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PORTFOLIO DIVERSIFICATION: AN EXPERIMENTAL STUDY

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Abstract

The paper analyses on an experimental basis the phenomenon of non-optimal under-diversification in portfolio choice decisions and investigates the reasons behind it. The most important obstacles for optimal diversification are studied – the correlation neglect hypothesis and the overconfidence which both lead to suboptimal diversification decisions. The investment alternatives are constructed in a way that the Markowitz' efficiency frontier is reduced to a single point in the return-risk diagram so that unambiguous interpretation of the results is possible: the subjects neglect the correlation between the assets, use naïve diversification strategies and take irrelevant information as a foundation for their investment decisions, the first effect being stronger than the second.

Keywords: *experimental economics; portfolio choice; investment decisions; correlation neglect; overconfidence*

JEL-Classification: C91, D81, G11

1 Introduction

The question of optimal portfolio choice is a very important one – for investment bankers dealing with billions of dollars as well for private investors securing their retirement income. Investment decision of both experienced and novice investors are often far from optimal and often made on a basis of simple rules and heuristics, see for example (Benartzi/Thaler (2007)), which is especially true for inexperienced private investors. One of the most severe problems is the lack of diversification which leads to suboptimal portfolio choices, higher welfare costs and overall instability of financial markets (see Brennan/Torous (1999)). Lots of studies address the lack of diversification of individual investors[1], with special attention being paid to the investment strategies of individuals in their pension saving plans[2]. De Bondt (1998) characterizes the individual investor as a person who discovers naïve patterns in past price movements, trades in suboptimal ways and does not diversify properly. The finding of non-optimal diversification is confirmed in both field and experimental studies (Goetzmann/Kumar (2001; Goetzmann/Kumar (2007), Benartzi/Thaler (2001), Fox/Bardolet et al. (2005), Guiso/Jappelli (2007)). The resource concentration heuristics include, for example, investments in employer stock (which may be correlated with the labour income), or investments in national or regional companies. On the other hand, psychological studies and consumer choice research show that individuals tend to seek variety, especially when under uncertainty (Fox/Bardolet et al. (2005), Fox/Ratner et al. (2005)) and allocate their resources according to a naïve diversification strategy ($1/n$ heuristic). How can this contradiction – the lack of diversification on the one hand and the search for variety on the other – be explained? One possibility is that in the case of complete uncertainty a naïve diversification strategy is used. As individuals tend to be averse to uncertainty, they prefer some information to no information and as soon as some information (not necessarily relevant) is available, it is used to justify resource concentration, which is not always optimal, for several reasons. Either the information is not enough to base the investment decision upon or the processing of the available information is not always correct due to cognitive limits, informational capacities etc. This leads to false (diversification) decisions.

How can sub-optimal diversification be explained? Along with institutional factors (see for example French/Poterba (1991)) there are behavioural factors which lead to under-

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[1] See for example Lease/Lewellen et al. (1974), Blume/Friend (1975), Bode/Echelpoel et al. (1994), Kelly (1995), Schiereck/Weber (2000)

[2] See for example Benartzi (2001), Benartzi/Thaler (2001), Agnew/Balduzzi et al. (2003), Meulbroek (2005), Huberman/Sengmueller (2004), Goetzmann/Kumar (2008)

diversification. These are the subject of this paper. The most interesting point is whether the correlation between the investment alternatives is properly evaluated and considered. As the diversification gains are based solely on incomplete correlation between the assets (see Markowitz (1952)), it is crucial for an investor to be able to correctly estimate it and incorporate it into the decision making process. Or, generally speaking, does more information about the investment alternative lead to better portfolios? As the correlation is the most relevant information for the diversification decision, it is interesting to also address the information which is completely irrelevant for the choice of portfolio and to study the behavioural response of the individuals to it.

