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INFORMATION ACQUISITION AND PORTFOLIO PERFORMANCE

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Abstract

Rational investors perceive correctly the value of financial information. Investment in information is therefore rewarded with a higher Sharpe ratio. Overconfident investors overstate the quality of their own information, and thus attain a lower Sharpe ratio. We contrast the implications of the two models using a unique survey of customers of an Italian leading bank with portfolio data and measures of financial information. We find that the portfolio Sharpe ratio is negatively associated with investment in information. The negative correlation is stronger for men than women and for those who claim they know stocks well, arguably because these investors are more likely to be overconfident. We also show that investment in information is associated with more frequent trading, less delegation of portfolio decisions and less diversified portfolios. In each case, the effect of information is stronger for investors who, a priori, are suspected to be more overconfident.

JEL: E2, D8, G1

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1 Introduction

How much financial information should investors collect? And what is the effect of information on portfolio performance? In models with rational investors the answer to these questions is straightforward. Investors should spend time and money collecting financial information up to the point where the marginal benefit of doing so exceeds the marginal cost. Since investors acquire more information only if their utility increases, information improves portfolio performance. Indeed, Peress (2004) shows that the portfolio expected Sharpe ratio of rational agents increases with the amount of information they optimally collect.

Behavioral models challenge the rational agent assumption. Drawing on a large body of evidence from experimental cognitive psychological research, one class of behavioral models argues that many investors are overconfident when they make financial decisions, see Barberis and Thaler (2003) for a survey. Overconfident investors collect too much private information, trade more and take more risk than rational agents with unbiased perceptions. As a result, they attain poorer portfolio performance. In a model with endogenous information acquisition, Odean (1998a) shows that overconfident investors are more likely to be informed and obtain lower utility than rational investors who choose to remain uninformed. Using a survey of accounts at a discount broker, Odean (1998b) and Barber and Odean (1999, 2001) show that investors make unprofitable trades in the sense that the assets they buy tend, on average, to under-perform the assets they sell, resulting in negative profits from trading even before trading costs are accounted for. In addition, men – arguably more overconfident than women according to the experimental psychology literature – trade more often and therefore perform less well than women. Biais, Hilton, Mazurier and Pouget (2005) reach similar conclusions in an experimental setting, where they relate directly trading performance to a measure of overconfidence obtained independently as part of the experiment.

The hypothesis underlying the overconfidence model is that investors systematically overestimate the value of the private signals and, for this reason, spend too much money and time acquiring information. In turn, overconfidence leads to inefficient portfolio allocations and trades, the more so the more information is acquired. This suggests that a proper test of this departure from rationality requires data on financial information *and* portfolio performance.

In this paper we provide such test. We contrast the rational and overconfidence models studying the determinants of information acquisition and the effect of information on portfolio performance. Peress (2004) shows that the portfolio Sharpe ratio of rational investors - who maximize expected utility and process information correctly - is positively correlated with the amount of private information acquired. Indeed, it is precisely the expected benefit of attaining a higher Sharpe ratio that induces investors to incur the cost of acquiring information.

Overconfident investors face the same incentives. But given their inability to process information correctly, the Sharpe ratio they obtain is lower than the Sharpe ratio they think they would obtain based on the wrong assessment of the precision of their information. Most importantly, we show that if investors are sufficiently overconfident, the actual portfolio Sharpe ratio is negatively correlated with the amount of information they collect, and this effect increases with overconfidence. Our test distinguishes the two models relying on variables that are potentially observable and measurable.

To implement the test, we use data from a survey of investors randomly sampled from customers of a leading Italian bank, with data on time people spend acquiring financial information, trading, risk attitudes, and socioeconomic variables. Detailed financial data allow us to construct a measure of the portfolio expected return and volatility for each investor.

In a first part of our analysis, we find that investment in financial information increases with wealth and risk tolerance, and is negatively associated with proxies of the cost of information. The findings are consistent with both the rational and the overconfidence models, as both predict that those who benefit more from extra information (the wealthy and the risk tolerant, because they invest more in risky, information intensive assets) and those who can obtain information at lower cost, collect more information. Our evidence suggests that investors respond to economic incentives in deciding how much information they acquire.

In a second step, we find that the portfolio Sharpe ratio is negatively associated with information, consistent with overconfidence. The negative relation is unchanged if we add further controls, and is robust with respect to sample definitions and sample selection. The relation is also economically important: those who spend between 2 and 4 hours per week in acquiring financial information have a Sharpe ratio that is 27% lower than those who spend no time. Evaluated at the sample median of the portfolio standard deviation, this is equivalent to a portfolio expected excess return of 16 basis points lower.

The negative relation between the Sharpe ratio and information might be driven by unobserved heterogeneity, for instance because those who enjoy trading stocks - a utility benefit that does not show up in measured portfolio returns and is not observed by the econometrician - also enjoy to collect financial information. We address this issue by an instrumental variables approach, using as instruments variables that are unlikely to be related with preference for finance, and find that the negative relation between information and the Sharpe ratio is, if anything, reinforced. We also find that the negative relation between the Sharpe ratio and information is stronger for groups that are, a priori, expected to be more overconfident. This suggests that the negative relation between the Sharpe ratio and information is likely to be due to overconfidence.

To further check the robustness of our conclusions we contrast the rational and overconfidence models from three further angles. First, more information collection should be associated with higher frequency of trading and, under the hypothesis of overconfidence, more trading should be associated with lower Sharpe ratio; the opposite if investors are rational. The econometric estimates confirm this hypothesis. Second, overconfident investors engage in too much stock-picking at the expense of diversification, thus attaining a lower Sharpe ratio. Consistent with this hypothesis, we find that those who spend more in information are less diversified, in the sense that they have relatively more single stocks than diversified equity mutual funds. Finally, the other side of overconfidence is lack of confidence in the information and ability of others, such as financial advisors and brokers, implying that the overconfident are less willing to delegate financial decisions to others. In line with this prediction, we find that those who acquire more information are less willing to delegate financial decisions, and that the effect is stronger among those that can be expected to be more overconfident.

Overall, our evidence conflicts with the rational model, and supports models where investors overstate the quality of information, invest too much in information and take too much financial risk. While these conclusions are similar to Odean (1998b) and Barber and Odean (2001), there are important substantive and methodological differences. First, the richness of our survey allows us to contrast the rational and overconfidence models from quite different perspectives, increasing the robustness and reliability of the results. Second, our results rely on a representative sample of retail investors with a bank account, while Odean (1998b) and Barber and Odean (2001) focus on a sample of investors at a large US discount broker. This is a highly selected sample of investors who want to trade stocks directly, without brokers' advice, perhaps because they think, rightly or wrongly, that they can do so.[1] Thus, it is likely to include relatively more investors with a predisposition for overconfidence or who, though rational, are willing to incur losses for the pleasure of trading. Discriminating between these two alternatives is not easy with Odean's (1998b) data. Our instrumental variables approach allows us to rule out the second possibility, while our representative sample limits the sample selection problem. Finally, while Odean (1998b) and Barber and Odean (2001) administrative data focus on common stock trading, we look at the performance of the entire financial portfolio.

Our findings are also related to a recent wave of papers that study the efficiency of households portfolio decisions. Like Calvet, Campbell and Sodini (2006) we document significant heterogeneity in the Sharpe ratio of households financial portfolios. However, we also provide an explanation for the observed heterogeneity and argue that it can partly be traced to differences in financial information coupled with overconfidence.

[1] Bilias, Georgarakos and Haliassos (2005) study households' portfolio inertia using data from the PSID and the Survey of Consumer Finances. In these representative samples households seldom trade: over a 5-year period (1994-99), 73.8% did not trade stocks. This contrasts with the trading activity of a minority of investors (less than 20%) that have a brokerage account (not necessarily a discount account): 70% trades stocks at least once a year.

Other recent papers find that portfolios are more concentrated in stocks that people are more familiar with (e.g. Huberman (2001)) and that there are "returns to concentration". Massa and Simonov (2006), using Swedish administrative data, find that concentrated stocks are those to which the investor is geographically or professionally closer, or that he has held for a long time. Ivkovic, Sialm and Weisbenner (2004), using individuals' investments at a US discount broker, find that concentrated stocks portfolios (especially those of large investors) actually outperform more diversified accounts. One potential explanation of these findings is that investors with concentrated portfolios are able to exploit some informational advantage that allows them to pick up winning stocks, as argued by Van Nieuwerburgh and Veldkamp (2005). This is only a conjecture, however, because in these studies investors' information is not observed. On this front, we find that investors who acquire more information tend to have less diversified portfolios; but at the same time those who diversify less attain a lower Sharpe ratio.

The rest of the paper proceeds as follows. Section 2 presents a theoretical framework, contrasting the predictions for the relation between information acquisition and portfolio performance in the rational and overconfident models. Section 3 describes the survey, and explains how we measure investment in information and portfolio performance. Section 4 presents evidence on the determinants of information acquisition. Section 5 presents the main results of the paper, relating the Sharpe ratio to investment in information. Section 6 explores the effect of financial information on trading, and Section 7 evidence on the relation between information, delegation of financial decisions, and portfolio diversification. Section 8 summarizes the results.

2 Theoretical framework

In models with rational investors the set of variables that affect asset allocation and information acquisition are well identified. For instance, Verrecchia (1982) shows that investors with higher cost of acquiring information and risk averse investors acquire less information, the latter because they intend to invest less in stocks and therefore information is less valuable for them. These empirical predictions, however, don't discriminate between rational and overconfident investors. Indeed, as we will see, overconfident investors behave very much like rational investors with respect to the determinants of information acquisition. The implications for the effect of information on portfolio performance are different.

Peress (2004) shows that in a model with rational investors information improves the allocation of wealth and is associated with a higher Sharpe ratio. Although the portfolio of informed investors is riskier, the risk-adjusted return is also higher. In contrast, overconfident investors acquire more information and react to information more strongly than rational investors. As in the rational model, portfolio risk and return increase with information. But the Sharpe ratio of the portfolio of an overconfident investor may be lower. This section presents a framework to distinguish the two models empirically. We summarize here the main propositions, and report the details in Appendix A.

2.1 Rational investors

Starting with Grossman and Stiglitz (1980), several papers propose models of rational investors where agents can increase, at a cost, information on the random return of a risky asset, see Verrecchia (1982) and Barlevy and Veronesi

(1999). For our purpose, Peress' (2004) framework is the most appropriate; we reproduce it here together with the main results. Rational investors maximize expected utility and perceive correctly the quality of the information purchased. Later we extend the model to the case of overconfident investors. Each investor j has CRRA preferences and chooses how to allocate a given amount of wealth (W_j) between stocks and the risk free asset, and how much information to purchase (x_j^R). Rational investors are identified by the superscript "R".

If no information is acquired, the stock payoff is $\pi \sim N(E\pi, \sigma_\pi^2)$ and the safe asset return is r_f. Each investor can purchase a private signal $S_j^R = \pi + \sqrt{\frac{1}{x_j^R}}\varepsilon$. The signal is noisy, and reveals the stock return π plus a random error $\sqrt{\frac{1}{x_j^R}}\varepsilon$, with $\varepsilon \sim N(0,1)$. Investors can purchase information to increase the signal's precision x_j^R. The signal costs $C(x_j^R)$, and the cost is increasing and convex in x_j^R, so that $C'(\ x_j^R) > 0$ and $C''(x_j^R) > 0$.[2]

Each investor chooses the portfolio after acquiring information, conditional on the signal and the stock price observed by all market participants. Peress (2004) shows that the optimal value of x_j^R is defined by the following expression:

$$C'(x_j^R) = \frac{1}{2}\tau(W_j)\phi_x'(x_j^R)$$

where $\tau(W_j)$ is absolute risk tolerance and $\phi(x_j^R)$ the expected square Sharpe ratio of the portfolio, defined as the ratio of the portfolio expected excess return and its standard deviation, conditional on the signal. The Sharpe ratio is an increasing function of the signal's precision x_j^R, hence $\phi_x'(x_j^R) > 0$. The expression states that the marginal cost of an extra unit of information (the left-hand-side) equals the marginal benefit (the right-hand-side).

[2] As Peress (2004), we also assume $C'(\ 0) > 0$ and $lim_{x\to\infty}\ C'(x)\ 0) = \infty$ to assure an internal solution.

The model delivers several important results. First, information purchased increases with investor's wealth and risk tolerance, and falls with the marginal cost of information. Wealthier and more risk tolerant investors value information more because they invest more wealth in the information intensive asset and, accordingly, the signal is more valuable for them. Second, corner solutions can be optimal. Poor or very risk averse investors benefit little from information, because they would invest little in stocks even if they had a very precise signal. Thus, they may choose to purchase no information; this will be the case if $C'(0) > \frac{1}{2}\tau(W_j)\phi_x'(0)$, which implicitly defines a threshold for wealth below which information is not acquired. Third, the expected portfolio return and volatility increase with information. More informed investors face less risk and invest more aggressively in stocks, obtaining higher returns. They react also more strongly to the signals they receive and trade more.

