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Real knowledge is to know the extent of one's ignorance

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Real knowledge is to know the extent of one's ignorance

By Ibrahim Filiz, Zulia Gubaydullina, Florian Kirchhoff, Thomas Nahmer, Markus Spiwoks and Peter von Holten

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Abstract: Does a higher level of ignorance lead to higher subjective confidence in making stock price predictions? This question is investigated in a controlled laboratory experiment. 150 subjects make stock price forecasts (directional forecasts: will or will not rise) for three listed companies. A Likert scale is then used to measure how confident the subjects are that their predictions will actually come true. Afterwards, the participants answer 50 capital market-related questions. The number of correct answers provides a quantitative indication of the level of knowledge and experience relevant to the stock market. The results show that individuals with limited specialist knowledge and experience are particularly confident in their forecasts and vice versa. This finding is evident for men and is statistically highly significant. In contrast, this correlation is only marginally observable among female subjects and is not statistically significant.

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Introduction

Some individuals appear to exhibit an unusually high level of confidence in their expertise despite a notable absence of relevant knowledge.

At the onset of November 2024, a substantial number of individuals held the conviction that the government under the leadership of US President Biden had failed completely and that its performance could not have been any more deficient. When these people are asked which of the more than 220 federal laws (public law) enacted by the 118th US Congress in the period from 2023 to 2024 they particularly disliked, there is usually no answer. Individuals who initially exhibited unwavering resolve in their convictions find themselves unable to cite even a single example of these more than 220 laws they disapprove. This phenomenon is indicative of a group that, while seemingly politically uninformed, maintains a steadfast belief in the accuracy of their overall political assessment of the Biden administration. In contrast, political observers who have already followed the genesis of a legislative proposal and are aware of the challenges involved in translating a political objective into a legal text often reach more differentiated conclusions (for similar constellations, see Anson, 2018).

Xenophobia is a phenomenon that has increased significantly in large parts of Europe over the past three to four decades. Empirical surveys show that people with limited or no exposure to foreigners are particularly xenophobic. These individuals hold strongly convinced beliefs that foreigners are characterized by negative qualities, such as a tendency towards criminal activity or a work-shy attitude. In contrast, people who have encountered foreigners in settings such as sports clubs, workplaces or residential neighborhoods often exhibit a much more differentiated assessment of their interactions (see Derin & Lafcı-Tor, 2024; Bozdag, 2020; Jolly & DiGiusto, 2014; Winkler, 2002; Amir, 1969; Allport, 1954).

Students who are active on the capital market sometimes enthusiastically express support for Bitcoin and other cryptocurrencies. These young capital market participants are convinced that investments in cryptocurrencies will result in significant financial gains (cf. e.g. Dewi & Diwya, 2024). However, when the role of cryptocurrencies in organized crime is mentioned, the young investors express astonishment. Cryptocurrencies provide a means for anonymous transactions, facilitating the collection of ransom payments in cases of kidnappings or extortion related to ransomware attacks. Illegal transactions in the areas of arms trafficking, human trafficking and drug trafficking can also be carried out safely in cryptocurrencies. Thus, Mafia-like groups worldwide play a substantial role in the proliferation of cryptocurrencies. The fact that cryptocurrencies are already banned in several countries (for example in China, Egypt and Turkey) and that other countries are considering similar measures (for example India) astonishes many young investors. Experienced capital market participants, who have already witnessed the collapse of several promising

investment domains (such as the bursting of the Japanese real estate bubble in 1990, the dotcom bubble in 2000 or the US real estate bubble in 2008), tend to exercise greater caution when evaluating the future prospects of cryptocurrencies (see, for example, Krugman, 2018).

Can these everyday observations be generalized? Does a lack of knowledge result in a systematic overestimation of the reliability of one's own assessments? Empirical research on overconfidence bias provides some indications that point in this direction. It shows that a comprehensive level of knowledge and/or a wealth of experience often leads to greater caution when assessing the reliability of one's own assessments. The study by Kruger & Dunning (1999) gave an important impetus to this debate. The researchers postulated that a lack of expertise or experience contributes to the fact that metacognition is impossible. Inexperienced and uninformed individuals lack the necessary knowledge to grasp the limits of their own ability.

When considering this idea in its logical conclusion, the following hypothesis is reached: individuals with a lower level of knowledge and wealth of experience tend to exhibit greater confidence in their own assessments. This hypothesis is examined in a laboratory experiment that focuses on share price forecasts.

The issue of gender differences will also be addressed. There are indications that overconfidence is significantly more pronounced among men than among women, particularly in the context of the capital market.

The findings of the laboratory experiment demonstrate that individuals with limited stock market-relevant knowledge and experience exhibit heightened levels of confidence in their share price forecasts. This correlation is evident in male subjects and is statistically significant. In contrast, the correlation among female subjects is observed to a lesser extent and does not attain statistical significance.

Literature

The tendency to systematically overestimate one's own abilities is usually referred to as the overconfidence bias. This phenomenon is a core component of behavioral economics and has been the subject of intensive research for some time. A number of empirical studies have provided evidence of the overconfidence bias, particularly among capital market players.

Huisman, van der Sar & Zwinkels (2012) surveyed bank customers and found a considerable degree of overconfidence among private investors, while Merkle (2017) surveyed customers of an online broker and also found a tendency towards overconfidence. Similarly, Baker et al. (2019) surveyed Indian investors and came to

similar findings. Bessière & Elkemali (2014) observed the reactions of stock market analysts to earnings announcements and identified a considerable degree of overconfidence. Gloede & Menkhoff (2014) found overconfidence among financial professionals with regard to their personal performance. Broihanne, Merli & Roger (2014) also observed overconfidence among financial professionals. Eshraghi & Taffler (2012) and Puetz & Ruenzi (2011) discovered overconfidence among fund managers, while Speirs-Bridge et al. (2010) found overconfidence in risk analysis experts. Sonsino & Regev (2013) discovered a tendency towards overoptimism among experienced investors as part of a field experiment. Shah, Raza & Khurshid (2012) arrived at similar conclusions. Bar-Yosef & Venezia (2014) discovered a significant tendency towards overconfidence in an experiment where subjects forecasted financial ratios and share prices. Heller (2014) also demonstrated in an experimental study that overconfidence exists and is reflected in the overestimation of one's own private information. Blockand & Harper (1991) found through experimentation that many people greatly overestimate the accuracy of their assessment of uncertain values. Pikulina, Renneboog & Tobler (2017), Wu, Johnson & Sung (2008) and Zacharakis & Shepherd (2001) also demonstrated experimentally that overconfidence occurs frequently. Jemaiel, Mamoghli & Seddiki (2013) found that even economic incentives are ineffective in reducing the tendency to overconfidence. Conversely, Amirkhanyan et al. (2024) and Proeger & Meub (2014) reached contradictory conclusions. Comprehensive literature reviews can be found in Singh et al. (2024), Kumar & Chaurasia (2024), Kumar & Prince (2023) and Grezo (2021).

