Are chartists artists? The determinants and profitability of recommendations based on technical analysis*

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Abstract

The value of technical analysis (TA) has been debated for decades; however, limited evidence exists on the profitability of investment recommendations issued by technical analysts. These 'chartists' sometimes claim that TA is an art rather than a science. We evaluated more than 5000 TA-based buy and sell recommendations for stocks and a market index in the Netherlands issued during the period 2004 – 2010. The sign of a recommendation was generally in line with trading signals resulting from technical trading rules. While recommendation levels were positively associated with price trends prior to the recommendation, we did not find evidence of (abnormal) stock returns after the publication of these recommendations. In addition, stop-loss levels did not contain informational value as no meaningful returns were detected after these trigger levels were met. Given that technical recommendations follow well-known trading rules and that these recommendations are not associated with future abnormal returns, we conclude that technical analysts do not exhibit 'artistic' skills.

1. Introduction

The relevance of recommendations published by security analysts has been subject to extensive academic research. The larger part of the literature is directed towards recommendations on the basis of fundamental analysis. Technical analysts represent a different category. They believe that past stock prices and trading volume may show patterns that indicate future trends. If that were true, price patterns on the stock market[1] would contradict weak-form market efficiency, which states that all information from historical data is already incorporated in current prices.

Tools based on technical analysis (TA) are widely available to investors. Many brokers offer TA functionalities to their clients, and investors can furthermore rely on commercial charting packages offered by professional vendors. It is therefore not surprising that TA is broadly used among investors. For the Netherlands, Hoffmann et al. (2010) showed that the number of private investors using TA was larger than the number of investors relying on fundamental analysis. The use of TA is not limited to private investors only. For professional investors, Carter and Van Auken (1990) and Menkhoff (2010) found that 35 percent and 87 percent, respectively, considered TA to be important for trading decisions.

Most of the research regarding the profitability of TA focuses on the usefulness of individual trading rules (i.e., trading rules based on one single method), of which many exist. Common trading rules rely on moving averages and on trading range breakouts (Brock et al., 1992). These rules are mostly applied on observed stock prices; past trading volume is generally only used as a secondary tool (Sullivan et al., 1999). Although some studies support the value of TA to some extent (e.g., Lo et al., 2000; Wong et al., 2003; Chong and Ng, 2008; and Metghalchi et al., 2008), many others did not find any evidence that TA can be used to generate abnormal returns (e.g., Kwon and Kish, 2002; Tian et al., 2002; Lento et al., 2007; Marshall and Cahan, 2005; Marshall et al., 2009; Schulmeister, 2009). Confronted with academic criticism of their methodology, technicians occasionally respond that technical analysis is an art rather than a science, as also stated by DeMark (1994: xi): "Technical analysis has always had more art than science to it". This suggests that technicians take into account more than simple trading rules when formulating investment recommendations. Therefore, in order to address this 'art'-component of TA, not

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[1] In this paper we focus solely on technical analysis applied to stocks and stock indices.

trading rules but TA-based recommendations published by specialized technicians should be studied, particularly because the 'art'-aspect of a technical analyst is likely to transcend the pure TA rules. Two major questions are relevant here: first, are recommendations associated with positive abnormal returns, and second, to what extent do these recommendations differ from signals derived from technical trading rules?

Evaluations of recommendations issued by technical analysts are relatively scarce and evidence is mixed. Cowles (1933) was the first to analyze recommendations published by technicians. He found that this type of recommendation published in the Wall Street Journal underperformed a buy-and-hold strategy. Brown et al. (1998) applied different statistical methods to Cowles' dataset and found that these recommendations in fact yielded risk-adjusted abnormal returns. Dawson (1985) analyzed recommendations issued by a Singapore investment advisory firm. He found that the recommended stocks did not outperform the market. Dawson (1985: 183) added that "from an optimal research perspective more than one investment advisor should be included". However, no other TA sources were available at that time.

The existing studies (Cowles, 1933; Dawson, 1985; and Brown et al., 1998) have several limitations: the number of considered recommendations is small, and the recommendations are published by only a limited number of technical analysts. Furthermore, the short-term profitability of TA has not been tested in these papers while Menkhoff (2010) reported that TA was most frequently used for investment decisions with a horizon of just some weeks.[2]

In our research, we employed a dataset of 5017 cases, containing 3967 stock recommendations and 1050 index recommendations[3] on the basis of TA concerning the Dutch stock market during the period 2004 to 2010. Recommendations were issued both by individual analysts and by professional trading services, such as banks and online signal services.[4] Given that TA can be associated with both absolute and relative price patterns, we evaluated both raw returns and abnormal returns in our analyses. Event study analysis shows that recommendations are not followed by statistically significant raw or abnormal returns. In fact, on average, buy

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[2] The number of weeks was not specified.

[3] An index recommendation reflects an analyst's view regarding the prospects of a stock index.

[4] Recommendations by these automated services generally rely on a combination of TA rules and can thus be regarded as potentially artistic. In the robustness checks we separately test the performance of individual technical analysts.

recommendations on the stock index are followed by a small but statistically significant decrease of the market index on the subsequent trading day. The accompanying stop-loss levels instruct investors to sell (buy) shares at a certain price when the stock price decreased (increased) after a buy (sell) recommendation. We did not observe consistent abnormal returns after a stop-loss level has been met, in other words, the imposed stop-loss levels were not useful to investors. Hence, judging from a return perspective, a technical analyst is not an artist.

Another test focused on the determinants of technical recommendations. If technicians are artists, then their recommendations are likely to be different from the outcomes based on simple trading rules. We found that the sign of a recommendation (i.e., buy or sell) was positively related to the signs of trading signals coming from a number of frequently used TA rules. In addition, we evaluated stock returns in the ten trading days up to and including the day of the recommendation. Our results showed that technicians based their recommendations on recent stock price trends. Cumulative returns, also when assessed on a risk-adjusted basis, were positive (negative) up to the publication day of the buy (sell) recommendation. The same pattern exists for index recommendations. We conclude that the sign of a recommendation is simply determined by recently observed short-term price trends, and that, also in this regard, technical analysts do not exhibit any artistic abilities.

We performed a number of robustness checks. As a first check, we followed the fundamental analyst literature (e.g., Womack, 1996) by studying return patterns surrounding recommendation changes. We found similar results as in our main analyses, meaning that recommendation changes did not signal future price patterns either. As a second robustness check, we analyzed returns surrounding recommendations stemming from individual analysts only, as one may argue that recommendations by individual analysts could be more 'artistic' than recommendations issued by professional services. We did not find materially different results as compared to our original tests. In a third robustness check, we tested whether 'artist-driven' recommendations outperformed other recommendations. For this purpose we split the recommendations in two groups. We compared recommendations which were not in line with the aggregate concurrent signal of TA trading rules (i.e., relatively 'arty' recommendations) with recommendations that were

in line with what common trading rules suggested. Returns between both groups did not differ significantly.

This paper contributes to the current literature in several ways. First, it contributes to the scarce empirical evidence on the value of recommendations based on technical analysis. We document that these recommendations are, on average, not associated with abnormal returns after the publication of the recommendations. As such, the findings of this study indicate that investors are better off ignoring these recommendations in their investment strategy as trading costs will ultimately result in investment returns lower than the benchmark. Second, this paper provides evidence of the determinants of TA-based recommendations. We find that these recommendations are largely driven by technical trading rules. The observation that TA-based recommendations are not associated with abnormal returns is in conjunction with this finding, given that technical trading rules are generally unable to generate abnormal returns. On average, technical analysts do not provide additional value on top of regular trading rules and their recommendations should, hence, be disregarded by investors. Third, we provide evidence that stop-loss levels incorporated in TA-based recommendations are irrelevant to investors as stock prices do not exhibit particular return patterns after these levels were reached. Since the use of technical analysis is widespread among investors, these findings are also highly relevant for practitioners.

The paper proceeds as follows. The next section gives a review of a number of popular TA methods, discusses literature regarding TA as applied to stocks and stock indices, and contains the development of our hypotheses. Section 3 gives the data description and methodology. Section 4 presents tests and results after which Section 5 presents robustness checks. Section 6 concludes the paper.

2. Literature and hypotheses

Technical analysis is widely used among investors (Menkhoff, 2010). One of the appeals of TA is that even people without a proper background in finance can be enabled to pick up buy or sell signals for stocks and stock indices. TA methods are based on information derived from past prices or trading volume. Clearly, any consistently successful method would conflict with the Efficient Market Hypothesis (EMH; Fama, 1970). The weak form of the EMH states that all past trading information is already reflected in current prices. The EMH is related to the random

walk hypothesis (Fama, 1965) which states that since new information will be immediately absorbed by the market and reflected in stock prices, future price changes can only be a result of unanticipated future news events and will be independent of past price changes. Since surprises are, by definition, random and unpredictable, price changes will be unpredictable as well. However, since the 1980s, some papers have been published which show that stocks do not follow a perfect random walk (see for example Lo and MacKinlay, 1988). Since then, the potential profitability of technical trading rules has been examined extensively in the literature. Section 2.1 discusses popular technical trading rules together with empirical findings regarding their profitability. Section 2.2 continues with a discussion of findings regarding the value of TA-based recommendations. Hypotheses are formulated in Section 2.3.

2.1. Literature review on technical trading rules

The largest part of the TA literature discusses the investment value of technical trading rules. This section discusses the mechanics of individual trading rules and some findings regarding their usefulness. As Brock et al. (1992) stated that moving averages (MA) and trading range breakouts (also known as support and resistance levels) are the two most popular technical analysis methods, this section starts with a discussion of these rules. From a literature search, we identified other frequently used TA rules. Most prominent trend-following rules are the moving average crossover, moving average convergence divergence, rate of change, and on-balance volume. We also considered two countertrend indicators, namely the relative strength index and the Bollinger bands methodology. In addition to defining commonly used rules, we will discuss empirical evidence regarding the profitability of trading rules. We only discuss recent empirical literature, as earlier studies do not take into account data snooping biases[5] (Park and Irwin, 2007).

Moving average

According to Brock et al. (1992: 1733), moving average (MA) rules belong to the "most popular technical rules". The popularity of MA rules has been further

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[5] There will always be some rules which perform better when a large number of trading rules are tested, which may be due to pure luck. In the more recent literature, one commonly corrects for such a selection bias.

confirmed by Cesari and Cremonini (2003) and Wong et al. (2003). The MA rule compares the current price (or the average price over the past x days) to a long-term average stock price over y days, where $y > x$. More formally constructed, for stock i the outcome of an MA at time t based on n observations can be defined as (Wong et al., 2003):

$$(2.1) \quad MA(P_i)_{t,n} = \frac{1}{n}\sum_{j=t-n+1}^{t} P_i$$
$$= (P_{i,t} + P_{i,t-1} + \cdots + P_{i,t-n+2} + P_{i,t-n+1})/n$$

In this equation, $MA(P_i)_{t,n}$ is the simple n-day moving average for stock i at day t, and $P_{i,t}$ is the closing price for stock i at day t. Hence, the calculated value of $MA(P_i)$ at time t will be positioned at the same spot on the time axis as the last observation of P_t used in the definition.

Usually two different time series of MA values are combined: a short-term moving average (MAS) and a long-term moving average (MAL). The number of stock prices of MAS typically varies between 1 day (in which case the original price series serves as the MAS) and 10 days. The number of stock prices included in the MAL is usually between 10 and 200 days. According to Brock et al. (1992), a commonly used MA rule is 1-200. This rule entails a combination of two moving averages in which the MAS is based on 1 day (i.e., the stock price) and the MAL on 200 days. Brock et al. (1992) further mentioned that MA 1-150, MA 5-150, and MA 2-200 are often applied.

For the purpose of defining trading rules, let k be the number of periods for MAS and l the number of periods for MAL. The trading rules can be summarized as: "Buy" if $MAS(P_i)_{t,k}$ crosses $MAL(P_i)_{t,l}$ from below and as long as $MAS(P_i)_{t,k} > MAL(P_i)_{t,l}$. A "Sell" signal is issued if $MAL(P_i)_{t,l}$ crosses $MAS(P_i)_{t,k}$ from above and as long as $MAS(P_i)_{t,k} < MAL(P_i)_{t,l}$.

Evidence on the profitability of MA rules is mixed. Significant positive abnormal returns for MA rules for the Singapore stock exchange were found by Wong et al. (2003). Chong and Ng (2008) confirmed the profitability of MA rules on the LSE FT30 index and Metghalchi et al. (2008) found outperformance using MA rules on the Swedish stock index. Other publications report the opposite. Kwon and Kish (2002) evaluated a number of MA rules on US indices in different time periods and found that the profitability of technical trading rules had decreased to zero over time. Tian et

al. (2002) evaluated 412 different trading rules based on, among others, the moving average on both US and Chinese markets. While these authors found no evidence of any predictive power of technical rules on the performance of US stocks, they found evidence that some MA rules led to outperformance in the less efficient Chinese market. Marshall and Cahan (2005) also studied less efficient markets and focused on the New Zealand stock exchange. Contrary to Tian et al. (2002), they concluded that MAs are not profitable even for a market which is characterized as less efficient (i.e., New Zealand).

Fong and Yong (2005) evaluated MA rules for individual US internet stocks from 1998 to 2002, and they concluded that market prices of most internet stocks behaved as random walks and hence they did not find evidence of significant trading profits using TA. Finally, Marshall et al. (2009) found that MA rules were not profitable for US stocks for their dataset. Their results held for different firm sizes, liquidity and industry effects.