The fourth implication of the model is that rational agents are willing to pay the cost of information precisely because they expect to obtain a benefit in terms of higher risk-adjusted return. This implies that the expected Sharpe ratio increases with information purchased, even accounting for trading and information costs. In fact, $Sharpe_j^R = \sqrt{\phi(x_j^R)}$, and thus $\partial Sharpe_j^R/\partial x_j^R = (0.5/\sqrt{\phi(x_j^R)}) \times \phi_x^{'}(x_j^R) > 0$.

Finally, risk aversion affects the Sharpe ratio only because it affects information purchased. In other words, risk aversion should not effect the Sharpe ratio, holding information constant. This is a neat exclusion restriction of the rational model that we are able to confront with the data.

2.2 Overconfident investors

Overconfident investors maximize expected utility, like rational investors. But unlike rational investors, overconfident investors (denoted by the superscript "K") don't perceive correctly the signal's quality:[3] they purchase information x_j^K and think they receive the signal $S_j^K = \pi + \sqrt{\frac{1}{Kx_j^K}}\varepsilon$ with $K > 1$, but in fact they overestimate the signal's precision and receive the true signal $S = \pi + \sqrt{\frac{1}{x_j^K}}\varepsilon$. Appendix A shows that this misperception alters the signal extraction problem and the equality between marginal costs and marginal benefits:

$$C'(x_j^K) = \frac{1}{2}\tau(W_j)K\phi'_x(Kx_j^K)$$

This condition is the same as that of a rational agent who perceives correctly a signal with precision $\frac{1}{Kx_j^k}$.

Thus, in the overconfidence model the decision to purchase information is driven by the same variables as in the rational model: wealth, risk tolerance and cost of information. However, overconfident investors purchase more information because the perceived value of information is higher than its true value. Proxies for overconfidence – for instance gender as in Lundeberg, Fax and Puncochar (1994) and Barber and Odean (2001) – should therefore help predicting investment in information. But apart from this, the information decision of overconfident investors is observationally equivalent to that of rational agents. This implies that the determinants of investment in information alone do not

[3] Here is one of many examples of overconfidence. In 1991, the US General Social Survey asked the following two questions: (1) "Compared to other people who do the same or similar kind of work that you do, how well would you say you do your job? Would you say much better, somewhat better, about the same, somewhat worse or much worse?" (2) "Compared to other people who do the same or similar kind of work that you do, how much work would you say you do? Would you say that you do much more, somewhat more, about the same, somewhat less or much less?" Over 72% percent answered to the first question they did better or much better than average; only 0.2% rated themselves below average. About 61% said they worked more or much more than other people, and only 3.3% below average.

allow to discriminate between the rational and the overconfidence model.

The difference between the two models lies in the consequence of information on portfolio performance. Odean (1998a) shows that overconfident investors attain lower utility than rational investors and take more risk, for given expected return. Paralleling Odean result, in Appendix A we show that overconfident investors attain a lower Sharpe ratio. But we go beyond this result, showing that overconfidence affects the relationship between portfolio performance and the amount of information purchased. Our main results are summarized in the following two propositions:

Proposition 1 *If the investor is sufficiently overconfident, the Sharpe ratio, obtained conditioning on the true signal rather than on the perceived signal, is a decreasing function of investment in information. Proof: See Appendix A.*

Proposition 2 *The more the investor is overconfident, the more negative is the relation between the Sharpe ratio and investment in information. Proof: See Appendix A.*

The first proposition predicts a relation between information and the Sharpe ratio opposite to that implied by the rational model, at least for high levels of overconfidence. This suggests that one can discriminate between the two models using variables that are observable and measurable, at least potentially. Our second proposition predicts different slopes of the relation between the Sharpe ratio and information in groups of investors with low or high overconfidence. Indeed, empirical research shows that overconfidence depends on specific domains of activities as well as individual attributes.[4]

[4] Overconfidence can be substantial especially when people face range questions. For instance, Russo and Schoemaker (1992) find that businessmen asked to provide 90 percent

Table 1 summarizes the empirical predictions of the rational and overconfident models. In both models, the numerator and the denominator of the Sharpe ratio increase with the amount of information. However, in the overconfident model one extra unit of information raises the standard deviation of the portfolio more than its expected return, because the misperception of the signal's precision induces investors to take some uncompensated risk.

Figure 1 plots the relation between the Sharpe ratio and information for different levels of overconfidence. The figure is obtained calibrating the model using the same parameters as in Peress (2004). In the rational model the relation between information and the Sharpe ratio is upward sloping. The relation flattens out as overconfidence increases, and becomes negative for medium and high levels of overconfidence. These theoretical predictions guide our empirical analysis of Section 4.

3 Data description

The Unicredit-Pioneer Economic Research Survey of Investors Behavior (UPS) is a very detailed survey of 1,834 customers of Unicredit, a leading Italian commercial bank with over 4 million accounts. The sample is representative of the population of Unicredit retail customers with a bank account (whereas 15% of the Italian population has not). Unicredit has a large market share, and thus relatively more customers, in Northern Italy, where people tend to be wealthier on average. The UPS therefore tends to over-sample relatively rich investors. The unit of observation is the customer, defined as a person with an account in one of Unicredit banks. Appendix B describes sample design and other charac-

confidence ranges have the correct answer within the stated range only 42 to 62 percent of the time; Klayman et. al. (1999) find similar results in an experiment that accounts for confounding statistical effects when measuring overconfidence.

teristics of the survey.

Differently from other customer surveys, UPS has information on real and financial assets of all household members, both inside and outside Unicredit. It has also data on investment in financial information, knowledge of specific financial assets, attitudes towards financial risk, bank-customer relations, reliance on financial advise, and delegation of financial decisions. The UPS represents therefore a unique opportunity to study the relation between financial information, portfolio allocation and portfolio performance, and to confront with the data the implications of the rational and overconfidence models outlined in Section 2.

3.1 Investment in financial information

The UPS has a question on time spent acquiring financial information: "Let's talk about financial information. How much time do you usually spend, in a week, to obtain information on how to invest your savings? (think about time reading newspapers, surfing the internet, talking to your advisor, reading companies balance sheets, etc.)."

Answers range from no time to more than 7 hours per week. Table 2 displays the sample distribution of the variable. Over one third of the sample spends no time, most respondents spend "Less than 30 minutes" or "Between 30 and 60 minutes" per week. At the other extreme, 13% of the sample spends more than 2 hours per week (5% of the average weekly working time). To provide further insights on the amount of time involved, the last row of the table reports the equivalent number of working days spent in information each year. The number ranges from zero to 43 days.

As suggested in Section 2, in both models those who invest more in stocks have a stronger incentive to acquire information. In turn, those who are more informed perceive lower return volatility, and should invest more in stocks. Thus, not surprisingly, those who collect more information are also more likely to own stocks and to invest a larger share of their wealth in stocks.[5]

3.2 Financial wealth and portfolio performance

Financial wealth is constructed from questions on ten different assets categories: (1) bank accounts; (2) repurchase agreements; (3) certificate of deposits; (4) government bonds; (5) corporate bonds; (6) derivatives: (7) shares of listed companies; (8) shares of unlisted companies; (9) mutual funds; (10) managed investment accounts. For each of these categories, the survey provides information on assets kept with Unicredit, as well as with other banks and financial institutions. Total financial wealth is the sum of all financial assets, both in Unicredit accounts and in other banks and financial institutions. Two definitions of financial wealth are available: respondents' wealth (the bank's customer), and household financial wealth, resulting from the sum of respondent' and other household members wealth, see Appendix B for details.

We measure portfolio performance by the Sharpe ratio of the investor's portfolio. To construct the ratio we use the same procedure and assumptions as Pelizzon and Weber (2005). We combine survey information on the ten financial assets with time series data on assets returns and compute, for each investor, the portfolio expected return and volatility, as described in Appendix B.

[5] Stock market participation is positively correlated with investment in information but the direction of causality is not obvious. If investors choose information after the participation decision, those who don't participate should not purchase information (unless they do it for pleasure). If information is purchased before the participation decision, some who don't participate may have purchased information, but have chosen to stay out of the market on the basis of the information purchased. In the data, even among those who acquire information, some don't buy stocks, suggesting that information is acquired before the participation decision, at least for this group.

Since not all investors own risky assets, the Sharpe ratio is defined for 1,365 out of 1,834 observations, 74.4% of the total sample. The remaining part of the sample invests only in risk-free assets. Figure 2 plots the sample distribution of the Sharpe ratio and Table 3 reports the mean and standard deviation. The average ratio is estimated at 0.26. In contrast to the uniformity of the Sharpe ratio predicted by standard finance theory, the observed ratio exhibits considerable sample variability, ranging from 0.108 to 0.538 with a standard deviation is 0.15.

Financial wealth data are also used to construct an index of portfolio diversification. Since we don't have information on individual stocks, we construct the index as the ratio of stocks held indirectly through mutual funds or investment accounts and total stocks (direct plus indirect stockholding). Table 3 shows that, on average, the index of diversification is 56%. The UPS also has detailed socioeconomic variables for the respondent and household members: education, gender, marital status, and residence. Summary statistics for the variables used in the estimation are also reported in Table 3.

3.3 Risk aversion, trading, and delegation

The UPS has an indicator of risk aversion patterned after the Survey of Consumer Finance:"Which of the following statements comes closest to the amount of financial risk that you are willing to take when you make your financial investment: (1) a very high return, with a very high risk of loosing the money; (2) high return and high risk; (3) moderate return and moderate risk; (4) low return and no risk."[6]

[6] The question does not distinguish between relative and absolute risk aversion. But since we can control for wealth, we can allow the risk aversion indicator to reflect differences in risk preferences that don't arise from differences in endowments.

Only 19% choose “low return and no risk”, so most are willing to accept some risk if compensated by a higher return. A recent literature on eliciting preferences from survey data shows that direct questions on risk aversion are informative and have predictive power.[7]

The survey has also another indicator of risk aversion obtained from the question: “With which of the following statements do you agree most? (1) Risk is an uncertain event from which one can extract a profit; (2) Risk is an uncertain event from which one should seek protection.” Most respondents (71%) answer (2), considering risk a threat rather than an opportunity. The two indicators of risk aversion, though based on quite different framing, are highly correlated. In the empirical analysis we rely mostly on the first indicator, but check the sensitivity of the results using also the second. Table 3 reports sample statistics for the risk aversion indicators.

In separate questions, respondents report how often they buy or sell financial assets and willingness to delegate decisions to financial advisors. Frequency of trading ranges from “every day” (2% of the sample) to “never” (17%); the median is “every six months.” Taking the mid-point of the reported intervals, each investor makes 0.23 trades every month.

When asked about willingness to delegate financial decisions, 28% of respondents report to take financial decisions alone, 58% take decisions alone but consult a financial advisor, and 12% delegate and let the advisor decide. These data will be used in Section 2 to contrast the rational and overconfidence model from different angles.

[7] See, among others, Barsky et al (1997) and Guiso and Paiella (2003).

4 Determinants of investment in financial information

As shown in Section 2, the rational model and the model with overconfident but utility-maximizing investors deliver similar predictions on the determinants of investment in information. Thus, one cannot rely on estimates of the demand for financial information alone to discriminate between the two models. Yet, looking at these determinants is useful for several reasons.

First, if the variables that theory predicts should explain investment in information play no role, one could argue that our indicator of information or the explanatory variables are fraught with errors. Second, the estimates of information investment might provide indirect evidence on overconfidence. If variables which tend to be associated with overconfidence – such as gender – have no effect on information, one may also doubt that overconfidence affects investors' decisions. Third, estimates of information investment help identifying variables that can be used as instruments when, later in the paper, we estimate the effect of information on portfolio performance.

The rational model in Section 2 suggests that three variables should affect investment in information: wealth, risk tolerance and the marginal cost of collecting financial information. Figure 3 plots investment in financial information (measured in minutes per week) against financial wealth. The relation is positive, particularly at low levels of wealth. Figure 4 shows that information is negatively correlated with the risk aversion indicator: investors who report to be risk averse invest much less in information than investors who are more risk tolerant.