However, the extant literature on the relationship between the overconfidence bias on the one hand and specialist knowledge and experience on the other hand presents an inconsistent set of findings. For instance, Gloede & Menkhoff (2014) found a decline in overconfidence bias among financial experts with increasing professional experience. Bessière & Elkemali (2014) emphasized that the experience of a serious crisis on the capital markets, such as the bursting of the dotcom bubble, significantly reduces the tendency towards overconfidence among corporate analysts. Kufepaksi (2008) noted that poorly informed economic subjects in particular tend to be overconfident. Santos et al. (2010) showed that the overconfidence bias decreases with increasing experience. Proeger & Meub (2014) demonstrated that regular feedback gradually leads to more realistic self-assessment, thereby reducing overconfidence. Filiz (2020) found that such learning effects occur at least in certain moods. Menkhoff, Schmeling & Schmidt (2013) reached mixed results, contingent on the comparison of institutional investors or investment advisors with private investors. However, their overarching conclusion is that overconfidence diminishes with increasing experience.

In contrast, Glaser, Langer & Weber (2013), Glaser, Langer & Weber (2005) and Bar-Yosef & Venezia (2014) demonstrated through experiments that professional financial market experts are even slightly more impacted by the overconfidence bias than students, who constitute the second group of subjects in their experiments. Deaves, Lüders & Schröder

(2010) also observed that increasing market experience was positively correlated with overconfidence. Mishra & Metilda (2015) found that investment experience and age were positively correlated with overconfidence.

Oberlechner & Osler (2012) did not find any influence of experience on the tendency to overconfidence among currency traders. Kansal & Singh (2018) observed by the help of a survey of Indian equity investors that the extent of overconfidence is independent of age and level of education.

Kruger & Dunning (1999) provided an important impetus for this debate. They noticed that incompetent individuals in particular tend to be overconfident. The researchers interpreted this finding to mean that the lack of knowledge and skills makes metacognition impossible. Such individuals are too incompetent to recognize how limited their abilities actually are. This phenomenon is referred to as the Dunning-Kruger effect. Pratt et al. (2024), Knof, Berndt & Shiozawa (2024), Canady & Larzo (2023), Arroyo-Barrigüete et a. (2023), Rubin & Froustis (2023), Bradley et al. (2022), Coutinho (2021), Tremayne et al. (2021), Rahmani (2020), Fitzmaurice (2020), Ahmed & Walsh (2020), Sullivan, Ragogna & Dithurbide (2018), Plohl, Musil & Slovenia (2018), Aqueveque (2018), Motta, Callaghan & Sylvester (2018), Pennycook et al. (2017), Mahmood (2016) and Modranský (2016) empirically confirmed the existence of the Dunning-Kruger effect. Zell & Krizan (2014) emphasized that most people have only a moderate overview of their abilities.

In contrast, Gignac & Zajenkowski (2023), Gignac (2022), McIntosh et al. (2022), Hofer et al. (2022), Magnus & Peresetsky (2022) and Gignac & Zajenkowski (2020) contend that the empirical findings of Kruger & Dunning (1999) are a statistical artifact. This assertion can probably be considered valid, despite the regression to the mean (Galton, 1886) hypothesis being less compelling than the reference to Ogburn (1934) would suggest. Unusual events (in this case, particularly successful or particularly unsuccessful actions) are systematically expected to occur less frequently than they actually do in reality. This observation by Ogburn (1934) is already sufficient to call into question the empirical approach of Kruger & Dunning (1999). Dunkel, Nedelec & van der Linden (2023) demonstrated that the Dunning-Kruger effect is indeed detectable with appropriate changes to the empirical methodology, even if it is relatively weak. Gignac (2024) also emphasized this aspect.

However, the intriguing interpretation proposed by Kruger & Dunning (1999) that individuals lacking in competence may encounter difficulties in recognizing their own deficiencies at all remains completely unaffected by this discussion. This suggests that particularly uninformed individuals often possess a notable degree of subjective confidence in their assessments. Dunning (2011) further underscores this notion. Consequently, this leads to the first hypothesis of the present experimental study. We expect that subjects will feel subjectively more confident when making share price

forecasts the less specialist and empirical knowledge they have related to capital markets. An operationalized formulation of the hypothesis is provided in the presentation of the experimental design in the following chapter.

Furthermore, the extant literature on overconfidence offers numerous indications suggesting that men and women possess different levels of confidence in their ability to make reasonable decisions on the capital markets. For instance, Spiwoks & Bizer (2018) found in an experiment on share price forecasting that men exhibited clear signs of overconfidence, while women displayed clear signs of underconfidence. However, the forecasting success rates of both groups did not differ significantly. Barber & Odean (2001) further demonstrated that men engage in more frequent information seeking regarding capital market developments and make more frequent reallocations in their securities portfolios compared to women. This discrepancy in behavior is a primary factor contributing to the lower average returns observed in men. Barber & Odean (2001) attribute this disparity to a higher level of overconfidence among men. Ifcher & Zarghamee (2014) posit that men exhibit heightened levels of overconfidence during periods of elevated mood, a tendency that does not manifest among women. More evidence supporting the hypothesis that men are more affected by overconfidence than women can also be found in Aristei & Gallo (2022), Wilaiporn, Nongnit & Surachai (2021), Baker et al. (2019), Kumar & Goyal (2016), Yang & Zhu (2016), Mishra & Metilda (2015), Hassan, Khalid & Habib (2014), Prasad & Mohta (2012), Santos et al. (2010), Dahlbom et al. (2010), Endres, Chowdhury & Alam (2008), Bhandari & Deaves (2006) and Pulford & Colman (1997).

Beckmann & Menkhoff (2008) found only an insignificantly higher tendency towards overconfidence in men, while Hardies, Breesch & Branson (2013) demonstrated that the differences in overconfidence between women and men are less significant than the differences in risk appetite. Specifically, men exhibited a significantly higher willingness to take risks in comparison to women. Conversely, D'Acunto (2015) found that men exhibited both significantly more overconfidence and a stronger willingness to take risks compared to women.

Hardies, Breesch & Branson (2011) found no gender differences among auditors with regard to their tendency to overconfidence. Similarly, no gender disparities in the extent of overconfidence were found among actors in the Indonesian (Kufepaksi, 2011) and Indian (Kansal & Singh, 2018) capital markets. García, Gómez & Vila (2022) arrived at comparable conclusions.

Nguyen, Lawrence & Wick (2024), Schiel (2023) and Kim, Lee & Kim (2022) came to the opposite conclusion that women are even more prone to overconfidence than men.

Despite the absence of a consensus, there is compelling empirical evidence suggesting that the propensity for overconfidence is less pronounced in women compared to men.

This observation forms the basis for the second hypothesis of this study. We expect that women's confidence in their own share price forecasts is not negatively correlated (or at least to a lesser extent than men's) with their specialist knowledge and experience. An operationalized formulation of the hypothesis is provided as part of the presentation of the experimental design in the subsequent chapter.

Experimental design and hypotheses

The objective of the present study is to assess whether subjects feel more confident about their share price forecasts the less stock market-relevant knowledge and experience they have. This research question shall be answered through a laboratory experiment. On the one hand, it is therefore necessary to task the subjects to make a number of share price forecasts and to ask them in each case how confident they feel in their forecasts. On the other hand, the extent of capital market-relevant knowledge and experience must be determined. The spectrum ranges from subjects with an affinity for capital markets, who have already acquired a considerable amount of stock market knowledge through their professional interest or their own investment activities on the capital markets, to subjects who are distant from the capital markets and have acquired very little relevant knowledge to date.