Trading range breakout

The trading range breakout (TRB) method is also known as the support and resistance indicator (Brock et al., 1992). This indicator signals minimum and maximum prices, respectively, for which a stock has traded over the past *n* days. Following Brock et al. (1992) we apply 50, 150 and 200 days for *n*:

$$(2.2) \ SUPPORT_{i,t} = MIN\big(P_{i,t-1}, P_{i,t-2}, \dots, P_{i,t-n-1}\big)$$

$$(2.3) \ RESISTANCE_{i,t} = MAX\big(P_{i,t-1}, P_{i,t-2}, \dots, P_{i,t-n-1}\big).$$

As an example, the 50-day resistance level for stock *i* on day *t* is the maximum stock price during the previous 50 trading days. According to technical analysts, investors will usually sell at the local maximum price. If on the other hand the stock price increases above this so-called resistance level, technical analysts become bullish on the stock. The reverse holds for the support level. The trading rules can thus be defined as "Buy" if $P_{i,t} > RESISTANCE_{i,t}$ and "Sell" if $P_{i,t} < SUPPORT_{i,t}$.

The TRB method has received considerable attention in the literature. Marshall et al. (2009) found that TRB rules were not profitable for US stocks for their dataset. Tian et al. (2002) also evaluated trading rules based on TRB rules on both US and Chinese markets. Similar to their findings on the MA rules, they did not find evidence of predictive power for US stocks, although the TRB method was more valuable on

the Chinese market. In contrast to Tian et al. (2002), Marshall and Cahan (2005) concluded that TRBs are not even profitable for a market which is characterized as less efficient.

Moving average crossover

The moving average crossover is related to the basic MA rule. The difference is that a buy (sell) signal is generated only on the day that the short period MA (i.e., MAS) crosses the long period MA (i.e., MAL) from below (above) (Schulmeister, 2009). The frequency of issued signals by this method is therefore lower than for the regular MA rules. We follow Brock et al. (1992) in limiting ourselves to the 1-150, 5-150, 1-200 and 2-200 rules. The following trading rules can be identified: "Buy" if $MAS(P_i)_{t,k} > MAL(P_i)_{t,l}$ while $MAS(P_i)_{t-1,k} < MAL(P_i)_{t-1,l}$. A "Sell" signal is issued if $MAS(P_i)_{t,k} < MAL(P_i)_{t,l}$ while $MAS(P_i)_{t-1,k} > MAL(P_i)_{t-1,l}$. Hence, these rules only issue signals on the day of the crossing.

Moving average convergence divergence

This rule is associated with three different trading signals. One follows from the moving average convergence divergence (MACD) itself, the others from the MACD signal line and the MACD histogram. We start with the definition of the MACD.

(i) The MACD is based on two exponential moving averages (EMA) and is defined as the difference between two different EMAs. According to Murphy (1999), the 12-day EMA and the 26-day EMA are the most frequently used ones (Murphy, 1999). The EMA is a variant of the simple MA, but this rule gives a higher weighting to the most recent closing price. This weighting factor is defined as $\frac{2}{n+1}$ where n is the EMA-period. The $MA(P_i)_{t,n}$ is generally used as a value for the first-day EMA-period. The following equations first define the exponential moving average where n is 12 for the 12-day EMA, and n equals 26 for the 26-day EMA. Seconc, the MACD rule which is based on two different exponential moving averages is defined.

(2.3) $EMA(P_i)_{t,n} = \left[P_{i,t} - EMA(P_i)_{t-1,n}\right] \times \frac{2}{n+1} + EMA(P_i)_{t-1,n}.$

(2.4) $MACD_{i,t} = EMA(P_i)_{t,12} - EMA(P_i)_{t,26}$

The following trading rule can be followed: "Buy" as long as $MACD_{i,t} > 0$ and "Sell" as long as $MACD_{i,t} < 0$.

To our knowledge, only Chong and Ng (2008) have tested the profitability of the basic MACD rule. Using data of the FT30 index from 1935 to 1994, they found that the MACD rule outperformed a simple buy-and-hold strategy.

(ii) The MACD signal line is a method related to the MACD. In this case a 9-day EMA of the MACD is constructed (e.g., in the next general equation, n should be replaced by 9). This is the so-called signal line:

$$(2.6) MACDSIGNAL_{i,t} =$$

$$\left[MACD_{i,t} - EMA(MACD_i)_{t-1,9}\right] \times \frac{2}{n+1} + EMA(MACD_i)_{t-1,9}$$

As a starting value $MA(MACD_i)_{t-1,9}$ is used. The following trading rule can be defined: "Buy" if $MACDSIGNAL_{i,t} > 0$ and "Sell" if $MACDSIGNAL_{i,t} < 0$.

(iii) Another method related to the MACD is the MACD histogram, which represents the difference between the MACD and the signal line:

$$(2.7)\ MACDHISTOGRAM_{i,t} = MACD_{i,t} - MACDSIGNAL_{i,t}.$$

Positive histogram values indicate an uptrend, and negative values indicate a downtrend. In other words: "Buy" as long as $MACDHISTOGRAM_{i,t} > 0$ and "Sell" as long as $MACDHISTOGRAM_{i,t} < 0$.

Rate of change

Rate of change (ROC) is related to momentum. This rule relates the current price to the price n days ago. A common time period is 10 trading days:

$$(2.8)\ ROC_{i,t} = P_{i,t} - P_{i,t-9}$$

A price increase corresponds to a positive momentum, and a negative value of ROC indicates negative momentum. The resulting trading rule is defined as follows: "Buy" as long as $ROC_{i,t} > 0$ and "Sell" as long as $ROC_{i,t} < 0$.

Jegadeesh and Titman (1993) found that momentum strategies are associated with positive abnormal returns over one to four calendar quarters when using formation periods of one to four quarters. In contrast, Gutierrez and Kelley (2008) showed that for a shorter formation period (five days) short-term winners were followed by a 10-day return reversal.

On-balance volume

On-balance volume (OBV) is the best-known indicator based on trading volume. The indicator starts at 0 and adds trading volume (V) of positive trading days (i.e., days during which the stock closed up) and deducts V of negative trading days (i.e., days during which the stock price decreased):

$$(2.9) \; OBV_{i,t} = OBV_{i,t-1} + \begin{cases} V \; if \; P_{i,t} > P_{i,t-1} \\ 0 \; if \; P_{i,t} = P_{i,t-1} \\ -V \; if \; P_{i,t} < P_{i,t-1} \end{cases}$$

The OBV indicator stipulates that volume precedes price changes. The assumption of the OBV indicator is that rising prices reflect positive volume pressure which in turn can lead to higher prices. Usually MA rules are applied to the OBV. Again, we refer to the short-term moving average as MAS and the long-term moving average as MAL. We consider the following MA rules: MA 1-150, MA 5-150, MA 1-200, and MA 2-200. This brings us to the following trading signals: "Buy" if $MAS(OBV_i)_{t,k}$ crosses $MAL(OBV_i)_{t,l}$ upwards and as long as $MAS(OBV_i)_{t,k} > MAL(OBV_i)_{t,l}$; "Sell" when $MAS(OBV_i)_{t,k}$ crosses $MAL(OBV_i)_{t,l}$ downwards and as long as $MAS(OBV_i)_{t,k} < MAL(OBV_i)_{t,l}$.

Relative strength index

Wong et al. (2003) suggested that the relative strength index (RSI) is the most frequently used countertrend indicator. The RSI uses closing prices and is the ratio of up-closes, $U_{i,t}$, to down-closes, $D_{i,t}$, over the time period selected for stock i. The length of this period is usually 14 days. The up-closes and down-closes are defined such that:

$$(2.10) \; U_{i,t} \begin{cases} P_{i,t} - P_{i,t-1} \; if \; P_{i,t} > P_{i,t-1} \\ 0 \qquad\qquad otherwise \end{cases} \; and \; D_{i,t} \begin{cases} P_{i,t-1} - P_{i,t} \; if \; P_{i,t-1} > P_{i,t} \\ 0 \qquad\qquad otherwise \end{cases}$$

The next step is to define the average level of the up- and down-closes:

$$(2.11) \; \overline{U}_{i,t} = \frac{1}{14}\sum_{t-13}^{t} U_{i,t}$$

$$(2.12) \; \overline{D}_{i,t} = \frac{1}{14}\sum_{t-13}^{t} D_{i,t}$$

The relative strength for stock i at time t is calculated as follows:

$$(2.13) \; RS_{i,t} = \frac{\overline{U}_{i,t}}{\overline{D}_{i,t}}.$$

The RSI for stock i at time t is defined as: $RSI_{i,t} = 100 - \frac{100}{1 + RS_{i,t}}$. The RSI is an oscillator with a level between 0 and 100. According to the RSI, a level higher than 70

normally indicates that the stock price has risen but is now overbought (i.e., one should sell the stock). A level lower than 30 indicates the exact opposite. Hence, the RSI method can be interpreted as a countertrend indicator. The trading rules can be summarized as: "Buy" as long as $RSI_{i,t} < 30$ and "Sell" as long as $RSI_{i,t} > 70$.

Empirically, Wong et al. (2003) and Chong and Ng (2008) found abnormal returns for a trading strategy based on the RSI rule.

Bollinger bands

The second countertrend indicator is the Bollinger band method (BB). This rule is related to MA trading rules because the BB method contains a moving average, around which two bands are plotted. According to Lento et al. (2007) the BB(20,2) is the traditional method. This refers to a 20-day moving average; the distance between the MA and the bands in this case is twice the standard deviation of the stock price measured over the most recent 20-day period, $\sigma_{P_i,20}$. At time *t* the upper band for stock *i* can thus be defined as:

(2.14) $BBUPPER_{i,t} = MA(P_i)_{t,20} + 2\sigma_{P_i,20}$.

The lower band can be defined as:

(2.15) $BBLOWER_{i,t} = MA(P_i)_{t,20} - 2\sigma_{P_i,20}$.

When the actual stock price exceeds one of those bands, it signals, according to the BB rule, that the stock price will return to the moving average. The BB method can thus be considered as a countertrend indicator. The trading rules can be specified as follows: "Buy" as long as $P_{i,t} < BB_{LOWER_{i,t}}$ and "Sell" as longs as $P_{i,t} > BB_{UPPER_{i,t}}$.

Lento et al. (2007) conducted research on the profitability of BB patterns. This strategy underperformed a simple buy-and-hold strategy. Leung and Chong (2003) compared BB rules with MA rules and concluded that BB rules underperformed regular MA rules.

2.2. Literature review on recommendations by technical analysts

According to some technical analysts the value of TA may not lie in strictly applying technical trading rules, but rather in interpreting and combining various signals into one recommendation (e.g., Dawson, 1985). This suggests that academic research should focus on recommendations based on technical analysis, rather than on trading rules themselves. Surprisingly, technical recommendations are hardly discussed in the

literature. Cowles (1933) was the first to analyze technicians. The editors of the Wall Street Journal at that time applied the Dow Theory – a theory in which different market phases and trends are described – to the Dow Jones Industrial Average (DJIA). They published 255 stock market forecasts using that methodology. Over the course of 26 years, the recommendations yielded a 12 percent average annual rate of return. The DJIA in turn rose 15.5 percent per annum in that period. The results for the Dow Jones Railroad Average showed a similar pattern, which led Cowles (1933: 323) to conclude that the returns were "poorer than the result of a continuous outright investment in representative common stocks for this period". More recently Brown et al. (1998) applied a risk correction to Cowles' analysis. They concluded that the recommendations actually outperformed the Dow Jones indices when a risk measure was taken into consideration.

Whereas Cowles (1933) and Brown et al. (1998) conducted research on index recommendations, Dawson (1985) focused on recommendations for individual stocks. He evaluated 292 round-trip stock recommendations which were based on TA. A round-trip implies that an initial buy recommendation has been closed at a later stage. The recommendations in their sample were issued by a Singapore investment advisory firm and were published in its newsletter. After controlling for transaction costs, trades based on these recommendations did not generate abnormal returns.

2.3. Development of hypotheses

Fund managers perceive TA to be valuable in the short run (Menkhoff, 2010). In prior research on TA-based recommendations, only returns for a medium to long-term horizon were evaluated. For example, Dawson (1985) calculated returns for holding periods of up to 280 days with a mean of 36 trading days. Another limitation of Dawson's (1985) is the use of only one investment advisor. A similar concern applies to Cowles (1933) and Brown et al. (1998). We tried to fill this gap by evaluating short-term returns surrounding TA-based recommendations, using a large dataset covering thousands of recommendations published by different analysts.

In the discussion on various trading rules in Section 2.1, we reported that research has shown that technical trading rules are generally unable to yield abnormal returns. Specifically for the Dutch stock market over the period 1983 to 2002, Griffioen (2003: 163) studied 787 computerized technical trading rules applied on both

individual stocks and the AEX index. He found that technical trading techniques "are not genuinely superior […] to the buy-and-hold benchmark". However, when technical analysts are artists, their recommendations are possibly more suited for the construction of outperforming strategies than individual TA rules. Recommendations can provide two sources of additional returns to investors. First, the stocks which are recommended to buy (sell) may outperform (underperform) the market. Second, TA may be used for market timing strategies. In this case analysts may correctly predict the direction of future price movements. If that would be true, buy recommendations would on average be followed by positive raw returns while sell recommendations would be followed by negative raw returns.

Following weak-form market efficiency (Fama, 1970) and prior evidence on TA rules on the Dutch stock market (Griffioen, 2003), and thus contrary to the technician's claim, we expect that technical recommendations can not be used to generate (abnormal) returns. Given that Menkhoff (2010) found that TA is used for investment horizons of some weeks, we employ a time period of 20 trading days after the recommendation. We can formulate this as follows:

H1: Recommendations based on technical analysis are not associated with statistically significant returns in the 20-day period following a recommendation.

