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#### Correlation Neglect and Overconfidence

#### An Experimental Study

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*An Experimental Study*

**Markus Spiwoкс and Kilian Bizer**

## Abstract

For the first time in economic research, the present experimental study confronted participants with the task to predict stock prices *ex ante* in order to analyze the interrelation of the behavioral anomalies overconfidence and correlation neglect. The study shows that the participants considerably overestimate their accuracy of forecasting (overconfidence). Almost half of all participants (42.2%) disregard the correlation among return developments for different means of investment (correlation neglect). It was also observed that the correlation neglect, when forecasting diversified means of investment (funds), has a cushioning effect on overconfidence.

**Keywords:** Behavioral Finance; Experiments; Correlation Neglect; Overconfidence; Stock Price Forecasts.

**JEL classification:** G02, G11, G12, G17, D81, D84.

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## 1. Introduction

The behavior of actors on the capital market has increasingly become the focus of attention in economic research. This scientific development was motivated by severe financial market turmoil that occurred during the past three decades (1987, 1990, 2000 and 2008) and that fueled the doubt concerning the neoclassic interpretation of capital-market operations (cf. e.g. Daniel and Hirshleifer, 2015).

The present study addresses two behavioral anomalies of capital-market actors: their disregard of the correlation among return developments for different means of investment (correlation neglect) and their tendency to overestimate their own abilities (overconfidence). Correlation neglect can lead to faulty diversifications in the security portfolios and thereby destabilize capital markets (cf. e.g. Gubaydullina and Spiwoks, 2015; Bennett and Sias, 2011; Brennan and Torous, 1999). Overconfidence can result in excessively frequent and/or risky transactions (cf. e.g. Ouarda and El Bori, 2014; Palomino and Sadrieh, 2011; Trinugroho and Sembel, 2011; Michailova, 2010; Grinblatt and Keloharju, 2009; Deaves, Lüders and Luo, 2008; Glaser and Weber, 2007; Biais, Hilton and Mazurier, 2005; Barber and Odean, 2002; Barber and Odean, 2001; Odean, 1999) and thus disrupt the market mechanism (cf. e.g. Adel and Mariem, 2013; Michailova and Schmidt, 2011).

Up to the present, few studies have addressed the connection between these two phenomena (cf. e.g. Heller, 2014; Merkle, 2014) or reflected the challenges that actors have to face on real capital markets (cf. e.g. Gloede and Menkhoff, 2014; Broihanne, Merli and Roger, 2014; Bessière and Elkemali, 2014; Glaser, Langer and Weber, 2013; Menkhoff, Schmeling and Schmidt, 2013; Sonsino and Regev, 2013; Huisman, van der Sar and Zwinkels, 2012; Puetz and Ruenzi, 2011; Deaves, Lüders and Schröder, 2010). For the first time in economic research, the present experimental study confronts its participants with the task to forecast the development of real stock prices to provide a basis for the analysis of the connection between the behavioral anomalies of overconfidence and correlation neglect. The study shows, among other results, that the phenomenon of correlation neglect extenuates overconfidence in dealing with diversified means of investment (such as equity funds).

## 2. Hypothesis and Experimental Design

The participants are asked to predict stock prices of five stocks from different sectors and from different parts of the world. These are (1) the US-American biotech company Gilead Sciences Inc., (2) the US-American social network Facebook Inc., (3) the Russian oil company Lukoil Neftyanaya Komp., (4) the German information technology company Bechtle AG and (5) the Chinese high street bank Bank of China.

The participants are presented with real securities and they are supposed to provide real prognoses *ex ante* so that their forecasting behavior can be realistically assessed. With experimental capital markets and fictional means of investment there is always the risk that the participants' behavior is unwittingly influenced or even "channeled", which can lead to artificial results.

Each of the participants is provided with very short information about the companies as well as with the current stock prices (closing prices of the previous day). They are supposed to estimate whether the stock prices (a) increase or (b) drop or hold steady until a due date that is set approximately six weeks in the future. The participants are then asked to self-evaluate the accuracy of their forecasts. Moreover, they are to estimate in which interval the stock prices will be with a probability of 90% at the end of the prognosis period (see appendix for detailed instructions given).

Considering various preceding studies that declare overconfidence to be a solid phenomenon, *hypothesis 1* reads as follows: economic subjects usually overestimate their accuracy of forecasting.