The question of whether individuals are able to recognize correlation has been widely addressed by psychologists (see Shanks (2004) for a review). A study for testing the influence of correlation on diversification decision has been conducted by Hedesstrom/Svedsater et al. (2006), who propose covariance neglect as a possible source for non-optimal diversification. According to the study, subjects tend not only to under-diversify their portfolios, but also to engage in too much diversification using naïve diversification heuristics in the cases where diversification is not desirable, e.g. when assets are fully correlated. The conclusion of the paper identifies several behavioural types – rational investors who diversify in the non-correlated treatments and do not in the correlated ones, and different types of irrational investment behaviour. However, their psychological experimental study does not include economic incentives and risk elicitation of the subjects. Besides, the formulation of the tasks is not clear enough. Our experiment is designed in such a way as to eliminate these shortcomings.

The other source of sub-optimality lies in the overconfidence of investors. Individuals tend to misinterpret additional information and discover patterns in the data which do not exist; see for example De Bondt (1998). Moreover, the more information they acquire, the worse portfolio choices they make Guiso/Jappelli (2007).

In the paper we ask how individuals diversify in the presence of the most relevant information about the investment alternatives (correlation between the assets) and the least relevant information (past performance) in their portfolio choice decisions. These questions test the covariance neglect hypothesis and the overconfidence of investors in the evaluation of additional information.

The rest of the paper is organized as follows: in section 2 we suggest an experimental setting to investigate individual behaviour. Experimental results are presented and discussed in section 3. Section 4 concludes.

2 Experimental design

The study of Hedesstrom/Svedsater et al. (2006) is a psychological one; the investment task presented in the study is to "imagine that they should invest a sum of money for the period of 10 years". No incentive was made for choosing a "better" portfolio. The subjects are assumed to be risk averse, without any risk elicitation procedure. Our experiment is designed in such a way that better performance of the portfolio is directly connected to the payoff and that the risk preferences are taken into account and the investment tasks are simple, clear and informative.

The study of Guiso/Jappelli (2007) concerning informational acquisition and portfolio performance offers interesting findings based on field data. Inherent to field data is the fact that it is generated in an uncontrolled environment and therefore has some shortcomings. The problem that unobserved factors (like ability) affect both portfolio performance and the acquisition of information is addressed with an instrumental variable option, but is not solved in a satisfactory way. The only possibility to test the performance is to conduct an experiment testing whether it is the lack of ability or the additional information which leads to worse portfolio choice. This problem is actually a question of causality – the more information, the lower the performance, or is it a reverse one – lower performance of an investor leads to him/her having a higher demand for information?

The other problem of this study comparing different portfolios on the basis of the Sharpe ratio is that this performance indicator cannot unambiguously make a distinction between an optimal portfolio and non-optimal one. A portfolio with a lower Sharpe ratio can be still rational if the risk preference of the investor is taken into account. The problem of risk preferences of the investors is not discussed – it is possible that the overconfident investors are risk-seeking and therefore prefer portfolios with lower Sharpe ratios.

The main focus of our experimental study lies on these two factors (covariance and overconfidence) possibly explaining the phenomenon of under-diversification. The above-mentioned studies motivate two hypotheses for our experimental study:

1. Subjects recognize the correlation between the assets and invest according to their risk preferences.
2. Subjects are not affected in their decision making by explicitly irrelevant information.

In order to obtain picture of investment behaviour which is as clear as possible, we designed an experiment which clearly states the correlation between the investment alternatives and offers additional information. This leads to three questions which need to be answered – how the

investment alternatives should be constructed, how the correlation between the assets is modelled and how the question about overconfidence/additional information is to be treated.

We introduce two types of investment alternatives: non-correlated and fully correlated assets. In both cases any combination of the investment alternative yields the same return. The only difference between the portfolios is the portfolio risk, measured as the variance in dividend payments. The investment alternatives are constructed in such a way that the Markowitz' efficiency frontier is reduced to a single point (*A*) in the risk/return diagram, which means that the given combination of the investment alternatives has a (second-order) stochastic dominance over all other alternatives. The risk-return diagrams for both non-correlated and correlated investment alternatives are depicted in Figure 1. In the case of non-correlated alternatives (Figure 1a) the complete diversification (an even split of the resources among the two equities x_1 and x_2) is the only rational decision for a risk-averse investor. In the case of correlated alternatives, shown in Figure 1b, the only rational decision for a risk-averse subject is to invest solely in the less risky alternative x_1. Since all distribution parameters except the variance are the same, the given choice is rational for all levels of risk aversion, and for all forms of subjects' indifferent curves, represented as dashed lines. Such a construction enables clear interpretation of the experiment's results.

