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TECHNICAL ANALYSIS GIVES YOU COURAGE, BUT NOT MONEY – ON THE RELATIONSHIP BETWEEN TECHNICAL ANALYSIS USAGE, OVERCONFIDENCE AND INVESTMENT PERFORMANCE

This paper investigates the psychological background of the use of technical analysis in the financial markets. Such a background may give additional explanations to the popularity and common usage of technical analysis as an investment decision tool. This popularity is puzzling due to the missing theoretical and scientific background of technical analysis and the contradictory empirical evidence on its effectiveness. We postulate that overconfidence (regardless of its manifestation: calibration, better than average, and illusion of control) reinforces technical analysis usage. This hypothesis is tested in the present study conducted with professionals (traders in a proprietary trading company) and novices (finance students). The hypothesis received partial empirical support. Overconfidence – in particular the illusion of control – explains technical analysis usage in both investigated groups.

Keywords: overconfidence, calibration effect, illusion of control, better than average, technical analysis
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1. INTRODUCTION

Technical analysis is a very popular method among investors, regardless of the lack of the systematic profitability postulated by each form of the Efficient Market Hypothesis (Fama, 1970). Starting from the earliest times, some empirical studies proved the lack of profitability of technical analysis methods. Fama and Blume (1966) showed that a stocks portfolio strategy based on filtering is not more profitable then the buy and hold strategy. James (1968) also pointed out that moving average rules could not beat the buy and hold strategy for US stocks (CRSP US Stock Databases). However, Smidt (1965) investigated the futures market and found that about 70% of trading rules tested on soybean futures contracts gave positive returns after

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commissions. One of the earliest studies of the forex market was conducted by Cornell and Dietrich (1978), who investigated six spot foreign currencies (mark, pound, yen, Canadian dollar, Swiss franc, and Dutch guilder), and they found that technical analysis models were more profitable then buy and hold strategies. In the most recent studies Hoffmann and Shefrin (2014) based on transaction records and questionnaire survey of Dutch discount brokerage clients, found that individual investors who use technical analysis earn lower returns. On the other hand, by examining more than one thousand moving average and momentum models for the yen/dollar exchange rate in the years 1976 to 2007, Schulmeister (2009) showed that systematically extended reactions to information can be profitably explored by technical analysis methods.

A literature review shows mixed results about the profitability of technical analysis methods, partially due to methodological problems, e.g. data snooping, ex post evaluation of models, and estimation of transaction costs. Nevertheless, in general studies since the 1960s have indicated that technical analysis may be profitable in forex and futures markets, but not at the stock exchange. These findings coincide with the Adaptive Market Hypothesis proposed by Lo (2004), which amalgamates behavioral and classical theories in finance. Lo states that the effectiveness of investment strategies depends on the investment environment, so some techniques can be profitable in forex or futures markets, but not in stock markets.

Attempts have been made to explain the popularity of technical analysis methods by psychological and behavioral factors (Zielonka 2002, 2004; Vasiliou, Eriotis and Papathanasiou, 2008). Academics, who were skeptical about the role of technical analysis while making investment decisions now agree that markets are inefficient, and investors are in practice irrational. They are moving from the Efficient Market Hypothesis towards the psychological and behavioral influences on stock-price determination. For example, they argue that technical analysis can work as a self-fulfilling prophecy if a large group of investors follows its signals (Merton, 1948). The behavior of noise traders create profitable trading opportunities that can be exploited by technical analysis tools (De Long et al., 1990). Menkhoff and Taylor (2007) provide an excellent summary of the popularity of technical analysis among traders; they call it “obstinate passion” to emphasize the strength of the phenomena. Technical analysis is treated as a tool for processing information from both fundamental and non-fundamental influences (Kubińska, Czupryna, Markiewicz and Czekaj 2017).

The cited literature shows that the popularity and effectiveness of technical analysis methods is linked to psychological factors. We presume that overconfidence is an important bias that affects the attitude towards technical analysis. The goal of this article is to examine the relationship between the trader's subjective confidence in his or her judgments and the propensity to use technical analysis models and believe in their effectiveness. Section 2 is devoted to the overconfidence bias and its various manifestations. Section 3 presents the study data sets and describes the variables used to measure overconfidence and attitudes towards technical analysis on the individual level. Section 4 provides verification of the hypotheses and Section 5 presents the conclusions.

2. OVERCONFIDENCE AND TECHNICAL ANALYSIS

Being overconfident means possessing inaccurate, overly positive perception of one's knowledge or ability compared to objective criteria (Larrick, Burson, and Soll, 2007; Moore and Healy, 2008). The concept of overconfidence has been discussed widely in the psychological literature. It is one of the most often identified propensities among investors (Tyszka and Zielonka 2002; Tetlock 2001; Kubińska and Markiewicz, 2013; Markiewicz and Weber, 2013; Michailova, 2010, Deaves, Lüders and Luo, 2009). In the early studies, it was documented that experts show more overconfidence than laymen and novice investors (Cabak, 2013; Kaustia and Perttula, 2012; Lin and Bier, 2008; McKenzie, Liersch and Yaniv, 2008; Russo and Schoemaker, 1992; Tyszka and Zielonka, 2002, Szyszka, 2013). Other research has shown that people are more confident of their predictions in domains for which they have self-declared expertise (see also Tyszka and Zielonka, 2002; Klayman, Soll, González-Vallejo and Barlas, 1999; Larrick, Burson and Soll, 2007).