In the initial phase of the experiment, respondents are asked to predict whether the share price of Adidas AG will rise or not rise over the next four months (from mid-November 2024 to the end of March 2025). Following this prediction, subjects are then asked to rate their confidence in their forecast on a Likert scale ranging from 1 (very unsure) to 10 (very sure). This procedure is repeated twice. Following the completion of the Adidas share price forecast and the related confidence evaluation, the subjects make forecasts (rising or not rising) for the Apple share and for the Netflix share and then record their corresponding subjective level of confidence on a Likert scale for each of them.

To provide the subjects with an impression of the share price performance over the course of the year, the share price at the beginning of the year (2 January 2024) and at the commencement of the laboratory experiment (11 November 2024) is presented. In addition, the percentage change in the share price from 2 January 2024 to 11 November 2024 is provided (see Appendix 2).

We decided to not request that the subjects provide point forecasts and/or confidence intervals, with the objective being to ensure that even respondents with no affinity for the capital market would find the forecasting task accessible. In the selection of the stocks, it was imperative that the companies were large, well-known entities whose products are likely to be familiar to the subjects from their everyday lives. This decision was made with the intention of facilitating access, particularly for respondents with no capital market experience. The requirement for three forecasts stems from the objective for ensuring

that the individual confidence levels recorded are not dependent on a single share. At the same time, we do not require more than three forecasts in order to prevent the subjects from thinking of diversifying their answers in the course of the experiment. When asking for significantly more than three forecasts, the subjects could potentially get the impression that they would expose themselves too much if they always selected a high value on the Likert scale. This could lead to a shift in subjects' behaviors, resulting in a more defensive approach over time. This, in turn, could introduce distortions into the experimental results.

In addition to recording the subjective confidence in forecasting share prices, the subjects' stock market-relevant knowledge and experience must also be assessed. For this purpose, the respondents have to answer 50 technical questions, each with six alternative answers. The subjects have a maximum time limit of one minute per question. A total of 300 multiple-choice questions were created, each with six alternative answers. These questions were grouped into three levels of difficulty: low, medium and high. This categorization was based on the average ratings of the six participating authors.

A random generator selects 50 questions for each participant. In this way, it is virtually impossible for respondents to give meaningful hints about the technical questions to other subjects who participate at a later time. The random generator ensures that each respondent receives 20 easy questions, 19 medium questions and eleven difficult questions. This prevents a participant from receiving a large number of difficult questions or a large number of easy questions. The percentages are derived from the composition of the entire 300 question catalog, which contains 40% easy, 38% medium and 22% difficult questions.

The following example illustrates a question categorized as easy: What is the name of the CEO of the well-known US electric car manufacturer TESLA? The answers to choose from are as follows: a) Donald Trump, b) George D. Tesla, c) Barrack Obama, d) Ralph Fiennes, e) Elon Musk or f) Bruno Mars. The following is an example of a difficult technical question: What does "CSRD" stand for in the context of corporate reporting? a) Centralized System for Risk Detection, b) Comprehensive Shareholder Rights Document, c) Corporate Sustainability Reporting Directive, d) Customer Service Regulation Directive, e) Certified Sustainability Reporting Database or f) Critical Success Rate Determination. Participants receive €0.20 for each correct answer. In addition to the show-up fee of €10.00, participants can earn a maximum of a an additional €10.00 (50 · €0.20) depending on their performance. This incentive structure is certainly effective in capturing capital market-relevant knowledge and experience.

In this manner, two values can be determined for each respondent: 1. the mean level of subjective confidence (y) regarding the three share price forecasts made (with $1 \leq y \leq 10$). 2. the extent of capital market-relevant specialist and empirical knowledge (x), which is approximated by the number of correctly answered technical questions (with $0 \leq x \leq 50$).

The point cloud of the x-y value pairs of all subjects provides information on whether the initial consideration is correct or not. The initial consideration is as follows: the subjects are all the more certain that their share price forecasts will prove to be correct the less stock market-relevant specialist and empirical knowledge they have.

This leads to hypothesis 1: There is a significant negative correlation between the extent of capital market-relevant knowledge and experience (x) and the average level of subjective forecasting confidence (y).

Null hypothesis 1 is therefore: There is no significant negative correlation between the extent of capital market-relevant knowledge and experience (x) and the average level of subjective forecasting confidence (y).

In light of the extant research on gender-specific differences in the tendency to overestimate oneself, we expect that the correlation described in hypothesis 1 will not occur among the female participants in the laboratory experiment.

Hypothesis 2 therefore states: Among women, there is no significant negative correlation between the extent of capital market-relevant knowledge and experience (x) and the average level of subjective forecasting confidence (y).

This leads to the null hypothesis 2: Among women, there is a significant negative correlation between the extent of capital market-relevant knowledge and experience (x) and the average level of subjective forecasting confidence (y).

The experimental survey is conducted as follows: The subjects are seated at their assigned computer in the Ostfalia Laboratory for Experimental Economic Research (OLEW), where they deposit their smartphones and smartwatches in mesh baskets that are both clearly visible and controllable by the supervisors during the experiment. This measure is implemented to prevent the subjects from utilizing external resources to answer the knowledge questions. The subjects then read the instructions for the game, which guide them in submitting their share price forecasts. They then submit their first share price prediction (indicating whether the Adidas share will rise or not) and rate their subjective confidence that this forecast will materialize. This process is repeated twice more, first for the Apple share and then for the Netflix share (see Appendix 2 for further details). Subsequent to the completion of this task, the subjects read the instructions for the 50 technical questions and respond to the control question (see Appendix 2). Thereafter, the answering of the 50 technical questions commences. Finally, demographic data is collected and the rewards are disbursed.