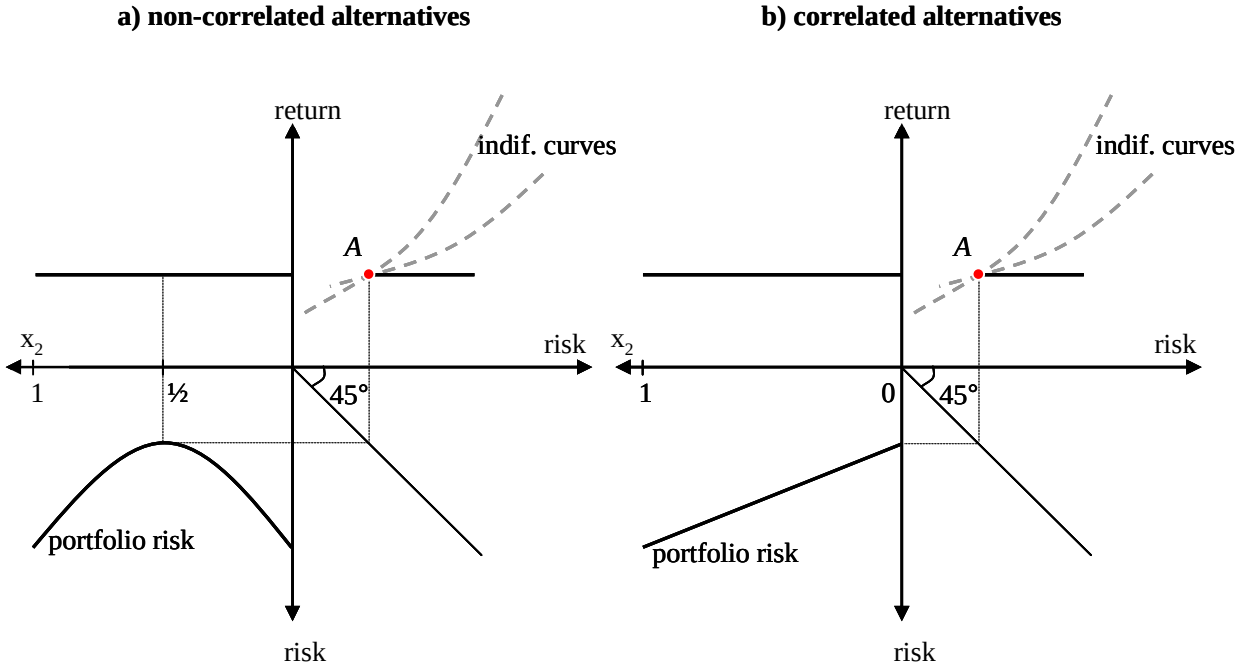

Figure 1. Risk-return diagrams for a) non-correlated alternatives and b) correlated alternatives

The overconfidence of the economic subjects can be modelled in as additional information which can be represented in the form of the dividend history of the investment alternatives.

Although the presentation of the dividends in the last 10 years does not contain any additional relevant information, it could influence the decision-making of the subjects. The subjects tend to misinterpret the information, even if they did not obtain it deliberately but just happened to have it, so their overconfidence is based not on the overestimation of their own ability to obtain and interpret information, but on an unconscious feeling of security when making decisions based on more information.