Figure 5 plots information against education. We have no direct measure of the cost of information, and proxy it with years of schooling. Education reduces the cost of acquiring information because investors with higher education need less time to obtain an extra unit of information. On the other hand, information requires time, and since higher education is associated with higher wages, investors with higher education also face a higher marginal cost of time. In the regression analysis we use also a dummy for retirement as a proxy for the value of time, and our expectation is that retired investors spend more time in gathering financial information. Empirically, we find a positive association between education and information, consistent with the hypothesis that investors with higher education have a lower cost of information. Since education is also positively correlated with the value of time, the coefficient is a lower bound of the cost effect of education. [8]

The regression analysis in Table 4 confirms the two-way correlations. Given the categorical nature of the dependent variable, the estimates are performed by ordered probit. We use three dummies for risk aversion, excluding the most risk-averse group. Even when financial wealth, risk aversion and education are introduced simultaneously, each variable has an independent and statistically significant effect on investment in information. The economic impact of these variables, however, is rather different. Raising financial wealth from the bottom to the top quartile lowers the probability of making no information investment

[8] An alternative interpretation is that those with higher education have a preference for finance. Some individuals may obtain utility from collecting financial information; for them the marginal benefit of financial information is even larger and thus they invest more in financial information. Even if these preferences are unobserved they will be reflected in the information acquired. Having raised this issue, note that unobserved taste for financial information does not necessarily affect the implications of the two models. If investors are rational, those who like finance purchase more information. But they also benefit more from information, and the Sharpe ratio is still positively correlated with information. If investors are overconfident, those who purchase more information for pleasure are also hurt more: information and the Sharpe ratio are negatively correlated, because investors are overconfident, not because they like finance. We come back to this issue in Section 5.

by only 2 percentage points (5% of the sample mean). Risk tolerance has a much stronger impact: being in the highest risk tolerance group lowers the probability of not acquiring information by 26 points (75% of the sample mean); increasing education by 5 years (one standard deviation) lowers information by 9 points.

In column 2 of Table 4 we add a dummy for retirement as a further proxy of the cost of information, and an indicator of income risk. This indicator equals one if the respondent is unable to predict if his or her income will fall significantly, increase significantly or remain unchanged in the 5 years following the interview. In more general models, any variable – such as income risk – that affects the demand for stocks should also affect the demand for information. For instance, those who expect to allocate less wealth to stocks, e.g. because of high income risk, also benefit less from information. Consistent with this interpretation, income risk is negatively associated with information. The coefficient of the dummy for retirement is positive as expected.

Column 3 adds other demographic variables to account for variation in preferences which are possibly correlated with wealth, education or risk aversion: region (a dummy for living in the North), gender, marital status and city size. The results are qualitatively unchanged, suggesting that the correlations between financial information and wealth, education and risk aversion are not due to omitted demographic characteristics.

Controlling for gender is particularly important in the present context. Previous empirical literature suggests that men tend to be more overconfident than women in relation to male specific tasks, such as finance (Lundeberg, Fox and Puncochar, 1994; Barber and Odean, 2001). The positive coefficient of the male dummy is consistent with this evidence. The probability that males spend no time in information is 33 percentage points lower than females, while the probability of spending more than two hours per week is 45 percentage points higher. Of course, we cannot rule out that the male dummy reflects omitted variables correlated with gender.

The other regressions in Table 4 report various sensitivity checks. In column 4 we replace the dummies for risk aversion with the alternative measure based on the respondents' opinion about risk. Viewing risk as a threat rather than as an opportunity is negatively associated with investment in information, but the other results are unchanged. Column 5 includes only stockholders, since acquiring information is mostly relevant for them and those who don't have stocks may provide inaccurate answers; results are again similar to the total sample estimates. Finally, column 6 drops those who spend more than 7 hours per week to make sure that the correlations between information and wealth, risk tolerance and education are not driven by a small group of outliers with above-average taste for financial information. The estimates are again unaffected.

Overall, the estimates are consistent with the hypothesis that those who invest in information do it because they expect, rightly (as in the rational model) or wrongly (as in the overconfidence model), to benefit from it. In the next section we test whether, in fact, they are right or wrong.

5 Information and portfolio performance

The regressions for the Sharpe ratio in Table 5 represent the core estimates of the paper. Since the Sharpe ratio is not defined for individuals who don't have risky assets, we have valid observations for 1,365 investors. Of these, 80% have accounts only with Unicredit, while 20% also with other banks. In the latter case, we observe both wealth components.

Column 1 reports OLS estimates using the indicator of financial information as the only explanatory variable. In a model where investors are free from psychological bias, cross-sectional differences in the Sharpe ratio arise only from differences in correctly processed information. Contrary to the prediction of the rational model, the coefficient of information is negative and statistically different from zero at the 1 percent level. The effect is also quantitatively large: those who spend between 2 and 4 hours per week in information have a Sharpe ratio that is 27% lower than those who spend no time. Increasing time spent in information from 30 minutes per week (the median) to 2-4 hours (the 90th percentile) lowers the Sharpe ratio by 13.5%. At the sample median of the portfolio standard deviation, this is equivalent to a 17 basis points reduction in the portfolio expected excess return.

The estimates may be affected by selection bias because, as noted above, the Sharpe ratio is defined only for investors with positive amounts of stocks. And some may choose not to invest in the stock market precisely because they receive bad signals from the market. To account for this source of selection bias, in column 2 we report the second stage regression of a Heckman two-step estimator. The first stage is a probit regression where the decision to invest in risky assets depends on investment in information, financial wealth (linear and quadratic terms), risk aversion and demographic variables. Identification is obtained omitting financial wealth from the second stage regression for the Sharpe ratio. The restriction is implied by the model of Section 2: if there are fixed transaction costs, financial wealth affects the decision to invest in risky assets, but it does not affect the Sharpe ratio once information is controlled for.[9] The results are similar: the coefficient of information is still negative and statistically different from zero, and its magnitude is only slightly reduced.

Column 3 of Table 5 adds dummies for region, gender, marital status and city size. In the rational model these variables should not affect the Sharpe ratio, unless they proxy for differences in information not captured by our indicator. The coefficients of these additional variables are jointly not statistically different from zero.

The results can be criticized for three reasons. First, the negative correlation between information and the Sharpe ratio may reflect unobserved factors (not captured by the demographic variables) that affect portfolio performance and are correlated with financial information. For instance, ability to manage the portfolio differs across investors, and smart investors could achieve a higher Sharpe ratio without spending too much time in collecting information. Time spent in information would then be negatively correlated with unobserved ability, resulting in a negative correlation with the Sharpe ratio. A second criticism is that the negative correlation may be the result of a systematic downward bias in measured returns resulting from unobserved taste for finance. Some investors may trade and invest in risky assets because they like it, but the utility gain from the extra risk is not reflected in the monetary portfolio payoff. Furthermore, since these investors enjoy finance they also spend more time collecting information, hence the negative correlation. Finally, if the information variable is measured with error the estimates are biased towards zero.

These concerns imply that our information indicator might be correlated

[9] The first stage results indicate that those who invest in information are more likely to invest in stocks. Causality however can run both ways depending on the timing of the participation decision and information acquisition. The coefficient of risk tolerance is positive. Wealth has a strong positive effect on participation, consistent with the presence of fixed transaction costs.

with the regression error, producing biased estimates. We address these concerns using an instrumental variable approach. We use as instruments the indicator of income risk and the retirement dummy. As shown in Table 4, both variables predict investment in information and there is no obvious reason why they should affect portfolio performance directly or be correlated with a taste for finance.

Column 4 of Table 5 reports the selectivity adjusted IV estimates. The coefficient of information is negative, precisely estimated, and larger in absolute terms than in the OLS estimates. The Sargan test of the over-identifying restrictions does not reject the null hypothesis that the instruments are orthogonal to the error term. The value of the F test for the excluded instruments in the first stage regression suggests that the estimates do not suffer from a weak instrument problem.

Column 5 adds to the second stage IV estimates three dummies for risk tolerance. In the rational model, risk tolerance should not affect the Sharpe ratio, once differences in information are controlled for (Peress, 2004). If our variables control imperfectly for differences in information, the correlation between risk tolerance and the Sharpe ratio should be positive, because risk tolerance and information are positively correlated, providing a supplementary test of the rational model. We find that risk tolerance is negatively correlated with portfolio performance: the Sharpe ratio of the most risk tolerant group is 7.8 percentage points lower than that of the least risk tolerant (the excluded category). This result contrasts with the rational model; to the extent that overconfidence is positively correlated with risk tolerance, it may be consistent with the overconfident model. The last regression in Table 5 excludes investors who spend more than 7 hours per week collecting information. The information coefficient is unaffected, implying that the results are not driven by a small group of investors with a taste for finance.

Table 6 repeats the OLS and IV estimates restricting the sample to investors with accounts only at Unicredit (1,098 customers). For these investors the administrative data provide a complete coverage of the household portfolio which is not affected by measurement error. The sample selection results in a loss of 267 households with multiple bank relations. The pattern of the estimates is unaffected: the portfolio Sharpe ratio is negatively correlated with investors' information and the result is robust to selection and correction for unobserved heterogeneity. The notable difference with respect to the estimates in Table 5 is that some of the demographic variables (gender and residence, in particular), affect the Sharpe ratio.

The negative relation between the Sharpe ratio and information begs the question of why informed investors attain a lower Sharpe ratio. Is it because their returns are "too low" or because risk is "too high"? To distinguish between these two possibilities, Table 7 reports regressions relating the expected return and standard deviation of the portfolio to financial information. Investors who collect more information have higher returns (the coefficient is 0.135). However, the portfolio volatility is strongly increasing in information, driving the negative correlation between the Sharpe ratio and information reported in Table 5, in contrast to models of rational investors.

To assess the role of overconfidence, we exploit the theoretical implication that the negative correlation between information and the Sharpe ratio should be stronger for investors that, a priori, can be classified as "more overconfident", as in Figure 1. Experimental evidence shows that overconfidence differs considerably across individuals and tasks (West and Stanovich, 1997). When individuals are subject to multiple experiments over different domains, those who show more overconfidence in one domain – e.g. a classical knowledge-based test of overconfidence – tend to exhibit also more confidence in other domains. This suggests that there are traits that are specific to individuals (rather than to tasks) that affect the degree of overconfidence.

Experimental research also shows that overconfidence is more likely to manifest itself when individuals face relatively difficult tasks, such as finance (Fischhoff, Slovic and Lichtenstein, 1977; and Yates (1990). Finally, researchers tend to agree that in tasks that are specific to a type, individuals of that type exhibit more overconfidence. In particular, in more masculine tasks males show more overconfidence than women and vice versa (Lundeberg Fax and Puncochar, 1994).

We split the sample using two different proxies for overconfidence. The first proxy is based on how well survey participants think they know stocks. One robust finding of the experimental literature is that when problems are grouped according to confidence level, the greatest overconfidence is observed for the problems answered with the greatest confidence, see Klayman, Soll, Gonzales-Vallejo, and Barlas (1999). Furthermore, several studies suggest that overconfident individuals tend to overestimate their knowledge, see Weinstein (1980), Svenson (1981), and Taylor and Brown (1988). Accordingly, we classify as overconfident those who claim they know stocks well or very well (56 percent of the sample). The second split is based on gender, on the assumption that finance is typically a masculine task, as sugested by Barber and Odean (2001).

In our sample males are responsible for financial matters of the household in 75 percent of the cases (85 percent excluding singles).

Results are reported in Table 8. The coefficient of information is more negative in the groups that are classified as more overconfident: males and those who claim to know stocks well. To provide a sense of the magnitudes involved, we compute the percent reduction in the Sharpe ratio when time spent increases from 30-60 minutes to 2-4 hours per week. Evaluated at sample means, the reduction in the ratio in the high overconfidence groups are between 10 and 20 percent higher. The results are consistent with the hypothesis that the propensity to take financial risk increases with overconfidence.

6 Trading, delegation and diversification

The survey allows us to delve deeper into the analysis of the effects of financial information on investors' behavior. Here we contrast three additional implications of models with rational and overconfidence investors. First, overconfident investors trade more than rational investors (Odean, 1998a) so that trading activity should increase with the degree of overconfidence. Second, overconfident investors are less willing to rely on information provided by financial advisors, banks or brokers and more likely to collect information directly. This implies that information acquisition should be negatively correlated with willingness to delegate financial decisions. Third, to the extent that overconfident investors collect information on specific stocks, they are more likely to engage in stock-picking, ending up with less diversified portfolios. As we shall see, trading activity, lack of delegation and lack of diversification are associated with lower Sharpe ratios, providing further links between overconfidence and poor portfolio performance.

6.1 Trading

The first regression of Table 9 relates "frequency of trading," a variable ranging from 0 ("never trades") to 365 ("trades every day"), to financial information, demographic variables and risk aversion indicators. The coefficient of information is positive and statistically different from zero at the 1 percent level. The positive correlation is consistent with the behavior of rational and overconfident investors alike. In fact, those who invest in information receive more signals and can therefore be expected to trade more frequently. However, if investors are overconfident, trading should increase with the degree of overconfidence, while if agents are rational the effect of information on trading should not vary across population groups.

