic groups. It should be noted that the answer "question is not clear" may both refer to not understanding the question or to not caring about it. Since the results are remarkably different between investors and non-investors, we present the findings for both categories. The results are presented in Table VIII.

[Please Insert Table VIII here]

In this table we present the total number and percentage of respondents in a certain demographic category that answers either 3 or 4, and we test whether the difference within this category is significantly different from zero. We restrict ourselves to Questions 1 to 4. Questions 5 to 8 are left out because respondents only received these questions if they answered Alternative 1 to Question 1, 2, or 3. Since the results are virtually the same for the two experiments, we only present the results for the first experiment.[21] Panel A of Table VIII presents the results for all the respondents. Here we see interesting differences within all demographic categories. For example, for Question 1 we see that 29% of the respondents under the age of 55 answers that they are indifferent (Alternative 3) or that the question is not clear for them (Alternative 4). This contrasts to 36% of the respondents of age 55 and older that give the Answers 3 or 4. This difference is significantly different from zero at the 1%-level. The same pattern holds for Questions 2 to 4. Thus, younger investors are more likely to make a firm choice (Alternative 1 or 2) than older investors. There is also a remarkable gender difference for all questions. In all

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[20] These results are, on request, available from the authors.
[21] The results for the second experiment are, on request, available from the authors.

cases, female respondents are more likely to answer "3" or "4" than male respondents. This is line with the results of Barber and Odean [2001] who find that men are more overconfident than women. Our results do not say that men are overconfident, but they do indicate that men are more confident than women in giving a firm answer. Similarly we find that better educated and higher earning respondents are more likely to make firm choices than less educated and lower earnings respondents. Panel B of Table VIII presents the results for the investors. Here we see that the difference between demographic categories becomes smaller. As far as education and income are concerned, we only see a significant difference in one out of four questions. Age is now only significant for two out of four questions. The only category where we still see significant differences for three out of four questions is gender. Apparently, male investors are more likely to make firm choices than female investors. These results can be explained by the fact that investors are more used to making investment choices, or that less confident individuals tend to not make risky investments.

IV. Summary and conclusions

Finance and investment textbooks generally consider the variance of portfolio returns to be the most important risk measure, used in the risk-return trade-off. On the other hand, in the common perception risk is mostly related to the possibility and magnitude of *negative* deviations from the benchmark. This definition is supported by, for example, Fishburn [1977], and is recognized by most of the financial institutions that construct risk profiles of their clients. Many of their questionnaires contain questions that measure risk tolerance both by the variance of returns and by shortfall measures. The

purpose of this paper is to test which risk measures influence the individual investors' decision making. We find that investors use a variety of risk measures at the same time. The variance is one of these risk measures, but besides the variance, investors also use several measures of shortfall risk. In particular, semi-variance of returns is found to reflect the investors' risk preferences most often. This risk measure combines the quadratic nature of variance with the common notion of risk as a negative phenomenon. Even stronger, we find that investors' real-life choices of risky investments are directly influenced by their risk preferences revealed in the experiment. The results of our study can be potentially useful for the financial institutions in finding out which risks are most important for their clients.

Another area where the results of this study can be useful is on the topic of benchmarking. We find an interesting discrepancy between investor responses and the results of an experiment on risk measures. In general individual investors claim that they find the initial investment to be the most important benchmark. However, the experiment shows that for a large amount (€ 20,000) the market return and the initial investment are virtually equally popular benchmarks. For a small investment (€ 1,000) the market return is considered to be the most important benchmark. In either case, the investors seem to make different choices from their stated preferences.

Appendix A. Questionnaire

This appendix contains the questionnaire as it was submitted to the members of the CenterData panel.[22] The questionnaire contains three parts. The first part consists of Experimental Questions 1 to 8. The second part consists of Questions 9 to 17 in which background information on the respondents is acquired. The third part is a repeat of Questions 1 to 8. However, in this part all of the answers are multiplied by 20. Since the third part is almost identical to the first part, we do not include this separately in the appendix. The paper does not use all the information acquired with Questions 9 to 17. However, interested readers can obtain all the data collected in this experiment from the authors.

Introduction (first computer screen)

The following questionnaire is part of a research project of the Erasmus University in Rotterdam, and Tilburg University. By means of this project we try to determine how individuals choose between different investment opportunities. The questionnaire is divided over two weeks. This week you receive part 1.

Introduction (second computer screen)

In the next questions we ask you how you would invest a specific amount. Each time you can choose between two possibilities. The difference between two possibilities is in the probability that you get a certain amount paid out. Next to a choice from the two alternatives you can also indicate that both possibilities are equally attractive (or equally unattractive) for you. Besides that, there is the possibility that you do not understand a question, for example because it is not clear. In that case you can choose the alternative: "The question is not clear for me". You will receive a minimum of 4 and a maximum of 8 questions in which you are asked to make a certain choice. The number of questions depends on the answers that you have given.

Question 1

Suppose that you plan to invest 1,000 euro of your own money in an investment fund. You can choose between 2 investment funds. Both funds will be liquidated after 1 year, and on average they pay out 1,100 euro (this is a return of 10%, which is equal to the average return on the stock market). The payment at the end of the year is unknown. You have the following probabilities of receiving different payments from the funds. What do you choose?

1. Fund A: 10% chance of 200 euro, and 90% chance of 1,200 euro
2. Fund B: 40% chance of 920 euro, and 60% chance of 1,220 euro
3. Both choices are equally attractive (or unattractive) to me
4. The question is not clear for me

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[22] The original questionnaire was in Dutch. This is a translation of the questionnaire that was presented to the panel. See Section III for details.