The experiment is built as a simple portfolio choice task: subjects have the possibility to choose 4 equities out of two available types. In each treatment they have two different investment alternatives and have to decide which and how many equities they would like to have in their portfolio. So they have five possibilities to build the portfolio, ranging from all four equities being of the same equity or any mix of the two investment alternatives. The incentive is provided in the form of dividends of the equities which they yield in the current year. The price development of the stocks does not play any role for the determination of the payoff. The experimental task is designed in a way that any long term considerations are eliminated and the only incentives are the dividends of the single period. Along with the information about the payoff calculation, the subjects are given different sorts of additional information depending on the treatment.

In order to test the hypotheses formulated, the experiment has two treatment variables: "correlation" and "history", where "correlation" is dependence between two investment alternatives and "history" is additional information for the investors. There are four treatments, as Table 1 indicates. In order to eliminate possible order effects the four treatments are conducted in the reverse order in two groups – one group with 1-2-3-4 and the other group with 4-3-2-1.

	correlation	no correlation
history	1	2
no history	4	3

Table 1. Experimental design

The payoff of the subjects depends on the performance of the portfolio they choose. The investment alternatives are constructed in a such way that there is only one rational decision for a risk-averse subject. The experimental design allows the identification of the effect on portfolio performance of correlation between investment alternatives as well as of additional (irrelevant) information about the investment alternatives. Now we would like to present the experimental modelling of these two parameters.

<u>"Correlation"</u>

The *correlated* investment alternatives are represented as two dependent equities of the same industry, with two possible dividend payments: high and low, with 50% probability each. The high/low dividend payment means 4/0 euros for the first equity and 3/1 euros for the second respectively. Any possible combination of the two stocks yields the same expected return, 8 euros. As the variance in the dividend payments of the first equity is very high, the portfolio variance grows with the number of the first equity in the portfolio (see Table 2).

		Portfolio performance				
	Number of the first equity in the portfolio	0	1	2	3	4
correlation condition	expected dividend payment	8	8	8	8	8
	variance in the "correlation" condition	**16**	25	36	49	64
no correlation condition	expected dividend payment	4	4	4	4	4
	variance in the "no correlation" condition	16	8.8	**6.4**	8.8	16

Table 2. Portfolio performance in the "correlation" and "no correlation" conditions

The *non correlated* investment alternatives are represented as two independent equities with only two possible dividend payments: 0 and 2 euros, with 50% probability each. The subjects have the possibility to obtain 4 equities and decide how many of each kind they take. Again, any combination of the two stocks yields the same expected return, 4 euros. In contrast to the correlation condition, where the dividend performance of one equity has a higher variance, there is no difference between the "first" and the "second" equity in the non-correlation condition and this labelling can be used interchangeably for both equities. The only difference is made by the portfolio variance – it is lowest if the resources are spent evenly between the two equities (see Table 2).

The information about the possible outcomes and their probabilities as well as about the dependence/independence of the investment alternatives is given to the subjects so that they can easily calculate the portfolio performance indicators. A rational risk-averse subject would prefer the portfolio with least variance. All other choices are either risk-seeking behaviour or irrational.

The correlation between the investment alternatives is the only factor determining the portfolio performance. The second treatment variable, "history" is only additional irrelevant information which does not affect the portfolio performance, as dividend payment is a random process with 50% for high or low values.

<u>"History"</u>

The additional information used to test the overconfidence of the investors is presented in the form of the dividend payments history for the last ten years. The histories presented are sections of random sequences with a target mean of 2 euros (correlated equities) or 1 euro (non-correlated

equities). The sequences of dividend payments for correlated equities are presented in Table 3. The dividend history of the uncorrelated equities is presented in Table 4. The question marks indicate that the dividend payment for the year 2009 has not yet been defined and represents the monetary incentive in the experiment. The information about the past dividend payments is given to the subjects in the "history" condition in addition to the information of the "no history" condition. In the "no history" condition the subjects do not have the information about past dividend payments. In both treatments the subjects are informed about the random nature of the dividend payment process and its probabilities.