In Table 9 we split the sample using the same indicators of overconfidence described in Section 5: self-reported knowledge of stocks and gender. The results show that investors that are likely to be more overconfident react to information more strongly than those classified as less overconfident. The effect of information on trading is almost three times as large for men, and almost five times as large for those who claim to know stocks well, lending support to the overconfidence model.

6.2 Delegation

Delegation opens up economies of scale in portfolio management and information acquisition.[10] But delegation is expensive, in terms of commissions and

[10] Financial advisors spread information costs among many investors, and know how and where to acquire information. Thus, by delegating financial decisions, retail investors may improve portfolio performance.

fees, and might give rise to agency problems. One should expect a negative correlation between information and delegation for both rational and overconfident investors. Indeed, Van Nieuwerburgh and Veldkamp (2005) show that if rational investors are constrained in the amount of information they can collect (or process), they may find it optimal to concentrate their efforts in collecting information on few, information intensive stocks and invest their wealth partly in a diversified mutual fund and partly in a small number of selected stocks. However, overconfident investors might delegate less than rational investors because they believe that self-collected information is of higher quality than it actually is. Therefore, if delegation is driven by overconfidence, the negative association between delegation and information collected directly will increase with the degree of overconfidence.

In Table 10 we relate the decision to delegate to information, financial wealth, demographic variables, risk aversion. We also add two dummies for trust in financial advisors, and expect that those who trust more, are more willing to delegate. The dependent variable in the ordered probit estimates for investors' willingness to delegate financial decisions is a categorical variable ranging from 1 (never delegates) to 4 (delegates completely to financial advisor/bank/broker). The first regression reports results for the total sample. The coefficient of information is negative and statistically different from zero (-0.07). Trust is positively associated with delegation, while males are less willing to delegate. The other regressions split the sample by the overconfidence indicators. The negative association between information and delegation is stronger for man than women, and for those who claim to know stocks well, consistent again with the hypothesis that overconfidence drives, at least in part, investors' decisions.

6.3 Diversification

As a proxy for portfolio diversification, we use the ratio between equity mutual funds plus equity investment accounts and total stocks, which includes these two items and directly held stocks (listed and unlisted). The ratio is computed for the subset of investors with stocks (directly or indirectly owned), and ranges from 0 (all stocks are directly held) to 1 (all stocks are held through mutual funds or other institutional investors).[11] This reduces the sample size to 1,172 observations. On average, investors own directly 44% of equities, highlighting substantial lack of stock market diversification.

In Table 11 we relate the index of portfolio diversification to information, trust, risk aversion, wealth and demographic variables. Since the dependent variable is truncated, the regressions are estimated by Tobit. Risk aversion and trust in financial advisors are associated with more diversification, with large effects. "High trust" investors hold 15.5% more in indirect stocks than those with low or no trust (the reference group), while the most risk tolerant group owns 21% more in direct stocks than the least tolerant. The coefficient of information is negative and statistically different from zero, and the effect is again notable. The portfolio of those who spend between 2 and 4 hours per week in collecting information is 15.2 percentage points less diversified (27 percent of the sample mean) than those who spend no time.

When we split the sample by the overconfidence indicators, we find that the negative correlation between information and diversification is stronger (in absolute value) in the more overconfident groups, a finding that is again broadly consistent with overconfidence.

[11] Unfortunately, the survey does not provide information on individual stocks owned.

6.4 The effect on portfolio performance

We complete the picture relating our measures of trading, delegation and diversification to portfolio performance (the Sharpe ratio). In the rational model investors benefit from information and trading, achieving higher returns per unit of risk (a higher Sharpe ratio), while overconfident investors are potentially harmed. On the other hand, the Sharpe ratio of rational investors should not be affected by the decision to delegate or by the index of diversification.

The first two columns of Table 12 report estimates of the relation between trading and the Sharpe ratio. Since the Sharpe ratio is not defined for those who don't have stocks, we report two-stage selectivity adjusted estimates, as in Table 6. The results show that trading activity is associated with a lower Sharpe ratio, in contrast with the implications of the rational model and consistent with overconfidence. In column (2) the correlation is attenuated, but still significant, when we control also for investment in information.

Since overconfident investors tend to rely more on themselves and less on financial advisors, lack of delegation might be associated with a lower Sharpe ratio. Indeed, the coefficient of delegation in column (3) of Table 12 is positive, suggesting that those who don't delegate (the overconfident) achieve a Sharpe ratio that is 6 percentage points lower than those who delegate. However, when we control for information in column (4), the coefficient is no longer significant. This suggests that investment in information already captures the effect of delegation on portfolio performance.

The final two regressions of Table 12 estimate the relation between diversification and portfolio performance. Overconfident investors choose less diversified portfolios, investing too little in mutual funds and too much in single stocks, resulting in a negative correlation between lack of diversification and the Sharpe ratio. On the other hand, the performance of the portfolio of rational agents should not be effected by diversification. The data provide again some support for the overconfidence model, as the Sharpe ratio is positively associated with diversification, even when we control for investment in information. Reducing the diversification index from one to zero, that is going from a diversified portfolio (through institutional investors) to direct stock investment, is associated with a reduction of about 10 percentage points of Sharpe ratio. This result is analogous to Ivkovich, Sialm and Weisbenner (2004) who also find that while concentrated household portfolios yield average higher returns than diversified ones, they entail larger total risk are larger and the Sharpe ratios of their stock portfolios are lower.

7 Summary

Investment in financial information differs considerably across investors. There is also a lot of heterogeneity in portfolio allocations, portfolio returns and volatility, rasing naturally the question of what is the relation between financial information and portfolio performance. Models with rational investors recognize that information is valuable and that investors have different endowments and preferences. Accordingly, investors purchase different amounts of information, and those who purchase more information achieve better portfolio allocations, as summarized by the portfolio Sharpe ratio. Therefore in models with rational agents investment in information and the Sharpe ratio are positively correlated.

This implication is not borne out in a representative survey of Italian investors. Instead, we find that investors that acquire more information attain lower returns per unit of risk (a lower Sharpe ratio). This is not due to selection bias or omitted variables, because the correlation is still negative and even stronger when we instrument our proxy for financial information acquisition and account for endogenous selection of stock market participants. The rational model is not supported by the data also on other grounds. For instance, the correlation of the Sharpe ratio with an indicator of risk tolerance is negative, in contrast to the model's predictions of absence of correlation.

We argue that the empirical correlation between the portfolio Sharpe ratio and investors' information is more easily understood if one allows investors to be overconfident about the quality of their information, while retaining expected utility maximization. Overconfident, but otherwise rational investors, collect information responding to the same economic incentives as rational investors but, compared to the former, collect too much information and rely too much on it. For moderate amounts of overconfidence, the correlation between the amount of information and the Sharpe ratio is actually negative. Our findings are consistent with these predictions. Furthermore, the negative relation between the Sharpe ratio and information is stronger among investors that can be classified as more overconfident. We also find that trading activity, lack of delegation and lack of diversification are associated with lower Sharpe ratios, again supporting models with overconfident investors.

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8 Appendix A: The rational and the overconfident models

As in Peress (2004), we consider a rational investor who chooses between a risk free asset (a "bond") and a risky asset (a "stock"). We first recall the expressions for the equilibrium price P, the optimal portfolio share of stocks α_j^R and the optimal level of information acquisition x_j^R. The equilibrium price, for small levels of z, which scales the level of risk in the economy is :

$$\ln P \approx pz = p_0(i)z + p_\pi(i)(\pi z - \mu\theta z) - r^f z$$

where:

$$\begin{aligned}
\pi z &\sim N((E\pi)z, \sigma_\pi^2 z) \text{ is the payoff of the risky asset} \\
\theta z &\sim N((E\theta)z, \sigma_\theta^2 z) \text{ is the supply of the risky asset} \\
p_0(i) &= \frac{1}{\bar{h}}(\frac{E\pi}{\sigma_\pi^2} + i\frac{E\theta}{\sigma_\theta^2} + \frac{1}{2}) \\
p_\pi(i) &= 1 - \frac{1}{\bar{h}\sigma_\pi^2} \\
\bar{h} &= \frac{1}{\sigma_\pi^2} + \frac{i^2}{\sigma_\theta^2} + \frac{i}{n} \text{ (aggregate precision)} \\
i &= \int_j x_j^R \tau_j(W_{0j}) dG(x_j^R, W_{0j}) \text{ (aggregate information)} \\
n &= \int_j \tau_j(W_{0j}) dG(x_j^R, W_{0j}) \text{ (aggregate risk tolerance)} \\
& \tau_j(W_{0j}) \text{ (absolute risk tolerance)} \\
& dG(x_j^R, W_{0j}) \text{ (density of investors with } x_j^R, W_{0j})
\end{aligned}$$

x_j^R is the amount of information acquired by investor j and is given by:

$$C'(x_j^R) = \frac{1}{2}\tau(W_j)\phi'_x(x_j^R, i)$$

where:

$$\begin{aligned}
\phi(x_j^R, i) &= h(i, x_j^R)A + \frac{1}{4h(i, x_j^R)} + q - 1 \text{ is increasing and convex in } x \\
A &= \frac{h(i,0)n^2 + 2in + \sigma_\theta^2}{(n\bar{h})^2} + q^2 \\
q &= \frac{E\theta}{n\bar{h}} - \frac{1}{2\bar{h}} \\
h(i, x_j^R) &= \frac{1}{\sigma_\pi^2} + \frac{i^2}{\sigma_\theta^2} + x_j^R
\end{aligned}$$

Theorem 1 in Peress (2004) proofs that the optimal amount of information is increasing in absolute risk tolerance $\tau(W_j)$ and wealth, and decreasing in the marginal cost of information. He also shows that there is a wealth threshold below which the investor does not purchase information.

The optimal share of stocks is:

$$\alpha_j^R = \frac{\tau(W_j)}{W_j}\left(\frac{E\pi}{\sigma_\pi^2} + \frac{iE\theta}{\sigma_\theta^2} + \frac{i^2}{\sigma_\theta^2}(\pi - \mu\theta) + x_j^R\frac{S_j^R}{z} + \frac{1}{2} - (p + r^f)h(i, x_j^R)\right)$$

where S_j^R is the signal received on the true payoff Π by investor j as he purchases the amount of information x_j^R :

$$\begin{aligned} S_j^R &= S(x_j^R) = \pi z + \sqrt{\frac{z}{x_j^R}}\varepsilon \\ \varepsilon &\sim N(0,1) \end{aligned}$$

8.1 The Sharpe ratio of the rational investor

The Sharpe ratio of the rational investor (dropping the index j for simplicity) is:

$$Sharpe^R = \frac{E(\alpha^R r^e)}{\sqrt{V(\alpha^R r^e)}} = \frac{\text{portfolio mean excess return}}{\text{portfolio standard deviation}}$$

where r^e is the excess return on the stock:

$$r^e = \frac{\Pi - P}{P} - r^f z$$

and the expected mean excess return on the portfolio is:

$$\begin{aligned} E(\alpha^R r^e) &= E(E(\alpha^R r^e |\ S^R, P)) \\ &= E\alpha^R E(r^e |\ S^R, P) \end{aligned}$$

Let us define

$$\begin{aligned} \lambda^R &= \alpha^R \frac{W}{\tau(W)} \frac{1}{\sqrt{V}} \\ &\quad \text{(the Sharpe ratio of the portfolio return)} \\ V &= V(\pi z \mid S^R, P) \end{aligned}$$

One can show that:

$$E(r^e |\ S^R, P) \simeq \lambda^R \frac{1}{\sqrt{V}}$$

So that:

$$\begin{aligned} E(\alpha^R r^e) &= E(\left(\lambda^R\right)^2)\frac{\tau(W)}{W} \\ &= \frac{\tau(W)}{W}\phi(i, x^R)z \end{aligned}$$

And the variance of the excess return on the portfolio is:

$$V(\alpha^R r^e) = E(V(\alpha^R r^e \mid S^R, P)) + V(E(\alpha^R r^e| \; S^R, P))$$

Since the mean excess return on the portfolio is of the order of z, $V(E(\alpha^R r^e| \; S^R, P))$ is of the order of z^2 and is negligible at the first order in z with respect to $E(V(\alpha^R r^e \mid S^R, P))$. This implies that:

$$\begin{aligned}
V(\alpha^R r^e) &\simeq E(V(\alpha^R r^e \mid S^R, P)) \\
&= E(\left(\alpha^R\right)^2 V(r^e \mid S^R, P)) \\
&\simeq E(\left(\alpha^R\right)^2 V(\pi z| \; S^R, P)) \\
&= E(\left(\lambda^R\right)^2 \frac{1}{V} V \left(\frac{\tau(W)}{W}\right)^2 \\
&= \left(\frac{\tau(W)}{W}\right)^2 \phi(i, x^R) z
\end{aligned}$$

and finally the Sharpe ratio is given by:

$$Sharpe^R = \sqrt{\phi(i, x^R) z}$$

As shown in Peress (2004), Appendix B, the Sharpe ratio of the rational investor increases with x^R and the amount of information purchased.