Question 2

Suppose that again you plan to invest 1,000 euro of your own money in an investment fund. You can choose between 2 investment funds. Both funds will be liquidated after 1 year, and on average they pay out 1,100 euro (this is a return of 10%, which is equal to the average return on the stock market). The payment at the end of the year is unknown. You have the following probabilities of receiving different payments from the funds. What do you choose?

1.   Fund A: 70% chance of 930 euro, and 30% chance of 1,500 euro
2.   Fund B: 20% chance of 780 euro, and 80% chance of 1,180 euro
3.   Both choices are equally attractive (or unattractive) to me
4.   The question is not clear for me

Question 3

Suppose that for the third time you plan to invest 1,000 euro of your own money in an investment fund. You can choose between 2 investment funds. Both funds will be liquidated after 1 year, and on average they pay out 1,100 euro (this is a return of 10%, which is equal to the average return on the stock market). The payment at the end of the year is unknown. You have the following probabilities of receiving different payments from the funds. What do you choose?

1.   Fund A: 10% chance of 640 euro, 60% chance of 990 euro, and 30% chance of 1,470 euro
2.   Fund B: 15% chance of 800 euro, 40% chance of 920 euro, and 45% chance of 1,360 euro
3.   Both choices are equally attractive (or unattractive) to me
4.   The question is not clear for me

Question 4

Suppose that for the fourth time you plan to invest 1,000 euro of your own money in an investment fund. You can choose between 2 investment funds. Both funds will be liquidated after 1 year, and on average they pay out 1,100 euro (this is a return of 10%, which is equal to the average return on the stock market). The payment at the end of the year is unknown. You have the following probabilities of receiving different payments from the funds. What do you choose?

1.   Fund A: 25% chance of 800 euro, and 75% chance of 1,200 euro
2.   Fund B: 10% chance of 750 euro, 87.5% chance of 1,100 euro, and 2.5% chance of 2,500 euro
3.   Both choices are equally attractive (or unattractive) to me
4.   The question is not clear for me

Respondents who have given Answer 1 to Question 1 and/or 3 automatically also get Question 5 and 6. Respondents who have given Answer 1 to Question 2 automatically get Questions 7 and 8. This means that the maximum number of questions that a respondent has to answer is 8, and the minimum is 4.

Question 5

Suppose that you plan to invest 1,000 euro of your own money in an investment fund. You can choose again between two funds. Both funds will be liquidated after 1 year, and on average they pay out 1,100 euro (this is a return of 10%). This average return is higher than the interest on a savings account. A savings account would have paid 1,040 euro with certainty (this is a return of 4%). You can use the interest on the savings account in order to make a comparison. It is *not* possible to put the 1,000 euro in a savings account. What do you choose?

1. Fund A: 10% chance of 680 euro, 5% chance of 1,050 euro, and 85% chance of 1,150 euro
2. Fund B: 5% chance of 730 euro, 70% chance of 1,050 euro, and 25% chance of 1,310 euro
3. Both choices are equally attractive (or unattractive) to me
4. The question is not clear for me

Question 6

Suppose that again you plan to invest 1,000 euro of your own money in an investment fund. You can choose again between two funds. Both funds will be liquidated after 1 year, and on average they pay out 1,100 euro (this is a return of 10%). This average return is higher than the interest on a savings account. A savings account would have paid 1,040 euro with certainty (this is a return of 4%). You can use the interest on the savings account in order to make a comparison. It is *not* possible to put the 1,000 euro in a savings account. What do you choose?

1. Fund A: 10% chance of 800 euro, 50% chance of 1,030 euro, and 40% chance of 1,260 euro
2. Fund B: 5% chance of 900 euro, 60% chance of 1,000 euro, and 35% chance of 1,300 euro
3. Both choices are equally attractive (or unattractive) to me
4. The question is not clear for me

Question 7

Suppose that you plan to invest 1,000 euro of your own money in an investment fund. You can choose again between two funds. Both funds will be liquidated after 1 year, and on average they pay out 1,100 euro (this is a return of 10%). This average return is higher than the interest on a savings account. A savings account would have paid 1,040 euro with certainty (this is a return of 4%). You can use the interest on the savings account in

order to make a comparison. It is *not* possible to put the 1,000 euro in a savings account. What do you choose?

1. Fund A: 20% chance of 940 euro, 70% chance of 1,070 euro, and 10% chance of 1,600 euro
2. Fund B: 60% chance of 990 euro, 20% chance of 1,070 euro, and 20% chance of 1,450 euro
3. Both choices are equally attractive (or unattractive) to me
4. The question is not clear for me

Question 8

Suppose that again you plan again to invest 1,000 euro of your own money in an investment fund. You can choose again between two funds. Both funds will be liquidated after 1 year, and on average they pay out 1,100 euro (this is a return of 10%). This average return is higher than the interest on a savings account. A savings account would have paid 1,040 euro with certainty (this is a return of 4%). You can use the interest on the savings account in order to make a comparison. It is *not* possible to put the 1,000 euro in a savings account. What do you choose?

1. Fund A: 10% chance of 900 euro, 70% chance of 1,030 euro, and 20% chance of 1,450 euro
2. Fund B: 50% chance of 970 euro, 20% chance of 1,030 euro, and 30% chance of 1,370 euro
3. Both choices are equally attractive (or unattractive) to me
4. The question is not clear for me

Intermediate Question

Do you ever save or invest?

1. Yes
2. No

Respondents who have given answer Yes to the Intermediate Question, automatically get Question 9. Respondents who have given answer No to the Intermediate Question; automatically get the final screen (see after Question 17).

Question 9-1

Can you please indicate what your most important goal is to save and/or to invest?