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
first equity	4 €	0 €	4 €	0 €	0 €	0 €	4 €	4 €	0 €	4 €	?
second equity	3 €	1 €	3 €	1 €	1 €	1 €	3 €	3 €	1 €	3 €	?

Table 3. Dividend payment history in the correlation treatment

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
first equity	0 €	0 €	2 €	0 €	0 €	0 €	2 €	2 €	2 €	2 €	?
second equity	0 €	2 €	2 €	2 €	0 €	2 €	0 €	0 €	2 €	0 €	?

Table 4. Dividend payment history in the non-correlation treatment

As the sequence of the past dividend payments contains no relevant additional information, the presentation of the sequence should not affect the choices of the subjects.

Risk elicitation

After the subjects have completed the treatments a risk elicitation procedure is introduced to them. Risk elicitation is not conducted beforehand because the experimental results could be influenced by this procedure. The risk elicitation is made according to the study of Holt/Laury (2002). The subjects have to decide which lottery (A or B) they prefer in 10 different cases. A randomly selected lottery is drawn at the end and the choice of the subject is the basis for the payoff. This strategy method allows testing for risk aversion – the more "A" choices a subject makes, the more risk averse he/she is. 4 "A"s are a sign for risk neutrality, numbers above this indicate risk aversion, while numbers below indicate risk-seeking behaviour.

After all treatments and the risk elicitation procedure the dividends for the year 2009 are determined. As the dividends are random, a coin is tossed in front of the subjects to determine how high the dividends are. A short questionnaire has to be completed after the experiment. After that the payoffs are calculated and paid.

To summarize the experimental design, the experiment consists of the following steps: introduction; four treatments, sequentially; risk elicitation; lottery for risk elicitation; dividend determination; a questionnaire about some demographic and personal characteristics; payment. The full instructions of the experiments are presented in the appendix.

3 Experimental results

The experiment was conducted at the University of Göttingen with 47 participants who were randomly assigned to the two groups, 23 in the first one and 24 in the second one. 32 participants are economics students, 15 are students of social sciences, and all of them have some economic background or are expected to be familiar with the theory of optimal diversification.

After the experiment a risk elicitation procedure was conducted and 40 out of 47 participants (20 in each group) were identified as risk-averse individuals, choosing more than 4 A's in the lottery choice. According to the choice structure of the portfolios it is only risk-averse individuals who should choose the least risk alternative. Therefore, only risk averse individuals are analyzed in the following section. The mean payoff in the experiment was 24.60 euros for approximately 90 minutes of participation.

The analysis of portfolio performance could be based on different criteria. The investment alternatives are designed in a way which allows a comparison of the portfolios according to the variance – because the expected dividends of the alternative portfolios are the same – which is used for the analysis of the portfolio choice in this section. The following table shows the mean portfolio variance in both groups and in total for all of the 4 decisions. The first column indicates the decision number: The decision order in the first group was 1-2-3-4, in the second group it was 4-3-2-1. The second and the third column represent the hypothetical mean portfolio variance if the choices of the participants were a) random (second column) or b) rational (third column). The actual mean portfolio variance is shown in the following columns: for the first group, for the second group and for both groups. The test for the difference between the actual and the random/rational decision making is represented in the form of stars. For example, three stars after a) mean that the actual mean portfolio variance differs significantly (0.01 level) from random decision making. No stars after b) mean that the actual portfolio variance in that decision is not statistically different from rational decision making. The significance test is the Wilcoxon signed rank test.

decision	hypothetical random choices a)	hypothetical rational choices b)	actual choices group 1	actual choices group 2	actual choices both groups
1	38.0	16.0	27.45 a)*** b)***	26.9 a)*** b)***	27.175 a)*** b)***
2	11.2	6.4	6.88 a)*** b)**	7.72 a)*** b)***	7.30 a)*** b)***
3	11.2	6.4	6.52 a)*** b)	6.88 a)*** b)	6.70 a)*** b)
4	38.0	16.0	27.00 a)*** b)***	26.1 a)*** b)***	26.55 a)*** b)***