Technical recommendations are sometimes accompanied by a stop-loss level. According to stop-loss rules, investors should sell (buy) if the market price goes below (above) this predetermined level (Tschoegl, 1988). Kaminski and Lo (2014) showed that stop-loss policies are not associated with abnormal returns under the Random Walk Hypothesis. They empirically studied stock market futures and Treasury note futures and applied different stop-loss rules to them. In accordance with theory, Kaminski and Lo (2014) found stop-losses to be of no value to investors using short-term sampling frequencies. However, at longer intervals stop-loss levels could lead to an increased Sharpe ratio. While Kaminski and Lo (2014) found that their self-designed stop-loss rules may be beneficial, no evidence exists so far on the added value of stop-loss levels which have actually been set by technical analysts. These analysts set stop-loss levels in the event of a buy recommendation lower than the value of the security at the time of the recommendation. According to the stop-loss rules, if the price drops below this level, investors should sell the security to protect themselves from accumulated losses. The stop-loss level accompanying a sell

recommendation is placed at a level higher than the stock price at the day of the publication of the recommendation. If the stock price reaches that price, the shorted security should be bought back to avoid further losses. For a stop-loss level to be useful, a stock price or index level should decrease (increase) after hitting the stop-loss level accompanying the buy (sell) recommendation. However, we expect, in line with weak-form market efficiency, that stop-loss levels are not followed by abnormal price patterns.

H2: Stop-losses accompanying technical analysis recommendations are not associated with statistically significant abnormal returns in the 20-day period following the day at which the stop-loss level was reached.

Independent of abnormal returns after the recommendation, technicians can only be called artists if they base their recommendations on other things than simple trading rules. Our second hypothesis therefore focuses on the determinants of TA-based recommendations. In accordance with Section 2.1, we select the following methods: MA, moving average crossover, TRB, RSI, BB, MACD, ROC, and OBV. For the MA, TRB, and OBV rules, several variations will be tested. The MACD method contains three different rules. Table 1 summarizes how buy and sell signals are derived from each TA method.

[INSERT TABLE 1 HERE]

We expect that technicians are simply following technical trading rules. The sign of the recommendation (i.e., buy or sell) will thus be related to the trading signal of the technical trading rules. This relation is postulated in the third hypothesis of this paper.

H3: TA recommendations are positively associated with trading signals stemming from technical trading rules.

Related to the third hypothesis, the fourth hypothesis considers stock price patterns prior to a recommendation. A collective feature of technical trading rules is that they are based on previous price or volume patterns; MA rules for example may use past stock prices from a time period as long as 200 days. Most TA methods are trend-following – only the RSI and BB methods are countertrend indicators – and as such the general rule for most methods is that they trigger a positive (negative) signal when stocks are in an uptrend (downward trend).

We therefore hypothesize that the price pattern prior to the publication of the recommendation is in line with the direction of the recommendation. We expect that a buy recommendation has been preceded by a stock price increase during the 10-day period up to the day of the recommendation. Similarly, we expect that a sell recommendation has been preceded by a stock price decrease during this 10-day period. The fourth hypothesis is formulated as follows:

H4: Buy (sell) recommendations based on technical analysis are preceded by positive (negative) abnormal returns in the period of 10 trading days up to the day of the publication of the recommendation.

In the following section, we present our sample and the methodology we used to test our hypotheses.

3. Data and methodology

3.1. Sample selection

We used a unique dataset[6] containing analyst recommendations issued by technical analysts for Dutch listed firms and for the major indices in the Netherlands.[7] Some recommendations had been issued by individual analysts, others by automated technical analysis websites. The dataset contained, in total, 5696 buy, hold and sell recommendations[8] related to the Dutch stock market recorded in the period November 2003 to December 2010.[9] The dataset did not include delisted stocks. We do not

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[6] Frequently used datasets containing analyst recommendations such as I/B/E/S and First Call rely on analysts who study firm fundamentals and simultaneously publish an earnings per share forecast and a forecasted stock price. As we study technical analysis recommendations in this paper, we could not use these datasets. Please see Gerritsen (2014) for an evaluation of recommendations on Dutch stocks based on I/B/E/S (publication in Dutch).

[7] We are grateful to Guruwatch.nl for sharing their dataset. Guruwatch is part of the IEX Finance Network which in turn is part of the publishing company Free Media Group. According to their website (http://www.freemediagroup.nl) the IEX Finance Network reaches 600.000 unique Dutch investors per month. As some private investors are interested in stock recommendations, Guruwatch has tracked the recommendations of both fundamental analysts and the best known Dutch technicians. In this paper we only use recommendations published by technicians. The website operates completely independently of the analysts who are covered. In addition, Guruwatch did not receive compensation in any form from the technicians featured on their website. We are not authorized to mention analysts by name or to publish their individual results.

[8] A well-known problem with technicians is that they often do not publish a clear-cut buy or sell signal. Cowles (1933: 309) already took note of this, stating that "some of the forecasters seem to have taken a page from the book of the Delphic Oracle, expressing their prophecies in terms susceptible of more than one construction". The technical outlooks have been carefully interpreted by the data vendor as buy, hold or sell recommendations.

[9] Only for the second quarter of 2005 no data has been recorded in the database.

expect that this bias influences our results as we are primarily concerned with short-term stock price movements.

Recommendations need to meet a number of criteria in order to be included in the final dataset for this research: (1) we only consider buy and sell recommendations; (2) recommendations had to be recorded on trading days; (3) when an analyst had issued several identical recommendations on a particular day for the same stock or index, only one recommendation will be included; (4) when an analyst issued both a sell and a buy recommendation on a given day for the same stock or index, both recommendations are omitted; and (5) with respect to index recommendations, only recommendations concerning the Dutch index (AEX index) are considered as the dataset contains relatively few recommendations for other indices. This index contains the 25 largest stocks of the Dutch stock market in terms of market capitalization. Our final sample totals 5017 recommendation which can be broken down into 3967 recommendations for 96 individual stocks and 1050 index recommendations. Roughly half of the stock recommendations were issued by individual technical analysts, another half by automatic TA-services, and just some recommendations by analysts which occasionally publish technical recommendations alongside their usual fundamentals-based recommendations. The recommendations in our final sample were issued in the period from January 7, 2004 to November 30, 2010. Overall, recommendations were collected from 101 different analysts, with the least active analyst providing 1 recommendation and the most active analyst providing 1237 recommendations. Table 2 depicts the composition of our final sample.

[INSERT TABLE 2 HERE]

Approximately two-thirds of the total number of stock recommendations represent a buy recommendation. The distribution of buy and sell recommendations on the index is more balanced as 57.6 percent of the recommendations constitute a buy recommendation whereas 42.4 percent pertain to sell recommendations.

A distinctive feature of a number of recommendations is that they came with a stop-loss level. We verified that the published stop-loss level was lower (higher) than the current price at the time of a buy (sell) recommendation. We excluded stop-losses

which were reached as a result of a capital adjustment such as a (reverse) stock split. We further included only the first published stop-loss level when an analyst published a series of identical stop-losses. The resulting sample consists of in total 500 stop-losses regarding stocks and 242 stop-loss levels regarding the index. Regarding stop-loss levels accompanying stock recommendations, the average level of a stop-loss was set 8.4% lower (8.6% higher) than the price at the time of the publication of the buy (sell) recommendation. For index recommendations these values were 2.5% lower and 2.6% higher, respectively.

Figure 1 shows the distribution of buy and sell recommendations per calender quarter. For each quarter, we present the percentage of buy recommendations on stocks relative to the total number of buy and sell recommendations issued on stocks. We performed the same procedure for index recommendations. We also show the quarterly return for the AEX index. For the first quarter of 2004, the stock dataset contained only buy recommendations, but as of Q2 2004 the sample got more balanced. A clear picture emerges; the percentage of buy recommendations in a calendar quarter is positively associated with the return on the stock index in that same quarter. Although Figure 1 suggests some degree of correlation between the average recommendation level and the return on the stock market, it remains inconclusive about the causality between stock market returns and technical recommendations.

[INSERT FIGURE 1 HERE]

Additional data was needed to test our hypotheses. We used Thomson Reuters Datastream to collect stock price, total returns (stock prices including reinvested dividends) and trading volumes on a daily basis for the AEX index and for each stock in our final sample. We used the AEX All Share index as the index representing the broad Dutch stock market. This is a market-weighted index containing all Dutch listed equities. Its daily returns are highly correlated to both the AEX index which contains the 25 largest listed stocks in the Netherlands ($\rho=0.99$) and the MSCI Netherlands index ($\rho=0.96$). For the AEX All Share index, we collected daily prices and total returns, and in addition we collected prices, returns, market values and book values for its constituents. For the risk-free interest rate, we used the Dutch 1-month interest

rate (as in Griffioen, 2003) provided by Thomson Reuters; this rate is similar to the 1-month Euribor rate.

3.2. Methodology

To test Hypotheses 1 and 4, we computed abnormal returns in the 30-day period around the publication of technical recommendations. The recommendations in our sample came with a date but not with a timestamp. Hence, for a particular day, recommendations might be issued before trading starts, during trading hours, or after the market was closed. Even recommendations which are published prior to the start of trading can be based on stock futures or other indicative opening prices. We therefore treat the return on the publication day as a pre-recommendation return. In our return analysis, we therefore treated the period (-9, 0) as a pre-recommendation period. Analogously, period (1, 20) was regarded as the post-recommendation period. For each stock in our sample, we collected daily stock prices (including reinvested dividend) as of January 1, 2003. We defined the abnormal return for stock i on day t as the difference between the realized excess return and the expected excess return, see Equation 3.1.

(3.1) $AR_{i,t} = R_{i,t} - E(R_{i,t})$

The realized excess return ($R_{i,t}$) for stock i on day t is defined as the difference between the raw stock return including reinvested dividends (as defined in Equation 3.2) and the risk free rate, see Equation 3.3.[10]

(3.2) $r_{i,t} = \frac{P_{i,t}}{P_{i,t-1}} - 1$

(3.3) $R_{i,t} = r_{i,t} - r_{f,t}$

Daily excess returns for the index are calculated similarly to a stock's excess return, see Equations 3.4 and 3.5. $P_{m,t}$ refers to the level of the market index at time t. Market prices include reinvested dividends.

(3.4) $r_{m,t} = \frac{P_{m,t}}{P_{m,t-1}} - 1$

(3.5) $R_{m,t} = r_{m,t} - r_{f,t}$

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[10] The analysis of abnormal returns has also been conducted using logarithmic returns. These results (not reported) exhibited a similar economic and statistical significance as the results reported in this paper.

The expected excess return $E(R_{i,t})$ is estimated using the Carhart 4-factor model (1997) model.[11] This model reads as:

(3.6) $E(R_{i,t}) = \alpha_{i,t} + \beta_{1i,t}R_{m,t} + \beta_{2i,t}SMB_t + \beta_{3i,t}HML_t + \beta_{4i,t}UMD_t$

The left-hand side of this model, $E(R_{i,t}) = E(r_{i,t}) - r_{f,t}$, is the expected excess return for stock i at day t. Further $R_{m,t} = r_{m,t} - r_{f,t}$ is the observed excess return on the AEX All Share index with $r_{m,t}$ denoting the market return including reinvested dividend payments. SMB_t and HML_t are the Fama and French (1993) factors at day t referring to the size effect (SMB, small minus big) and the book value effect (HML, high minus low), respectively. To compute these factors, we used all constituents of the AEX All Share index. We computed these factors on a daily basis where SMB_t represents the return on a value-weighted portfolio consisting of the 30% smallest stocks less the return on a value-weighted portfolio consisting of the 30% largest stocks, both in terms of market capitalization. HML_t is the return on a portfolio that is long in the 50% stocks with the highest book-to-market ratio, and short in the 50% lowest book-to-market stocks. Finally, UMD_t refers to the Carhart (1997) momentum factor. This is the return on a portfolio that is long in the 30% stocks with the highest return in the past year, and short in the 30% stocks with the lowest return.[12] The alpha and the four beta-coefficients in this expected return regression are estimated on a daily basis, with an estimation period of 260 trading days.

With respect to the analysis of recommendations on the AEX index, we have to compute expected market excess returns. We first calculated the mean-adjusted excess return for the AEX index, see Equation 3.7. As estimation period for the mean-adjusted excess return, we used the period of 250 days prior to the 10th day before a recommendation is issued. Next we calculated the abnormal return by subtracting the expected return from the observed return, see Equation 3.8.

(3.7) $E(R_{AEX,t}) = \frac{1}{250} \times \sum_{-10}^{-260} R_{AEX,t}$

(3.8) $AR_{AEX,t} = R_{AEX,t} - E(R_{AEX,t})$

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[11] This model is an extension of the Fama and French 3-factor model (1992). Fama and French (1993) showed that including factors for size and book value increased the explanatory power of portfolio returns to 90%, as compared to about 70% in the traditional 1-factor CAPM model. Carhart (1997) added a fourth factor to capture the momentum effect as documented by Jegadeesh and Titman (1993).
[12] One may argue that TA recommendations are partly based on momentum so that we shoud not control for this factor. Unreported tests document that our results do not qualitatively change when we omit the UMD factor from our analyses.