1. An addition to my retirement pension
2. In order to be able to retire before the official pension date
3. In order to make a big investment such as a house, boat or car
4. To save for the education of my children

5.   A necessary addition to my current income
6.   No specific goal (general increase of capital)
7.   To leave an inheritance
8.   Other

If the respondent answers Alternative 8 to Question 9-1 she is also asked to answer the question: "Which other goal do you have to save and/or invest?"

Question 9-2

Can you please indicate what your second most important goal is to save and/or to invest?

1.   An addition to my retirement pension
2.   In order to be able to retire before the official pension date
3.   In order to make a big investment such as a house, boat or car
4.   To save for the education of my children
5.   A necessary addition to my current income
6.   No specific goal (general increase of capital)
7.   To leave an inheritance
8.   Other

If the respondent answers Alternative 8 to Question 9-2 she is also asked to answer the question: "Which other goal do you have to save and/or invest?"

Question 9-3

Can you please indicate what your third important goal is to save and/or to invest?

1.   An addition to my retirement pension
2.   In order to be able to retire before the official pension date
3.   In order to make a big investment such as a house, boat or car
4.   To save for the education of my children
5.   A necessary addition to my current income
6.   No specific goal (general increase of capital)
7.   To leave an inheritance
8.   Other

If the respondent answers Alternative 8 to Question 9-3 she is also asked to answer the question: "Which other goal do you have to save and/or invest?"

If the respondent answers Alternative 1, or 2 to either Question 9-1, 9-2, or 9-3, she automatically gets Question 10, otherwise she skips Question 10

Question 10

In how many years do you plan to retire or to retire early?

If the respondent answers Alternative 3 to either Question 9-1, 9-2, or 9-3, she automatically gets Question 11, otherwise she skips Question 11

Question 11

In how many years do you plan to make the big investment (house, boat, reconstruction, or car)?

If the respondent answers Alternative 4 to either Question 9-1, 9-2, or 9-3, she automatically gets Question 12, otherwise she skips Question 12

Question 12

In how many years do you think that your first child will start to follow an education?

Question 13

Which of the following financial products do you currently own and/or did you own during the last three years (yes/no)?

13.01   Stocks of exchange-listed companies other than investment funds
13.02   Stocks of investment funds
13.03   Stocks in privately-owned companies
13.04   Government bonds
13.05   Corporate bonds
13.06   Convertible bonds
13.07   Savings accounts
13.08   Click funds
13.09   Stock lease plans
13.10   Reverse convertibles
13.11   Call options
13.12   Put options
13.13   Call warrants
13.14   Put warrants
13.15   Investment mortgage
13.16   Life annuity with investment in stocks
13.17   Life annuity without investment in stocks
13.18   Others (please specify)

If the respondent answers Yes to Question 13.18 she receives the question: "Which financial product did you possess during the last 3 years?"

Question 14

When you evaluate the performance of your stock investments (including stocks in investment funds), what is your relevant benchmark?

1.   I mainly look whether my investments increase in value compared to the price that I paid for them;
2.   I mainly look whether my investments make more than the return on a savings account
3.   I mainly look whether my investments outperform a relevant index, such as the AEX index
4.   Other

If the respondent answers Alternative 4 to Question 14 she is also asked to answer the question: "With what do you compare the performance of your stock portfolio?"

Question 15

When you evaluate the performance of your investments do you look at the performance of individual shares or the performance of the whole portfolio?

1.   I look at the individual shares
2.   I both look at the individual shares and at the whole portfolio
3.   I look at the whole portfolio

Question 16

How often do you evaluate the performance of your stock portfolio on average? An evaluation can take different forms. It can, for example, vary from including recent prices in a spreadsheet to simply checking in newspapers or on teletext how the shares perform.

1.   Daily
2.   Weekly
3.   Monthly
4.   Quarterly
5.   Annually
6.   Less often

Question 17

How often do you change your stock portfolio by buying or selling shares without the need for cash?

1.   Daily
2.   Weekly
3.   Monthly
4.   Quarterly
5   Annually

6.   Less often

Remark

This was the last question. Thank you very much for cooperating. Do you have any remarks on this questionnaire?

1.   Yes
2.   No

Respondents that answered Yes to the remark were asked to give your comments.

Appendix B. Note to Questions 1 to 8

Questions 1 to 8 simulate investment opportunities close to those existing on the stock market. All alternatives are calibrated in such a way that their expected return is equal to 10 percent and their standard deviation lies between 14 and 26 percent.

Questions 1 to 4 are designed to determine which measure corresponds most closely to the subjects' perception of risk. While all the alternatives have the same expected return (10 percent), they have the following values of the four risk measures that we study:

Question, alternative	Standard deviation	Probability of loss	Expected value of loss	Semi-variance	Expected outcome
1,1	30.0	0.10	-8.0	640	(1) will be chosen if the subjects are mostly concerned about probability of loss
1,2	14.7	0.40	-3.2	25.6	
2,1	26.1	0.70	-4.9	34.3	(1) will be chosen if the subjects are mostly concerned about semi-variance
2,2	16.0	0.20	-4.4	96.8	
3,1	26.4	0.70	-4.2	130.2	(1) will be chosen if the subjects are mostly concerned about expected value of loss
3,2	23.9	0.55	-6.2	85.6	
4,1	17.3	0.25	-5.0	100.0	(1) will be chosen if the subjects are mostly concerned about total variance
4,2	24.8	0.10	-2.5	62.5	

Depending on their answers to Questions 1-4, subjects will be presented with the next two pairs of alternatives (Questions 5-8). These questions are meant to find out which of the following three benchmarks are most common when individuals are concerned with downfall risk: (1) zero, (2) risk-free rate, (3) market return.