However, while some authors believe that these overconfidence manifestations share a common psychological bias that could be related to overconfidence (Larrick et al., 2007), others suggest there are various operationalizations of overconfidence that differ in important ways and are not necessarily interchangeable measures of the same construct (Moore, 2007; Moore and Healy, 2008). Existing research suggests several overconfidence manifestations. The calibration effect is an excessive certainty regarding the accuracy of one's belief, leading to setting overly narrow confidence intervals (Lichtenstein, Fischhoff, and Phillips, 1982).

The better than average effect was introduced by Svenson (1981) in a study that showed that individuals believed themselves to be better than others, even when they are not.Dunning, Heath, and Suls (2004) provide a variety of better than average effect examples in other domains. This effect is also called overplacement (Moore, 2007). The last form of overconfidence is the illusion of control; described in a study where the participants had an expectancy of success much higher than the objective probability (Langer, 1975; Alloy and Abramson, 1979). The illusion of control can also be seen as a special case of overestimation, where people overestimate their level of control, when in fact the control is low (Moore, 2007). Based on the literature review, three forms of overconfidence are considered: (1) the calibration effect, (2) the illusion of control, and (3) the better than average effect.

Investors' tendency to use technical analysis methods and their belief in the profitability of this investment tool might be associated with all of the above-mentioned forms of overconfidence. Overconfidence has a trait-related component that develops before anyone learns technical analysis methods, so it is more probable that overconfident investors choose technical analysis rather than the opposite causal relationship. However, it still might be possible that technical analysis usage develops overconfidence among investors, reinforcing the hypothesized correlation. Menkhoff and Taylor (2007) give as one of the reasons for the popularity of technical analysis methods among foreign exchange professionals the supposition that technical analysis can be an indicator of not fully rational behavior. As one example they listed the underestimation of risk involved in transactions. In fact, some authors (Fenton-O'Creevy, Nicholson, Soane, and Willman, 2003) argue that overconfidence in all forms causes "insensitivity to feedback, impedes learning, and predisposes toward greater objective risk-taking (since subjective risk will be reduced by the illusion of control)". Other studies support this notion, stressing that illusion of control is related to lower risk perception (Houghton, Simon, Aquino, and Goldberg, 2000) and higher risk-taking (Fellner, 2009; Kubińska and Markiewicz, 2012a, 2012b, 2013). Additional studies link overconfidence with other negative consequences such as excessive trading (Barber and Odean, 2000; Barber and Odean, 2001a, 2001b, 2002; Lin and Bier, 2008) or portfolio under diversification (Markiewicz, 2011). In the next section, we relate the specific overconfidence manifestations with the use of technical analysis.

(1) Overconfidence in the form of the calibration effect is directly related to the underestimation of financial risk, measured by the variance of returns

(Glaser and Weber, 2007; Hilton, 2001). As a result this makes investors less effective in terms of the monetary yield brought by them, and less capable of effective risk management. Underestimation of financial risk is assumed to be one of the reasons for common technical analysis usage. We argue that the tendency to use technical analysis tools, such as channels or lines of resistance, is directly related to narrowing the confidence intervals for the future prices of securities. This implies the potential positive relationship between overconfidence in the form of the calibration effect and attitudes towards technical analysis, i.e. both the scope in which technical analysis is used and the belief in its effectiveness.

H_a: There is a positive relationship between overconfidence in the form of the calibration effect and the positive attitude towards technical analysis (both the scope in which technical analysis is used and the belief in its effectiveness).

(2) The other form of not fully rational behavior related to technical analysis usage can be overconfidence with the specific case of the illusion of control, which causes the investors to think they have some control over random outcomes[1]. This form of overconfidence in the group of investors means that they can overvalue the control they have on their portfolio, as mentioned by Barber and Odeon (2001b). Investors often mistake control of an executed transaction (the real one) with the control of portfolio performance (the fictitious one); simply having control over transactions does not give control over the portfolio performance. An important factor that may affect the illusion of control is an active attitude, for example individuals actively involved in the determination of some aspects of the game, like the color of a winning chip, have greater confidence in their success than those who take part in the game, where similar characteristics of the game were randomly assigned (Wortman, 1975). The selection by investors of a certain model of technical analysis and setting its parameters can create the impression that investors actively take part in the game, where

[1] In the literature of overconfidence, there is a clear-cut living example of the illusion of control manifestation. Explaining the illusion of the control concepts, Gino, Sharek, and Moore (2011) cite the 2004 New York Times article: "In the 1970s, the city of New York installed buttons at intersections with traffic lights. Helpful signs instructed pedestrians: "To cross street, push button. Wait for walk signal." Since then, pedestrians in New York routinely have assumed that pushing the button speeds the arrival of the walk signal. As it happens, their faith is misplaced. Since the late 1980s, traffic signals in New York have been controlled by a computer system that determines when the walk signal is illuminated (Luo, 2004). Pushing the button has no effect. But because the city has not paid to remove the signs or the buttons, pedestrians continue to push the buttons."

the result is the future asset price. The other characteristic that strengthens the illusion of control is the preference for predicting future outcomes rather than guessing past events (Brun and Teigen, 1990). The idea of predicting future outcomes based on historical formations is the basic idea of technical analysis, and it can also enhance the illusion of control. These observations justify a hypothesized positive relationship between overconfidence in the form of illusion control and attitudes towards technical analysis, i.e., both the scope in which technical analysis is used and the belief in its effectiveness.

H_b: There is a positive relationship between overconfidence, in the form of illusion of control, and a positive attitude towards technical analysis (both the scope in which technical analysis is used and the belief in its effectiveness).