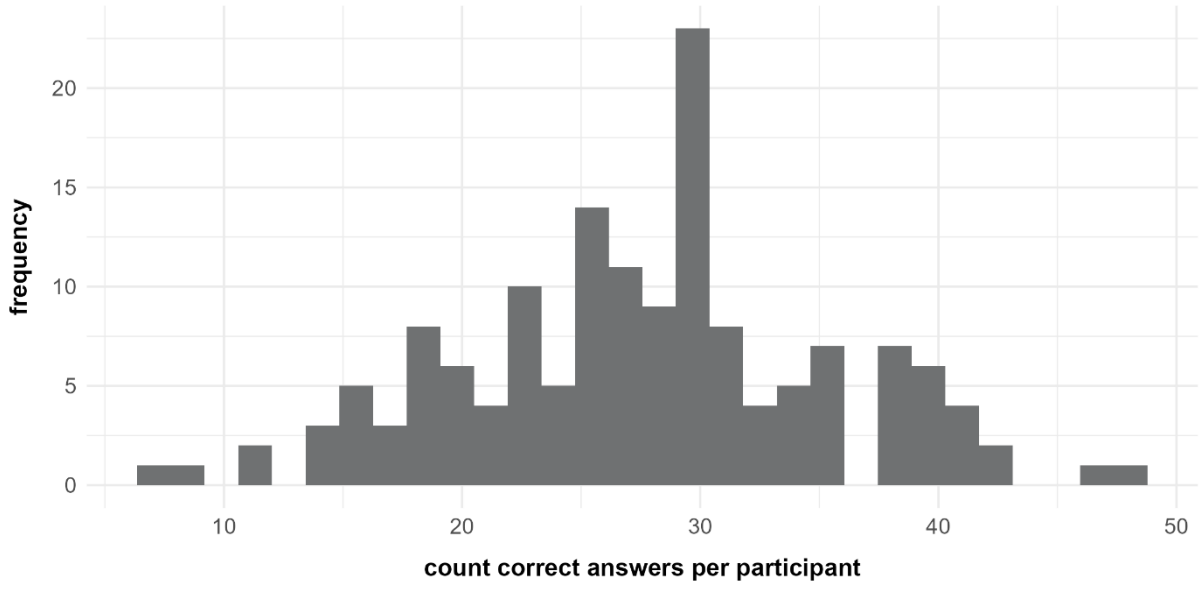
The experiment is programmed and executed using the software "z-Tree" (Fischbacher, 2007).

Results

The laboratory experiment was conducted from 13 November 2024 to 22 November 2024 in the Ostfalia Laboratory for Experimental Economic Research (OLEW) with a total of 150 subjects (98 male [65.3%], 50 female [33.3%], two non-binary [1.3%]). 115 subjects are students of the Faculty of Business (76.7%), 18 subjects are students of the Faculty of Automotive Engineering (12.0%), eleven subjects are students of the Faculty of Computer Science (7.3%) and six subjects are students of other faculties (4.0%) at Ostfalia University of Applied Sciences. 132 subjects are enrolled in a Bachelor's degree program (88.0%), while 16 are enrolled in a Master's degree program (10.7%) and two participants (1.3%) did not provide any information regarding their academic status. The average age of the subjects was 23.2 years. 75 subjects (50.0%) took part in an economic experiment for the first time. 64 subjects (42.7%) took part in an economic experiment for the second time. Nine subjects (6.0%) took part in an economic experiment for the third time. Two subjects (1.3%) already had more experience with economic laboratory experiments.

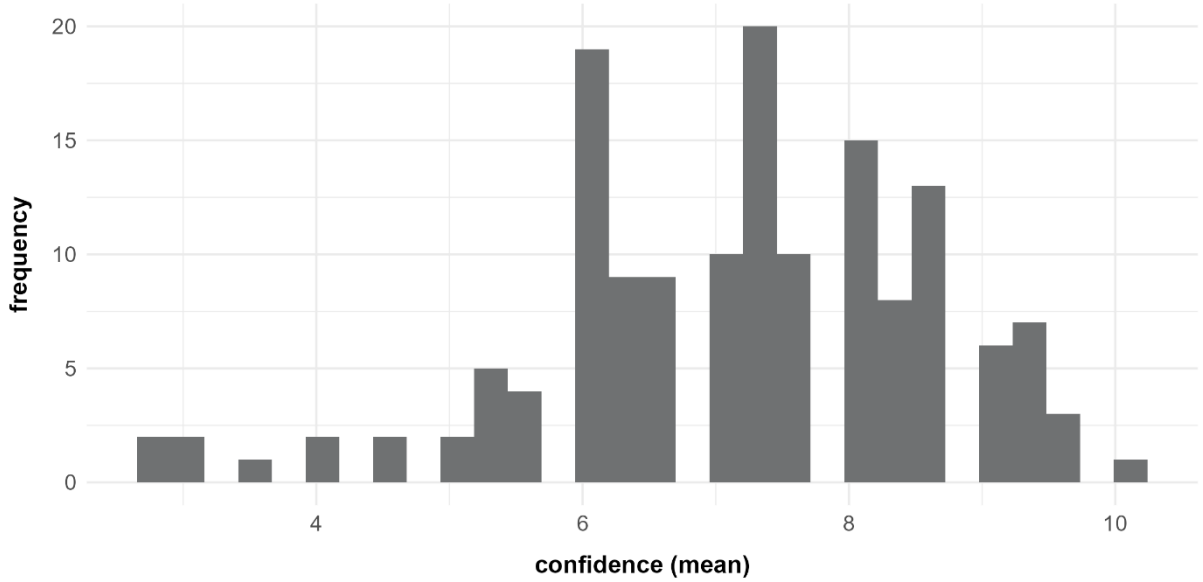
The distribution of responses to the 50 technical questions ranged from a minimum of seven correct answers (14.0%) to a maximum of 48 (96.0%), indicating a substantial spread that is essential for the planned data analysis (see Figure 1). If there had been a strong clustering in a narrow range of points (e.g. in the range of 20 to 25 points), it would have been considerably more difficult to achieve significant results. The selection of questions and the weighting of the difficulty levels were thus deemed adequate. On average, 27.6 of the 50 questions (55.2%) were answered correctly.

Figure 1: Histogram of the number of correct answers



The mean subjective confidence that each of the three share price forecasts will come true also demonstrates a reasonable spread (see Figure 2). The lowest arithmetic mean value is 2.67, while the highest arithmetic mean value is 10.0.

Figure 2: Histogram of subjective confidence (arithmetic mean)



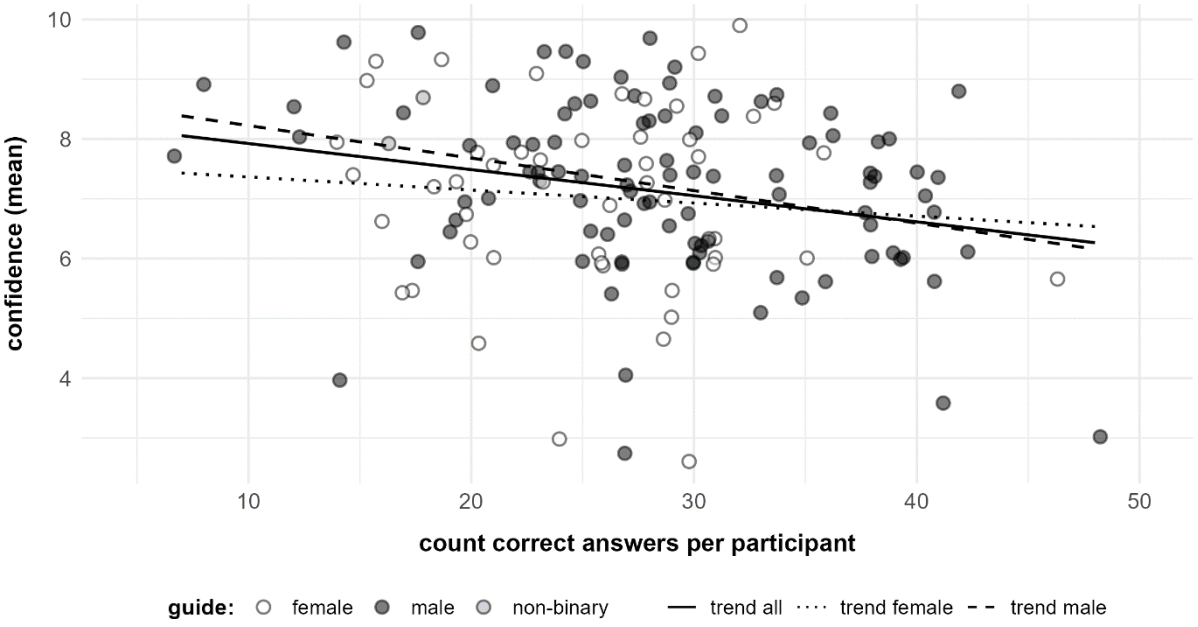
The share price forecasts (rising or non-rising) are quite different among the three shares (see Table 1). Specifically, a rising share price is projected for Apple shares, with approximately three-quarters of respondents (75.33%) anticipating an increase in Apple's share price during the period between 11 November 2024 and 31 March 2025. In contrast, there is a greater degree of skepticism concerning Netflix shares. Only slightly more than half of the respondents (52.67%) anticipate an increase in Netflix's share price during the aforementioned period.