Since Menkhoff (2010) found that TA-based decisions are mostly used for short-term asset allocation decisions, we are, for both stocks and the index, interested in the average abnormal return (AAR) in the thirty trading days around the publication of TA-based recommendations. As we refer to event days instead of calendar days, we denote the days around the recommendation by t'. We calculated two series of AAR values, one for buy and one for sell recommendations. The estimator of an AAR for day t', is defined as:

$$(3.9) \ AAR_{t'} = \frac{1}{N_{t'}} \Sigma_{i=1}^{N_{t'}} AR_{i,t'}$$

Where $AR_{i,t'}$ is the abnormal return for stock i on day t' and $N_{t'}$ is the number of firms with a buy or a sell recommendation at day t'. For the calculation of the significance of abnormal returns, we calculated a t-statistic to test the hypothesis that the average abnormal return on an event day is not equal to zero:

$$(3.10) \ t - statistic_{t'} = \frac{AAR_{t'}}{S(AR)_{t'}/\sqrt{N_{t'}}}$$

Where $S(AR)_t$ is an estimate of the standard deviation of the average abnormal return. In addition, we used a nonparametric test. With the generalized sign test (Sanger and McConnell, 1986; Cowen and Sergeant, 1996), we tested if the frequency of positive (negative) abnormal returns on each day in the event window differs significantly from the frequency of positive (negative) abnormal returns in the period (-260, -10) prior to a buy (sell) recommendation. This statistic is defined in Equation 3.11, where p refers to the fraction of positive abnormal returns in the pre-event window, and $p_{t'}$ to the fraction of positive abnormal returns on day t'.

$$(3.11) \ GS - statistic_{t'} = \frac{|p_{t'} - p|}{\sqrt{p(1-p)/N_{t'}}}$$

Finally, the cumulative average abnormal return (CAAR) is defined as the summation of average abnormal returns over a certain event window:

$$(3.12) \ CAAR_{t'} = \Sigma_{t'}^{T} AAR_{t'}$$

We calculated CAARs in six different 5-day event windows. We recorded CAARs for the period (-9, -5), (-4, 0), (1, 5), (6, 10), (11, 15), and (16, 20). The t-statistics for the CAARs are based on the hypothesis that the cumulative abnormal return in a 5-day window is not different from zero.

Hypothesis 2 refers to the returns after the stop-loss levels accompanying the recommendations were reached. We applied a similar methodology as in Hypotheses 1 and 4. In this case, day 0 refers to the day on which the stop-loss level was reached.

By definition, the return on this day is positive for stop-losses after sell recommendations and negative for stop-losses after buy recommendations.

Hypothesis 3 refers to the relation between recommendations and trading signals resulting from TA methods. While our sample contains recommendations, we still have to calculate daily trading signals for each stock and the index. For all eight trading rules listed in Table 1, we calculated trading signals for each stock in our sample on a daily basis. Some TA methods, such as the MA method, can have several versions. In those cases, we considered the most common ones. For the calculation of each trading signal, we used daily stock data. For each stock on any given day, three distinct signals were possible for each trading rule. We labeled these as "1" on days for which the trading rule issued a buy signal, "-1" on days for which a rule issued a sell signal, and "0" on days without a buy or a sell signal. Note that for the MA crossover rule, there were many days with a 0-score because it only issued a buy or sell signal on the day of the crossover.

Next, we calculated the average signal value for each trading rule in three different states: (1) for days on which a buy recommendation had been published by technical analysts; (2) for days on which a sell recommendation had been published; and (3) for all other days. We calculated these averages separately for stock receiving a recommendation and for the index. A positive (negative) average signal value for days on which a buy (sell) recommendation had been issued would indicate that the sign of the recommendation was in line with the signals issued by the trading rules.

For each trading rule, we compared the average trading rule signal when a buy recommendation had been issued with the average trading rule signal when a sell recommendation had been published. We used a simple t-test to test whether the difference is statistically significant. In addition, the relation between recommendations and TA rules is tested using a multinomial regression model. We regressed all observed recommendations across all stocks and trading days (an ordinal variable which takes on the values "1" for buy, "0" for no recommendation or "-1" for a sell recommendation) on the concurrent signal values for each TA rule, see Equation 3.13. In case of multiple variations of the same rule (MA, MA crossover, TRB, and OBV), we included the variation with the highest statistical significance in the preceding t-test.

$$(3.13) \; Recommendation_{i,t} = \propto_{i,t} + \beta_{1,i,t}(MA)_{i,t} + \beta_{2,i,t}(MA\ crossover)_{i,t} + \beta_{3,i,t}(BB)_{i,t} + \beta_{4,i,t}(MACD)_{i,t} + \beta_{5,i,t}(RSI)_{i,t} + \beta_{6,i,t}(ROC)_{i,t} + \beta_{7,i,t}(TRB)_{i,t} + \beta_{8,i,t}(OBV)_{i,t} + \varepsilon_{i,t}$$

We conducted this procedure for both stock recommendations and index recommendations.

4. Empirical results

4.1. Returns after the publication of TA-based recommendations

Panel A of Table 3 shows the daily raw and abnormal returns for the 5-day period following the publication of the recommendation. We detected some statistically significant abnormal returns in these five days. For example, the index decreased significantly on both the first and the fourth day after a buy recommendation had been published. Buy recommendations on the index are thus followed by statistically significant negative abnormal returns. With regard to stocks, we found a statistically significant decreas on the second day after a sell recommendation was published. This finding only holds for raw returns and not for abnormal returns. However, none of these statistically significant event days are economically significant (i.e., all significant returns are very small in size). Buy (sell) recommendations therefore seem not be followed by positive (negative) returns.

In Panel B of Table 3, cumulative average abnormal returns (CAARs) after the publication of a recommendation are displayed. This analysis is conducted for 20 trading days after the publication of a recommendation. Interestingly, the CAAR for the index is significant and negative (-0.32%) in the week after a buy recommendation, while the CAAR is significant and positive in the second week after a sell recommendation (0.27%). Hence, the statistical evidence for index recommendations points at small return reversals after the publication of TA-based recommendations while these recommendations are mainly designed for continuatins of past patterns. The effect sizes of these reversals are, however, fairly small. More statistically significant CAARs were detected during the period (16, 20) after a recommendation publication. Given the absence of significant returns during the prior weeks, we are cautious to attribute these returns to the recommendation.

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Cumulative average raw returns (CARRs) are positive in the third and fourth weeks after buy recommendations. Again, we are careful to ascribe these returns to recommendations since there were no signs of abnormal returns in the preceding weeks. On top of that, the sign and magnitude of these returns is roughly similar to those after sell recommendations. We can therefore not conclude that technical analysts exhibit particular timing skills.

[INSERT TABLE 3 HERE]

We further tested our hypothesis by employing a generalized sign test. The results are displayed in Table 4. The left-hand side depicts the results for stock recommendations, and the right-hand side shows results for index recommendations. In the estimation period (days -260 to -10) stocks with a buy recommendation outperformed the market on a risk-adjusted basis in 47.9% of the days. The same percentage applies to stocks with a sell recommendation. For raw returns the percentages are 48.7% and 47.0%, respectively. In the generalized sign test, outperformance (underperformance) is acknowledged when the percentage of stocks achieving positive abnormal returns is larger (smaller) than in the estimation period. In the event of a buy recommendation on stocks, consistent outperformance is virtually non-existent after the day of the recommendation. The same holds for sell recommendations. The results are more pronounced when we consider index recommendations (see the right-hand side of Table 4). Panel A shows that the index exhibited negative abnormal returns in three out of the first five days following a buy recommendation. In line with the returns on the individual days, the CAAR also indicates underperformance after the index received a buy recommendation. The publication of a sell recommendation was generally not followed by statistically significant abnormal returns.

[INSERT TABLE 4 HERE]

We conclude from this analysis that technical analysts are no artists, as they did not exhibit particular stock market forecasting skills. The only category with significant results constituted buy recommendations on the index. The index level, however, on

average, decreased after such a recommendation had been published. In Section 4.3 we aim to explain these findings by investigating the determinants of technical recommendations.

4.2. The relevance of stop-loss levels

A number of published recommendations was accompanied by a stop-loss level. For buy recommendations, this level was set at a price below the concurrent stock price, while stop-losses in case of sell recommendations were typically set at a price above the current market price. Accordingly, we verified for our sample that the hitting of a stop-loss level occurred at days of a rising (declining) stock price or index level in case of sell (buy) recommendation. The rationale of a stop-loss trigger accompanying a buy (sell) recommendation is that the shareholder (shorting party) in the event of a price decrease (increase) can sell (buy back) the shares to prevent further losses.

For a stop-loss level to be relevant, it needs to be significantly related to price patterns in the days following the crossing of a stop-loss level. Table 5 shows the returns for both stocks and the index.

[INSERT TABLE 5 HERE]

The general lack of significant returns in Panel A of Table 5 is evidence for limited relevance of published stop-loss levels. Returns on a day-by-day basis do not exhibit any consistent patterns. With respect to cumulative returns as depicted by Panel B, we find some positive cumulative raw returns in periods (11, 15) and (16, 20) but none in the periods (1, 5) and (6, 10). We therefore conclude that stock prices do not do not follow a specific pattern once stop-loss levels are met. The results for the generalized sign test are displayed in Table 6. Contrary to the return analysis, we find that the second and fourth day after the crossing of a buy-stop-loss is associated with a lower percentage of positive stock returns. Stop-loss levels in these instances were intended to prevent investors from future losses as a result of falling stock prices. While this would indicate that the stop-loss level was useful, we detected opposite findings for index recommendations, see the right-hand side of Table 6. Measured on the basis of abnormal returns, the index outperformed on the second day after a stop-loss which accompanied a buy recommendation was met. However, this stop-loss was intended

to protect against further price decreases. As Panel B does not reveal consistent patterns on cumulative returns either, we conclude that there is no evidence that stop-loss levels exhibit any relevance in the investment process.

[INSERT TABLE 6 HERE]

4.3. The technical nature of TA-based recommendations

In this section, we test whether TA recommendations are consistent with signals from TA trading rules. We start by relating buy and sell recommendations to the average signal value resulting from technical trading rules, as we defined in Table 1. For each trading day, we calculated for each stock and the AEX index whether these technical trading rules would issue a buy signal or a sell signal (or no signal at all). Next, we calculated the average signal value for each rule for three different events: first, days on which analysts published a buy recommendation; second, days on which analysts published a sell recommendation; and third, days on which no recommendation was issued. These average signal values are by definition bounded by the values -1 to +1.

The results are summarized in Table 7. The left-hand side represents findings for stock recommendations and the right-hand side for index recommendations. The first and second columns indicate which specific trading rule we have applied. Columns 3 to 5 depict the average signal values for these rules in the case of a buy recommendation, sell recommendation, or no recommendation at all, respectively. For illustrative purposes, we highlight one row in Table 7. This row shows that at times of a buy recommendation, the average technical signal value for stocks which received a buy recommendation was +0.398 for the 1-200 version of the moving average. At times of a sell recommendation, this MA rule had an average value of -0.348. This implies that buy (sell) recommendations were more often accompanied by MA1-200-based buy (sell) signals than by MA1-200-based sell (buy) signals. Column 5 shows the average value of the signals for all trading days for all stocks when no recommendation had been issued. Column 6 shows the difference in value between buy and sell signals, and is computed as the value in Column 3 minus the value in Column 4. The t-value for a simple t-test testing whether this difference is

significantly different from zero is presented in Column 7.[13] The last column shows the number of buy and sell recommendations included in the tests. The number of recommendations is lower for the on-balance volume (OBV) indicator. This is due to the fact that Datastream omitted trading values for some days for some stocks. The stocks with missing data have been excluded from the OBV analysis.

For stock recommendations, the difference in values between buy and sell recommendations, as shown in Table 7, is mostly in accordance with our expectations. The value of each technical trading rule is higher for buy recommendations than for sell recommendations, except for the relative strength index.

A buy signal from the RSI rule is more often associated with a sell recommendation than with a buy recommendation. This reverse pattern for the RSI can be explained by the fact that the RSI may issue buy signals when stock prices have decreased (in other words the stock may be 'oversold'). Thus, by nature the RSI is different from the other indicators which generally regard positive momentum as a positive factor. Although the BB rule is also perceived as a countertrend indicator, we do not identify a similar pattern as that for the RSI.

We find similar results for index recommendations. A difference occurs with respect to the moving average crossover rule, as only two variations are statistically significant.

[INSERT TABLE 7 HERE]

We tested the relationship between recommendations and trading signals more formally using a multinomial logistic regression analysis. For each stock and for each trading day, we observed recommendations and we computed trading signals. As a dependent variable we used the published recommendation which could take on the values of "1" (buy), "-1" (sell) and "0" (no recommendation). In Table 7, we analyzed different versions for each rule. In the multinomial regression, we included for each trading rule only the sub rule with the highest level of significance as was indicated in

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[13] We also applied the Wilcoxon-Mann-Whitney test to test for differences; significance levels were in line with the simple t-test.

Table 7. We used the computed values for the trading rules (for which Table 7 showed the averages) as independent variables.

Table 8 shows the results of this analysis. Panel A considers stock recommendations, while Panel B considers index recommendations. The base scenario of these multinomial logistic regressions is that no new recommendation is issued. The significant variables in Panel A mostly exhibit the expected signs. All trading rules have a negative coefficient when a sell recommendation is published. For buy recommendations, most trading rules exhibit negative coefficients. In this case, the MACD is insignificant and the OBV is negatively related. In contrast to Table 7, the RSI has the expected sign for both buy and sell recommendations now that we control for other technical trading rules.

For the index specification, each variable is significantly related to either buy or sell recommendations. The coefficients of the MA and BB are positively and significantly related to buy recommendations, while the moving average crossover, RSI, ROC and TRB are all related to sell recommendations. The signs of the non-significant variables are as expected. In the index specification, the MACD is also statistically insignificant. This indicates that the MACD rule is relatively unimportant to providers of TA-based recommendations.

We tested both specifications for multicollinearity by using the variance-inflation factor (VIF). None of the variables exceed a VIF of 1.94, with a mean VIF of 1.56 for all variables. These values are well below the cut-off level of 10 (Belsley et al., 1980; Studenmund, 1992). We can therefore conclude that multicollinearity is not an issue of concern in these specifications.

[INSERT TABLE 8 HERE]

Given the results in both Table 7 and Table 8, we confirm the relation between TA-based recommendations and technical trading signals and we conclude for our sample that TA recommendations are associated with TA trading rules.[14] Again, we dismiss the notion of artistic abilities among technical analysts; recommendations from

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[14] Although the model is statistically significant, its R^2 is modest, which suggests that technical recommendations can not entirely be explained by the TA trading rules in our model. The low value of R^2 may be due to the fact that the model incorporates only a limited number of rules as compared to the large number of possible trading rules. As an example, Sullivan et al. (1999) considered in total 7846 different trading rules.

technical analysts are largely in line with simple technical trading rules. In the next section, we explore this finding further, using stock and index returns prior to the publication of a recommendation.