(3) The Efficient Market Hypothesis (EMH), which is one of the most dominant theories in finance, states that a security's market price incorporates all relevant information rationally and instantaneously (Fama, 1970). If the market is efficient, then it is assumed that investors cannot "beat the market"; they cannot earn consistently better returns than the market results. If an investor believes that he/she is able to beat the market and gains profits in a systematic way by using technical analysis or any other method, then he/she manifests a better than average effect, the belief that he/she is better than other investors and thus can achieve higher yields than the market and the other traders[2]. Therefore it seems that a better than average effect is linked with technical analysis usage.

H_c: There is a positive relationship between overconfidence, in the form of the better than average effect, and positive attitudes towards technical analysis (both the scope in which technical analysis is used and the belief in its effectiveness).

3. METHOD

3.1. Participants

The data sets came from two independent studies with two groups of participants. The first study was conducted with the third-year undergraduate students taking the Technical Analysis course in 2013 at the Faculty of Finance, Cracow University of Economics. Within this group there were

[2] The conviction of traders that one can beat the market is strengthened by their observations that the futures markets are often inefficient.

43 students (32 males and 11 females) with an average age of 21 years (M = 21.26; SD = .82).

The second study was conducted with professional traders who dealt with financial instruments (futures contracts) on behalf of the firm employing them (proprietary trading). The traders participated in the online study in two tranches, the first one was done in June-July 2013, while the second one was done in August-September 2014. The first one was done with 17 traders employed in one branch of a trading company. All traders were male, with an average age of 28 years (M = 28.06; SD = 2.02) and had been employed in the company for an average of 29 months (SD = 21 months). The second tranche was conducted with 36 traders employed in five different branches of a trading company located in Poland. In the second tranche, all traders were male, with a similar average age of 28 years (M = 28.44; SD = 3.07) and had been employed in the company for an average of 19 months (SD = 18 months). For further analysis, we considered 43 traders that were older than 25 years old. The reason was to have a non-overlapping group of traders that differs from the group of students also in terms of age. We wanted to eliminate from the survey students who worked as traders. The average age of the final group of traders was 29 years old (M = 29.23; SD = 2.45) and the average time of employment was 24 months (M = 24.32; SD = 20.74).

The students are considered as non-expert because only a limited number of them had real-life investment experience. However the judgments of this group were based mainly on the second-hand experience and theoretical knowledge gained from their major area of study, i.e. Capital Markets. In this research we compare students and traders to analyze the impact of professional experience on attitudes toward technical analysis and overconfidence. Both of our samples are intentionally selected due to the fact that within the survey study we asked about specific aspects of the investment decision-making process. Respondents should have some basic preliminary knowledge about technical analysis and investments. This is a common approach in behavioral finance that is present in the article cited above.

3.2. Materials – overconfidence measures

Most of the previous studies investigated overconfidence at the group level. In this study, we used an individual difference framework, treating overconfidence as a trait-like component. This allowed us to measure

individual differences. Fenton-O'Creevy et al. (2003) present evidence that overconfidence propensity could be related to some stable personality traits. Furthermore, despite Heath and Tversky's (1991) admonition that the degree of overconfidence often varies between domains, the previous studies often investigated the influence of *general overconfidence* on investor behavior (Biais, Hilton, Mazurier, and Pouget, 2005; Grinblatt and Keloharju, 2009) or overconfidence related to general economic knowledge (Glaser and Weber, 2007). Although these studies tried to relate overconfidence to stock market decisions, neither of them measured overconfidence specific to the investment context. For our study we constructed scales of overconfidence focused specifically on the trading domain. Thus our scales are directly aimed at the participants' area of expertise. Based on the literature review (Larrick et al., 2007; Moore, 2007; Moore and Healy, 2008), we decided to measure each manifestation of overconfidence separately.

Illusion of control

Illusion of control has usually been measured behaviorally in prior experiments. Usually such experiments involved a task in which participants were told that they control (to some degree) the desired outcome (e.g. the movement of the price trend, switching the lights, etc.), where actually there was no relationship between the outcome and the participants' actions (similar to the described situation of NYC pedestrians). These studies measured illusion of control by asking participants to estimate the degree of their level of control over the desired outcome (Alloy and Abramson, 1979; Fenton-O'Creevy et al., 2003; Gino, Sharek, and Moore, 2011). Since, for organizational reasons, we were able to conduct only a questionnaire study with the professional traders, we decided to develop a questionnaire measure of the illusion of control. The illusion of control factor was measured with the use of three statements, on which the subjects expressed their opinions on a 5-point scale, where 1 means "I definitely do not agree" and 5 "I definitely agree". All items on the scale asked investors about their perceived control of these financial outcomes:

1. I always know the status of my finances.
2. I control my personal finances.
3. I control, and I am fully responsible for, the results of my financial decisions.

Better than average effect

To measure overconfidence in the form of the better than average effect, we asked students and traders about their predicted performance in comparison with others in their respective groups. In both studies the respondents used a 5-point scale where 1 means that they predicted definitely lower results than the average results of their colleagues/co-workers, 5 means a definitely higher result compared to the results obtained by colleagues/ co-workers, and 3 means a result similar to the ones obtained by colleagues/ co-workers.

Calibration

Ten classic questions measuring overconfidence in the form of the calibration effect (Lichtenstein et al., 1982; Russo and Schoemaker, 1992) were posed in both groups of respondents[3]. Students and traders were asked to give the lower and upper limits of a 90% confidence interval for unknown values, checking the general knowledge of the respondents. The number of questions in which the correct answer was not included in the confidence interval given by the respondent was the measure of overconfidence in the form of the calibration effect in the domain of general knowledge.

3.3. Materials – measures of technical analysis following

The students' and traders' attitudes towards technical analysis were measured by behavioral and cognitive factors. The two first measures are behavioral and the third one is cognitive.