8.2 The effect of overconfidence

We now introduce overconfidence in the previous model and compute the optimal portfolio and the optimal amount of information purchased by the overconfident investor. We assume that overconfident investors have mass zero among all other rational agents, so they don't affect the equilibrium price or the choice of other rational agents.

An overconfident investor who purchases the amount of information x^K thinks he is receiving the signal $S^K = \pi z + \sqrt{\frac{z}{Kx^K}}\varepsilon$ although he is actually receiving the signal $S(x^K)$. That is, he overestimates the true precision of the signal by a factor $K > 1$ measuring the degree of overconfidence. This alters the signal extraction problem he solves when he computes the optimal portfolio and chooses the optimal amount of information. Since the overconfident investor behaves as a rational investor who gets a signal with precision Kx^K,the optimal amount of information purchased is:

$$C'(x_j^K) = \frac{1}{2}\tau(W_j) K \phi'_x(Kx_j^K, i)$$

Following the same line of proof as Peress (2004), optimal information of the overconfident investor increases with risk tolerance, wealth and degree of overconfidence K, and decreases with the marginal cost of acquiring information. Here too, there is a threshold level of wealth below which the overconfident investor does not acquire information but, *ceteris paribus*, the threshold is lower than for the rational investor. This can be seen by noticing that information is not acquired if $C'(0) > \frac{1}{2}\tau(W_j)K\phi'_x(0)$, which requires a lower value of wealth the larger is K.

The optimal portfolio is given by:

$$\alpha_j^K = \frac{\tau(W_j)}{W_j}\left(\frac{E\pi}{\sigma_\pi^2} + \frac{iE\theta}{\sigma_\theta^2} + \frac{i^2}{\sigma_\theta^2}(\pi - \mu\theta) + Kx_j^K\frac{S^K}{z} + \frac{1}{2} - (p + r^f)h(i, Kx_j^K)\right)$$

Proof: The proof follows Peress (2004) except for the signal extraction problem. Now:

$$\begin{aligned} E(\pi z \mid S^K, P) &= \frac{1}{h(i, Kx_j^K)}\left(\frac{E\pi}{\sigma_\pi^2}z + \frac{iE\theta}{\sigma_\theta^2}z + z\frac{i^2}{\sigma_\theta^2}(\pi - \frac{\theta}{i}) + Kx_j^K S_j^K\right) \\ V(\pi z \mid S^K, P) &= \frac{z}{h(i, Kx_j^K)} \end{aligned}$$

and for small z the optimal portfolio is still given by :

$$\alpha_j^K = \frac{\tau(W_j)}{W_j}\frac{E(\pi z \mid S_j^K, P) + \frac{1}{2}V(\pi z \mid S_j^K, P) - pz - r^f z}{V(\pi z \mid S_j^K, P)}.$$

Substituting for the expected stock return and variance conditional on the signal gives the optimal portfolio choice above.

8.3 The perceived Sharpe ratio of an overconfident investor

The perceived Sharpe ratio of an overconfident investor can be computed exactly along the same lines followed for the rational investor but conditioning on the perceived signal. This gives:

$$Perceived\ Sharpe^K = \sqrt{\phi(i, Kx^K)z}$$

The perceived ratio increases with K (the overconfidence parameter) and x^K (the amount of information purchased). Thus, the overconfident investor is indeed tempted to purchase even more information than the rational investor. However, the true Sharpe ratio of the overconfident investor is different from the one he expects.

8.4 The actual Sharpe ratio of an overconfident investor

To compute the true Sharpe ratio of the overconfident investor, we need to condition on the true signal:

$$E(\alpha^K r^e) = E(E(\alpha^K r^e |\ S^R, P))$$

Define:

$$\begin{aligned}
\alpha^{RK} &= \alpha^K - \alpha^R \\
\lambda^{RK} &= \alpha^{RK} \frac{W}{\tau(W)} \sqrt{V}
\end{aligned}$$

where α^R denotes the portfolio choice of a rational investor who would be choosing the amount of information x^K.

Thus the average portfolio return of the overconfident investor, conditioning on the true distribution of signals, is:

$$\begin{aligned}
E(E(\alpha^K r^e |\ S^R, P)) &= E((\alpha^R + \alpha^{RK}) E(r^e |\ S^R, P)) \\
&= \frac{\tau(W)}{W} E(\lambda^R + \lambda^{RK}) \lambda^R \\
&= \frac{\tau(W)}{W} \left(E(\left(\lambda^R\right)^2) + E(\lambda^{RK} \lambda^R) \right)
\end{aligned}$$

and the portfolio variance:

$$\begin{aligned}
V(\alpha^K r^e) &\simeq E(V(\alpha^K r^e \mid S^R, P)) \\
&= E(\alpha^{RK} + \alpha^R)^2 V(r^e \mid S^R, P) \\
&= \left(\frac{\tau(W)}{W}\right)^2 (E(\lambda^{RK} + \lambda^R)^2) \\
&= \left(\frac{\tau(W)}{W}\right)^2 (E(\lambda^{RK})^2 + E(\lambda^R)^2 + 2E(\lambda^R \lambda^{RK}))
\end{aligned}$$

Thus, the true Sharpe ratio of the overconfident investor is:

$$Sharpe^K = \frac{E(\left(\lambda^R\right)^2) + E(\lambda^{RK} \lambda^R)}{\sqrt{E(\lambda^R)^2 + E(\lambda^{RK})^2 + 2E(\lambda^R \lambda^{RK})}}$$

Note that $E\left(\lambda^R\right)^2$ is the square of the Sharpe ratio of an investor who is not overconfident and perceives the signal correctly but who would purchase the amount of information x^K.We are interested in showing how the Sharpe ratio of the overconfident investor compares to that of the rational investor and how it varies with the amount of information x^K.

Let us compute the different terms that come into play:

$$\begin{aligned}
\lambda^R &= \frac{1}{\sqrt{zh(i,x^K)}} \times \\
&\quad (p_0(i)(i/n - x^K)z + \pi z(1-p_\pi(i))(x^K - i/n) + \\
&\quad (\theta z/i)((1-p_\pi(i))i/n + p_\pi(i)x^K) + \sqrt{zx^K}\varepsilon) \\
\lambda^{RK} &= \frac{1}{\sqrt{zh(i,x^K)}} \times \\
&\quad (-(K-1)xp_0(i)z + (1-p_\pi(i))(\pi z)(K-1)x^K + \\
&\quad p_\pi(i)(K-1)x^K(\theta z/i) + \varepsilon(\sqrt{K}-1)\sqrt{zx^K})
\end{aligned}$$

where ε is a random variable with a standard normal distribution (mean 0 and variance 1)

And where (to a first-order approximation in z):

$$E(\left(\lambda^R\right))^2 = \phi(i, x^K)$$

$$\begin{aligned}
E(\lambda^R\lambda^{RK}) &= \frac{x^K}{h(i,x^K)} \times \\
&\quad (((1-p_\pi(i))^2\sigma_\pi^2 + (p_\pi(i))^2\frac{\sigma_\theta^2}{i^2})(x^K - i/n)(K-1) + \\
&\quad p_\pi(i)\frac{i}{n}\frac{\sigma_\theta^2}{i^2}(K-1) + (\sqrt{K}-1))
\end{aligned}$$

and

$$\begin{aligned}
E(\lambda^{RK})^2 &= \frac{\left(x^K\right)^2}{h(i,x^K)}((1-p_\pi(i))^2\sigma_\pi^2 + p_\pi(i)^2\sigma_\theta^2/i^2)(K-1)^2 \\
&\quad + (\sqrt{K}-1)^2\frac{x^K}{h(i,x^K)}
\end{aligned}$$

Going back to the expression for the "true" Sharpe ratio of the overconfident investor, we have that:

$$Sharpe^K = \frac{N}{\sqrt{D}}$$

where:

$$\begin{aligned}
N &= E(\lambda^R)^2 + E(\lambda^R\lambda^{RK}) \\
D &= E(\lambda^R)^2 + 2E(\lambda^R\lambda^{RK}) + E(\lambda^{RK})^2
\end{aligned}$$

Although it is not obvious from the formulas that $Sharpe^K < Sharpe^R$, we know that the amount of information purchased by the overconfident investor

x^K is strictly greater than that purchased by the rational investor, so that the portfolio allocation of the overconfident investor is suboptimal given the equilibrium returns, implying $Sharpe^K < Sharpe^R$. (In equilibrium, the Sharpe ratio is maximized at the optimal level of information given the true signalling structure).

To see how the Sharpe ratio varies with a marginal increase in information , we compute the derivatives of the various terms of the ratio with respect to x^K :

$$\begin{aligned}
\frac{\partial E(\lambda^R)^2}{\partial x^K} &= \frac{\partial \phi(i, x^K)}{\partial x^K} = A - \frac{1}{4\left(h(i,x^K)\right)^2} \\
\frac{\partial E(\lambda^R \lambda^{RK})}{\partial x^K} &= (K-1)C\frac{x^K}{h(i,x^K)} + \\
&\quad (C(x^K - i/n)(K-1) + p_\pi(i)\frac{i}{n}\frac{\sigma_\theta^2}{i^2}(K-1) + (\sqrt{K}-1)) \\
&\quad \times \left(\frac{1}{h(i,x^K)} - \frac{x^K}{\left(h(i,x^K)\right)^2}\right) \\
\text{where } C &= (1-p_\pi(i))^2\sigma_\pi^2 + p_\pi(i)^2\sigma_\theta^2/i^2 \\
\frac{\partial E(\lambda^{RK})^2}{\partial x^K} &= \left(\frac{2x^K}{h(i,x^K)} - \frac{\left(x^K\right)^2}{\left(h(i,x^K)\right)^2}\right) C(K-1)^2 \\
&\quad + (\sqrt{K}-1)^2 \left(\frac{1}{h(i,x^K)} - \frac{x^K}{\left(h(i,x^K)\right)^2}\right)
\end{aligned}$$

So that:

$$\begin{aligned}
\frac{\partial N}{\partial x^K} &= \frac{\partial E(\lambda^R)^2}{\partial x^K} + \frac{\partial E(\lambda^R \lambda^{RK})}{\partial x^K} > 0 \\
\frac{\partial D}{\partial x^K} &= \frac{\partial E(\lambda^R)^2}{\partial x^K} + 2\frac{\partial E(\lambda^R \lambda^{RK})}{\partial x^K} + \frac{\partial E(\lambda^{RK})^2}{\partial x^K} > 0
\end{aligned}$$

And finally:

$$\begin{aligned}
\frac{\partial Sharpe^K}{\partial x^K} &= \frac{1}{D}\left(\frac{\partial N}{\partial x^K}\sqrt{D} - N\frac{\frac{\partial D}{\partial x^K}}{2\sqrt{D}}\right) \\
&= \frac{1}{2D\sqrt{D}}\left(2\frac{\partial N}{\partial x^K}D - N\frac{\partial D}{\partial x^K}\right)
\end{aligned}$$

A marginal increase in the amount of information of overconfident investors has two effects. It increases the true excess mean return of the portfolio $\left(\frac{\partial N}{\partial x^K} > 0\right)$, but it also increases the true variance of the excess return $\left(\frac{\partial D}{\partial x^K} > 0\right)$.

Proof of Propositions 1 and 2. In general, it is not possible to establish analytically the sign of the above derivative. But we see that for large K, the extra term $E(\lambda^{RK})^2$ in the denominator of the Sharpe ratio of the overconfident investor dominates and the Sharpe ratio becomes:

$$Sharpe^K \sim B\frac{1}{h(i,x^K)} \text{ for large } K$$

where B is a positive constant. Since $h(i,x^K)$ is strictly increasing in x^K, when overconfidence is sufficiently large the Sharpe ratio is decreasing in K.

To see how the Sharpe ratio varies with the amount of information and the degree of overconfidence, we evaluate the ratio using the same assumptions as in Peress (2004, Section 6). In particular, we use a CRRA specification for the utility function with a coefficient of relative risk aversion of 5 to compute the level of aggregate risk tolerance n (using the same number for aggregate financial wealth of 5,184 billion dollars):

$$n = 1,037 \text{ billion (USD)}$$

and:

$$\begin{aligned}
\sigma_\pi^2 &= 0.0275 \text{ (the historical moments of stock returns in the US)} \\
E\theta &= n \times 2.750 \\
\sigma_\theta^2 &= n \times 6.539 \\
\mu &= 100 \times n
\end{aligned}$$

The computation is not meant to be realistic but rather to provide a qualitative numerical description of how the Sharpe ratio varies with information and the overconfidence parameter. Figure 1 in the text plots $Sharpe^K$ as a function of x^K for the increasing degree of overconfidence starting with $K = 1$.