Questions 5 and 6 are presented to subjects who chose "1" as an answer to Questions 1 and/or 3. Alternatives 1 and 2 in these questions have the same expected value and standard deviation, but are associated with the following downside risk measures:

Question, alternative	Target = zero		Target = risk-free rate (4%)		Target = market return (10%)		Expected outcome
	Probability of loss	Expected value of loss	Probability of loss	Expected value of loss	Probability of loss	Expected value of loss	
5,1	0.10	-3.2	0.10	-3.6	0.15	-4.4	(1) will be chosen if the subjects are mostly concerned about probability/ expected value of underperforming relative to the market
5,2	0.05	-1.4	0.05	-1.6	0.75	-5.3	
6,1	0.10	-2.0	0.60	-2.9	0.60	-6.4	(2) will be chosen if the subjects are mostly concerned about probability /expected value of losing part of the initial investment
6,2	0.05	-0.5	0.65	-3.1	0.65	-7.0	

Questions 7 and 8 are presented to subjects who chose "1" as an answer to Question 2. Alternatives 1 and 2 in these questions have the same expected value of 10% and standard deviation, but are associated with the following values of semi-variance:

Question, alternative	Target = zero	Target = risk-free rate (4%)	Target = market return (10%)	Expected outcome
7,1	7.2	20.0	54.4	(1) will be chosen if the subjects are mostly concerned about the semi-variance of returns relative to the market
7,2	0.6	15.0	71.5	
8,1	10.0	20.3	75.69	(2) will be chosen if the subjects are mostly concerned about the semi-variance relative to zero
8,2	4.5	24.7	97.49	

Questions 18 to 25 are identical to questions 1 to 8, but involve larger monetary amounts (20,000 euro instead of 1,000).

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Table I. Investment products.

This table reports the results of a question in which 2,226 respondents of the CentERpanel were asked which financial products they own or have owned in the past three years. Notes: [1] A click fund is a fund for which the minimum value at the maturity date is guaranteed. In addition, the underlying value is "clicked" at pre-specified levels. If a value is "clicked" it becomes the new minimum guaranteed payment. [2] A stock lease plan is the combination of a stock investment and a loan. In this case, the loan is used to finance the stock investment. [3] Reverse convertibles are bonds that carry high coupon payments, but for which the issuer has the option at the maturity date to either redeem the bonds in cash, or to deliver a pre-specified number of shares. [4] Call and put warrants are bank-issued options. [5] The investment mortgage is a combination of a mortgage loan and an investment. Individuals pay interest on the mortgage loan, but do not repay the loan until the end of the maturity. Instead they contribute to a life insurance. This contribution is invested for them by the mortgage bank. [6] In a life annuity the individual pays part of her income to a life insurance company. The insurance company invests the money in stock or in riskless assets. The choice of investment is at the discretion of the investor. The contribution is deducted from income for tax purposes in the year it is paid to the insurance company. At the end of the maturity the individual is obliged to buy a life annuity from the insurance company in order to supplement her pension. The payments for the life annuity are taxable.

Financial product	Number of respondents	Percent
1. Stocks of exchange-listed companies other than investment funds	285	17.50
2. Stocks of investment funds	593	36.40
3. Stocks in privately-owned companies	44	2.70
4. Government bonds	38	2.33
5. Corporate bonds	82	5.03
6. Convertible bonds	19	1.17
7. Savings accounts	1442	88.52
8. Click funds[1]	69	4.24
9. Stock lease plans[2]	97	5.95
10. Reverse convertibles[3]	6	0.37
11. Call options and warrants[4]	54	3.31
12. Put options and warrants[4]	26	1.60
13. Investment mortgage[5]	196	12.03
14. Life annuity with investment in stocks[6]	280	17.19
15. Life annuity without investment in stocks[6]	202	12.40
16. Others	89	5.46
Total	1629	100

Table II. Summary of the results for the experimental questions.

Panel A presents the results for the experimental questions (1 to 8) for the marginal investment (an investment of 1,000 euro). Panel B presents the results for the experimental questions (1 to 8) for the total investment (an investment of 20,000 euro). Columns 2 to 6 show the distribution (in both number of answers and percentage) of all the answers on Questions 1 to 8. The remaining columns only take into account the respondents who chose Alternatives 1 or 2. They exclude those who answered "3" (Both choices are equally attractive (or unattractive) to me) or "4" (The question is not clear for me). Only answers of individuals who have investments in risky assets (excluding savings accounts and investment mortgages/life annuities) are presented. The numbers in parentheses below the means show values of t-statistics (null hypothesis: mean is equal to 1.5). The numbers in parentheses below the medians show values of Wilcoxon signed ranks test (null hypothesis: median is equal to 1.5). Asterisks indicate significance levels of these tests: [*] 10 percent; [**] 5 percent; [***] 1 percent.

Panel A. Marginal investment.