Technical analysis declared usage (behavioral factor)

Both groups of participants were asked about the factors influencing their investment decisions in the following question, where one of the listed factors was technical analysis.

Technical Analysis Question 1: What factors do you take into consideration while making investment decisions? Using a scale from 1 (no impact at all) to 5 (big impact), please specify the impact of the factors listed below on your decisions.

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[3] Questions: 1. Martin Luther King's age at death, 2. Length of the Nile River, 3. Number of countries that are members of OPEC, 4. Number of books in the Old Testament, 5. Diameter of the moon, 6. Weight of an empty Boeing 747, 7. Year in which Wolfgang Amadeus Mozart was born, 8. Gestation period (in days) of an Asian elephant, 9. Air distance from London to Tokyo, 10. Deepest (known) point in the oceans.

- Technical Analysis
- Fundamental Analysis – economic information from the market
- Recommendations of colleagues
- Your own intuition and hunches

The traders were also asked a question intended to measure their level of sophistication while using technical analysis: "To what extent do you use these particular technical analysis methods?" (**Technical Analysis Question 2**). The respondents answered using a five-point scale, where 1 means "totally not used" and 5 means "used very often" for the following items:

- Basic analysis of charts – for example, resistance lines, trend lines, moving averages, etc.
- More advanced formations – for example, head and shoulders, crab downward/upward, butterfly downward/upward, bat downward/upward, etc.
- Analysis of indicators – RSI, CCI, MACD, stochastic oscillator, etc.

The students were asked about their use of different forms of technical analysis methods in the context of the trading systems that they were preparing during the course. They were asked the following question: "Please specify which of the groups of technical analysis methods are you going to use in your auto-trading system" with the answers on a dichotomous scale, where 1 means "I'm not going to use" and 2 is "I'm going to use".

Belief in the effectiveness of technical analysis (cognitive factor)

Belief in the effectiveness of technical analysis models was measured by the four following statements:

1. Technical analysis indices are able to generate above-average returns.
2. Charts analysis (e.g. trend lines, support and resistance line) allow one to achieve superior returns.
3. Methods and tools of technical analysis are derived from empirical observations of the market and therefore they are effective.
4. Technical analysis is a more effective method of investing in financial markets than fundamental analysis.

3.4. Procedure

The students at the beginning were asked to complete the set of questionnaires in LimeSurvey 2.06 version. They were designed to measure the tendency towards three forms of overconfidence and attitudes toward

technical analysis usage. The students were also asked to take part in a cyclical survey during every week's class. During the course, the students prepared a computerized technical trading system based on any chosen technical analysis model, e.g. moving averages, channels, or stochastic oscillators. The trading systems were verified during the exam by checking returns generated by the system on data sets provided by the lecturer (unknown to the students before the exam). The data sets contained the closing prices and the volume of three selected stocks listed on the Warsaw Stock Exchange; one had an upward trend, the second had a downward trend, and the third stock had a horizontal trend. The students were evaluated based on the system's design and coherence, but not on the rate of return (with the exception of extremely good or bad results) generated by the system for the data provided by the lecturer on the exam day. Thus the number of technical analysis models used, the parameterization that was introduced, and the logical rule for making the final signal were important for the students' evaluation, less important was the effectiveness of the system.

All the traders completed the initial set of questionnaires as well as the weekly follow-up short-answer questions. The questionnaires were distributed in electronic form as in the group of students. In the case of the traders, the survey was conducted with no direct contact of researchers with the traders; it was coordinated by the managers of the company. The trading company provided data about the weekly performance of traders who took part in the survey (profitability and trading volume were linearly transformed for confidentiality reasons).

4. EMPIRICAL RESULTS

4.1. Overconfidence and technical analysis following in the group of traders and students

The illusion of control factor was measured with the use of three statements given in the Materials section:

1. I always know the status of my finances.
2. I control my personal finances.
3. I control, and I am fully responsible for, the results of my financial decisions.

Principal Components Analysis showed that the three statements load on a single factor (with eigenvalues over 1, explaining 51% of the variance in

the students subsample, and 81% in the traders subsample) called the illusion of control. The factor based on those statements has high internal consistency (with Cronbach's Alpha of .794 within the students subsample and .879 within the traders subsample). Hence the illusion of control scale was calculated as the mean of the three answers given for the statements listed above (M = 3.439; SD = 0.718 for all respondents together). The results are not statistically significantly different between the groups of traders and students, as presented in Table 1 below.

One might argue that the scale measures impression of control rather than illusion of control, which is usually defined by comparing measures of subjective control with objective control However other researchers (Klayman, Soll, González-Vallejo and Barlas, 1999; Larrick et al., 2007) have demonstrated that confidence measures tend to be positively correlated with overconfidence measures, thus feelings of being in control as the result of knowledge and available information could be in fact a relevant proxy of illusion of control.

The better than average effect was measured by respondents' judgments about their results compared to the average results of their colleagues/co-workers. The questions in the questionnaires distributed to the students and traders were different because they did not have the same common area of expertise. The traders were asked about their weekly trading performance in comparison with other traders. The differences between the students and the traders are statistically significant (see Table 1), however due to the different nature of the measured process (virtual money vs. real money), we refrain from direct comparisons of the better than average effect measure between the groups.