4.4. Returns prior to the publication of TA-based recommendations

In the next statistical analysis, we related the publication date of a recommendation to the abnormal returns in the 10-day period preceding it. Panel A of Table 9 shows both raw and abnormal returns for the second half of this period. As of day -4 most daily returns surrounding stock recommendations were strongly significant. The 'run-down' in terms of abnormal returns prior to sell recommendations typically only started at day -3, while the positive returns prior to buy recommendations lastedfor the full 5-day period. The finding of a run-up (run-down) prior to buy (sell) recommendations also held for index recommendations.

Next, we analyzed the cumulative average abnormal return (CAAR) prior to the publication of a recommendation, see Panel B of Table 9. In the week leading up to and including the recommendation, both stocks and the index showed significant abnormal returns in the expected direction. In the week prior to a buy (sell) recommendation, stock prices exhibited cumulative average abnormal returns of on average 2.04% (-2.59%) and the index level increased by 0.78% (-0.97%) from an abnormal return perspective. Cumulative average raw returns confirmed these patterns. We also detected a significant increase in stock prices in the period (-9, -5) prior to a buy recommendation. The index exhibited significantly negative abnormal returns in days (-9, -5) prior to a sell recommendation.

The return patterns prior to the recommendation indicate that technical analysts are primarily capable of 'predicting the past' with their recommendations.

[INSERT TABLE 9 HERE]

We further tested our findings by employing a generalized sign test. The results for individual trading days are displayed in Table 10, Panel A. In the estimation period (days -260 to -10) stocks with a buy recommendation outperformed the market on a risk-adjusted basis in 47.9% of the days; the same percentage applied to stocks which got a sell recommendation. In the event of a buy recommendation, a large proportion of stocks exhibited positive average (abnormal) returns for each day during the period

(-4, 0). The percentage of stocks with positive abnormal returns increased from 51.1% on day -4 to 64.1% on day 0. Regarding sell recommendations, for each day during the period (-3, 0), the percentage of stocks with negative abnormal returns was significantly higher than in the estimation period. Here the percentage of stocks exhibiting positive abnormal returns decreased from 45.0% on day -3 to as little as 26.2% on day 0. This pattern starts already at day -4 when we take only raw returns into account.

Index recommendations showed a similar, but shorter, pattern: stock prices increased over the period (-2, 0) prior to a buy recommendation and over the period (-1, 0) prior to a sell recommendation. These results are confirmed by the findings from our 5-day intervals; see Panel B of Table 10. The week prior to a recommendation exhibited significant test statistics across both buy and sell recommendations for stocks as well as the index.

[INSERT TABLE 10 HERE]

Although we established in Section 4.3 that analysts based their recommendations partly on countertrend indicators, the evidence presented here indicates that recommendations are mostly trend-following.

4.5. Connecting the evidence

So far we have analyzed the returns prior and subsequent to recommendations in isolation. Figure 2 connects both analyses graphically. This figure displays abnormal returns both before and after a recommendation. We present the returns surrounding the publication of both stock and index recommendations for the period (-9, 20). For illustrative purposes, we show only cumulative average abnormal returns as of day -9. In other words, the CAAR graphs are a graphical representation of the findings in Tables 5 and 9. Panel A of Figure 2 shows a pattern of rising (declining) prices up to and including the day of the publication of a buy (sell) recommendation. In general, stock prices do not seem to increase or decrease after the publication of a recommendation. In addition, the figure displays CAARs after stop-loss levels has been met. The cumulative average abnormal return is slightly positive after the stop-loss level accompanying a buy recommendation is reached. These trigger levels were

in this case intended to prevent further price decreases. This illustrates that stop-loss levels were not particularly useful. A similar picture emerges for these types of stop-loss levels corresponding to the index level (Panel B). Regarding index recommendations, the index level tends to exhibit some degree of mean reversion after a recommendation has been published: an increase (decrease) in the index level triggered a buy (sell) recommendation after which the index level decreased (increased).

[INSERT FIGURE 2 HERE]

5. Robustness checks

This section contains three different robustness checks. First, it is well established in the fundamental analyst literature (e.g., Womack, 1996) that recommendation revisions are potentially more informative than recommendation reiterations. Although most of the recommendations in our sample constitute reiterations, the dataset also contains a considerable number of recommendation revisions, i.e., recommendations upgrades from sell to buy or downgrades from buy to sell. The dataset consists of 1143 stock recommendation revisions and 281 index recommendation revisions which are both almost equally divided among up- and downgrades. Table 11 depicts both returns and cumulative returns surrounding revisions.

[INSERT TABLE 11 HERE]

Interestingly, the reported raw returns and abnormal returns prior to revisions are not only statistically significant up to the day of the revision, but the coefficients are also slightly larger than presented in Table 9. This indicates that revisions are preceded by relatively pronounced price patterns. Judging from an inspection of Panel B, no significant cumulative returns were detected for the first two trading weeks after a recommendation revision was published. The third week after a sell recommendation on stocks is associated with a negative abnormal return of -0.37%. As of the third trading week after recommendation announcements, we detected some statistically significant cumulative raw returns after buy recommendations on both stocks and the

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index. This could indicate some timing abilities. However, the magnitude of the raw returns did not differ significantly from that of these after the publication of sell recommendations. Summarizing, we reject technical analysts' 'artistic' skills when inspecting revisions.

The TA-based recommendations in our sample have been published by a variety of sources. Some recommendations were automatically generated by professional TA-services; other recommendations were published by individuals who also issued recommendations based on fundamental analysis, and another category consists of recommendations published by analysts with a sole focus on technical analysis. Although automatically generated recommendations are generally also based on a combination of TA rules, they may be less 'arty' than recommendations published by technical analysts of 'flesh and blood'. We therefore separately tested the performance of the latter group in our second robustness check. Constrained by the size of our sample, we only considered recommendations regarding stocks. We identified 31 different individual technical analysts who had published 1503 buy recommendations and 433 sell recommendations. The maximum number of recommendations per analyst is 443, and the minimum number of recommendations is 1. On average, individual technical analysts have published 62 recommendations.

We analyzed the abnormal returns in the six-week period around the publication of the recommendation. Panel A of Table 12 summarizes our findings for 10 individual trading days. For buy recommendations, days -4 up to and including day 0 showed both positive raw returns and positive abnormal returns. Interestingly, during the period after the publication of the recommendation, the average abnormal return on day 3 was negative and statistically significant, but, the magnitude is relatively small. Sell recommendations show a pattern of negative abnormal returns prior to the publication of a recommendation. These negative abnormal returns lasted for the period (-3, 0).

Panel B of Table 12 shows cumulative average abnormal returns. We found significant cumulative abnormal returns in the 1-week period leading up to the issue of recommendations. The CAAR prior to buy and sell recommendations was 1.26% and -1.60%, respectively. After a buy recommendation, only for the third week we find positive cumulative raw returns. Given the absence of statistically significant returns in the periods (1, 5) and (6, 10), we conclude that we did not find qualitatively

different results than those reported in our main tests when we restrict our sample to individual analysts only.

[INSERT TABLE 12 HERE]

A third robustness test involves a division of our recommendations. So far, we have found that both stocks and the index go up (down) prior to buy (sell) recommendations, while there were no meaningful returns afterwards. The finding that recommendation publications are not followed by meaningful abnormal returns is in line with our finding that technical analyst recommendations are to a large extent similar to technical trading rules, which are mostly unrelated to future returns on the Dutch stock market (Griffioen, 2003). However, in our sample, not every buy (sell) recommendation was accompanied by a positive (negative) signal from TA trading rules. Some recommendations might therefore be based on aspects other than simple trading rules. To accommodate the possibility that these relatively artistic recommendations outperformed simple trend-following recommendations, we divided both our stock sample and our index sample into several segments. For each published recommendation, we calculated the number of TA rules which were in line with the recommendation. In this robustness check, a method was valued at "+1" if the trading rule stemming from a TA method issues a buy signal; its value was "0" if it is neutral, and it is assigned a value of "-1" otherwise. When a TA method consists of several variations (n) we weighted each variation with a factor $1/n$. For example, we used four versions for the MA method. In this case 0.25 point can be awarded for each variation. We subsequently summed the scores for all TA trading rules. For stocks (the index) the maximum value would be 8 (7) since there were eight (seven) different TA rules. For example, when all trading rules for a stock implied a buy signal, the resulting score would be 8. If the MA1-200 and MA5-150 would be neutral, then the score would be 7½.

We divided our sample into trend-following recommendations which were supported by a similar average signal value (i.e., a buy (sell) recommendation accompanied by a positive (negative) aggregate TA value) and artistic recommendations which were not in line with the average signal value. We did not include recommendations when the sum of the signal scores equaled 0. Given the

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resemblance of raw returns and abnormal returns in all tests, we consider only abnormal returns in this instance. As we are interested in the forecasting skills of analysts, we evaluated the returns for five trading days starting on the day after the publication of the recommendation, see Table 13.

[INSERT TABLE 13 HERE]

We explain our findings as displayed in Table 13 by discussing day 1 after a sell recommendation. Stocks exhibiting trend-following sell recommendations (i.e., a sell recommendation together with an aggregate negative technical signal value), declined with 0.19% on average on the day after the recommendation. Negatively recommended stocks with on average positive technical signals increased by 0.09%. The difference between both values has been tested with a simple t-test and was statistically insignificant. The second day exhibited a 0.21% difference between artistic and trend-following recommendations. The third day, however, reverses this trend to a large extent. We find also for buy recommendations that artistic recommendations underperform trend-following recommendations on the first two trading days after recommendations were published, but also this trend is reversed at a later stage during this five-day post-event period. To conclude, for some days we could find significant differences between artistic and trend-following recommendations, but there is no strong evidence that relatively artistic recommendations outperform recommendations which are based on simple trading rules.[15]

6. Conclusion and discussion

Most studies on technical analysis focus on the profitability of single trading rules, while technical analysts stress the importance of constructing indicators based on a combination of trading rules. Yet, to date, only a small number of publications exist

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[15] We have tested this proposition in various forms. An alternative test is to split artistic in 'extremely artistic' (buy (sell) recommendation coupled with a TA signal value lower than -3 (+3)) and 'modestly artistic' (buy (sell) recommendation together with a TA signal value in between and including -3 (+3) and -1 (+1)). We could similarly split trend-following in two categories. There are signs of positive cumulative abnormal returns during days 1 to 5 when buying after the publication of extremely artistic buy recommendations. However, extremely artistic sell recommendations are also followed by positive abnormal returns in that period. In conclusion, there is no convincing evidence that a more fine-grained division of recommendations is related to significant outperformance.

on the potential profitability of recommendations based on technical analysis. The existing literature reports mixed results, and available datasets have been relatively small.

Employing a dataset of 5017 stock and stock index recommendations on the basis of technical analysis, we have tested whether technical analyst recommendations are 'artistic' or whether they are not different from simple TA trading rules. We find that the sign of these recommendations (i.e., buy or sell) is consistent with various technical trading rules. In terms of returns, both stock prices and index levels exhibit statistically significant (abnormal) returns prior to the recommendation in accordance with the sign of the TA-based recommendation. In other words, both stocks and the stock index have the tendency to rise (decline) prior to a buy (sell) recommendation. Despite these patterns prior to the publication, we find that these recommendations can not be used by investors to earn positive abnormal returns. The 20-day period after the issue of the buy and sell recommendations on stocks shows that the observed trends do not persist. In addition to the lack of abnormal returns, technical analysts do not seem to exhibit strong timing skills. Even when positive returns after a buy recommendation were found for a certain week, then these returns did not differ much from the reported returns after a sell recommendation. Some recommendations came with a stop-loss level. We did not observe any particular price patterns once such a level has been reached, and we conclude that stop-loss levels do not contain any informational value. With regard to index recommendations, we found that buy recommendations are followed by significantly negative abnormal returns in the first week after the publication. The magnitude of these returns is, however, small. In general, the findings indicate that on average, technical analysts just follow simple TA trading rules.

Our first robustness check considered the returns surrounding recommendation revisions. We found more pronounced returns prior to the recommendation as compared to our full sample. We did, however, not find consistent abnormal returns for the days following a recommendation revision.

Not all recommendations in our sample were published by individual technical analysts as, among others, recommendations from professional TA websites were also included. In our second robustness check, we have repeated our analyses for individual technical analysts only. We did not find qualitatively different results.

In a third robustness check, we have tested whether artistic recommendations (i.e., recommendations which are not in line with technical trading rules) exhibit a different performance than trend-following recommendations. We did not find large differences between these types of recommendations and we conclude that recommendations which seem to stem from artistic capabilities do not outperform others.

The evidence presented in this paper is in line with the literature on weak-form market efficiency. We contribute to the scarce literature on technical recommendations by illustrating that technical analysts are, at best, capable of identifying trends *ex post*. Technical analysts do not exhibit any forecasting abilities which can be used to generate positive abnormal returns. We conclude that chartists do not exhibit 'artistic' skills, at least, not with respect to the stock market. Our findings are highly relevant to practitioners, since studies have shown that the use of TA is widespread among both private investors (Hoffmann et al., 2010) and professional investors (Carter and Van Auken, 1990; Menkhoff, 2010). Overall, this study indicates that trading on the basis of TA recommendations does not contribute to abnormal investment returns.