Question	Number of answers (percentage in parentheses)				Total number of observations	Number of answers (only answers 1 and 2 count)			Mean	Median
	1	2	3	4		1 (%)	2 (%)	Total (number)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(10)	(11)	(12)
1: (1=probability of loss is most important; 2=other risk measures)	226 (28.64)	393 (49.81)	132 (16.73)	38 (4.82)	789	36.51	63.49	619	1.63[***] (6.97)	2[***] (6.71)
2: (1=semi-variance is most important; 2=other risk measures)	303 (38.40)	302 (38.28)	150 (19.01)	34 (4.31)	789	50.08	49.92	605	1.50 (-0.04)	1 (0.04)
3: (1=expected value of loss is most important; 2=other risk measures)	162 (20.53)	363 (46.01)	226 (28.64)	38 (4.82)	789	30.86	69.14	525	1.69[***] (9.49)	2[***] (8.77)
4: (1=variance is most important; 2=other risk measures)	243 (30.80)	391 (49.56)	123 (15.59)	32 (4.06)	789	38.33	61.67	634	1.62[***] (6.04)	2[***] (5.88)
5: Benchmark (1=market; 2=risk-free rate or zero)	147 (45.65)	158 (49.07)	16 (4.97)	1 (0.31)	322	48.20	51.80	305	1.52 (0.63)	2 (0.63)
6: Benchmark (1=market or risk-free rate; 2= zero)	141 (43.79)	134 (41.61)	45 (13.98)	2 (0.62)	322	51.27	48.73	275	1.49 (-0.42)	1 (0.42)
7: Benchmark (1=market; 2=risk-free rate or zero)	168 (55.45)	110 (36.30)	22 (7.26)	3 (0.99)	303	60.43	39.57	278	1.40[***] (-3.55)	1[***] (3.48)
8: Benchmark (1=market or risk-free rate; 2= zero)	174 (57.43)	99 (32.67)	26 (8.58)	4 (1.32)	303	63.74	36.26	273	1.36[***] (-4.71)	1[***] (4.54)

Panel B. Total investment.

Question	Number of answers (percentage in the parentheses)				Total number of observations	Number of answers (only answers 1 and 2 count)			Mean	Median
	1	2	3	4		1 (%)	2 (%)	Total (number)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(10)	(11)	(12)
1: (1=probability of loss is most important; 2=other risk measures)	177 (26.90)	314 (47.72)	148 (22.49)	19 (2.89)	658	36.05	63.95	491	1.64*** (6.43)	2*** (6.18)
2: (1=semi-variance is most important; 2=other risk measures)	200 (30.40)	267 (40.58)	172 (26.14)	19 (2.89)	658	42.83	57.17	467	1.57*** (3.13)	2*** (3.10)
3: (1=expected value of loss is most important; 2=other risk measures)	129 (19.60)	242 (36.78)	266 (40.43)	21 (3.19)	658	34.77	65.23	371	1.65*** (6.15)	2*** (5.87)
4: (1=variance is most important; 2=other risk measures)	147 (22.34)	344 (52.28)	146 (22.19)	21 (3.19)	658	29.94	70.06	491	1.70*** (9.70)	2*** (8.89)
5: Benchmark (1=market; 2=risk-free rate or zero)	130 (49.62)	107 (40.84)	23 (8.78)	2 (0.76)	262	54.85	45.15	237	1.45 (-1.50)	1 (1.49)
6: Benchmark (1=market or risk-free rate; 2= zero)	89 (33.97)	124 (47.33)	47 (17.94)	2 (0.76)	262	41.87	58.22	213	1.58** (2.43)	2** (2.40)
7: Benchmark (1=market; 2=risk-free rate or zero)	92 (46.00)	90 (45.00)	17 (8.50)	1 (0.50)	200	50.55	49.45	182	1.49 (-0.15)	1 (0.15)
8: Benchmark (1=market or risk-free rate; 2= zero)	88 (44.00)	89 (44.50)	22 (11.00)	1 (0.50)	200	49.72	50.28	177	1.50 (0.07)	2 (0.07)

Figure I.
Marginal Investment.

Of which at least one
asymmetric measure
chosen

Which asymmetric
measure?

Probability of
loss:
73 (45.34%)

Yes²

161
(85.19%)

Semi-variance:
104 (64.60%)

189
(42.09%)

No²

28
(14.81%)

Expected
value of loss:
43 (26.71%)

Yes¹

Variance as
risk measure

Probability of
loss:
90 (40.91%)

No¹

Yes²

220
(84.62%)

Semi-variance:
138 (62.73%)

260
(57.91%)

No²

40
(15.38%)

Expected
value of loss:
97 (44.09%)

45

Figure I summarizes the individual choices of the respondents for those who answered "1" or "2" (i.e., gave firm preferences) in all four questions. The total number of observations is equal to 449. The figure starts with the answer to Question 4 in Panel A of Table I and continues from there.

Notes. [1] The proportion of respondents who chose variance (first node) is significantly different from 0.5 at the 1%-level (the value of the t-test is 3.390; the value of the Wilcoxon test is 3.350). [2] The proportion of respondents who choose at least one asymmetric risk measure is significantly different from 0.5 at the 1%-level. For the 189 respondents who chose variance in the first node, the value of the t-test is equal to 13.580, the value of the Wilcoxon test is 9.674. For the 260 respondents who did not choose variance in the first node, the value of the t-test is equal to 15.440, the value of the Wilcoxon test is 11.163.