The accuracy of judgments is an important issue for the study of overconfidence in the form of the better than average effect (Alba and Hutchinson, 2000). The measure of better than average effect accuracy was defined by comparing the assessment of the traders and students performance with their real profits generated in trading and respectively the returns of trading systems applied to the independent data during the exam. Some of the traders or students were indeed definitely better than the average, and in such cases, the high values on the 5-point scale described above were justified. Weekly profits were assigned to five quintiles, assuming the normal distribution of profits for every branch office of the trading company. The mean and standard deviation for weekly profits were provided by the trading company for every trader. In order to preserve

a 5-point scale, the first quintile consists of the worst 20% of the results, while the fifth quintile consists of the best 20% of the results of the traders in a given week. The difference between the weekly assessment of the traders about their own performance on a 5-point scale and the quintile number for their real weekly results was taken as a measure of better than average effect accuracy (M = –0.171; SD = 1.271). At the very beginning of the course, the students were asked about the returns to be generated by their trading system at the final exam. They gave their opinion on the 5-point scale described above. The effectiveness of the trading systems was verified on three data sets provided by the lecturer, i.e. the quotation time series of three stocks listed on the Warsaw Stock Exchange. The real performance was determined based on the average return generated by the trading system for the three stocks by dividing the sample of students into five quintiles to provide a 5-point scale. The difference between their assessment of their trading system and the real performance at the exam is the variable measuring better than average effect accuracy in the group of students (M = 0.775; SD = 1.074). In the case of the students, the detailed distribution concerning their real performance is available because all the students took part in the study, so no simplifying assumption on the normal distribution of results was necessary[4]. The traders seem to be very accurate in the opinion about their own performance due to their weekly evaluation of their trading results. The difference between the students and the traders is statistically significant in the case of above average-accuracy (see Table 1).

Table 1

Overconfidence characteristics in subsamples of students and traders

	Students			**Traders**			**t-test**	**df**	**p-value**
	M	**SD**	**N**	**M**	**SD**	**N**			
Illusion of control	3.387	0.638	43	3.395	0.749	43	0.052	81.901	0.959
Above average	3.186	0.6638	42	2.738	1.013	42	2.404*	70.481	0.018
Above average – accuracy	0.775	1.074	40	–0.171	1.271	35	3.455***	66.949	0,0009
Calibration effect	6.860	1.820	43	6.279	2.218	43	1.328	80.918	0.1877

Notes: Definitions of the dependent variable are presented in Method section. Statistical significance codes for given probability levels: 0.001; 0.01; 0.05; 0.1 are respectively: ***; **; *; ^.

Source: authors computations. The empirical analysis was performed with R

[4] In the case of traders only some took part in the study, so we had to assume the normal distribution with the statistics provided by the trading company for the branch offices.

The very final measure of overconfidence is the number of questions in which the correct answer was not included in the confidence interval given by the respondent, which is the measure of overconfidence in the form of the calibration effect. The differences between the students and the traders are not statistically significant in the case of calibration effect (see Table 1).

The students' and the traders' attitudes towards technical analysis were measured by behavioral and cognitive factors described in material section 3.3. Within **Technical Analysis Question 1,** respondents were asked to what extent they use the given methods in the investment decision process. There are differences in the approach towards the technical and fundamental analysis in the analyzed groups. The traders assigned much higher importance to technical analysis in making investment decisions, while the students favored fundamental analysis (Table 2).

Table 2

Comparison of factors influencing investment decisions in groups of traders and students

	Factor	**Traders (N=43)**		**Students (N=43)**		**t-test**		
	Behavioral indicator: Technical Analysis Question 1	**M**	**SD**	**M**	**SD**	**t-test**	**df**	**p-value**
1	Technical Analysis	4.162	0.784	2.884	1.005	6.578***	79.334	0.000
2	Fundamental Analysis	2.953	1.112	3.791	0.914	–3.814***	80.985	0.0002
3	Recommendations	2.442	0.853	2.441	0.983	0.000	83.964	1.000
4	Intuition	4.046	0.898	3.767	0.781	1.536	82.426	0.128
	Cognitive indicator							
	Belief in the effectiveness of technical analysis	2.796	0.634	2.256	0.601	4.0561***	83.759	0.0001

Notes: Definitions of the dependent variable are presented in Method section. Statistical significance codes for given probability levels: 0.001; 0.01; 0.05; 0.1 are respectively: ***; **; *; ^.

Source: authors computations. The empirical analysis was performed with R

The analysis of the relationships among the four factors that are taken into account when making investment decisions gives significant results for only three of all the potential correlation pairs. The negative correlation between the usage of technical analysis and recommendations of colleagues in the group of students ($r(43) = –0.30$; $p = 0.0528$), implies that students treat technical analysis as a tool for helping them to make individual decisions instead of following the recommendations of colleagues. There is also a positive correlation between the recommendations of colleagues and intuition in the group of students ($r(43) = 0.30$; $p = 0.048$) and in the group of traders ($r(43) = 0.32$; $p = 0.034$). Investment strategies that comply with

the recommendations of colleagues are also supported by intuition in both analyzed groups.

The second question was about the use of particular technical analysis methods:

- Basic analysis of charts – for example, resistance lines, trend lines, moving averages, etc.
- More advanced formations – for example, head and shoulders, crab downward/upward, butterfly downward/upward, bat downward/upward, etc.
- Analysis of indicators – RSI, CCI, MACD, stochastic oscillator, etc.

Traders in their daily work use technical analysis methods in simple forms like the analysis of charts ($r(43) = 0.5218$, $p = 0.00006$) and some advanced formations ($r(43) = 0.5442$, $p = 0.00002$). The tendency to use technical analysis methods while making investment decisions (Question 1) is not significantly correlated with the most advanced use of indicators like RSI, CCI, MACD, and stochastic oscillator ($r(43) = -0.0761$, $p = 0.5879$).

Contrary to the traders, the students do not manifest any significant relationship between the declared usage of technical analysis in building their trading system and the three levels of technical analysis (Table 3).