Table 1: Share price forecasts and subjective confidence

Share	Adidas	Apple	Netflix
Percentage of the forecast "share price rises"	68.67%	75.33%	52.67%
Percentage of the forecast "share price falls or stays the same"	31.33%	24.67%	47.33%
Average level of subjective confidence	6.79	7.55	7.13

The substantial variability observed in the scatterplot indicates only a modest correlation between subjective confidence and the available specialist knowledge and experience (see Figure 3). However, this correlation actually aligns with hypothesis 1. The rank correlation analysis according to Spearman (Spearman, 1906; Spearman, 1904) reveals that when all 150 x-y value pairs are considered, there is a statistically significant relationship. With a probability of error of less than 1%, a negative correlation is observed between the extent of capital market-relevant expertise and experience (x) and the average level of subjective forecast confidence (y) (rho = -0.218; p-value = 0.007). However, it should be noted that there are ties (i.e., a lack of differentiation due to equal scores) in the ranks. This indicates that the p-value of the Spearman approach is only an approximation. A total of 19 ties were observed for the variable "subjective forecast confidence", while 28 ties were recorded for the variable "expertise and experience". Given the substantial number of ties, it is advisable to also consider the Kendall's tau correlation (Kendall, 1949; Kendall, 1962; Kendall & Gibbons, 1990). Similarly, this analysis reveals a negative correlation between the extent of capital market-relevant expertise and experience (x) and the average level of subjective forecast confidence (y) with a probability of error less than 1% (tau = -0.157; p-value = 0.007) when all 150 x-y value pairs are considered.

Figure 3: Scatterplot (number of correct answers / subjective confidence)



Therefore, null hypothesis 1 must be rejected. It can therefore be assumed that subjects feel more confident about their share price forecasts the weaker their capital market-specific specialist and empirical knowledge is.

It is irrelevant whether the arithmetic mean or the median is used as the central measure of confidence when calculating Spearman's rho and Kendall's tau. Regardless of the chosen metric, there is a negative correlation between subjective forecasting confidence and stock market-relevant knowledge and experience. The probability of error is less than 1% in any case (see Table 2). The lower the level of stock market knowledge, the more confident the respondents are with their share price forecasts.

Table 2: Median versus arithmetic mean as a measure of confidence

Point measure of confidence	n	Spearman's rho	Spearman's rho p-value	Kendall's tau	Kendall's tau p-value
Arithmetic mean	150	-0.218	0.007	-0.157	0.007
Median	150	-0.214	0.009	-0.159	0.009

Given the negligible differences observed when employing the arithmetic mean or the median as the central measure of confidence, all subsequent evaluations are based on the arithmetic mean.

Robustness tests, including outlier analysis with the removal of potentially problematic outliers, bootstrapping procedures and permutation tests substantiate the reliability and robustness of these findings (see Appendix 1).

A particularly noteworthy aspect of the data analysis is the differentiation of the x-y value pairs by gender, as illustrated in Figure 3. The dark gray dots represent the x-y value pairs of the 98 male subjects. The white dots represent the x-y value pairs of the 50 female subjects. The light gray dots represent the x-y value pairs of the two non-binary subjects for whom no correlation was calculated due to an insufficient amount of data.

The dashed black regression line represents the regression line of the x-y value pairs of the 98 male subjects. Its course demonstrates a slightly more negative slope. The rank correlation according to Spearman reveals that these 98 x-y value pairs exhibit a negative correlation with a probability of error less than 1% (rho = -0.300; p-value = 0.003). This outcome is confirmed by Kendall's tau (tau = -0.217; p-value = 0.003). In contrast, the dotted black regression line representing the x-y value pairs of the 50 female subjects displays a less pronounced negative slope. A subsequent Spearman's rank correlation analysis reveals that these 50 x-y value pairs demonstrate a correlation that does not differ significantly from zero (rho = -0.058; p-value = 0.691). This result is once again confirmed by Kendall's tau (tau = -0.040; p-value = 0.698). Therefore, the null hypothesis 2 must be rejected. The findings indicate an absence of a significant correlation between

the subjective confidence in the accuracy of share price forecasts and the level of capital market-specific knowledge and experience among women (see Table 3).

Table 3: Differences between male and female subjects

Gender	n	Spearman's rho	Spearman's rho p-value	Kendall's tau	Kendall's tau p-value
Male	98	-0.300	0.003	-0.217	0.003
Female	50	-0.058	0.691	-0.040	0.698

These results are also verified through additional robustness tests, such as the bootstrapping method and permutation tests, which support their reliability and robustness (see Appendix 1).

It is important to note that this study does not examine the existence of the overconfidence bias or the Dunning-Kruger effect. Instead, the overconfidence literature and the literature on the Dunning-Kruger effect serve as a foundation for the research question. The central research question guiding this study is as follows: Does a higher degree of ignorance lead to a higher subjective confidence in making assessments – in this case, share price forecasts? The results of this study are clear: this is the case for men, but not for women.

Summary

Everyday experience occasionally gives rise to the assumption that especially unsuspecting people feel particularly confident in their judgment. Empirical research has yielded a substantial body of evidence suggesting that many people tend to overestimate themselves (overconfidence bias). Incompetent people in particular may be susceptible to overconfidence, as they lack the ability to metacognize. They are unable to recognize their own incompetence because they lack the necessary knowledge (Dunning-Kruger effect).

The present study poses the question of whether economic subjects exhibit greater confidence in their share price forecasts when they are less knowledgeable about the capital markets. This research question is examined as part of a controlled laboratory experiment.

A total of 150 subjects were tasked with making three share price forecasts and subsequently indicated their self-rated confidence in the accuracy of their forecasts

using a Likert scale. Following this, the subjects were required to respond to 50 technical questions designed to assess their expertise in the domain of the capital market. The number of correct answers given by the subjects served as an indicator of their existing specialist knowledge and experience relevant to the capital market.

A comparison of subjective forecasting confidence and capital market-relevant specialist and empirical knowledge indeed demonstrates that the respondents with less capital market knowledge exhibit greater confidence in their forecasts.