A limitation of this paper is that it is based on recommendations for the Dutch stock market only. Future research may be directed to the relevance of technical recommendations on other markets since these may be characterized by a different levels of market efficiency. Conducting a study using TA-based recommendations for US stocks may verify whether TA-based recommendations do not have investment value either in other relatively efficient markets. Alternatively, it would be interesting to analyze a sample of TA-based recommendations on emerging market stocks in for example Brazil, China or South Africa. Tian et al. (2002) indicated that the Chinese market can be seen as a less efficient markets. When a market would not even be weakly efficient, recommendations by technicians may contain relevant information for investment decisions.[16] A last interesting venue for future research would involve the collection and analysis of technical recommendations for the foreign exchange

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[16] The literature on fundamental analyst recommendations distinguishes emerging markets from developed markets. Moshirian et al. (2009: 74) emphasized the informational role of security analysts on emerging markets as they stated that these markets are often viewed by investors as "too exotic, too risky, too hard to research on and too difficult to invest in". Gerritsen and Lötter (2014) provided evidence on the role of security analysts in one specific emerging market (e.g., South Africa).

market, as a large percentage of foreign exchange dealers use technical analysis when forming decisions (Taylor, 1992).

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Tables

Table 1. Trading rules based on frequently used TA methods

This table contains a brief explanation of how the technical analysis methods in this study are used. We consider eight frequently employed methods of technical analysis. Some methods can contain different variations.

	Technical analysis method	Corresponding to buy recommendation when:	Corresponding to sell recommendation when:
1	Moving average (MA) [4 different variations]	the short run MA is higher than the long run MA	the short run MA is lower than the long run MA
2	Moving average crossover [4 different variations]	the short run MA crosses the long run MA from below	the long run MA crosses the short run MA from above
3	Bollinger bands (BB)	the stock price is below the lower band	the stock price is above the upper band
4	Moving average convergence divergence (MACD)	the MACD is positive (>0)	the MACD is negative (<0)
	MACD Signal	the MACD Signal is positive (>0)	the MACD Signal is negative (<0)
	MACD Histogram	the MACD Histogram is positive (>0)	the MACD Histogram is negative (<0)
5	Relative strength index	the RSI has a value lower than 30	the RSI has a value higher than 70
6	Rate of change (ROC)	the ROC is positive (>0)	the ROC is negative (<0)
7	Trading range breakout (TRB) (support and resistance levels) [3 different variations]	the stock price is higher than the resistance level	the stock price is below the support level
8	On-balance volume (OBV) [4 different variations]	the short run MA of the OBV exceeds the long run MA	the short run MA of the OBV is below the long run MA

Table 2. The distribution of buy and sell recommendations

This table shows the number of recommendations in our sample. Some recommendations came with stop-loss levels which were ultimately triggered. The number of triggered stop-losses is shown in the column 'Stop-loss'.

Category		Recommendation	%	Stop-loss	%
Stock	Buy	2687	67.7%	370	74.0%
	Sell	1280	32.3%	130	26.0%
	Total	3967	100%	500	100%
Index	Buy	605	57.6%	145	59.9%
	Sell	445	42.4%	97	40.1%
	Total	1050	100%	242	100%

Table 3. Returns after the publication of a recommendation

This table displays the returns after a buy or sell recommendation has been published. Note: ***, **, and * denote significance levels of 0.1%, 1%, and 5%, respectively, for the test statistic.

Panel A: Average raw returns (ARR) and average abnormal returns (AAR) in the 5 days after the publication of the recommendations.

	Stock recommendations				Index recommendations			
	Buy		Sell		Buy		Sell	
Day	ARR	AAR	ARR	AAR	AR	AAR	AR	AAR
1	0.04%	-0.01%	0.01%	-0.00%	-0.05%	-0.12%**	0.09%	0.03%
	(0.91)	(-0.15)	(0.08)	(-0.00)	(-1.21)	(-3.15)	(1.29)	(0.45)
2	0.01%	-0.01%	-0.22%*	-0.08%	0.04%	-0.04%	0.11%	0.05%
	(0.13)	(-0.39)	(-2.33)	(-1.01)	(0.88)	(-0.81)	(1.72)	(0.82)
3	0.01%	-0.06%	-0.09%	-0.07%	0.06%	-0.02%	0.03%	-0.02%
	(0.32)	(-1.78)	(-1.02)	(-1.07)	(1.46)	(-0.43)	(0.45)	(-0.34)
4	0.03%	0.00%	-0.15%	-0.03%	-0.03%	-0.10%*	0.11%	0.05%
	(0.78)	(0.05)	(-1.71)	(-0.43)	(-0.68)	(-2.48)	(1.40)	(0.65)
5	0.06%	0.07%	0.11%	0.06%	0.03%	-0.05%	0.10%	0.04%
	(1.16)	(1.43)	(1.09)	(0.80)	(0.66)	(-1.04)	(1.59)	(0.67)

Panel B: Cumulative average raw returns (CARR) and cumulative average abnormal returns (CAAR) in four 5-day intervals

	Stock recommendations				Index recommendations			
	Buy		Sell		Buy		Sell	
Period	CARR	CAAR	CARR	CAAR	CARR	CAAR	CARR	CAAR
(1, 5)	0.16%	-0.01%	-0.34%	-0.11%	0.05%	-0.32%***	0.43%**	0.15%
	(1.54)	(-0.12)	(-1.91)	(-0.86)	(0.58)	(-3.59)	(3.05)	(1.02)
(6,10)	0.05%	-0.13%	0.06%	0.24%	0.34%**	-0.03%	0.55%***	0.27%*
	(0.46)	(-1.62)	(0.31)	(1.71)	(3.65)	(-0.28)	(4.32)	(2.10)
(11,15)	0.23%*	-0.04%	0.11%	0.18%	0.21%*	-0.16%	0.46%**	0.18%
	(2.49)	(-0.62)	(0.54)	(1.15)	(2.24)	(-1.62)	(3.39)	(1.27)
(16,20)	0.26%**	-0.10%	0.62%**	0.34%*	0.53%***	0.16%	0.56%***	0.27%*
	(2.95)	(-1.51)	(3.25)	(2.18)	(5.55)	(1.59)	(4.89)	(2.36)

Table 4. Generalized sign test on the returns after the publication of a recommendation

The reference percentage is based on the period (-260, -10) and is calculated as the number of positive returns divided by the sum of the number of positive and negative returns. For the columns 'Raw' we based calculations on raw returns, whereas we used abnormal returns for the columns labeled 'Abnormal'. Note: ***, **, and * denote significance levels of 0.1%, 1%, and 5%, respectively, for the test statistic.

Panel A: Five individual days after the publication

	Stock recommendations				Index recommendations			
	Buy		Sell		Buy		Sell	
Day	Raw	Abnor-mal	Raw	Abnor-mal	Raw	Abnor-mal	Raw	Abnor-mal
(-260, -10)	48.7%	47.9%	47.0%	47.9%	53.6%	51.4%	52.9%	51.4%
1	48.1%	46.6%	48.3%	46.6%	51.2%	46.1%**	55.1%	51.7%
	(0.62)	(1.37)	(0.88)	(0.89)	(1.00)	(2.62)	(0.90)	(0.11)
2	48.8%	47.7%	44.8%	46.3%	53.4%	49.8%	56.6%	53.5%
	(0.16)	(0.21)	(1.58)	(1.17)	(0.10)	(0.82)	(1.58)	(0.38)
3	47.9%	47.2%	45.9%	48.4%	51.2%	48.1%	55.3%	53.7%
	(0.77)	(0.83)	(0.85)	(0.34)	(1.01)	(1.64)	(1.00)	(0.34)
4	48.6%	48.2%	44.5%	46.1%	48.6%*	44.6%***	50.3%	48.1%
	(0.04)	(0.29)	(1.87)	(1.28)	(2.13)	(3.36)	(1.09)	(1.41)
5	46.7%*	47.3%	47.5%	49.1%	50.9%	46.6%*	56.9%	52.4%
	(2.05)	(0.63)	(0.33)	(0.85)	(1.15)	(2.37)	(1.67)	(0.39)

Panel B: Four 5-day intervals

	Stock recommendations				Index recommendations			
	Buy		Sell		Buy		Sell	
Day	Raw	Abnor-mal	Raw	Abnor-mal	Raw	Abnor-mal	Raw	Abnor-mal
(-260, -10)	48.7%	47.9%	47.0%	47.9%	53.6%	51.4%	52.9%	51.4%
(1,5)	48.0%	47.4%	46.2%	47.3%	51.1%	47.0%*	54.8%	51.9%
	(0.66)	(0.55)	(0.62)	(0.43)	(1.08)	(2.16)	(0.81)	(0.19)
(6,10)	47.8%	46.8%	47.1%	49.3%	53.3%	49.0%	57.3%	54.5%
	(0.90)	(1.19)	(0.03)	(1.02)	(0.16)	(1.18)	(1.87)	(1.29)
(11,15)	48.5%	47.7%	47.5%	48.9%	53.4%	49.3%	55.4%	52.0%
	(0.18)	(0.27)	(0.33)	(0.71)	(0.12)	(1.05)	(1.04)	(0.22)
(16,20)	48.9%	47.4%	48.5%	49.0%	53.7%	50.7%	56.4%	53.2%
	(0.23)	(0.53)	(1.05)	(0.77)	(0.01)	(0.35)	(1.48)	(0.76)

Table 5. Returns after the stop-loss level has been reached

A number of recommendations (see Table 2 for a detailed overview) came with stop-loss levels. Stop-loss levels for buy (sell) recommendations were set at a value below (above) the stock price when the recommendation was published. This table provides the returns in the period after the stop-loss level is reached. Note: ***, **, and * denote significance levels of 0.1%, 1%, and 5%, respectively, for the test statistic.

Panel A: Average raw returns (ARR) and average abnormal returns (AAR) in the 5 days after the publication of the recommendations.

| | Stock recommendations | | | | Index recommendations | | | |
| | Buy | | Sell | | Buy | | Sell | |
Day	ARR	AAR	ARR	AAR	ARR	AAR	ARR	AAR
1	0.17%	0.06%	0.33%	0.11%	0.20%	0.14%	0.18%**	0.12%
	(0.87)	(0.36)	(1.96)	(0.73)	(1.07)	(0.73)	(2.85)	(1.85)
2	-0.18%	0.03%	-0.01%	0.06%	0.33%	0.27%	0.12%	0.06%
	(-1.06)	(0.26)	(-0.06)	(0.34)	(1.72)	(1.40)	(1.21)	(0.61)
3	0.35%	0.13%	0.01%	0.00%	0.19%	0.12%	0.06%	0.01%
	(1.96)	(1.13)	(0.06)	(-0.03)	(1.10)	(0.74)	(0.69)	(0.06)
4	0.15%	0.07%	-0.01%	0.04%	0.28%	0.22%	-0.09%	-0.15%
	(1.18)	(0.67)	(-0.03)	(0.26)	(1.54)	(1.19)	(-1.01)	(-1.61)
5	0.10%	0.05%	0.19%	-0.09%	-0.35%	-0.41%	0.14%	0.08%
	(0.65)	(0.44)	(1.34)	(-0.71)	(-1.49)	(-1.77)	(1.28)	(0.76)

Panel B: Cumulative average raw returns (CARR) and cumulative average abnormal returns (CAAR) in four 5-day intervals

| | Stock recommendations | | | | Index recommendations | | | |
| | Buy | | Sell | | Buy | | Sell | |
Period	CARR	CAAR	CARR	CAAR	CARR	CAAR	CARR	CAAR
(1, 5)	0.59%	0.33%	0.52%	0.11%	0.63%	0.33%	0.42%	0.13%
	(1.54)	(1.07)	(1.30)	(0.33)	(1.96)	(1.04)	(1.77)	(0.51)
(6,10)	0.16%	0.36%	-0.42%	-0.48%	-0.20%	-0.51%	0.39%	0.10%
	(0.55)	(1.63)	(-0.99)	(-1.49)	(-0.64)	(-1.64)	(1.51)	(0.36)
(11,15)	0.32%	0.14%	1.48%***	0.48%	0.09%	-0.21%	0.22%	-0.07%
	(1.19)	(0.71)	(3.41)	(1.50)	(0.35)	(-0.82)	(0.95)	(-0.28)
(16,20)	0.46%	0.16%	0.66%*	0.08%	0.14%	-0.17%	0.55%**	0.25%
	(1.44)	(0.60)	(1.99)	(0.28)	(0.43)	(-0.51)	(2.61)	(1.18)

Table 6. Generalized sign test on the returns after the stop-loss level has been reached

A number of recommendations came with stop-loss levels. Stop-loss levels for buy (sell) recommendations were set at a value below (above) the stock price when the recommendation was published. The reference percentage in this test is based on the period (-260, -10) and is calculated as the number of positive returns divided by the sum of the number of positive and negative returns. For the columns 'Raw' we based calculations on raw returns, whereas we used abnormal returns for the columns labeled 'Abnormal'. Note: ***, **, and * denote significance levels of 0.1%, 1%, and 5%, respectively, for the test statistic.