After forecasting the stock price development, the participants are shown two fictional equity funds which solely invest in the five stocks analyzed before. They are informed about the structure of the funds: 12.5% (25%) of the fund "Worldwide ZZX-2" ("Global PPS-1") are Gilead stocks, 12.5% (16%) Facebook stocks, 25% (17%) Lukoil stocks, 25% (25%) Bechtle stocks and 25% (17%) Bank of China stocks. For these funds, the participants were again asked to forecast if the prices would (a) increase or (b) drop or remain constant until the due date of the forecast. The participants are then supposed to self-assess the accuracy of their own forecasts and, in a last step, to estimate in which interval the prices of the funds are

going to settle with a probability of 90% at the end of the prognosis period.

Five stocks from different sectors and different parts of the world are very likely to have a diversification effect. Therefore, the price fluctuation of the funds has to be estimated lower than the average fluctuation of the five individual stock prices. The major aim of the experiment is to ascertain if the participants discern the risk diversification that is inherent to the two funds and if they, consequently, set narrower 90% intervals for the market trends of the funds.

Considering the numerous empirical evidence on the phenomenon of correlation neglect, *hypothesis 2* reads as follows: proportionally, the participants are not going to set the 90% confidence intervals for the two funds (Worldwide ZZX-2 and Global PPS-1) narrower than for the five stocks.

Supposing that the participants disregard the expected diversification effect, they will not set the 90% confidence intervals for both funds much narrower than for the five stocks. In reality, the diversification effect will most probably occur. The prices of the funds will therefore fluctuate less than the average prices of the five stocks. If the confidence intervals for the funds are not set much narrower than for the stocks but if their price fluctuation is minor in comparison, the fund prices should be within the intervals more often than the stock prices. Setting the confidence intervals too narrow is an indication of overconfidence. Correspondingly, we can expect to observe this phenomenon rather for the prognosis of stock prices than for the forecast of the funds. This expectation leads to the pointed remark that the extent of overconfidence when forecasting diversified means of investment (funds) is reduced by the phenomenon of correlation neglect. Therefore, *hypothesis 3* reads as follows: the extent of overconfidence will be less in the forecast of fund prices than in the forecast of stock prices.

The experiment was conducted in two parts to avoid the dependency of the results from a single situation on the capital market. The first part took place on 22, 23 and 24 April 2015. The participants forecasted the price development until 7 June 2015, which is a prognosis period of about six weeks. The second part was conducted on 27/28/29 May 2015. The participants forecasted the price development until 10 July 2015, which, again, is a prognosis period of about six weeks. 240 students of business administration of the Ostfalia University of Applied Sciences participated in the experiment. Those 30 students with the most exact forecasts were rewarded

€ 50 each. The total sum of rewards was € 1,500 which equates to € 6.25 for each participant. The experiment lasted approximately 20 minutes. All participants seemed motivated and eager to give the best prognoses possible. Since the experiment was conducted in the classroom, the opportunity costs for the participants were very low which is why there was no show-up fee. The participation in the experiment was voluntary.

**Table 1:** Price Development of the Analyzed Stocks and Funds in the Prognosis Periods

Experiment Part I: 22/23/24 April 2015							
	Price on 22.04.15	Real Course	Price on 23.04.15	Real Course	Price on 24.04.15	Real Course	Price on 07.06.15
Gilead Sciences Inc.	€ 97.96	↗	€ 97.06	↗	€ 97.09	↗	€ 102.33
Facebook Inc.	€ 77.86	↘	€ 76.83	↘	€ 76.18	↘	€ 73.75
Lukoil Neftyanaya	€ 47.12	↘	€ 46.76	↘	€ 47.19	↘	€ 40.50
Bechtle AG	€ 68.36	↘	€ 68.53	↘	€ 67.40	↗	€ 68.27
Bank of China 100s	€ 64.00	↘	€ 64.90	↘	€ 63.90	↘	€ 58.90
Fund ZZX-2	€ 53.48	↘	€ 53.43	↘	€ 53.03	↘	€ 51.14
Fund PPS-1	€ 87.69	↘	€ 87.38	↘	€ 86.80	↘	€ 85.81
Experiment Part II: 27/28/29 May 2015							
	Price on 27.05.15	Real Course	Price on 28.05.15	Real Course	Price on 29.05.15	Real Course	Price on 10.07.15
Gilead Sciences Inc.	€ 100.79	↗	€ 103.02	↘	€ 102.97	↘	€ 101.74
Facebook Inc.	€ 72.86	↗	€ 73.83	↗	€ 73.11	↗	€ 78.63
Lukoil Neftyanaya	€ 45.00	↘	€ 44.71	↘	€ 44.53	↘	€ 39.00
Bechtle AG	€ 65.62	↗	€ 65.94	↗	€ 67.10	↗	€ 72.80
Bank of China 100s	€ 63.10	↘	€ 63.10	↘	€ 60.10	↘	€ 51.00
Fund ZZX-2	€ 52.11	↘	€ 52.44	↘	€ 51.95	↘	€ 50.60
Fund PPS-1	€ 86.12	↘	€ 87.02	↘	€ 86.57	↘	€ 86.09