Furthermore, noteworthy distinctions between male and female subjects are evident. For male subjects, the observed correlation is clearly identifiable and statistically significant. In contrast, for female subjects, the negative correlation between subjective forecasting confidence and capital market-relevant knowledge and experience is less pronounced and does not reach statistical significance.

Consequently, it can be inferred that men should particularly heed the adage attributed to Confucius, which asserts that real knowledge is to know the extent of one's ignorance.

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The creation of the 300 multiple-choice questions, including the six answer options, employed in the experiment as described in the manuscript, was partially supported by the use of perplexity.ai. The authors carefully reviewed and validated the AI-generated output and take responsibility for its accuracy and relevance.

Data availability

The underlying experimental data for this study can be found here: https://doi.org/10.25625/7UT793

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Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix 1: Additional robustness tests

Outlier analysis with removal of potentially problematic outliers

Upon examination of the stock market-relevant expertise and experience, two upward outliers and two downward outliers were identified (see Figure 4). Data points that are more than 1.5 interquartile ranges below the 1st quartile or more than 1.5 interquartile ranges above the 3rd quartile can be regarded as outliers (cf. Chambers et al., 1983). The two upward outliers, on the one hand, are certainly not random events, but rather an expression of the high level of technical competence of the two subjects. The two downward outliers, on the other hand, are possibly of a problematic nature. These are two subjects who did not learn the language in which the technical questions were presented during the experiment (German) as their mother tongue. However, these two subjects are also able to cope with studying in the language of these questions. Nevertheless, it cannot be entirely ruled out that their limited performance in answering the technical questions is attributable to their language limitations, which might have hindered their comprehension of the questions. As these two subjects indicated a high level of subjective predictive confidence, it cannot be completely dismissed that the results of the correlation analyses are distorted by these two outliers.

Figure 4: Boxplot of the number of correct answers to the 50 technical questions

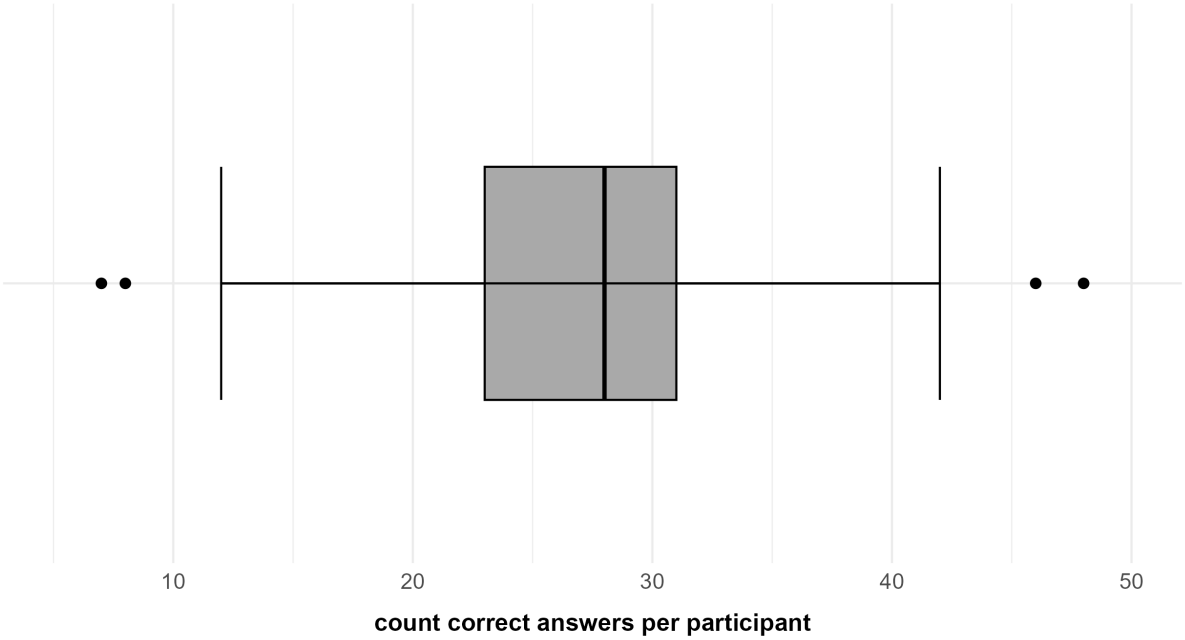


Table 4: Correlations after removing the outliers

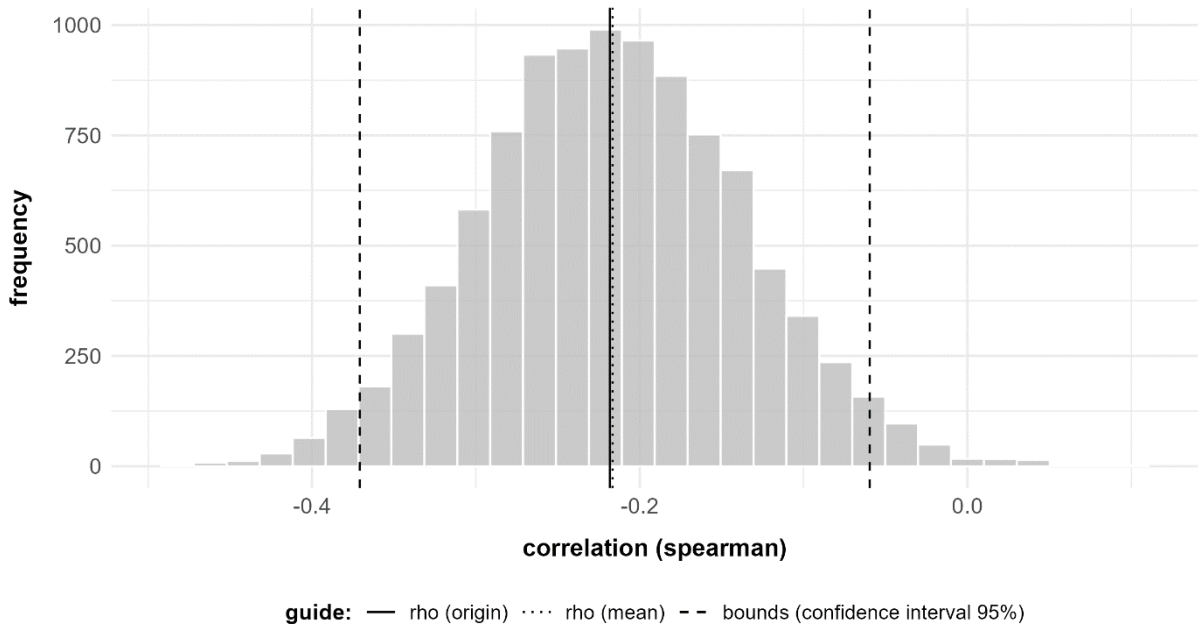
n	Spearman's rho	Spearman's rho p-value	Kendall's tau	Kendall's tau p-value
148	-0.202	0.014	-0.147	0.012

The removal of the two potentially problematic outliers leads to results that largely confirm the outcomes without the removal of outliers. With a probability of error of less than 5%, a significant negative correlation is evident between stock market-relevant knowledge and experience on the one hand and subjective forecasting confidence on the other.