Significance levels: 1% ***, 5% **, 10%*; the a) index in the "actual choices" – columns indicates the significance of the difference to the a)-column of the hypothetical random choice; the b) index indicates the significance of the difference to the b)-column of the hypothetical rational choice

Table 5. Mean portfolio variance: hypothetical and actual decision making

The table shows that the decision making of the participant in all treatments is significantly different from the random decision making. The hypothesis of rational behaviour can also be rejected in the decisions 1, 2 and 4. The decision making in the third decision (no correlation, no history) is not significantly different from rational behaviour. So we can state that the choices of the participants are not random. And in the absence of irrelevant information the subjects diversify their portfolio, though it is not clear enough whether this means rationality or only a naïve diversification strategy.

In the following table the mean portfolio variance of both groups for different treatments is presented (second and third column) and the hypotheses of the equality of the medians of the groups cannot be rejected (see the p-value in the last column). Both groups can be considered together as there is no significant order effect between the groups among all treatments.

Decision	Group 1	Group 2	p-value
1	27.45	26.9	0.8794
2	6.88	7.72	0.1594
3	6.52	6.88	1.0000
4	27.0	26.1	0.6248
1+2 ("history")	17.165	17.31	0.6987
3+4 ("no history")	16.76	16.49	0.8897
1+4 ("correlation")	27.225	26.500	0.6423
2+3 ("no correlation")	6.7	7.3	0.2177
Total	16.9625	16.9000	0.8598

Table 6. Group comparison: order effect

There are also no learning effects to be found. If there were some learning or experience effects, the first group should do better in decision 4 compared to decision 1 and in decision 3 compared to decision 2. The reverse order effects should be applicable to the second group. In Table 7 the statistical analysis of this problem is represented. Whereas in the first group some positive effect can be observed (which is still insignificant), the portfolio variance rises after repetition in the second group (insignificant as well).

	Mean portfolio variance	
Comparable decisions	Group 1	Group 2
1	27.45	26.9
4	27.0	26.1
p-value of the difference, matched pairs	0.617	0.474
2	6.88	7.72
3	6.52	6.88
p-value of the difference, matched pairs	0.149	0.091

Table 7. Mean portfolio variance and learning effects

As there are no differences between the groups and no learning effect within the groups, the hypothesis test can be made on the basis of the whole set of (risk averse) subjects.

The statistical comparative analysis of the two groups shows that no matter whether the subjects get the irrelevant additional information at the beginning of the experiment or later, it does not affect their investment behaviour. The order change of the correlation in the decision tasks produces no significant differences. Overconfidence thus exists even if the subjects start with only relevant information and make better investment decisions and the irrelevant information is introduced afterwards.

Hypothesis test: Correlation neglect

The decisions with and without correlation are not comparable in terms of portfolio variance: the portfolio variance in the "no correlation" condition ranges from 6.4 to 16, whereas in the "correlation" condition it ranges from 16 to 64. Comparability can be achieved if we recode the values of the variance in the different levels of variance. The "no correlation" condition has three possible values for the mean portfolio variance; the "correlation" condition" has five possible values for the mean portfolio variance (see Table 2). So it is possible to recode the variances as follows:

	Portfolio variance				
"correlation" condition	16	25	36	49	64
recoded	1	2	3	4	5
"no correlation" condition	16	8.8	6.4	8.8	16
recoded	5	3	1	3	5

Table 8. Recoding of portfolio variance

The transformation enables the comparison between the "correlation" and "no correlation" conditions. The following table shows this comparison. The "correlation"/"no correlation" conditions are represented in columns, the "history"/"no history" condition in rows. The difference between the "correlation"/"no correlation" conditions is tested with one-sided Wilcoxon-Mann-Whitney and Wilcoxon signed rank tests and the p-values of the test are noted in the last column. The hypothesis of the median equality between the "correlation" and "no correlation" condition can be strongly rejected (p-value<1%), see Table 9.

		correlation		p-value[a)]	p-value[b)]
		yes	no		
history	yes	2.125	1.65	0.048	0.0049
	no	2.05	1.15	0.0001	0.0000
total		2.088	1.40	0.0000	0.0000

[a)] matched pairs, wilcoxon signed rank test, tie-adj., one sided

[b)] wilcoxon-mann-whitney test, tie-adj., one-sided

Table 9. Recoded mean portfolio variance and the correlation neglect

This finding means that the participants are diversifying their portfolios regardless of the correlation between the investment alternatives, so that the diversification is more of the "naïve" sort than a rational one.