real course = price development from the time when the prognosis was given to the end of the prognosis period; ↘ = price has dropped during the prognosis period; ↗ = price has risen during the prognosis period; 100s = block containing 100 stocks.

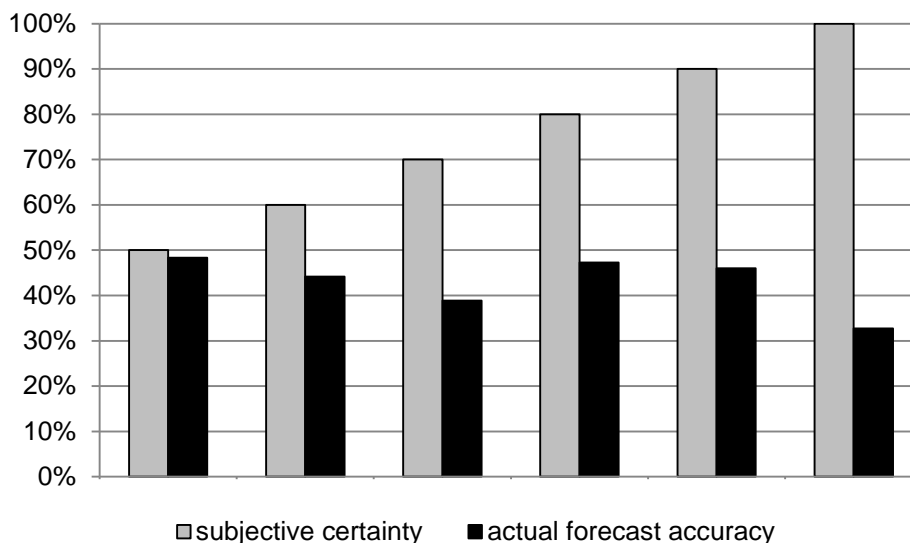
Within the prognosis periods the prices developed in different directions (table 1). The stock price of Gilead Sciences Inc. increased from € 97.96 to € 102.33 from 22 April to 7 June 2015. The stock price of Facebook, however, dropped from € 77.86 to € 73.75.

When analyzing the arrows indicating the price development, it can be observed that the prices of the five stocks developed differently in the first and second prognosis period. Some prices increased while others dropped. The effect of diversification caused by this development can be established when looking at the relatively constant price development of the funds.

### 3. Results

Many participants show extreme overconfidence. Figure 1 illustrates the extent of the misjudgment concerning their own accuracy of forecasting. Those who were 100% certain with their prognosis (increasing or dropping price; gray bar on the right) were accurate in only 32.7% of their forecasts (black bar on the right). The participants who were 90% certain of their forecast (increasing or dropping price) were accurate in only 46.0% of all cases. The 80% (70% / 60%) subjective certainty lead to accurate forecasts in only 47.25% (38.84% / 44.14%) of the cases. Only 12% of given forecasts were estimated correctly. Those participants that did not trust their forecasts (increasing or dropping price) more than they would trust a coin toss (subjective certainty 50%), correctly evaluated their forecasts in 48.34% of all cases.

**Figure 1:** Subjective Certainty and Actual Accuracy for the Forecast „Increasing Price“ or „Dropping/Steady Price“



These results are based on 1,680 decisions in total (240 participants, each giving seven prognoses). The same number of decisions was made for a 90% confidence interval concerning the price development of the five stocks and the two funds. It could be established that not 90% of prices turned out to be within the 90% confidence intervals at the end of the forecast period but only 35.2%. Hence, the confidence intervals were systematically set too narrow which can be interpreted as an indication of overconfidence. It is likely, after all, that economic subjects set

larger margins the more uncertain they are about price development.