Figure II.
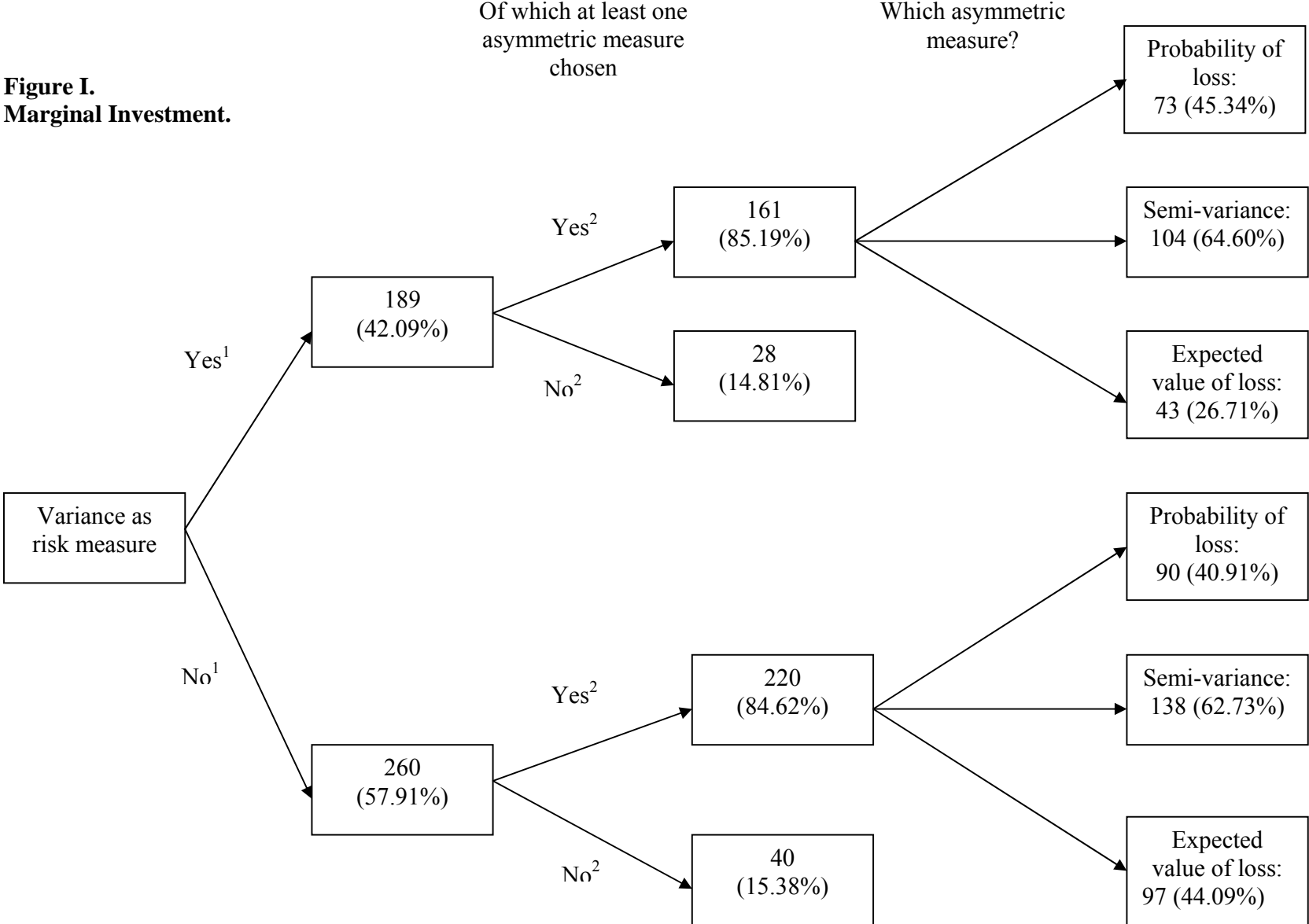**Total Investment.**
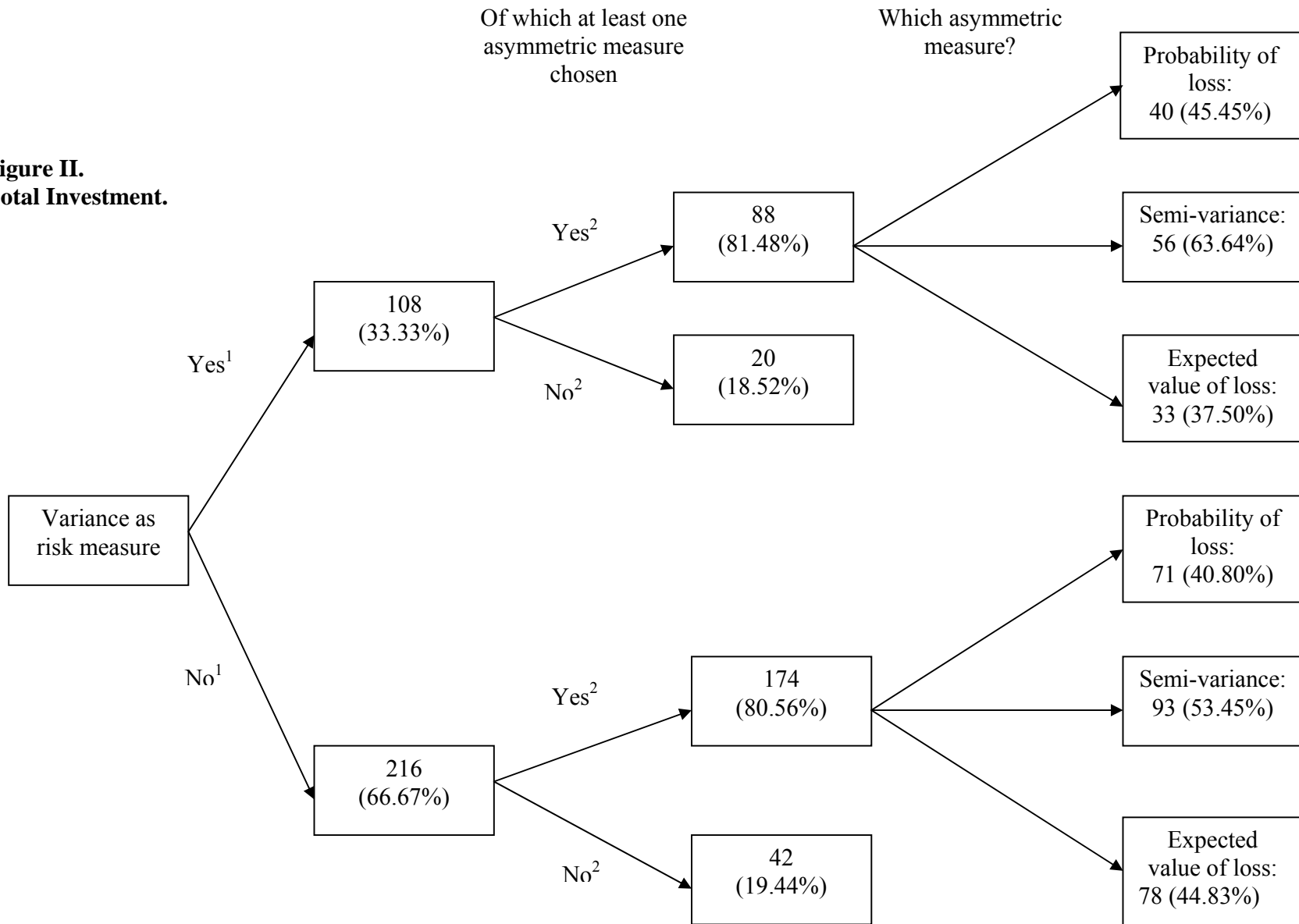
Figure II summarizes the individual choices of the respondents for those who answered "1" or "2" (i.e., gave firm preferences) in all four questions. The total number of observations is equal to 324. The figure starts with the answer to Question 4 in Panel B of Table I and continues from there.