Hypothesis test: History effect

The second hypothesis to be tested is whether the representation of the dividend history has an effect on the investment decisions of the subjects. The comparison should be made between the "history" and "no history" conditions for both "correlation" and "no correlation" treatment. The results are represented in the following table. Again, the mean portfolio variance is recoded into the variance levels instead of the variance values scheme (see Table 8). The last row indicates the p-values for the Wilcoxon signed rank and Wilcoxon-Mann-Whitney tie-adjusted one sided test.

		Both groups		
		correlation		total
		yes	no	
history	yes	2.125	1.65	1.888
	no	2.05	1.15	1.60
	p-value[a)]	0.2371	0.0117	0.0358
	p-value[b)]	0.2978	0.0023	0.0174

[a)] matched pairs, wilcoxon signed rank test, tie-adj., one-sided

[b)] wilcoxon-mann-whitney test, tie-adj., one-sided

Table 10. Recoded mean portfolio variance and the "history" effect

The results show that there is some "history" effect – the participants decide differently depending on additional but irrelevant information about the dividend history over the last 10 years. This effect is most pronounced in the "no correlation" condition. The effect is not significant in the "correlation" condition. This means that the correlation neglect effect is stronger than the "history" effect: if the investment alternatives are correlated, subjects are less rational and this effect dominates the outcomes. Still, the composite examination of the history/no history treatment cannot reject the hypothesis of no "history" effect. The subjects interpret the additional information in the wrong way. Of all the subjects, only 6 managed to make a right decision in all treatments.

4 Concluding remarks

The experiment shows that the subjects are not able to use the most relevant information about the correlation between the investment alternatives in making their portfolio choice, and are not able to prescind from clearly irrelevant information. The first effect represents correlation neglect, and the second effect means overconfidence, the two stumbling blocks for optimal diversification. The first effect dominates the second – even in the absence of irrelevant information the subjects neglect the correlation between the assets. With the additional information the effect is even more pronounced. These findings pose question about regulating pension funds to ensure optimal diversification of the pension savings and spreads some light on the development of financial crises.

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6 Appendix: Experimental Instructions

Correlation Condition

You can choose between two shares (share A and share B) of a specific sector of industry. You can read in the table how high the dividend payments for both stocks was during the past 10 years. If the economic situation in the sector is good, the dividend of share A is € 4 and that of share B is € 3. If the economic situation in the sector is poor, the dividend of share A is € 0 and that of share B is € 1. The economic trend in this sector can vary from year to year and has to be viewed as a random process: the probabilities of a good or poor economic situation in the year 2009 are 50% respectively.

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Share A	4 €	0 €	4 €	0 €	0 €	0 €	4 €	4 €	0 €	4 €	?
Share B	3 €	1 €	3 €	1 €	1 €	1 €	3 €	3 €	1 €	3 €	?

You receive four free shares. You can choose whether you want to have 4 A shares, 4 B shares, 3 A shares + 1 B share, 3 B shares + 1 A share or 2 A shares + 2 B shares. The dividend payments which your four shares yield in 2009 are paid out to you. The development of the prices of the shares are of no significance to you.

Make your selection now!

I select
- O 4 A shares
- O 4 B shares
- O 3 A shares + 1 B share.
- O 3 B shares + 1 A share.
- O 2 A shares + 2 B shares.

Please give brief reasons for your selection (e.g. on the back of the paper). These reasons have **no** effect on the payout! You can therefore write down your thoughts openly and honestly.