Table 3

The relationship between the use of technical analysis while making investment decisions (Question 1) and different levels of sophistication of technical analysis methods for students (Question 2) (N=43)

Question 2	1 – "I'm not going to use"		2 – "I'm going to use"		t-test	df	p-value
	Mean of Question 1	N	Mean of Question 1	N			
Basic analysis of charts	3.143	7	2.833	36	0.984	12.267	0.344
Advanced formations	2.533	15	3.071	28	–1.649	25.895	0.111
Indicators	3.000	7	2.861	36	0.250	7.044	0.810

Notes: Definitions of the dependent variable are presented in Method section. Statistical significance codes for given probability levels: 0.001; 0.01; 0.05; 0.1 are respectively: ***; **; *; ^.

Source: authors computations. The empirical analysis was performed with R

The very final measure in the group of technical analysis is the cognitive factor: belief in the effectiveness of technical analysis. This was based on the opinion about the following statements:

1. Technical analysis indices are able to generate above-average returns.

2. Charts analysis (e.g., trend lines, support and resistance line) allow one to achieve superior returns.

3. Methods and tools of technical analysis are derived from empirical observations of the market and therefore they are effective.

4. Technical analysis is a more effective method of investing in financial markets than is fundamental analysis.

Principal Components Analysis showed that the four statements load on a single factor (explaining 58% of the variance in the students subsample, and 60% in the traders subsample). The scale has a relatively high internal consistency (Cronbach Alphas are 0.76 and 0.767 for subsets of students and traders, respectively). The factor based on four items representing belief in the effectiveness of technical analysis methods was calculated as the mean of all four statements (M = 2.526, SD = 0.671 calculated for all respondents).

Based on the answers to Question 1 we found that traders use technical analysis more often than students, while in the case of fundamental analysis there is the opposite result. This is confirmed by the variable "belief in the effectiveness of technical analysis" as presented in the bottom row of Table 2. The traders believe more strongly in the effectiveness of technical analysis methods ($t(83{,}759) = 4.0561$; $p < 0{,}001$). Belief in the effectiveness of technical analysis is positively correlated with the previously introduced measures (Table 4). The only exception is the reliance on the most advanced technical analysis models (indicators like RSI, CCI, MACD, and stochastic oscillator), but this variable was not related to the previous measures.

Table 4

Correlation coefficients between the cognitive factor - belief in the effectiveness of technical analysis and Question 1 – the use of technical analysis while making investment decisions and Question 2 – three levels of sophistication of technical analysis methods for traders (N=35)

	Correlation coefficient	**N**	**p-value**
Question 1 – Technical Analysis	0.3991**	43	0.0080
Question 2 – Basic analysis of charts	0.2908^	43	0.0585
Question 2 – Advanced formations	0.4412**	43	0.0031
Question 2 – Indicators	–0.0226	43	0.8855

Notes: Definitions of the dependent variable are presented in Method section. Statistical significance codes for given probability levels: 0.001; 0.01; 0.05; 0.1 are respectively: ***; **; *; ^.

Source: authors computations. The empirical analysis was performed with R.

4.2. Relation between overconfidence and technical analysis usage – testing hypotheses

The hypotheses were tested by examining the relationships between different measures of attitudes towards technical analysis and the three types of overconfidence: calibration effect, illusion of control, and better than average effect. Each manifestation refers to the respective hypothesis. We have proved that there is a significant relation in the case of illusion of control (H_b), while the other forms of overconfidence, i.e. calibration and better than average effect (H_a and H_c) have not received empirical support. In the next section, we describe the results in a more detailed way. The relevant hypotheses are cited again for the consistency of the argument.

The first hypothesis (H_a) states that there is a positive relationship between overconfidence in the form of the calibration effect and the belief in the effectiveness of technical analysis methods. There is no statistically significant relationship between the calibration effect and the propensity towards technical analysis models in both the examined groups (Table 5 and Table 6). This negative result suggests further research where the questions

Table 5

Correlation coefficients between different measures of usage and belief in effectiveness of technical analysis methods and overconfidence in the form of illusion of control and better than average effect in the group of traders

	Belief in the effectiveness of technical analysis		**Question 1 – Technical analysis**		**Question 2 – Basic analysis of charts**		**Question 2 – Advanced formations**		**Question 2 – Indicators**	
	Corr.	**p-value**	**Corr.**	**p-value**	**Corr.**	**p-value**	**Corr.**	**p-value**	**Corr.**	**p-value**
Illusion of control (N=43)	0.2775^	0.071	0.3253*	0.033	0.2025	0.192	0.3021*	0.049	0.1109	0.479
Better than average effect (N=43)	0.0338	0.831	–0.0023	0.988	–0.0925	0.559	–0.1013	0.522	–0.0372	0.814
Above average – accuracy (N=35)	0.3799*	0.024	0.3744*	0.026	0.1992	0.251	0.2072	0.232	–0.0086	0.961
Calibration effect (N=43)	–0.1273	0.416	–0.3381*	0.026	–0.1583	0.310	–0.1699	0.276	0.0194	0.901

Notes: Definitions of the dependent variable are presented in Method section. Statistical significance codes for given probability levels: 0.001; 0.01; 0.05; 0.1 are respectively: ***; **; *; ^.

Source: authors computations. The empirical analysis was performed with R

that measure calibration effect will be more closely linked with the use of certain technical analysis models. For example, respondents can be asked to determine a 90% confidence interval for future values of a stock exchange index by means of selected technical analysis models, and then they can be asked about the width of confidence intervals.