We see that the true Sharpe ratio of the overconfident investor is strictly lower than the Sharpe ratio of the rational investor and decreasing in the level of overconfidence. The sensitivity to the amount of information is also lower the higher the degree of overconfidence. Furthermore, for K sufficiently large, the Sharpe ratio is negatively related to the amount of information at all levels of information. In our computations the relation between the Sharpe ratio and information becomes negative when overconfidence is such that the investor's perceived standard deviation of returns is half its true value.

9 Appendix B: Data sources and variables' definitions

9.1 The Unicredit-Pioneer Survey

The Unicredit-Pioneer Economic Research Survey of Investors' Behavior (UPS) draws on the population of clients of one of the three largest Italian banks, with over 4 million accounts. The sample includes 1,834 individuals with a checking account in one of the banks that are part of the Unicredit Group. The sample is representative of the eligible population of customers, excluding customers less than 20 years old or older than 80, and those who hold accounts of less than 1,000 euro or more than 2.5 million euro.

UPS' goal is to study retail customers' behavior and expectations. The survey has detailed information on households' demographic structure, wealth (both within and outside the bank), and income. It has data on multi-banking, attitudes towards saving and financial investment, propensity to take financial risk, retirement saving and life insurance. Interviews have been administered between September 2003 and January 2004 by an Italian leading poll agency, which also serves the Bank of Italy for the Survey on Household Income and Wealth (SHIW). Most interviewers had substantial experience in administering the Bank of Italy SHIW, which is likely to increase the quality of the data. The Computer Assisted Personal Interview (CAPI) methodology was employed for all interviews. Before the interview, each customer was contacted by phone.

The sampling design is similar to that of the Bank of Italy SHIW. The population of account holders is stratified along geographical area of residence (North-East, North-West, Central and Southern Italy), city size (less that 30,000 inhabitants and more), and wealth held with Unicredit (as of December 31, 2003). The questionnaire was designed with the help of field experts and academic researchers. It has eight sections, dealing with household demographic structure, occupation, propensity to save, to invest and to risk, individual and household financial wealth, real estate, entrepreneurial activities, income and expectations, life insurance and retirement income. The wealth questions match those in the Bank of Italy SHIW, and allow interesting comparison between the wealth distributions in the two surveys.

An important feature of the UPS is that sample selection is based on individual clients of Unicredit. The survey, however, contains detailed information also on the household head – defined as the person responsible for the financial matters of the family – and spouse, if present. Financial variables are elicited for both respondents and household.

9.2 Construction and definition of wealth

UPS contains detailed information on ownership of real and financial assets, and amount invested. Real assets refer to the household. Financial assets refer to both the account holder and the household. For real assets, UPS reports separate data on primary residence, investment real estate, land, business wealth, and debt (mortgage and other debt). Real asset amounts are elicited without use of bracketing.

Two definitions of financial wealth are available. One refers to the individual account holder, and the other to the entire household. The two can differ because some customers keep financial wealth also in different banks or financial institutions (multi-banking) and/or because different household members have different accounts.

Calculation of financial assets amounts requires some imputation. First of all, respondents report ownership of financial assets grouped in 10 categories. Respondents are then asked to report financial assets amounts; otherwise, they are asked to report amounts in 16 predetermined brackets and if the stated amount is closer to the upper or lower interval within each bracket. The questions are the same used in the Bank of Italy SHIW.

9.3 Expected return, standard deviation and Sharpe ratio

To construct the portfolio Sharpe ratio we rely on Pelizzon and Weber (2005), who further classify the 10 UPS asset categories in short-term government bonds (considered to be the risk-free asset), medium-term government bonds (MTGB), long-term government bonds (LTGB), and stocks, as explained in Table A1. The questionnaire does not contain exact information on the maturity of government bonds, and the composition of mutual funds and managed investment accounts. Even if the precise split is not known, the survey asks if mutual funds are predominantly stocks or bonds, and we can combine this information with aggregate data to reclassify mutual funds and managed investment accounts.

We estimate the proportion invested in stocks using the average portfolio allocation of Italian managed funds in the Assogestioni Technical Report (January 2004 edition). For those who state that mutual funds or managed investment accounts are mostly stocks we assume that 88.61% is invested in stocks, 1.47% in bonds, 9.92% in the risk-free rate asset. For those who state that they are equally distributed between stocks and bonds, we assume that 43.07 percent is invested in stocks, 49.56% in bonds, 7.37% in the risk-free rate asset. For those who state that they are mostly invested in bonds, we assume that 1.55% is invested in stocks, 93.3% in bonds, 5.2% in stocks. Government bonds are allocated according to the composition of Italian public debt: 55% short-term bonds, 1% medium-term bonds, 54% long-term bonds.

Pelizzon and Weber then estimate the first and second moments of asset returns. Holding period returns for short term government bonds are computed from the 6-month Treasury Bill rate, assumed to be the risk free rate. For MTGB the holding period returns is a weighted average of holding period returns of medium term government bonds (80%) and corporate bonds (20%). The holding period return of medium term government bonds is derived from the RENDISTAT index assuming a duration of two years. For corporate bonds we use the RENDIOBB index (the index of Italian corporate bonds yields) and a duration of three years. For long term bonds we use the estimated term structure of interest rates and a duration of five years. All returns are net of withholding tax, on the assumption that for most investors other tax distortions are relatively minor (financial asset income in Italy is currently subject to a 12.5% withholding tax). Stocks returns are computed from the MSCI Italy Stock Index total return.

The sample period is 1989-2003, because some assets did not exist prior to 1989. Pelizzon and Weber exploit the convergence process of Italian interest rates to German rates that accelerated dramatically before the introduction of the Euro in January 1999. Using Weighted Least Squares, the early return series are down-weighted more the farther away they are from November 1998, and weight one after November 1998. The weights are a geometrically declining function of the lag operator multiplied by α, with α equal to 0.8. The weighted series is used to compute sample first and second moments reported in Table A2.

9.4 Definition of variables constructed from survey responses

Delegation. Based on question: "Which of the following statements describes better your behavior when you make financial decisions?" (1) I take financial decisions alone, on the basis of information that I collect directly; (2) I use the advise of my bank/financial advisor, but the final decision is mine; (3) I let my bank/financial advisor decide, but I ask to be informed of the decision; (4) I delegate to my bank/financial advisor without asking too much details. The variable delegation is a dummy which equals to 1 if the variable code is 4.

Financial diversification. The variable is the ratio of stocks held in mutual funds and other investment accounts to total stocks (direct plus indirect). The index ranges from 0 to 1.

Income risk. Based on question: over the next 5 years, do you expect your income to: (1) fall significantly; (2) rise significantly; (3) remain unchanged; (4) unable to tell. The dummy equals one for those unable to tell.

Knowledge of financial assets. Investors report knowledge of 10 categories of financial assets by answering the following set of questions: "How well do you think you know the characteristics of [this financial asset]?" Answers are coded as: not at all; little; medium; well; very well.

Risk aversion. Response to the question: "Which of the following statements comes closest to the amount of financial risk that you are willing to take when you make your financial investment?: (1) a very high return, with a very high risk of loosing the money; (2) high return and high risk; (3) moderate return and moderate risk; (4) low return and no risk." As an alternative indicator we use: "With which of the following statements do you agree most? (1) Risk is an uncertain event from which one can extract a profit; (2) Risk is an uncertain event from which one should seek protection."

Time spent in collecting financial information. Response to question: "How much time do you usually spend, in a week, to acquire information on how to invest your savings? (think about time reading newspapers, internet, talk to your financial advisor, etc.). Coded as: no time; less than 30 minutes; between 30 minutes and 1 hour; 1-2 hours; 2-4 hours; 4-7 hours; more than 7 hours.

Trading. Response to question: "How often do you trade financial assets (sell or buy financial assets)?" Coded as: every day; at least once a week; about every two weeks; about every month; about every three months; about every six months; about every year; less than once a year; at maturity; never.

Trust in financial advisor. Response to question: "How much do you trust your financial advisor for your investments?" Coded as: very high, high, medium, low, very low. The variable "Trust in financial advisor" is defined as very high or high.

Figure 1
Information and portfolio Sharpe ratio

The figure plots the relation between investment in information and the portfolio expected Sharpe ratio for the rational investor and for investors with different values of the overconfidence parameter. Calculations are made calibrating the model with the same parameters used by Peress (2004): CRRA utility with relative risk aversion equal to 5, variance of stock returns equal to 2.75%, and equity premium of 6.5%. The relation between the Sharpe ration and information becomes negative when overconfidence is such that the investors perceived standard deviation of stock returns is half its true value.