Panel A: Five individual days

| Day | Stock recommendations | | | | Index recommendations | | | |
| | Buy | | Sell | | Buy | | Sell | |
	Raw	Abnor-mal	Raw	Abnor-mal	Raw	Abnor-mal	Raw	Abnor-mal
(-260, -10)	48.3%	47.7%	47.8%	47.5%	52.6%	51.4%	52.1%	50.5%
1	53.0%	1.1%	53.8%	48.5%	51.0%	51.0%	57.7%	58.8%
	(1.79)	(1.32)	(1.39)	(0.23)	(0.30)	(0.02)	(1.12)	(1.66)
2	42.7%*	47.0%	43.8%	51.5%	61.4%	60.7%*	55.7%	48.5%
	(2.19)	(0.24)	(0.90)	(0.93)	(1.78)	(2.40)	(0.70)	(0.39)
3	50.3%	47.0%	51.5%	49.2%	49.7%	46.9%	56.7%	53.6%
	(0.74)	(0.24)	(0.86)	(0.41)	(0.48)	(0.98)	(0.91)	(0.62)
4	47.3%	46.2%	52.3%	47.7%	62.1%	51.0%	40.2%*	36.1%**
	(0.40)	(0.55)	(1.04)	(0.05)	(1.92)	(0.02)	(2.39)	(2.95)
5	47.0%	49.7%	51.5%	47.7%	57.2%	53.8%	52.6%	45.4%
	(0.50)	(0.80)	(0.86)	(0.05)	(0.93)	(0.68)	(0.09)	(1.01)

Panel B: Four 5-day intervals

| Day | Stock recommendations | | | | Index recommendations | | | |
| | Buy | | Sell | | Buy | | Sell | |
	Raw	Abnor-mal	Raw	Abnor-mal	Raw	Abnor-mal	Raw	Abnor-mal
(-260, -10)	48.3%	47.7%	47.8%	47.5%	52.1%	52.6%	51.4%	52.1%
(1,5)	48.1%	48.2%	50.6%	48.9%	56.3%	52.7%	52.6%	48.5%
	(0.11)	(0.22)	(0.65)	(0.34)	(0.74)	(0.42)	(0.09)	(0.39)
(6,10)	48.0%	47.8%	48.0%	44.6%	57.0%	55.0%	49.5%	47.2%
	(0.13)	(0.07)	(0.06)	(0.65)	(0.87)	(0.99)	(0.52)	(0.64)
(11,15)	47.7%	45.0%**	50.8%*	48.2%	58.2%	52.4%	49.9%	46.2%
	(0.63)	(2.74)	(2.15)	(0.50)	(1.13)	(0.36)	(0.44)	(0.84)
(16,20)	47.9%	47.2%	47.4%	47.5%	56.4%	50.3%	58.4%	47.2%
	(0.46)	(0.43)	(0.27)	(0.06)	(0.76)	(0.14)	(0.76)	(0.64)

Table 7. The relation between recommendations and trading rules

Technical indicator		Stock recommendations						Index recommendations					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(3)	(4)	(5)	(6)	(7)	(8)
Rule	Variation	Buy	Sell	No recommen-dation	Diffe-rence buy-sell	t-value	# Obser-vations buy&sell	Buy	Sell	No recommen-dation	Diffe-rence buy-sell	t-value	# Obser-vations buy&sell
Moving average	1-200	0.398	-0.348	0.138	0.746	23.78***	3967	0.700	0.191	0.245	0.508	9.70***	1050
	1-150	0.400	-0.444	0.121	0.843	27.27***	3967	0.676	0.173	0.211	0.503	9.46***	1050
	5-150	0.295	-0.309	0.122	0.604	18.65***	3967	0.620	0.191	0.218	0.429	7.85***	1050
	2-200	0.360	-0.308	0.138	0.668	20.93***	3967	0.712	0.187	0.235	0.529	10.11***	1050
Moving average crossover	1-200	0.034	-0.052	0.000	0.087	11.23***	3967	0.008	-0.016	0.004	0.024	1.66	1050
	1-150	0.032	-0.053	-0.000	0.086	10.67***	3967	-0.003	-0.004	0.010	0.014	1.00	1050
	5-150	0.018	-0.032	0.000	0.050	8.51***	3967	0.000	-0.002	0.001	0.002	0.28	1050
	2-200	0.025	-0.049	0.000	0.074	10.81***	3967	0.007	-0.027	0.005	0.034	2.83**	1050
Bollinger bands		0.233	-0.294	0.015	0.527	32.46***	3967	0.109	-0.072	-0.025	0.181	7.70***	1050
Moving average convergence divergence		0.382	-0.502	0.081	0.884	28.73***	3967	0.521	0.047	0.219	0.473	8.25***	1050
	Signal line	0.294	-0.350	0.083	0.644	19.98***	3967	0.491	0.146	0.185	0.348	5.98***	1050
	Histogram	0.378	-0.495	0.012	0.874	28.34***	3967	0.240	-0.187	0.084	0.526	6.99***	1050
Relative strength index		-0.152	0.134	0.017	-0.286	-20.86***	3967	-0.060	-0.025	-0.123	-0.035	-1.89	1050
Rate of change		0.588	-0.316	0.231	0.903	35.14***	3967	0.544	-0.009	0.334	0.553	10.58***	1050
Trading range breakout	50 day	0.261	-0.341	0.023	0.602	35.06***	3967	0.208	0.013	0.080	0.195	7.45***	1050
	150 day	0.140	-0.151	0.021	0.290	21.89***	3967	0.150	0.043	0.081	0.108	4.91***	1050
	200 day	0.127	-0.120	0.021	0.247	19.78***	3967	0.136	0.036	0.064	0.100	4.87***	1050
On-balance volume	1-200	0.335	-0.258	0.239	0.594	16.30***	3211						
	1-150	0.331	-0.330	0.211	0.661	18.25***	3211						
	5-150	0.267	-0.240	0.210	0.507	13.69***	3211						
	2-200	0.317	-0.228	0.238	0.545	14.86***	3211						

Note: ***, **, and * denote significance levels of 0.1%, 1%, and 5%, respectively, for the test statistic.

Table 8. Multinomial logistic regression of TA-based recommendations on the technical trading rules

We estimated the regression model for stocks as captured by Equation 3.13. For each rule we included the variation with the highest level of significance in Table 7. We excluded the OBV indicator since this variable could not be computed for the index. Note: ***, **, and * denote significance levels of 0.1%, 1%, and 5%, respectively, for the test statistic.

Panel A: Stock recommendations

Rule	Variation	Buy		Sell	
		Coefficient	z-statistic	Coefficient	z-statistic
Moving average	1-150	0.108	3.27**	-0.090	-1.95
Moving average crossover	1-200	0.529	4.15***	-0.504	-3.27**
Bollinger bands		0.866	12.36***	-1.014	-10.24***
MACD		-0.039	-1.29	-0.140	-3.04**
Relative strength index		0.316	4.51***	-0.508	-4.93***
Rate of change		0.212	6.36***	-0.242	-5.52***
Trading range breakout	50	0.815	11.47***	-1.278	-11.84***
On-balance volume	1-150	-0.079	-2.77***	-0.253	-6.41***
Intercept		-3.90	-137.35***	-4.760	-114.57***

Notes to Panel A: Number of observations: 88150; Wald chi^2: 2018.30; Prob > chi^2: 0.0000; Pseudo R^2: 0.0653

Panel B: Index recommendations

Signal	Variation	Buy		Sell	
		Coefficient	z-statistic	Coefficient	z-statistic
Moving average	2-200	0.629	8.54***	0.094	1.30
Moving average crossover	2-200	-0.583	-1.32	-1.091	-2.87**
Bollinger bands		1.19	6.18***	-0.051	-0.25
MACD		-0.020	-0.28	-0.038	-0.46
Relative strength index		0.039	0.20	-0.915	-4.19***
Rate of change		0.139	0.18	-0.449	-5.72***
Trading range breakout	50	0.080	0.54	-0.320	-1.79
Intercept		-1.03	-14.88***	-0.927	-15.18***

Notes to Panel B: Number of observations: 2231; Wald chi^2: 227.71; Prob > chi^2: 0.0000; Pseudo R^2: 0.0616

Table 9. Abnormal returns prior to publication of recommendations

This table depicts the returns prior to the publications of buy and sells recommendations published by technical analysts. Note: ***, **, and * denote significance levels of 0.1%, 1%, and 5%, respectively, for the test statistic.

Panel A: Average raw returns (ARR) and average abnormal returns (AAR) in the 5 days after the publication of the recommendations

Day	Stock recommendations				Index recommendations			
	Buy		Sell		Buy		Sell	
	ARR	AAR	ARR	AAR	ARR	AAR	ARR	AAR
-4	0.30%***	0.14%***	-0.39%***	-0.10%	0.18%***	0.10%*	-0.02%	-0.07%
	(7.02)	(4.07)	(-4.83)	(-1.46)	(3.47)	(2.02)	(-0.28)	(-1.17)
-3	0.26%***	0.19%***	-0.40%***	-0.17%*	0.11%**	0.04%	0.00%	-0.05%
	(6.12)	(5.39)	(-4.32)	(-2.15)	(2.70)	(0.91)	(0.03)	(-0.85)
-2	0.40%***	0.19%***	-0.71%***	-0.31%***	0.30%***	0.22%***	-0.13%*	-0.19%**
	(9.92)	(5.55)	(-8.34)	(-4.10)	(6.84)	(5.13)	(-2.04)	(-2.88)
-1	0.81%***	0.52%***	-1.16%***	-0.59%***	0.26%***	0.18%***	-0.18%**	-0.24%***
	(16.21)	(12.19)	(-11.21)	(-6.91)	(5.74)	(4.05)	(-2.90)	(-3.80)
0	1.43%***	1.00%***	-2.35%***	-1.43%***	0.30%***	0.23%***	-0.36%***	-0.41%***
	(20.30)	(15.94)	(-22.63)	(-16.01)	(6.25)	(4.65)	(-5.15)	(-5.99)

Panel B: Cumulative average raw returns (CARR) and cumulative average abnormal returns (CAAR) in four 5-day intervals

Period	Stock recommendations				Index recommendations			
	Buy		Sell		Buy		Sell	
	CARR	CAAR	CARR	CAAR	CARR	CAAR	CARR	CAAR
(-9,-5)	0.64%***	0.27%***	-0.24%	0.16%	0.24%*	-0.13%	-0.26%	-0.54%***
	(6.88)	(3.70)	(-1.28)	(0.99)	(2.42)	(-1.28)	(1.96)	(-3.98)
(-4,0)	3.21%***	2.04%***	-5.00%***	-2.59%***	1.15%***	0.78%***	-0.69%***	-0.97%***
	(27.39)	(20.97)	(-25.41)	(-16.05)	(11.79)	(7.68)	(-4.44)	(-6.20)

Table 10. Generalized sign test prior to the publication of stock and index recommendations

The reference percentage is based on the period (-260, -10) and is calculated as the number of positive returns divided by the sum of the number of positive and negative returns. For the columns 'Raw' we based calculations on raw returns, whereas we used abnormal returns for the columns labeled 'Abnormal'. Note: ***, **, and * denote significance levels of 0.1%, 1%, and 5%, respectively, for the test statistic.

Panel A: Five individual days

Day	Stock recommendations				Index recommendations			
	Buy		Sell		Buy		Sell	
	Raw	Abnor-mal	Raw	Abnor-mal	Raw	Abnor-mal	Raw	Abnor-mal
(-260, -10)	48.7%	47.9%	47.0%	47.9%	53.6%	51.4%	52.9%	51.4%
-4	53.0%***	51.1%**	43.0%**	47.1%	54.9%	50.9%	54.6%	53.7%
	(4.45)	(3.23)	(2.95)	(0.55)	(0.53)	(0.26)	(0.71)	(0.97)
-3	52.7%***	51.6%***	39.1%***	45.0%*	53.1%	50.2%	50.3%	46.7%*
	(4.14)	(3.77)	(5.85)	(2.07)	(0.24)	(0.58)	(1.09)	(1.98)
-2	55.9%***	53.7%***	37.2%***	43.2%***	62.5%***	58.2%***	50.1%	48.3%
	(7.54)	(6.02)	(7.30)	(3.38)	(3.85)	(3.37)	(1.19)	(1.31)
-1	64.5%***	58.5%***	28.0%***	38.8%***	61.2%**	57.9%**	48.3%	44.9%**
	(17.18)	(11.11)	(15.21)	(6.70)	(3.26)	(3.20)	(1.95)	(2.75)
0	59.8%***	64.1%***	20.3%***	26.2%***	60.7%**	57.0%**	42.7%***	39.8%***
	(23.87)	(17.44)	(23.77)	(17.67)	(3.04)	(2.78)	(4.36)	(5.02)

Panel B: Four 5-day intervals

Day	Stock recommendations				Index recommendations			
	Buy		Sell		Buy		Sell	
	Raw	Abnor-mal	Raw	Abnor-mal	Raw	Abnor-mal	Raw	Abnor-mal
(-260, -10)	48.7%	47.9%	47.0%	47.9%	53.6%	51.4%	52.9%	51.4%
(-9,-5)	49.1%	48.5%	45.1%	47.4%	52.5%	48.7%	52.5%	50.2%
	(0.44)	(0.56)	(1.41)	(0.36)	(0.49)	(1.33)	(0.16)	(0.52)
(-4,0)	59.2%***	55.8%***	33.5%***	40.0%***	58.4%*	54.8%	59.2%	46.7%*
	(11.07)	(8.19)	(10.27)	(5.72)	(2.06)	(1.69)	(1.57)	(2.00)

Table 11. Returns surrounding the publication of a recommendation revision

This table provides the returns surrounding a recommendation revision. Revisions can be either from Sell to Buy (Sell → Buy) of from Buy to Sell (Buy → Sell). Note: ***, **, and * denote significance levels of 0.1%, 1%, and 5%, respectively, for the test statistic.