The second hypothesis (H_b) states that there is a positive relationship between overconfidence in the form of illusion of control and the faith in the effectiveness of technical analysis methods. As reported in Table 5, there are statistically significant correlation coefficients between illusion of control and technical analysis usage-related questions: belief in the effectiveness of technical analysis methods, as well as the usage of advanced formations (Question 2). The positive relationship between illusion of control and willingness to use technical analysis methods in making investment decisions (Question1) has been also observed in the group of traders. This relation is also statistically significant in the group of students (Table 6).

Table 6

Correlation coefficients between different measures of usage and faith in effectiveness of technical analysis methods and overconfidence in the form of illusion of control and better than average effect in the group of students

	Illusion of control (N=43)		**Better than average effect (N=43)**		**Above average – accuracy (N=40)**		**Calibration effect (N=43)**	
	Corr.	**p-value**	**Corr.**	**p-value**	**Corr.**	**p-value**	**Corr.**	**p-value**
Belief in the effectiveness of technical analysis	–0.103	0.512	0.058	0.708	0.026	0.872	0.042	0.787
Question 1 – Technical analysis	0.306*	0.046	–0.122	0.433	–0.207	0.200	0.135	0.387

Notes: Definitions of the dependent variable are presented in Method section. Statistical significance codes for given probability levels: 0.001; 0.01; 0.05; 0.1 are respectively: ***; **; *; ^.

Source: authors computations. The empirical analysis was performed with R

The third hypothesis (H_c) states that there is a positive relationship between overconfidence in the form of better than average effect and a belief in the effectiveness of the technical analysis methods. The better than average effect is not significantly correlated with any measure of technical analysis followed in the group of traders, but we have observed some positive relationships in the case of accuracy (Table 5). Better than average accuracy is positively related to a belief in the effectiveness of technical

analysis methods and the usage of more advanced chart analysis (Question 2). In the group of students there is a statistically significant relationship between the better than average effect and the usage of basic analysis of charts – the group of students that is going to use those methods in their trading system during the exam had a statistically higher assessment of their performance (Table 7).

Table 7

The impact of different levels of sophistication of technical analysis methods (Question 2) on overconfidence in the form of illusion of control, better than average effect, and calibration effect in the group of students

ILLUSION OF CONTROL							
Question 2	**1 – "I'm not going to use"**		**2 – "I'm going to use"**		**t-test**	**df**	**p-value**
	Mean	**N**	**Mean**	**N**			
Basic analysis of charts	3.476	7	3.370	36	0.305	7.108	0.769
Advanced formations	3.356	15	3.405	28	–0.240	29.309	0.812
Indicators	3.333	7	3.398	36	–0.199	7.363	0.847
ABOVE AVERAGE EFFECT							
Question 2	**1 – "I'm not going to use"**		**2 – "I'm going to use"**		**t-test**	**df**	**p-value**
	Mean	**N**	**Mean**	**N**			
Basic analysis of charts	2.857	7	3.250	36	–2.14	15.253	0.048*
Advanced formations	3.400	15	3.071	28	1.596	29.941	0.121
Indicators	3.285	7	3.166	36	0.389	7.849	0.707
ABOVE AVERAGE EFFECT – ACCURACY							
Question 2	**1– "I'm not going to use"**		**2 – "I'm going to use"**		**t-test**	**df**	**p-value**
	Mean	**N**	**Mean**	**N**			
Basic analysis of charts	0.714	7	0.788	33	–0.180	9.823	0.861
Advanced formations	1.000	14	0.654	26	1.021	30.702	0.315
Indicators	0.857	7	0.758	33	0.223	8.861	0.829
CALIBRATION EFFECT							
Question 2	**1 – "I'm not going to use"**		**2 – "I'm going to use"**		**t-test**	**df**	**p-value**
	Mean	**N**	**Mean**	**N**			
Basic analysis of charts	8.000	7	6.639	36	2.090	9.589	0.064^
Advanced formations	6.067	15	7.286	28	–1.974	21.826	0.061^
Indicators	7.286	7	6.778	36	0.711	8.995	0.495

Notes: Definitions of the dependent variable are presented in Method section. Statistical significance codes for given probability levels: 0001; 0.01; 0.05; 0.1 are respectively: ***; **; *; ^.

Source: authors computations. The empirical analysis was performed with R.

4.3. The impact of employment, age and profits on technical analysis usage and overconfidence

The relation between different forms of overconfidence and technical analysis following with time of employment, age, and weekly profits or losses was checked in the group of traders. General reliance on technical analysis models does not provide better investment results; the more traders rely on technical analysis models while making investment decisions, the worse are the weekly profits ($r(35) = -0.3284$; $p = 0.0541$). Belief in technical analysis methods is related only to age; the older the trader, the less he/she believes in the effectiveness of technical analysis methods ($r(43) = -0.3104$; $p = 0.0427$). The tendencies to use different methods of technical analysis that vary in sophistication, like simple versus more advanced formations or indicators (Question 2) are not significantly related to time of employment, age, and weekly profits or losses. Among the different measures of overconfidence that were used there are statistically significant relationships only between the calibration effect and weekly profits ($r(35) = 0.5509$; $p = 0.0006$). The more inaccurate confidence intervals the traders gave for unknown variables, the better weekly results they obtain. Inaccurate confidence intervals are actually too narrow, so if traders underestimate the risk then they are rewarded by the markets for doing that. There is also a negative correlation between the accuracy of better than average and profits ($r(35) = -0.3755$; $p = 0.0262$); the more traders overestimate their real performance, the lower weekly results they realized.

The multiple regression model with weekly profits or losses as a dependent variable was matched (the results are presented in Table 8). The goodness of fit of the entire model is high, multiple R-squared is 0.7678 ($F(7.27)= 12.75$, p-value<0.0001). There are three significant independent variables: above average effect, its accuracy and calibration effect.