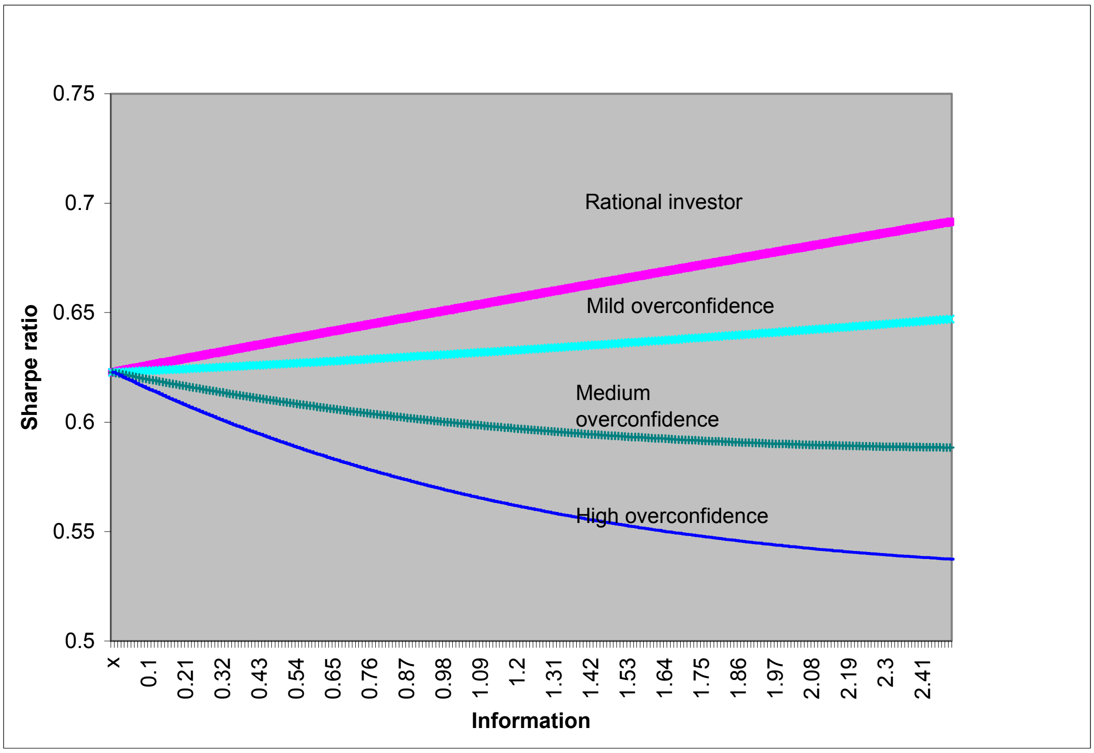

Figure 2
The sample distribution of the Sharpe ratio

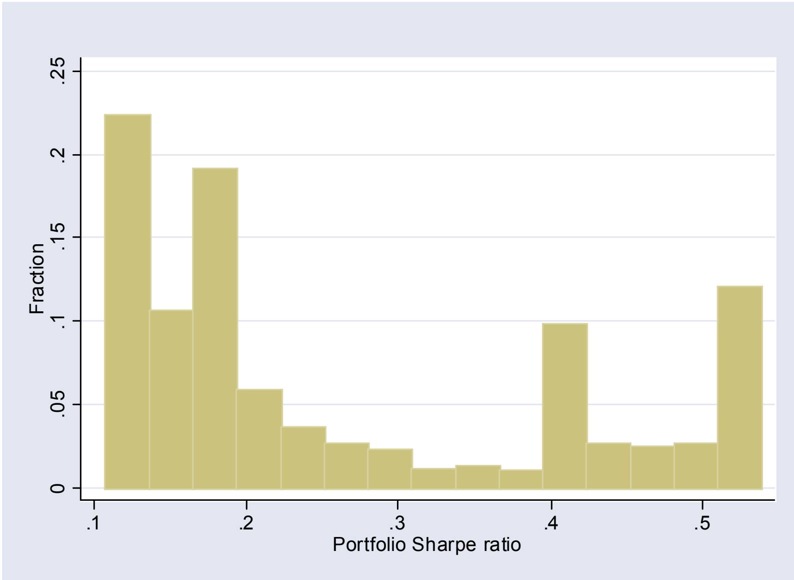

Figure 3
Investment in information and financial wealth

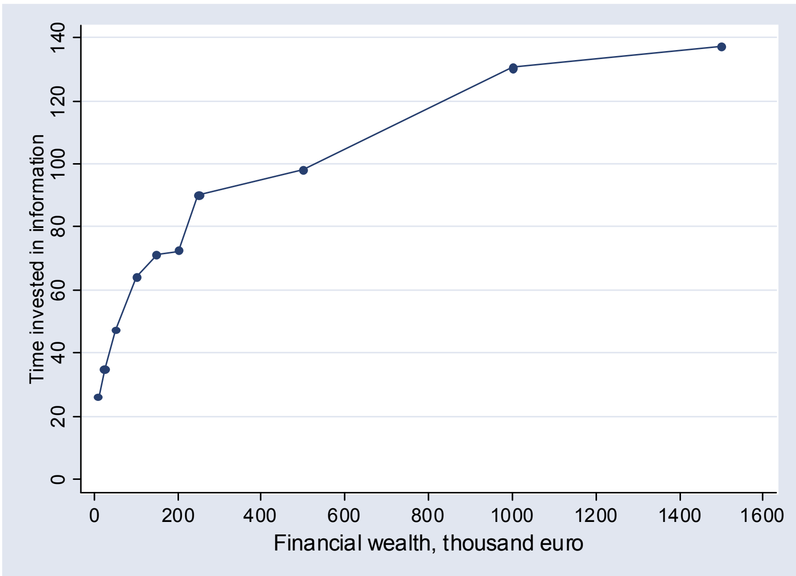

Figure 4
Investment in information and risk aversion

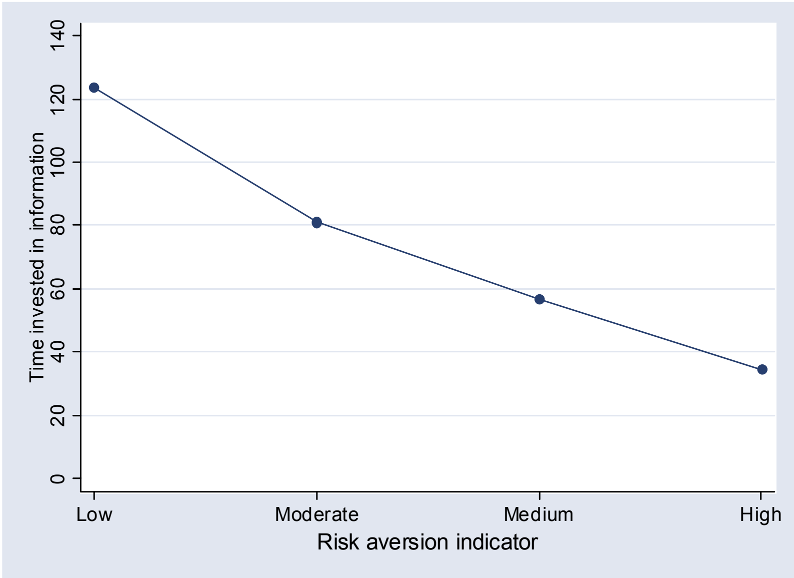

Figure 5
Investment in information and education

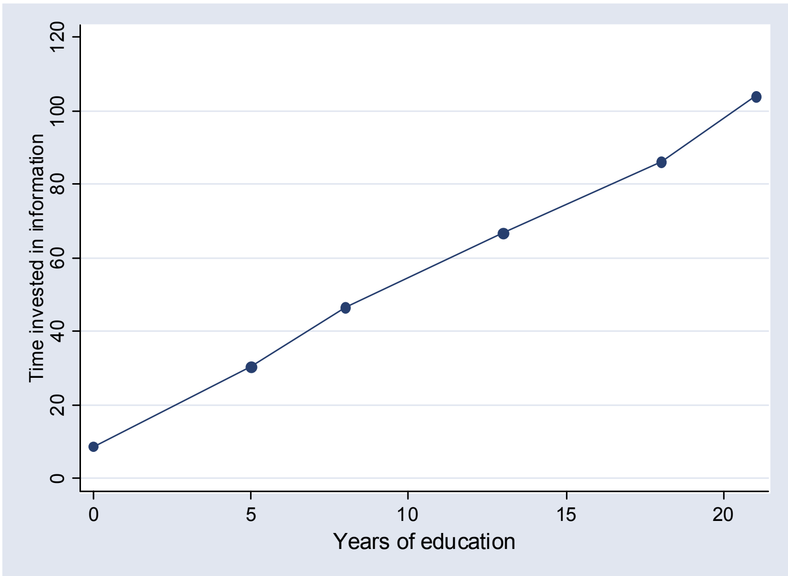

Table 1
Effect of information and risk tolerance on portfolio performance

	Model with rational investors		Model with overconfident investors	
	Effect of information	Effect of risk tolerance	Effect of information	Effect of risk tolerance
Portfolio expected return	+	+	+	+
Portfolio standard deviation	+	+	+	+
Sharpe ratio	+	0	- (more negative if more overconfident)	- (if risk tolerance is correlated with overconfidence)

Table 2
Investment in financial information

The table reports the sample distribution of time spent in financial information in a typical week.

Time spent collecting financial information	*No time*	*Less than 30 minutes*	*30-60 minutes*	*1 to 2 hours*	*2 to 4 hours*	*4 to 7 hours*	*More than 7 hours*
% of investors	36.5	24.8	14.7	10.9	6.5	2.8	3.6
Equivalent number of working days in a year	0	1.5	4.5	8.4	18	33	42
% owning stocks	59.2	82.0	85.2	95.0	93.3	98.1	98.5
% invested in stocks	12.6	21.8	24.2	31.0	35.6	38.0	43.1

Table 3
Summary statistics

The table reports summary statistics for the variables used in the estimation. Means and standard deviations are computed using population weights. See Appendix B for variables' definitions.

	Mean	Standard deviation
Investment in information		
Time spent collecting financial information	2.09	1.36
Financial wealth and portfolio performance		
Respondent's financial wealth ('000 euro)	40.0	170.3
Household's financial wealth ('euro)	90.6	375.4
Expected return of the portfolio	1.02	0.44
Standard deviation of the portfolio	3.69	4.73
Sharpe ratio	0.27	0.15
Share of risky assets in mutual funds (portfolio diversification)	0.58	0.44
Risk aversion, trading and delegation		
Low risk aversion	0.02	0.15
Moderate risk aversion	0.25	0.44
Medium risk aversion	0.47	0.50
High risk aversion	0.25	0.43
Risk is an opportunity	0.26	0.44
Trading activity (trades per month)	0.23	1.14
Delegation of financial decisions	1.88	0.77
Demographic variables		
Age	51.7	15.0
Male	0.68	0.46
Married	0.65	0.47
Living in the North	0.75	0.43
Living in a city	0.51	0.49
Years of education	11.1	4.23

Table 4

Determinants of investment in financial information

Ordered probit estimates for time spent to acquire financial information. The trimmed sample excludes investors who spend more than 7 hours per week. Standard errors are reported in parenthesis. Two stars denote significance at 1% or less; one star significance at 5% or less.

	Total sample				Stockholders only	Trimmed sample
	(1)	(2)	(3)	(4)	(5)	(6)
Financial wealth	0.619	0.548	0.478	0.487	0.334	0.454
	(0.092)**	(0.093)**	(0.094)**	(0.094)**	(0.095)**	(0.099)**
Years of education	0.049	0.056	0.060	0.065	0.052	0.056
	(0.006)**	(0.006)**	(0.006)**	(0.006)**	(0.007)**	(0.007)**
Retired		0.270	0.221	0.189	0.109	0.180
		(0.053)**	(0.054)**	(0.053)**	(0.060)	(0.055)**
Low risk aversion	0.919	0.983	0.972		0.917	0.879
	(0.147)**	(0.148)**	(0.148)**		(0.165)**	(0.157)**
Moderate risk aversion	0.561	0.588	0.567		0.449	0.514
	(0.076)**	(0.076)**	(0.076)**		(0.087)**	(0.078)**
Medium risk aversion	0.356	0.374	0.367		0.285	0.381
	(0.072)**	(0.072)**	(0.072)**		(0.083)**	(0.073)**
Income risk		-0.161	-0.154	-0.161	-0.131	-0.124
		(0.059)**	(0.059)**	(0.059)**	(0.066)*	(0.060)*
Risk is an opportunity				0.152		
				(0.056)**		
Male			0.437	0.451	0.468	0.412
			(0.061)**	(0.060)**	(0.068)**	(0.061)**
Married			0.086	0.088	0.086	0.078
			(0.058)	(0.058)	(0.065)	(0.059)
Resident in the North			0.325	0.314	0.274	0.343
			(0.053)**	(0.052)**	(0.059)**	(0.054)**
Resident in a small city			-0.038	-0.042	-0.012	-0.009
			(0.053)	(0.053)	(0.060)	(0.054)
Observations	1,834	1,834	1,834	1,834	1,419	1,767

Table 5
Sharpe ratio and investment in financial information: total sample

The dependent variable is the Sharpe ratio, computed as the ratio of the portfolio expected excess return and the portfolio standard deviation. Column 1 reports OLS estimates, the other columns the second stage estimates of a Heckman selection model. The IV-Selection adjusted estimates use as instruments dummies for income risk and retirement. The sample includes only those with financial investment. The last column excludes investors who spend more than 7 hours per week in information. Standard errors are reported in parenthesis. Two stars denote significance at 1% or less; one star significance at 5% or less.

	OLS	*Selection adjusted*		*IV-Selection Adjusted*		
	(1)	(2)	(3)	(4)	(5)	(6)
Investment in information	-0.018	-0.017	-0.016	-0.079	-0.052	-0.057
	(0.002)**	(0.003)**	(0.003)**	(0.021)**	(0.020)**	(0.020)**
Male			-0.015	0.019	0.008	0.004
			(0.010)	(0.016)	(0.015)	(0.013)
Married			-0.007	-0.013	-0.011	-0.014
			(0.009)	(0.011)	(0.010)	(0.010)
Resident in the North			-0.003	-0.015	-0.016	-0.015
			(0.008)	(0.010)	(0.009)	(0.009)
Resident in a small city			0.003	0.006	0.006	0.010
			(0.008)	(0.009)	(0.009)	(0.009)
Low risk aversion					-0.078	-0.102
					(0.029)**	(0.028)**
Moderate risk aversion					-0.078	-0.082
					(0.013)**	(0.013)**
Medium risk aversion					-0.046	-0.045
					(0.012)**	(0.013)**
Mills ratio		0.006	0.003	-0.217	-0.149	-0.132
		(0.017)	(0.018)	(0.076)**	(0.071)*	(0.054)*
Sargan test				1.311	0.876	1.065
p-value				(0.252)	(0.349)	(0.302)
F-test for excluded instruments				16.01	13.73	23.04
Observations	1,365	1,780	1,780	1,780	1,780	1,780

Table 6
Sharpe ratio and investment in financial information:
sample of clients with only one bank relation

The dependent variable is the Sharpe ratio, computed as the ratio of the portfolio expected excess return and the portfolio standard deviation. The sample is restricted to households that have accounts with only one bank. Column 1 reports OLS estimates, the other columns the second stage estimates of a Heckman selection model. The IV-Selection adjusted estimates use as instruments dummies for income risk and retirement. The sample includes only those with financial investment. The last column excludes investors who spend more than 7 hours per week in information. Standard errors are reported in parenthesis. Two stars denote significance at 1% or less; one star significance at 5% or less.