Bootstrapping procedure

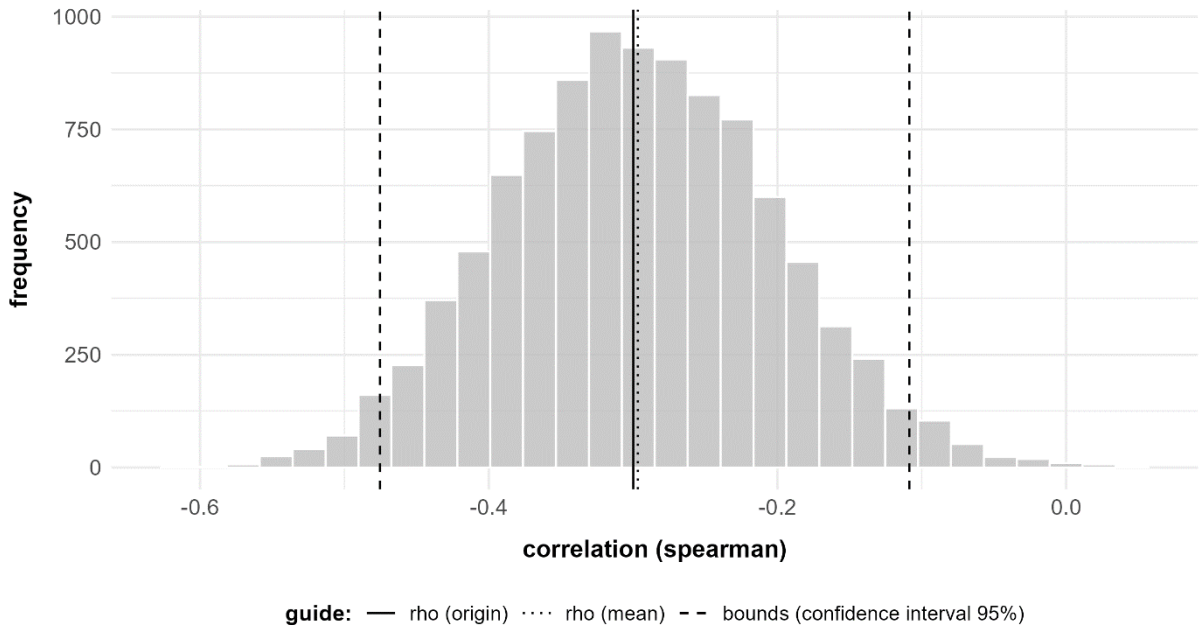
Bootstrapping is another method of assessing the reliability of results by drawing numerous random samples (10,000 in this case) with backing and calculating the correlation coefficient. A confidence interval (95%) is then determined. If this interval includes zero, the results are deemed to be significantly influenced by the original sample. This could be indicative of a random correlation (see Manly, 2018). However, as evidenced in Figures 5 and 6, this is not the case in the present context. The results obtained thus far prove to be robust.

Figure 5: Distribution of the Spearman correlation (bootstrapping) for all subjects



Confidence interval 95% bootstrapping (dashed lines) ranging from -0.371 to -0.060
Mean Spearman correlation of bootstrapping (dotted line): -0.217
Original Spearman correlation (solid line): -0.218

Figure 6: Distribution of the Spearman correlation (bootstrapping) for the male subjects



Confidence interval 95% bootstrapping (dashed lines) ranging from -0.475 to -0.109
Mean Spearman correlation of bootstrapping (dotted line): -0.297
Original Spearman correlation (solid line): -0.300

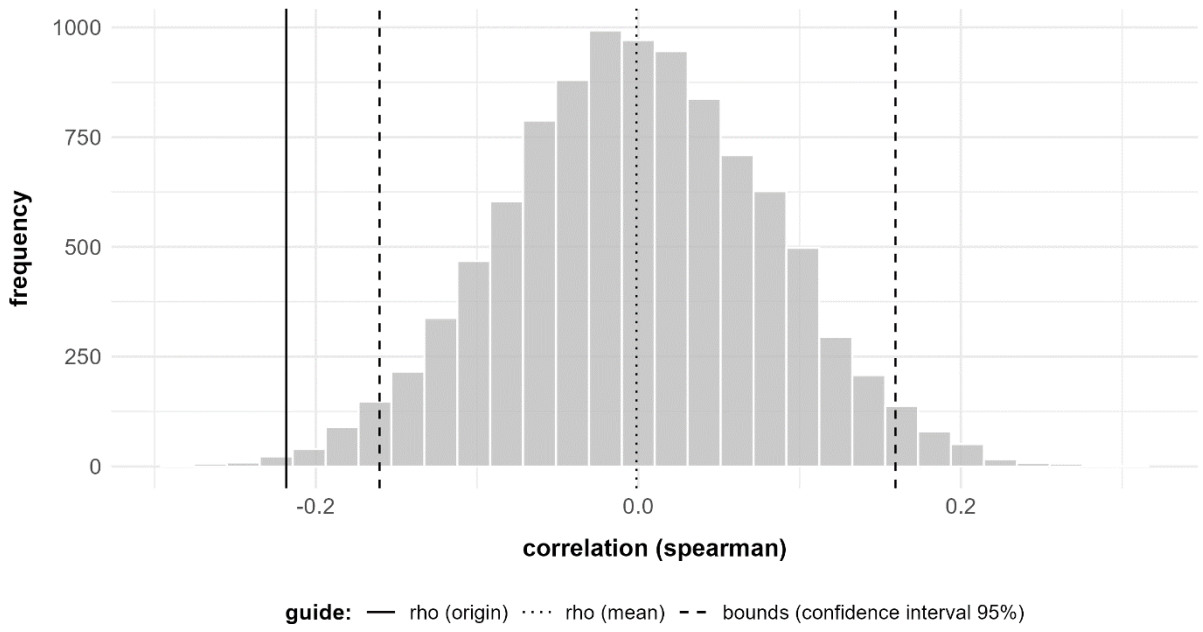
Permutation tests

A permutation test is a statistical method used to verify the statistical significance of a correlation. For this purpose, the order of the values of one of the variables is randomly shuffled repeatedly (in this case 10,000 times), while the order of the other variable remains unchanged. This process creates random pairings of the variables. The calculation of the correlation coefficient for each of these random pairings serves to model the distribution of correlations under the null hypothesis ("no correlation") (see Collingridge, 2013).

The permutation results provide a zero distribution of the correlation coefficients. If the observed correlation falls within the central 95% of this distribution, it is indicative of the possibility that the correlation could be random. Conversely, if the observed correlation falls within the extreme ranges (the upper or lower 2.5%), it is indicative of a significant correlation.