Notes. [1] The proportion of respondents who chose variance (first node) is significantly different from 0.5 at the 1%-level (the value of the t-test is 6.354; the value of the Wilcoxon test is 6.000). [2] The proportion of respondents who choose at least one asymmetric risk measure is significantly different from 0.5 at the 1%-level. For the 108 respondents who chose variance in the first node, the value of the t-test is equal to 8.383, the value of the Wilcoxon test is 6.542. For the 216 respondents who did not choose variance in the first node, the value of the t-test is equal to 11.320, the value of the Wilcoxon test is 8.981.

Table III. Consistent choices of risk measure.

This table presents the risk preferences of the sub-sample of investors who make a consistent choice in Questions 1 to 4. For example, a "consistent choice" of variance implies always choosing the alternative with the least variance, i.e. answering "1" in Question 4, and "2" in Questions 1 to 3. Panel A presents results for the marginal investment of 1,000 euro. Panel B presents results for an investment of 20,000 euro. The first line in each panel shows the total number of respondents who systematically choose a certain risk measure. The second line is the percentage of the systematic choices that goes to this risk measure. The last row is the percentage of investors who answer "1" or "2" (i.e., make a clear decision) on all Questions 1 to 4, and who systematically choose for a specific risk measure. Investors are defined as those respondents who have investments in risky assets (excluding savings accounts and investment mortgages/life annuities). The last column shows values of the χ^2 test for non-randomness of the distribution of the answers. The numbers in the parentheses are the significance levels of the χ^2 statistics with 3 degrees of freedom.

	Probability of loss	Semi-variance	Expected value of loss	Variance	Total	χ^2 test value
Panel A. Marginal investment						
- number	31	74	22	28	155	43.84
- percent	20.00	47.74	14.19	18.06	100	($p =$ 0.000)
- percent out of 449	6.90	16.48	4.90	6.24	34.52	
Panel B. Total investment						
- number	35	55	24	20	134	22.00
- percent	26.12	41.04	17.91	14.93	100	($p =$ 0.000)
- percent out of 324	10.80	16.98	7.41	6.17	41.36	

Table IV. Marginal and total investment.

This table documents the relationship between individual's answers to Questions 1 to 8 for the amounts of 1,000 and 20,000 euro. Pearson's χ^2 statistics is used to test whether the replies to each pair of questions are independent. Phi coefficients measure the association between these responses in a way similar to the correlation coefficient. Phi coefficients can vary from 0 to 1, with a higher number indicating a stronger relation between the two series. Asterisks indicate significance levels of the Pearson's χ^2: [*] 10 percent; [**] 5 percent; [***] 1 percent.

Question	Number of observations	Phi coefficient	Pearson's χ^2
Panel A. Preferred risk measure questions			
1	658	0.462	140.37[***]
2	658	0.458	137.72[***]
3	658	0.463	141.21[***]
4	658	0.482	153.13[***]
Panel B. Investors' benchmark questions			
5	150	0.286	12.287[*]
6	150	0.347	18.073[***]
7	115	0.468	25.156[***]
8	115	0.412	19.519[**]

Table V. Investors' benchmark.

Summary of the answers to the question: "When you evaluate the performance of your stock investments (including stocks in investment funds), what is your relevant benchmark?" Only answers of individuals who have investments in risky assets (excluding savings accounts and investment mortgages/life annuities) are presented. The "Probability" column reports one-sided p-values of the normal approximation for the binomial test (expected proportion of 0.25).

Benchmark	Number of responses	Percent of responses	Probability
1. Initial investment	405	58.95	0.000
2. Risk-free rate of return	193	28.09	0.031
3. Market return	49	7.13	0.000
4. Other	40	5.82	0.000
Total	687	100.00	

Table VI. Experimental questions on investors' benchmark.

This table summarizes the answers of respondents to Questions 5 to 8 of the survey, which measure the benchmark against which investors evaluate the investment alternatives. Only answers of individuals who have investments in risky assets (excluding savings accounts and investment mortgages/life annuities) are presented. Only respondents who indicate a preference for one or more asymmetric risk measures in Questions 1-4 are asked. The initial investment corresponds to the set of answers (5-2, 6-2) or (7-2, 8-2). The risk-free rate of return corresponds to the set of answers (5-2, 6-1) or (7-2, 8-1). The market return corresponds to the set of answers (5-1, 6-1) or (7-1, 8-1). Finally, answering (5-1, 6-2) or (7-1, 8-2) is inconsistent. The "Probability" column reports one-sided p-values of the normal approximation for the binomial test (expected proportion of 0.25). Panel A presents the results for the marginal investment (1,000 euro), and Panel B presents the results for the total investment (20,000 euro).