	OLS	*Selection adjusted*		*IV-Selection Adjusted*		
	(1)	(2)	(3)	(4)	(5)	(6)
Investment in information	-0.011	-0.018	-0.018	-0.033	-0.027	-0.029
	(0.003)**	(0.003)**	(0.003)**	(0.010)**	(0.010)**	(0.012)*
Male			-0.005	0.004	0.001	0.005
			(0.009)	(0.011)	(0.011)	(0.011)
Married			-0.025	-0.028	-0.028	-0.031
			(0.009)**	(0.009)**	(0.009)**	(0.009)**
Resident in the North			-0.015	-0.019	-0.019	-0.022
			(0.008)	(0.009)*	(0.009)*	(0.009)*
Resident in a small city			0.002	0.004	0.003	0.004
			(0.008)	(0.008)	(0.008)	(0.008)
Low risk aversion					-0.037	-0.039
					(0.026)	(0.027)
Moderate risk aversion					-0.036	-0.036
					(0.012)**	(0.012)**
Medium risk aversion					-0.031	-0.033
					(0.011)**	(0.011)**
Mills ratio		-0.104	-0.122	-0.170	-0.162	-0.167
		(0.019)**	(0.020)**	(0.036)**	(0.036)**	(0.034)**
Sargan test				0.001	0.024	0.000
p-value				(0.980)	(0.877)	(0.996)
F-test for excluded instruments				18.04	15.73	23.04
Observations	914	914	914	914	914	868

Table 7
Financial information, excess return and standard deviation of the portfolio

OLS estimates of the relation between the portfolio expected return (columns 1-3) and standard deviation (columns 4-6) and investment in financial information. Standard errors are reported in parenthesis. Two stars denote significance at 1% or less; one star significance at 5% or less.

	Excess return			*Standard deviation*		
	(1)	(2)	(3)	(4)	(5)	(6)
Investment in information	0.135	0.127	0.115	0.999	0.938	0.823
	(0.008)**	(0.008)**	(0.008)**	(0.068)**	(0.070)**	(0.070)**
Male		-0.006	-0.011		0.290	0.238
		(0.031)	(0.031)		(0.261)	(0.258)
Married		0.031	0.031		0.191	0.195
		(0.030)	(0.030)		(0.252)	(0.248)
Resident in the North		0.171	0.182		0.736	0.846
		(0.027)**	(0.027)**		(0.226)**	(0.223)**
Resident in a small city		-0.094	-0.093		-0.669	-0.659
		(0.027)**	(0.027)**		(0.225)**	(0.221)**
Low risk aversion			0.304			3.616
			(0.079)**			(0.653)**
Moderate risk aversion			0.221			2.045
			(0.039)**			(0.320)**
Medium risk aversion			0.141			1.182
			(0.036)**			(0.299)**
Observations	1,780	1,780	1,780	1,780	1,780	1,780

Table 8
Sharpe ratio and in financial information: sample splits by overconfidence

Selectivity adjusted estimates of the relation between investment in information and the Sharpe ratio for various sample splits. The first stage probit of the two-stage Heckman estimator includes investment in information, financial wealth linear and square, three dummies for risk tolerance, education and demographics. Low and high knowledge of stocks split the sample between those who report knowing very well or well stocks, and those who don't. The sample includes only people with financial investment. Standard errors are reported in parenthesis. Two stars denote significance at 1% or less; one star significance at 5% or less.

	Low knowledge of stocks (1)	*High knowledge of stocks* (2)	*Women* (3)	*Men* (4)
Investment in information	-0.006	-0.013	-0.009	-0.016
	(0.007)	(0.003)**	(0.006)	(0.003)**
Male	-0.025	-0.003		
	(0.016)	(0.012)		
Married	0.012	-0.015	-0.008	-0.003
	(0.016)	(0.011)	(0.016)	(0.011)
Resident in the North	-0.012	0.006	-0.038	0.011
	(0.016)	(0.010)	(0.017)*	(0.010)
Resident in a small city	-0.004	0.003	0.013	-0.000
	(0.015)	(0.010)	(0.016)	(0.009)
Mills ratio	0.014	0.012	0.041	0.007
	(0.029)	(0.026)	(0.029)	(0.022)
Observations	482	883	376	989

Table 9
Trading and investment in information

The table reports OLS estimates of frequency of trading, measured as number of trades per year. Low and high knowledge of stocks split the sample between those who report knowing very well or well stocks, and those who don't. The sample includes people with financial investment. Standard errors are reported in parenthesis. Two stars denote significance at 1% or less; one star significance at 5% or less.

	Total sample *(1)*	Low knowledge of stocks *(2)*	High knowledge of stocks *(3)*	Women *(4)*	Men *(5)*
Investment in information	9.994	2.366	11.659	3.763	11.588
	(0.899)**	(0.823)**	(1.311)**	(1.381)**	(1.099)**
Male	0.557	1.170	-1.177		
	(3.440)	(2.244)	(5.470)		
Married	1.975	1.579	3.574	2.851	0.595
	(3.302)	(2.241)	(5.138)	(3.821)	(4.526)
Resident in the North	-0.650	-0.460	-0.961	6.537	-2.960
	(2.952)	(2.067)	(4.500)	(3.955)	(3.759)
Resident in a small city	-7.475	0.173	-10.368	-8.146	-6.558
	(2.909)*	(2.029)	(4.467)*	(3.852)*	(3.731)
Low risk aversion	15.278	-0.487	16.081	0.061	19.705
	(8.304)	(6.641)	(12.347)	(11.107)	(10.602)
Moderate risk aversion	2.996	-0.718	2.276	8.316	0.143
	(4.327)	(2.793)	(7.398)	(5.460)	(5.659)
Medium risk aversion	-2.454	2.548	-5.226	-0.961	-3.264
	(4.129)	(2.486)	(7.293)	(4.990)	(5.465)
Observations	1,421	521	900	389	1,032

Table 10
Delegation and investment in information

Ordered probit estimates of willingness to delegate financial decisions. The dependent variable is a categorical variable measuring the degree of delegation of financial decisions to financial advisors, banks or brokers. Delegation is a categorical variable ranging from 1 (investors decide alone and don't delegate) to 4 (investors let financial advisors/banks decide without asking details). Standard errors are reported in parenthesis. Two stars denote significance at 1% or less; one star significance at 5% or less.

	Total sample (1)	*Low knowledge of stocks* (2)	*High knowledge of stocks* (3)	*Women* (4)	*Men* (5)
Investment in information	-0.047	-0.024	-0.062	-0.025	-0.057
	(0.018)*	(0.037)	(0.023)**	(0.039)	(0.021)**
High trust in advisor	1.047	0.870	1.228	0.996	1.081
	(0.074)**	(0.108)**	(0.104)**	(0.137)**	(0.089)**
Medium trust in advisor	0.586	0.197	1.031	0.667	0.561
	(0.097)**	(0.139)	(0.141)**	(0.187)**	(0.115)**
Financial wealth	0.431	1.031	0.375	0.387	0.443
	(0.102)**	(0.316)**	(0.117)**	(0.192)*	(0.121)**
Low risk aversion	-0.661	-0.292	-0.903	-0.229	-0.820
	(0.166)**	(0.289)	(0.219)**	(0.315)	(0.198)**
Moderate risk aversion	-0.302	-0.258	-0.410	-0.056	-0.400
	(0.080)**	(0.112)*	(0.124)**	(0.145)	(0.096)**
Medium risk aversion	-0.201	-0.140	-0.322	-0.178	-0.219
	(0.074)**	(0.098)	(0.120)**	(0.131)	(0.090)*
Years of education	-0.021	-0.035	-0.005	-0.042	-0.010
	(0.007)**	(0.010)**	(0.010)	(0.012)**	(0.008)
Male	-0.163	-0.179	-0.117		
	(0.063)**	(0.089)*	(0.092)		
Married	-0.035	-0.082	-0.005	-0.164	0.038
	(0.061)	(0.088)	(0.087)	(0.101)	(0.078)
Resident in the North	0.146	0.105	0.192	0.087	0.188
	(0.056)**	(0.083)	(0.078)*	(0.103)	(0.067)**
Resident in a small city	-0.181	-0.353	-0.004	-0.284	-0.128
	(0.056)**	(0.083)**	(0.079)	(0.104)**	(0.067)
Observations	1,834	805	1,029	530	1,304

Table 11
Diversification and investment in information

The table reports Tobit estimates of the effect of investment in information on portfolio diversification. The dependent variable is the share of stocks held indirectly in the form of managed investment accounts and stock mutual funds on total stocks (directly plus indirect). The sample includes people with financial investment. Standard errors are reported in parenthesis. Two stars denote significance at 1% or less; one star significance at 5% or less.

	Total sample	*Low knowledge of stocks*	*High knowledge of stocks*	*Women*	*Men*
	(1)	(2)	(3)	(4)	(5)
Investment in information	-0.046	-0.008	-0.038	-0.031	-0.048
	(0.009)**	(0.020)	(0.011)**	(0.021)	(0.010)**
High trust in advisor	0.155	0.020	0.186	-0.027	0.193
	(0.042)**	(0.077)	(0.049)**	(0.101)	(0.046)**
Medium trust in advisor	0.128	0.030	0.137	0.056	0.138
	(0.056)*	(0.098)	(0.067)*	(0.133)	(0.062)*
Financial wealth	0.141	0.139	0.154	0.154	0.136
	(0.045)**	(0.098)	(0.050)**	(0.089)	(0.052)**
Low risk aversion	-0.210	-0.206	-0.137	-0.059	-0.264
	(0.085)*	(0.174)	(0.099)	(0.167)	(0.099)**
Moderate risk aversion	-0.167	-0.115	-0.109	-0.026	-0.214
	(0.046)**	(0.071)	(0.061)	(0.089)	(0.054)**
Medium risk aversion	-0.106	-0.128	-0.047	-0.055	-0.123
	(0.044)*	(0.063)*	(0.060)	(0.081)	(0.052)*
Years of education	0.005	0.001	0.013	0.004	0.005
	(0.004)	(0.006)	(0.004)**	(0.007)	(0.004)
Male	0.035	0.021	0.052		
	(0.036)	(0.056)	(0.045)		
Married	-0.071	0.005	-0.096	-0.031	-0.096
	(0.033)*	(0.055)	(0.041)*	(0.060)	(0.041)*
Resident in the North	0.041	0.062	0.037	0.034	0.036
	(0.031)	(0.053)	(0.037)	(0.064)	(0.035)
Resident in a small city	0.042	0.030	0.037	0.040	0.040
	(0.031)	(0.051)	(0.037)	(0.061)	(0.035)
Observations	1,172	369	803	297	875

Table 12
Trading, delegation, diversification, and the Sharpe ratio

The table reports two-stage selectivity adjusted estimates of the effect of trading, willingness to delegate financial decisions, and stock market diversification on the Sharpe ratio. Trading is measured as number of trades per month. Delegation of financial decisions is a categorical variable ranging from 1 (investors decide alone and don't delegate) to 4 (investors let financial advisors/banks decide without asking details). Stock market diversification is the share of stocks held indirectly on total stocks. The first stage regression includes the variables in the second sage, plus financial wealth (linear and square), dummies for risk aversion, age and education. The sample includes people with financial investment. Standard errors are reported in parenthesis. Two stars denote significance at 1% or less; one star significance at 5% or less.

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Trading	-0.008	-0.005				
	(0.002)**	(0.002)*				
Delegation			0.015	0.007		
			(0.006)*	(0.006)		
Diversification					0.102	0.097
					(0.009)**	(0.009)**
Investment in information		-0.013		-0.015		-0.006
		(0.003)**		(0.003)**		(0.003)*
Male	-0.024	-0.015	-0.024	-0.015	-0.004	-0.001
	(0.010)*	(0.010)	(0.010)*	(0.010)	(0.009)	(0.009)
Married	-0.012	-0.012	-0.007	-0.007	-0.010	-0.011
	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Resident in the North	-0.001	0.001	-0.006	-0.004	0.005	0.004
	(0.009)	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)
Resident in a small city	-0.000	-0.001	0.005	0.003	-0.007	-0.006
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Mills ratio	0.052	0.020	0.032	0.010	0.008	-0.008
	(0.033)	(0.036)	(0.016)*	(0.019)	(0.014)	(0.016)
Observations	1,401	1,401,	1,780	1,780	1,587	1,587

Table A1
Asset classification

The table reports the reclassification of the assets in the UPS in three asset groups: risk-free, medium term government bonds (MGTB), and long-term government bonds (LTGB).

	Fraction with positive amount of the asset	*Reclassified asset category in the UPS*
Bank accounts	94.1	Risk-free
Repurchase agreements	4.9	Risk-free
Certificate of deposits	7.9	MTGB
Government bonds	28.8	Risk-free, MTGB, LTGB
Corporate bonds	27.7	MTGB
Derivatives	2.9	Stocks
Shares of listed companies	39.4	Stocks
Shares of unlisted companies	3.1	Stocks
Mutual funds	41.4	MTGB, stocks, risk-free
Managed investment accounts	23.3	MTGB, stocks, risk-free

Table A2
Excess returns, standard deviations and correlation matrix

The table reports excess returns, standard deviation, and correlation matrix of medium term government bonds (MGTB), long-term government bonds (LTGB) and stocks. The return on the risk-free asset is 0.9275 percent.

	LTGB	*MTGB*	*Stocks*
Excess return (%)	1.7402	0.9449	2.1789
Standard deviation (%)	4.2711	2.1547	20.2309
Correlation matrix	1	0.9476	-0.1940
		1	-0.1266
			1

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