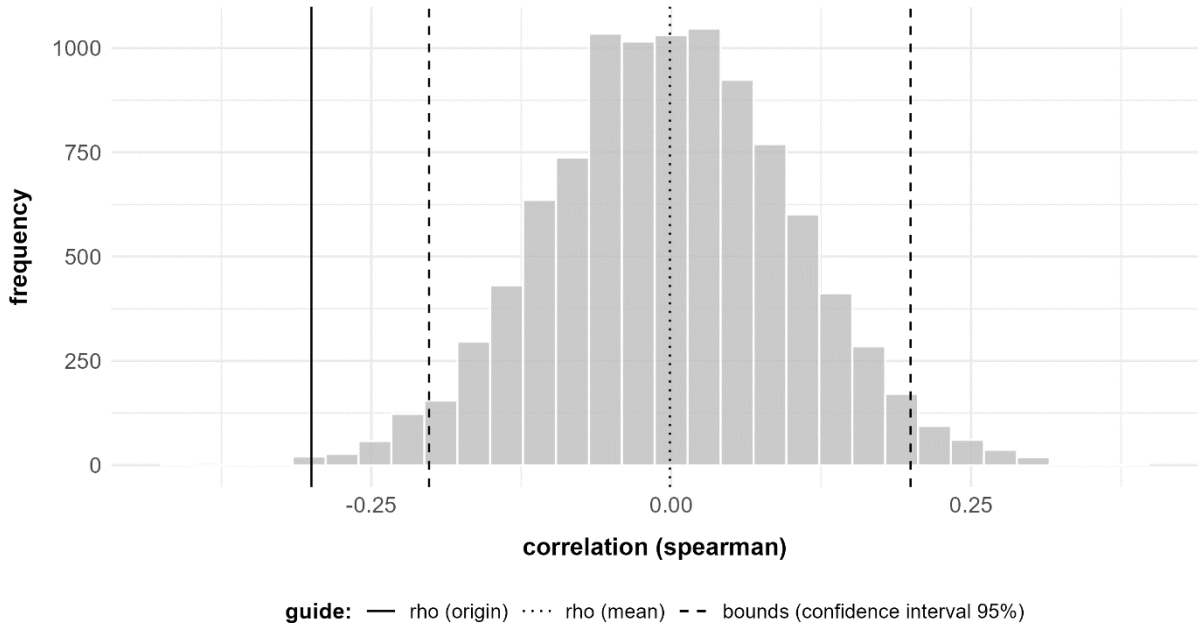
Subsequently, a p-value is calculated, which quantifies the likelihood of obtaining the observed correlation (or a more extreme one) under the null hypothesis (no correlation). If the p-value is less than a specified significance level (e.g. 5%), the null hypothesis is rejected and the correlation between the two variables can be considered significant.

Figure 7: Distribution of Spearman correlations in the permutation test for all subjects



Confidence interval 95% permutation test (dashed lines) ranging from -0.160 to 0.159
Mean Spearman correlation of the permutations (dotted line): -0.001
Original Spearman correlation (solid line): -0.218

Figure 8: Distribution of Spearman correlations in the permutation test for the male subjects



Confidence interval 95% for permutation test (dashed lines) ranging from -0.202 to 0.199
Mean Spearman correlation of the permutations (dotted line): -0.001
Original Spearman correlation (solid line): -0.300

As illustrated by Figure 8, the observed correlations lie outside the central 95% of this distribution. This indicates that the correlation is not random and that there is a significant correlation. The p-value of the permutation test for all subjects is 0.006. The p-value of the permutation test for the male subjects is 0.003.

Appendix 2: Presentation of the economic experiment

Task 1

Your task

In this task, you will be presented with three different investment options in which one can invest money on the capital markets.

The following information will be provided for each investment option:

- The price at which the investment option was traded on the capital markets at the beginning of this year (reporting date: 02.01.2024).
- The price at which the investment option is currently traded (approx., reporting date: 11.11.2024).
- The percentage change in the price of the investment option between the above two reporting dates.

For each of these three investment options, you must then make a forecast as to whether you think the respective share price will rise, fall or remain the same in the coming months (reporting date: 31.03.2025).

For each of your forecasts, you must also give an assessment on a scale of 1 (very unsure) to 10 (very sure) of how certain you are about your forecast.

Forecast screen 1

Forecast 1: Adidas AG

Ticker: ADS | WKN: A1EWWW | ISIN: DE000A1EWWW0

This investment option has developed as follows since the beginning of the year:

Price at the beginning of the year (reporting date: 02.01.2024)	Current price (approx., reporting date: 11.11.2024)	Percentage change since the beginning of the year
182.22 EUR	223.30 EUR	+22.54%

Please now enter your forecast as to whether you think the price of the above investment option will rise, fall or remain the same in the coming months (reporting date: 31.03.2025):

Price rises O O Price falls or remains the same

Screen for recording subjective confidence with forecast 1

How sure are you about the forecast you have just made?

Very unsure O O O O O O O O O O Very sure

Forecast screen 2

Forecast 2: Apple, Inc.

Ticker: AAPL | WKN: 865985 | ISIN: US0378331005

This investment option has developed as follows since the beginning of the year:

Price at the beginning of the year (reporting date: 02.01.2024)	Current price (approx., reporting date: 11.11.2024)	Percentage change since the beginning of the year
169.28 EUR	209.40 EUR	+23.70%

Please now enter your forecast as to whether you think the price of the above investment option will rise, fall or remain the same in the coming months (reporting date: 31.03.2025):

Price rises O O Price falls or remains the same

Screen for recording subjective confidence with forecast 2

How sure are you about the forecast you have just made?

Very unsure O O O O O O O O O O Very sure

Forecast screen 3

Forecast 3: Netflix, Inc.

Ticker: NFLX | WKN: 552484 | ISIN: US64110L1061

This investment option has developed as follows since the beginning of the year:

Price at the beginning of the year (reporting date: 02.01.2024)	Current price (approx., reporting date: 11.11.2024)	Percentage change since the beginning of the year
439.70 EUR	744.70 EUR	+69.37%

Please now enter your forecast as to whether you think the price of the above investment option will rise, fall or remain the same in the coming months (reporting date: 31.03.2025):

Price rises O O Price falls or remains the same

Screen for recording subjective confidence with forecast 3

How sure are you about the forecast you have just made?

Very unsure O O O O O O O O O O Very sure

Task 2

Your task

In this task, you will be presented with 50 different questions on various aspects of financial and capital markets.

There are 6 different answer options available for each question.

There will always be only one correct answer option.

Your goal is to answer as many questions correctly as possible.

At the end of the experiment, you will receive EUR 0.20 for each correctly answered question.

For each question, you have a time limit of 60 seconds to enter your answer.

Important! <u>You must confirm your answer by clicking OK before the time limit expires!</u> If the time limit expires before then, your answer will not be counted and you will not receive any payment for it.

You can change your answer at any time before clicking OK or before the time limit expires. You will then automatically be shown the next question.

Control question

<u>Control question:</u> What payment do you receive for each correctly answered question?

O 0.20 EUR (Correct!)

O 0.50 EUR

O 1.00 EUR

Answering the 50 technical questions (exemplary presentation of one question)

Remaining time [in seconds]: **60**

Question 1 of 50

What is stock picking?

O A method for inventory management in high-frequency trading

O An automated trading system

O The selection of individual stocks based on their expected performance (Correct!)

O A technique for market manipulation

O The alternative method of calculating an index for share prices according to Howard Stock

O A form of dividend payment from the financial basis of a company