Panel A: Average raw returns (ARR) and average abnormal returns (AAR) in the 10 surrounding the publication of a recommendation revision

| | Stock recommendations | | | | Index recommendations | | | |
| | Sell → Buy | | Buy → Sell | | Sell → Buy | | Buy → Sell | |
Day	ARR	AAR	ARR	AAR	ARR	AAR	ARR	AAR
-4	0.57%***	0.23%**	-0.40%***	-0.11%	0.22%	0.17%	0.12%	0.06%
	(5.51)	(2.67)	(-3.72)	(-0.40)	(1.75)	(1.32)	(1.12)	(0.56)
-3	0.45%***	0.29%***	-0.49%***	-0.27%	-0.02%	-0.07%	0.02%	-0.04%
	(4.31)	(3.50)	(-4.20)	(-1.20)	(-0.19)	(-0.68)	(0.16)	(-0.36)
-2	0.67%***	0.35%***	-0.65%***	-0.29%	0.50%***	0.44%***	-0.19%	-0.25%*
	(6.75)	(4.61)	(-5.76)	(-1.78)	(4.15)	(3.70)	(1.46)	(-1.91)
-1	1.34%***	0.82%***	-1.20%***	-0.61%***	0.21%*	0.15%	-0.31%**	-0.37%**
	(11.52)	(8.17)	(-10.28)	(-4.82)	(2.28)	(1.68)	(-2.69)	(-3.22)
0	2.75%***	1.88%***	-2.38%***	-1.45%***	0.66%***	0.60%***	-0.50%***	-0.56%***
	(13.62)	(10.25)	(-17.31)	(-9.98)	(5.04)	(4.60)	(-4.24)	(-4.75)
1	0.22%	0.10%	0.04%	-0.02%	0.02%	-0.04%	-0.03%	-0.09%
	(1.59)	(0.76)	(0.29)	(-0.13)	(0.20)	(-0.49)	(-0.22)	(-0.67)
2	0.11%	0.06%	-0.14%	-0.05%	0.09%	0.04%	0.19%	0.13%
	(1.06)	(0.72)	(-0.96)	(-0.32)	(1.02)	(0.45)	(1.53)	(1.03)
3	0.17%	0.02%	0.07%	-0.05%	-0.05%	-0.10%	-0.06%	-0.12%
	(1.48)	(0.22)	(0.56)	(-0.24)	(-0.60)	(-1.22)	(-0.44)	(-0.93)
4	-0.07%	-0.05%	-0.12%	0.05%	-0.05%	-0.14%	0.06%	-0.00%
	(-0.67)	(-0.63)	(-0.98)	(0.19)	(-0.58)	(-1.62)	(0.37)	(-0.03)
5	0.19%	0.24%	0.02%	-0.01%	-0.09%	-0.07%	0.04%	0.04%
	(0.99)	(1.36)	(0.14)	(-0.02)	(-1.04)	(-0.76)	(0.86)	(0.32)

Panel B: Cumulative average raw returns (CARR) and cumulative average abnormal returns (CAAR) in six 5-day intervals

| | Stock recommendations | | | | Index recommendations | | | |
| | Sell → Buy | | Buy → Sell | | Sell → Buy | | Buy → Sell | |
Period	CARR	CAAR	CARR	CAAR	CARR	CAAR	CARR	CAAR
(-9,-5)	1.16%***	0.59%**	-0.36%	-0.06%	-0.41%	-0.67%**	-0.46%	-0.76%**
	(4.97)	(3.19)	(-1.42)	(-0.30)	(-1.93)	(-3.04)	(-1.80)	(-2.97)
(-4,0)	5.78%***	3.58%***	-5.12%***	-2.72%***	1.56%***	1.30%***	-0.87%**	-1.17%***
	(19.94)	(14.08)	(-20.18)	(-11.29)	(6.86)	(5.41)	(-3.27)	(-4.53)
(1,5)	0.61%	0.37%	-0.13%	-0.07%	-0.08%	-0.34%	0.26%	-0.04%

	(1.94)	(1.25)	(-1.62)	(0.36)	(-0.44)	(-1.79)	(0.92)	(-0.15)
(6,10)	-0.03%	-0.17%	-0.39%	-0.03%	0.30%	0.04%	0.44%	0.14%
	(-0.13)	(-1.14)	(-1.62)	(-0.14)	(1.48)	(0.19)	(1.75)	(0.56)
(11,15)	0.44%	-0.16%	-0.23%	-0.37%*	0.57%**	0.31%	0.39%	-0.02%
	(1.86)	(-0.87)	(-0.92)	(-2.00)	(3.00)	(1.62)	(1.09)	(-0.06)
(16,20)	0.46%*	-0.10%	0.31%	-0.23%	0.44%*	0.18%	0.35%	0.05%
	(2.33)	(-0.65)	(1.26)	(-1.25)	(2.24)	(0.89)	(1.57)	(0.22)

Table 12. Returns around the publication of recommendations by individual analysts

In this table we display the returns surrounding recommendations published by individual analysts with a sole focus on technical analysts. In other words, we have excluded automated TA recommendation providers and analysts who sometimes publish recommendations based on fundamental analysis as well. Note: ***, **, and * denote significance levels of 0.1%, 1%, and 5%, respectively, for the test statistic.

Panel A: Average raw returns (ARR) and average abnormal returns (AAR) in the 10 days surrounding the publication of a recommendation by an individual analyst

	Stock recommendations			
	Buy		**Sell**	
Day	ARR	AAR	ARR	AAR
-4	0.30%***	0.14%**	-0.23%	0.03%
	(5.17)	(3.08)	(-1.88)	(0.34)
-3	0.17%**	0.15%***	-0.58%***	-0.39%*
	(3.01)	(3.38)	(-3.32)	(-2.58)
-2	0.36%***	0.14%**	-0.79%**	-0.30%*
	(6.66)	(3.18)	(-5.07)	(-2.39)
-1	0.67%***	0.43%***	-1.00%***	-0.63%***
	(10.01)	(7.61)	(-4.89)	(-4.07)
0	0.66%***	0.41%***	-0.74%***	-0.31%**
	(9.42)	(6.90)	(-5.65)	(-2.95)
1	0.02%	-0.01%	0.06%	-0.01%
	(0.46)	(0.27)	(0.41)	(-0.15)
2	-0.06%	-0.03%	-0.23%	-0.08%
	(-1.14)	(-0.76)	(-1.50)	(-0.79)
3	-0.07%	-0.11%**	-0.13%	0.01%
	(-1.35)	(-2.83)	(-0.96)	(0.12)
4	0.05%	-0.01%	-0.44%**	-0.08%
	(0.92)	(0.15)	(-3.37)	(-0.79)
5	0.00%	0.01%	0.21%	0.03%
	(0.04)	(0.20)	(1.56)	(0.12)

Panel B: Cumulative average raw returns (CARR) and cumulative average abnormal returns (CAAR) in six 5-day intervals

	Stock recommendations			
	Buy		**Sell**	
Period	CARR	CAAR	CARR	CAAR
(-9,-5)	0.33%**	0.14%	-0.88%**	-0.40%
	(2.65)	(1.43)	(-3.01)	(-1.93)

(-4,0)	2.16%***	1.26%***	-3.34%***	-1.60%***
	(14.94)	(11.17)	(-8.89)	(-5.39)
(1,5)	-0.05%	-0.14%	-0.53%	-0.14%
	(-0.53)	(-1.46)	(-1.79)	(-0.72)
(6,10)	0.08%	-0.16%	-0.05%	0.13%
	(0.58)	(-1.53)	(-0.17)	(0.61)
(11,15)	0.36%**	0.11%	0.07%	0.07%
	(2.97)	(1.28)	(-0.23)	(0.31)
(16,20)	0.15%	-0.14%	0.21%	0.21%
	(1.23)	(-1.61)	(0.70)	(0.91)

Table 13. Average abnormal returns for recommendations depending on the TA signal value

For each recommendation, we computed whether the TA trading signals (as discussed in Table 1) confirmed the sign of the recommendation. We divided our sample into trend-following recommendations which were recommendations that were supported by a similar average signal value (i.e., a buy (sell) recommendation accompanied by a positive (negative) aggregate TA value) and artistic recommendations which were not in line with the average signal value. We computed the abnormal returns surrounding artistic recommendations and trend-following recommendations, and considered the difference between them and the t-value of the difference. Note: ***, **, and * denote significance levels of 0.1%, 1%, and 5%, respectively, for the test statistic.

	Stock recommendations							
	Buy				**Sell**			
Day	Artistic (A)	Trend-following (TF)	A – TF	t-value	Artistic (A)	Trend-following (TF)	A – TF	t-value
1	-0.07%	-0.01%	-0.06%	-0.43	0.09%	-0.19%	0.29%	1.65
2	-0.18%	-0.01%	-0.17%	-2.03*	0.04%	-0.16%	0.21%	1.28
3	-0.06%	-0.03%	0.03%	0.34	-0.26%	0.10%	-0.36%	-2.53*
4	0.02%	0.03%	-0.01%	-0.08	0.09%	-0.02%	0.11%	0.62
5	0.24%	-0.06%	0.30%	3.01**	0.03%	0.08%	-0.05%	-0.30

	Index recommendations							
	Buy				**Sell**			
Day	Artistic (A)	Trend-following (TF)	A – TF	t-value	Artistic (A)	Trend-following (TF)	A – TF	t-value
1	-0.05%	-0.13%	0.08%	0.87	-0.07%	0.15%	-0.21%	-1.58
2	0.13%	-0.07%	0.21%	1.84	-0.01%	0.13%	-0.14%	-1.08
3	0.14%	-0.05%	0.19%	1.96	0.00%	-0.05%	0.05%	0.36
4	-0.22%	-0.07%	-0.16%	-1.49	-0.08%	0.20%	-0.29%	-1.82
5	-0.12%	-0.02%	-0.10%	-0.92	-0.01%	0.11%	-0.12%	-0.98

Figures

Figure 1. Percentage of buy recommendations versus stock index returns

This figure provides the percentage of buy recommendations published for stocks and for the index. For each calendar quarter, this percentage is defined as the number of buy recommendations divided by the sum of the number of buy recommendations and the number of sell recommendations. Given that the index recommendations concern the AEX index, we plot the percentage of buy recommendations versus the quarterly return on the AEX index. The performance of this index is closely related to that of the AEX All Share index ($\sigma = 0.99$) which is used as benchmark in our abnormal return analyses. Note: Our dataset does not contain recommendations published in Q2 2005.
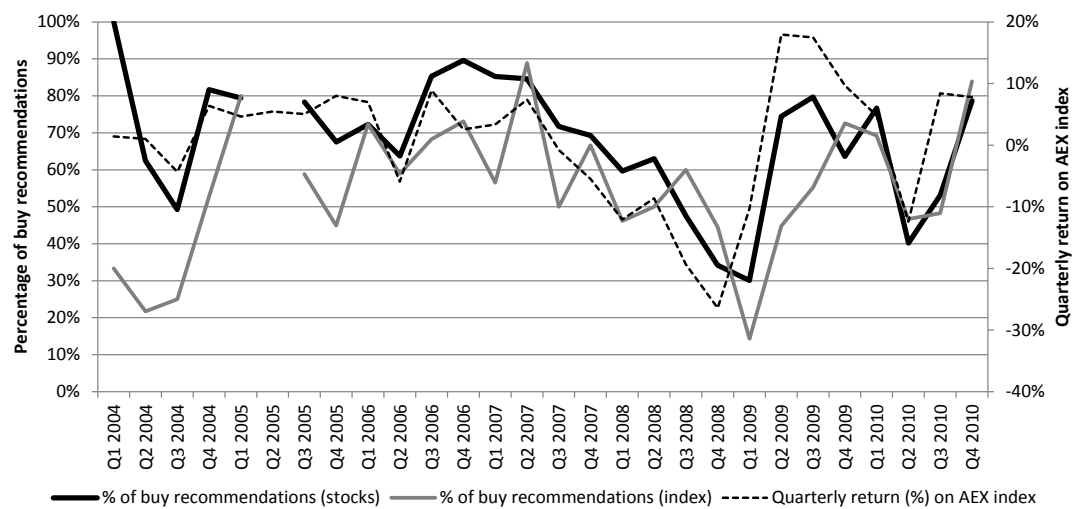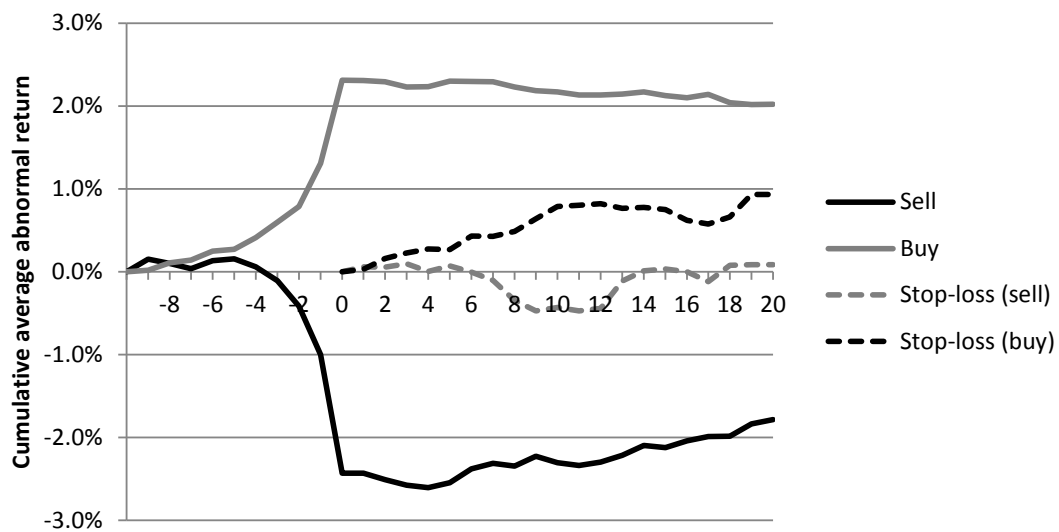
Figure 2. Abnormal returns in the period surrounding TA-based recommendations and stop-loss crossings

This figure displays the abnormal returns in the six-week period surrounding the publication of a TA-based recommendation. In addition, it plots the abnormal returns after the stop-loss level for a TA-based recommendation has been reached. 'Stop-loss (buy)' shows the abnormal returns during the 20-day period after the stop-loss level accompanying a buy recommendation has been reached. Note: the horizontal axis displays the considered event days around both the publication of the recommendation (bold lines) and the hitting of a stop-loss level (dashed lines).

Panel A: Stock recommendations

Panel B: Index recommendations

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