The positive coefficient for the above average effect suggest that traders who perceived themselves higher compared to the average results of their colleagues/co-workers, they also have higher weekly investment results. On the other hand, the negative coefficient for above average – accuracy variable suggests that the more traders overestimate their skills compared to the real performance, the worse their investment results are. These two results together proves the rule that traders should be confident, but they cannot be arrogant. Next, the significant positive result for the calibration effect suggests that being overconfident in the form of narrowing the confidence intervals affects the investment outcome positively. Variables

Table 8

Regression models for weekly profits or losses (dependent variable) and different measures of technical analysis following and overconfidence (independent variables) in the group of traders

Coefficients	Estimate	Std. Error	t-value	Prob(>|t|)
(Intercept)	–8048.07	1802.05	–4.466	0.000 ***
Belief in the effectiveness of technical analysis	453.67	315.30	1.439	0.161
Question 1 – Technical analysis	512.72	342.37	1.498	0.145
Question 2 – Basic analysis of charts	–518.20	279.14	–1.856	0.074^
Illusion of control	231.20	302.83	0.763	0.451
Above average effect	1450.84	251.36	5.772	0.000 ***
Above average – accuracy	–1463.02	186.75	–7.834	0.000 ***
Calibration effect	278.02	87.78	3.167	0.003 **

Notes: The variable weekly profits or losses is dependent variable in the multiple regression model. Multiple R-squared: 0.7678, F(7.27)= 12.75, p-value<0.0001, N=35. Definitions of the dependent variable are presented in Method section. Statistical significance codes for given probability levels: 0.001; 0.01; 0.05; 0.1 are respectively: ***; **; *; ^.

Source: authors computations. The empirical analysis was performed with R

representing the following technical analysis are less related to weekly profits, there is only one variable that is significant at tendency level (p-value<0,10), that is the tendency to use the basic analysis of charts while making investments decisions. The more traders use technical analysis the lower they investment results are.

4.4. Fundamental analysis

In Question 1 (What factors do you take into consideration while making investment decisions?), beside technical analysis there was also an option: fundamental analysis - economic information from the market. Based on the answers given to the option of fundamental analysis and technical analysis, we wanted to verify if the hypothesized relations are true for any tool that supports investment decisions or are exclusively for technical analysis. The usage of fundamental analysis while making investment decisions was positively correlated only with calibration ($r(35) = 0.3680$, $p = 0.0296$). Fundamental analysis usage was also negatively correlated with the time of the employment ($r(43) = –0.3519$, $p = 0.0206$); the longer traders worked in the market, the less they used fundamental analysis in the process of making investment decisions. The links of fundamental analysis usage with the three

analyzed forms of overconfidence: calibration effect, illusion of control, and better than average effect were not statistically significant. This result confirms that overconfidence is strongly associated solely with technical analysis usage by investors and not generally with all the tools that support investment decision-making.

CONCLUSIONS

This study integrates the findings of both the psychological and financial perspectives on technical analysis usage. The relationships between overconfidence manifestations with technical analysis usage have been investigated by the authors before, but the research was limited only to the students (Czupryna, Kubińska and Markiewicz, 2015). The present paper completes and investigates the declarations and behavior of both finance students and professional traders. Comparing the behavior of these two groups (experts and non-experts) provides additional insight into the analyzed relations between psychological traits and behavior and is used in the behavioral finance literature.

The hypothesized relationship does not extend to all overconfidence manifestations. The link between technical analysis usage and calibration effect gets no empirical support; the relation with illusion of control was verified positively; the third hypothesis related to better than average effect was confirmed only in the case of some measures of technical analysis. These results are not surprising, since the lack of correlation between the different forms of overconfidence is a common finding. Moore and Healy observed the inconsistent results between different forms of overconfidence (Moore, 2007; Moore and Healy, 2008). Therefore it would be more precise to say that technical analysis usage is more related to the illusion of control and some aspects of the better than average effect than to overconfidence as a general concept.

The better than average effect was the only manifestation of overconfidence that was significantly related to technical analysis usage in the group of novices in the market (Czupryna, Kubińska and Markiewicz, 2015). A comparison of the results about the better than average effect in the group of students and traders within this study suggests that the accuracy of judgments about own performance plays a crucial role in the analysis of overconfidence in the form of the better than average effect. Traders as a group are very accurate about their performance due to the regular evaluation of their performance within their daily work. This can be the

reason that we had no empirical support of the hypothesized relationship between the better than average effect and the usage of technical analysis methods in the group of traders. The illusion of control seems to be more related with technical analysis usage in the group of professional traders than in the group of students. This can be explained by the nature of the situations favoring the illusion. The previous studies documented that when a decision situation involves skill-related cues: exercise of choice, competition, familiarity with the stimulus, and involvement in the decision (Langer, 1975; Thompson, Armstrong, and Thomas, 1998), decision-makers behave as if the chance outcome was determined by skill, perceiving more control than they actually have. One can easily remember that in fact the set of "skill cues" reflects the traders' tasks and their environment, which makes traders prime candidates for this type of overconfidence manifestation. In fact, (Fenton-O'Creevy et al., 2003) demonstrated that professional traders reveal this propensity. Investors who select a certain model of technical analysis and set its parameters can create the impression that they actively control the outcome of the investment, while in fact they control only the investment parameters, not the outcome. This fact can support the strong relationship that has been observed between overconfidence in the form of illusion control and attitudes towards technical analysis, i.e. both the scope in which technical analysis tools are used and the faith in their effectiveness.

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