(Note: in the "no history" condition the sentence about the past dividend payments and the table are omitted)

No Correlation Condition

You can choose between two shares (share X and share Q) of a specific sector of industry. You can read in the table how high the dividend payments for both stocks was during the past 10 years. In the case of both companies, the dividend payments are a random process with the two possible values € 2 and € 0 and an expectancy value of € 1.

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
first equity	0 €	0 €	2 €	0 €	0 €	0 €	2 €	2 €	2 €	2 €	?
second equity	0 €	2 €	2 €	2 €	0 €	2 €	0 €	0 €	2 €	0 €	?

You receive four free shares. You can choose whether you want to have 4 X shares, 4 Q shares, 3 X shares + 1 Q share, 3 Q shares + 1 X share or 2 X shares + 2 Q shares. The dividend payments which your four shares yield in 2009 are paid out to you. The development of the prices of the shares is of no significance to you.

Make your selection now!

I select
- O 4 X shares
- O 4 Q shares
- O 3 X shares + 1 Q share.
- O 3 Q shares + 1 X share.
- O 2 X shares + 2 Q shares.

Please give brief reasons for your selection (e.g. on the back of the paper). These reasons have **no** effect on the payout! You can therefore write down your thoughts openly and honestly.

(Note: in the "no history" condition the sentence about the past dividend payments and the table are omitted)

Risk elicitation

You make your decision in the table below. Each decision is a choice between variant A and variant B. Each variant is a type of lottery with different payout sums and probabilities of occurrence. You make 10 decisions and note them in the right-hand column of the table. One of these decisions will be used to determine your payout in the lottery. This is done as follows: after you have made all ten decisions, a ten-sided dice is thrown to determine which of the ten decisions will be used. Each of the decisions thus has the same 10% probability of being used. Then the chosen lottery (A or B) is played. The probability of occurrence is simulated with the help of playing cards: the number of red cards in a pile of 10 cards indicates the probability with which the higher payout sum will occur.

Example of decision no. 8: in a pile of ten cards there are eight red and two black cards. The probability that a randomly drawn card is red is thus 80%. If the drawn card is red, you receive € 2 in variant A and € 3.85 in variant B. If the drawn card is black, however, you receive € 1.60 in variant A and € 0.10 in variant B.

You thus make ten decisions (either A or B). One of these is randomly chosen (with a dice) and played (with playing cards) – the result determines your payout.

Before you fill in the table, please answer the following questions in order to check that we have explained everything correctly. When you have finished the questions, please tell us so that we can check them. Please only fill in the table after your answers have been checked.

Questions:

How high is the maximum payout in the lottery? _____ How high is the minimum payout? _____

If the dice selects the 7th decision, you have chosen variant A in the 7th decision, and you have chosen a black card from the pile, how high is your payout? _____

How many black cards are in the pile if the dice selects the 10th decision? _____

How many red cards are in the pile if the dice selects the 4th decision? _____

Now please make the ten decisions: which variant would you rather choose – A or B?

	Lottery A:				Lottery B:				Your choice: A or B?
No.	p(2€)		p(1.60€)		P(3.85€)		p(0.10€)		
1	10%	2€	90%	1.60€	10%	3.85€	90%	0.10€	
2	20%	2€	80%	1.60€	20%	3.85€	80%	0.10€	
3	30%	2€	70%	1.60€	30%	3.85€	70%	0.10€	
4	40%	2€	60%	1.60€	40%	3.85€	60%	0.10€	
5	50%	2€	50%	1.60€	50%	3.85€	50%	0.10€	
6	60%	2€	40%	1.60€	60%	3.85€	40%	0.10€	
7	70%	2€	30%	1.60€	70%	3.85€	30%	0.10€	
8	80%	2€	20%	1.60€	80%	3.85€	20%	0.10€	
9	90%	2€	10%	1.60€	90%	3.85€	10%	0.10€	
10	100%	2€	0%	1.60€	100%	3.85€	0%	0,10€	

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