Overconfidence is evident, wherefore hypothesis 1 is proven. This result is in accordance with those of previous studies on the same topic.

A closer analysis of the 90% confidence intervals produces interesting results because it reveals if the participants understood the characters of the funds as diversified means of investment that are less volatile. To consider the different price levels of the stocks in question we calculated the percental relative margins of the 90% confidence intervals (*PRM*). To do so, the lower margin of the confidence interval is subtracted from the upper margin, the resulting expected margin is divided by the price at the moment of the forecast (equation 1).

$$(1) \quad PRM = \frac{\text{upper margin CI} - \text{lower margin CI}}{\text{current price}} \cdot 100\%$$

Showing:

*PRM* = percental relative margin of the 90% confidence interval

*CI* = 90% confidence interval

The participants set the percental relative margins for the funds narrower than for the stocks (table 2). The average percental relative margin for the stock price forecasts is 12.25%, and 11.45% for forecasts of the fund prices. The differences are slight but, with a 5% probability of error, they are significant in consideration of the Wilcoxon-Mann-Whitney Test. The value P is 0.0144, wherefore hypothesis 2 has to be rejected. The participants realize that the fund prices are less volatile than the stock prices, which is why they set narrower percental relative margins for the funds.

**Table 2:** Percental Relative Margins of the Forecast 90% Confidence Intervals

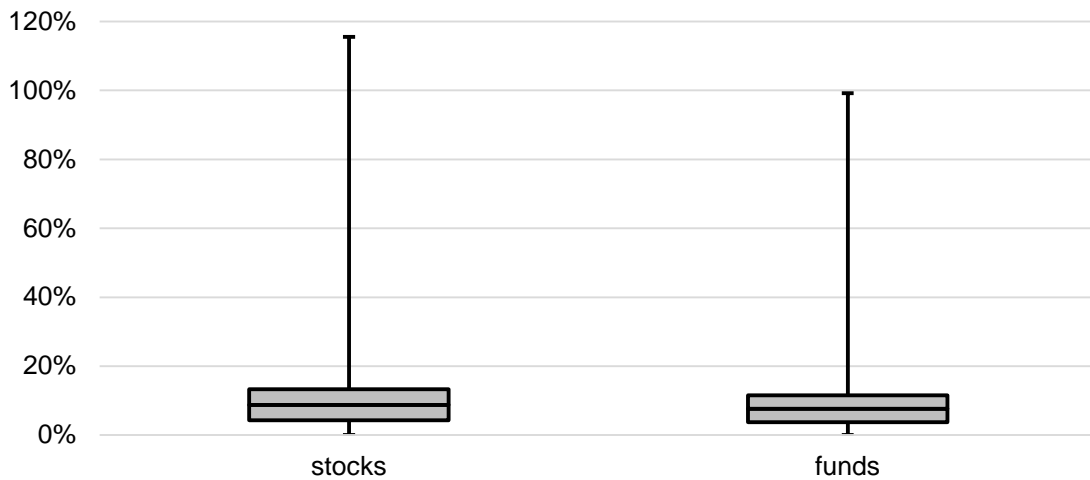
	Stocks	Funds
average PRM (standard deviation)	12.25%** (14.52%)	11.45%** (14.61%)
minimum PRM	0.00%	0.00%
maximum PRM	115.48%	99.20%

\*\*\* = significant with a 1% error rate, \*\* = significant with a 5% error rate, \* = significant with a 10% error rate.



Taking a closer look at the boxplots (figure 2) we can see that the differences between the percental relative margins of forecasts for the stocks and funds are not very wide. Ignoring the upper whisker, the differences are not in any case striking.

**Figure 2:** Boxplot Showing the Percental Relative Margins of the Stock and Fund Price Forecasts



Analyzing if each participant expected higher percental relative margins (*PRM*) for the five stocks or for the two funds gives a rather disillusioning result. Only 57.8% of all participants expect lower *PRMs* for the funds than for the stocks. However, 42.2% of the participants expect the prices of the stocks to be less volatile than the prices of the funds. A large part of participants (42.2%) finds it extremely difficult to realize the effect of diversification that affects both funds and to adequately consider it when giving their forecasts. This must be the reason why the average *PRM* of the stocks (12.25%) is only a little higher than the average *PRM* of the funds (11.45%).