Panel A. Marginal investment.

Benchmark	Subjects who chose probability of loss or expected value of loss			Subjects who chose semi-variance of returns			All respondents		
	Number of observations	Percent	Probability	Number of observations	Percent	Probability	Number of observations	Percent	Probability
Initial investment	84	31.46	0.007	67	25.77	0.387	151	28.65	0.026
Risk-free rate of return	56	20.97	0.064	37	14.23	0.000	93	17.65	0.000
Market return	81	30.34	0.022	128	49.23	0.000	209	39.66	0.000
Inconsistent results	46	17.23	0.002	28	10.77	0.000	74	14.04	0.000
Total	267	100		260	100		527	100	

Panel B. Total investment.

Benchmark	Subjects who chose probability of loss or expected value of loss			Subjects who chose semi-variance of returns			All respondents		
	Number of observations	Percent	Probability	Number of observations	Percent	Probability	Number of observations	Percent	Probability
Initial investment	62	30.39	0.038	64	36.99	0.000	126	33.42	0.000
Risk-free rate of return	33	16.18	0.002	19	10.98	0.000	52	13.79	0.000
Market return	53	25.98	0.373	67	38.73	0.000	120	31.83	0.001
Inconsistent results	56	27.45	0.209	23	13.29	0.000	79	20.95	0.035
Total	204	100		173	100		377	100	

Table VII. Risk preferences and holding of risky assets.

This table presents estimation results of a logit model, where the dependent variable is equal to 1 when the respondents own particular risky assets and 0 otherwise. We use the preference for a certain risk measure, as measured by choosing this risk measure against the other three risk measures in Questions 1 to 4, as explanatory variables. Values of z-statistic are in parentheses. Asterisks indicate significance levels of z-statistics: [*] 10 percent; [**] 5 percent; [***] 1 percent.

	Dependent variable: Risky assets owned		
	Exchange-traded stocks	Investment funds	Corporate bonds
Constant	-1.744[***] (-16.917)	-0.753[***] (-9.449)	-3.175[***] (-17.272)
Q.1 = 1 (Probability of loss)	0.066 (0.438)	0.350[***] (2.951)	0.581[**] (2.412)
Q.2 = 1 (Semi-variance)	0.375[***] (2.728)	0.314[***] (2.833)	-0.086 (-0.345)
Q.3 = 1 (Expected value of loss)	0.113 (0.692)	-0.059 (-0.441)	-0.094 (-0.321)
Q.4 = 1 (Variance)	0.029 (0.202)	-0.007 (-0.063)	0.305 (1.259)
Number of observations	1629	1629	1629
LR statistic	9.193	15.232	8.342
p-value of LR statistic	0.056	0.004	0.080

Table VIII. Demographic profiles and (the lack of) investment choices.

This table presents the total number and percentages of respondents who reply either "3" (I am indifferent) or 4 (The question is not clear for me) to Questions 1 to 4 of the survey (for the questions on an investment of 1,000 euro). The column "Total" refers to the total number of respondents who choose 3 or 4 (percentage is in parentheses). Percentages are also presented for different demographic groups. The t-test presented after each demographic pair tests the hypothesis that the percentages are equal in both corresponding subgroups. Panel A presents answers of all respondents. Panel B presents only answers of individuals who have investments in risky assets (excluding savings accounts and investment mortgages/life annuities).

Panel A. All respondents.

Question	Total	Age			Gender			Education			Monthly gross Income		
		Below 55	55 and over	t-test	Male	Female	t-test	University or college	Lower	t-test	Below 2000 euro	Above 2000 euro	t-test
1: (1=probability of loss is most important; 2=other risk measures)	695 (31.2%)	29	36	3.55^{***}	29	34	2.49^{**}	25	35	5.03^{***}	35	26	4.54^{***}
2: (1=semi-variance is most important; 2=other risk measures)	703 (31.6%)	30	36	2.79^{***}	28	36	3.88^{***}	28	34	3.22^{***}	36	26	4.74^{***}
3: (1=expected value of loss is most important; 2=other risk measures)	909 (40.8%)	39	44	2.41^{**}	37	45	3.50^{***}	38	42	2.12^{**}	44	36	3.85^{***}
4: (1=variance is most important; 2=other risk measures)	646 (29.0%)	27	33	2.82^{***}	25	33	4.34^{***}	23	33	5.21^{***}	33	23	5.39^{***}

Panel B. Investors only.

Question	Total	Age			Gender			Education			Monthly gross Income		
		Below 55	55 and over	t-test	Male	Female	t-test	University or college	Lower	t-test	Below 2000 euro	Above 2000 euro	t-test
1: (1=probability of loss is most important; 2=other risk measures)	170 (21.55%)	19	26	2.52**	20	24	1.35	21	22	0.36	24	20	1.37
2: (1=semi-variance is most important; 2=other risk measures)	184 (23.32%)	21	27	1.72*	19	30	3.40***	23	23	0.08	27	20	2.14**
3: (1=expected value of loss is most important; 2=other risk measures)	264 (33.46%)	32	36	1.20	30	40	2.98***	32	35	1.04	36	32	1.11
4: (1=variance is most important; 2=other risk measures)	155 (19.65%)	18	22	1.38	16	26	3.18***	17	23	2.00**	22	18	1.35