This raises the question of whether the diversification neglect concerning the funds that can be frequently observed has a cushioning effect on overconfidence when forecasting the volatility of fund prices. The more the necessary margin of the confidence interval is underestimated the stronger are the effects of overconfidence. Table 3 shows how often the actual stock prices were within the 90% confidence intervals at the end of the prognosis period. Only 31.1% of the actual stock prices were within the forecast 90% confidence intervals at the end of the prognosis period. The prognoses of the funds were clearly more successful. In

45.5% of the cases, the actual prices of the funds were within the forecast 90% confidence intervals at the end of the forecast period. The success rate is only half as high as could be expected of economic subjects that do not overestimate their own ability of forecasting. Nevertheless, the extent of overconfidence when forecasting the volatility of the fund prices is much less in comparison to forecasting the volatility of the stock prices. In these cases, only a third of the success rate that would be expected of economic subjects that do not overestimate their own abilities of forecasting is achieved.

**Table 3:** Actual Prices at the End of the Prognosis Period Within and Outside of the Forecast 90% Confidence Interval

	Stocks		Funds	
	Quantity	Share in %	Quantity	Share in %
Price in CI	372	31.1%	217	45.5%
Price not in CI	824	68.9%	260	54.5%
Total	1196	100.0%	477	100.0%

CI = 90% confidence interval

Therefore, hypothesis 3 is supported by our findings. It is obvious that overconfidence is less likely when assessing diversified means of investment in comparison to non-diversified means of investment. This can be attributed to the behavioral anomaly of correlation neglect. Investors who intend to reduce any damages of overconfidence are hereby advised to increasingly invest in diversified means.

#### **4. Summary**

For the first time in scientific research, the present experimental study confronted participants with the task to predict stock prices *ex ante* in order to analyze the interrelation between the behavioral anomalies overconfidence and correlation neglect. The anomaly of overconfidence is significantly dominant in all participants. Those participants, for instance, who were 100% sure of their forecast (increasing or dropping prices) only made a correct estimate in 32,7% of all cases. This result is confirmed with regard to gauging the 90% confidence intervals. In only about a third of all cases (35.2%) the prices developed according to the forecast 90% confidence intervals.

On average, the percental relative margins of the 90% confidence intervals turned out to be lower for the funds (11.45%) than for the stocks (12.25%). The neglect of the correlations among return developments of different means of investment (correlation neglect) could not be proven for the entire group of participants. The individual analysis of each participant, however, showed that a considerable 42.2% of participants forecasted lower percental relative margins for the stocks than for the funds. Hence, a significant number of participants was subject to the phenomenon of correlation neglect.

It is of particular interest that correlation neglect evidently has a cushioning effect on overconfidence in the case of diversified means of investment (such as funds). Whereas considerable 45.5% of all actual funds price were within the forecast 90% confidence intervals, only 31.1% of actual stock prices developed this way. We conclude that possible damages caused by overconfidence can be prevented if investors increasingly rely on diversified means of investment.

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## Appendix: Instructions

Your task is to forecast stock prices and prices of stocks in a fund.

A reward of € 50 is paid to the five participants who give the best forecasts in today's inquiry.

### GILEAD SCIENCES INC. Current price: €97.96

Gilead Sciences Inc. is an independent company, operating globally in the biotech industry. They focus on developing therapeutic solutions for treating fatal infectious diseases.

Please tick the box.

- The stock price will increase until 7 June 2015.
- The stock price will decrease or hold steady until 7 June 2015.

How certain are you regarding your estimate? How probable do you believe your forecast to be? Please tick the box.

- 50%       60%       70%       80%       90%       100%

Please state the interval in which the stock price will be on 7 June 2015 with a probability of 90%!

Lower margin of stock price interval: \_\_\_\_\_ €      Upper margin of stock price interval: \_\_\_\_\_ €

### Fund Worldwide ZZX-2      Current price: €53.48

At 12.5%, the Worldwide ZZX-2 fund consists of Gilead shares, at 12.5% of Facebook shares, at 25% of Lukoil shares, at 25% of Bechtle shares and at 25% of Bank of China shares.

Please tick the box.

- The fund price will increase until 7 June 2015.
- The fund price will decrease or remain constant until 7 June 2015.

How certain are you regarding your estimate? How probable do you believe your forecast to be? Please tick the box.

- 50%       60%       70%       80%       90%       100%

Please state the interval in which the stock price will be on 7 June 2015 with a probability of 90%!

Lower margin of stock price interval: \_\_\_\_\_ €      Upper margin of stock price interval: \_\_\_\_\_ €