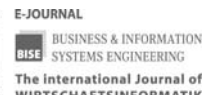Discussion Paper WI-197

# Technical Analysis as a Method of Risk Management

by

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*Chapter 1*

# TECHNICAL ANALYSIS AS A METHOD OF RISK MANAGEMENT

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**Abstract**

While the academic world is still discussing if charting works or if it is more or less something like "Voodoo finance", the practical orientated world has been using technical analysis for decades. One argument of practitioners is that technical analysis is useful to "disciplinate" the trader and consequently is a method of risk reduction. We discuss this argument theoretically and empirically and show that it is not always right.

## 1.   Motivation

Technical Analysis (TA) can be defined as the analysis of historical stock quotes with the aim of predicting future stock quotes. There has been a lot of empirical work on the performance and the prediction power of TA, with both negative[1] and positive[2] findings. Empirical research on TA trading rules is problematic, since scientists face quite a few methodical problems.[3] From a theoretical point of view it is impossible to earn above-average returns with the help of TA, if the efficient market hypothesis is taken for granted.[4] Although the academic finance has still not found an argumentation why TA should work, charting is widespread in industry practice.[5] Two reasons for the enormous popularity of TA in the practical finance world are the simple handling in comparison to "fundamental" methods and a reputation to have at least a litte forecasting power. A newer argument stated by trading professionals is that TA is mainly an instrument which helps to reduce risk. Practitioners point out that TA helps to "disciplinate" an investor by forcing him to leave the market from time to time, when a corresponding signal appears. With the end of the dotcom bubble the demand for effective risk management systems has grown, especially for private investors. In this context, TA seems to play a more and more important role as an instrument for risk management. As an example, one of the largest German direct brokers offers a service tool based on TA, which analyses the investment risks of every stock held in the portfolio.

In this paper we discuss the question, whether TA is an useful instrument for risk management, or to be more precise for risk reduction. We show that using TA for investment decisions can have a bad effect on the volatility of an investment.

## 2.   The Model

In this paper, we define risk as the standard deviation of returns.[6] We focus on a certain security or stock index (from now on referred to as "share") with prices $K_t$ at times $t = 0, 1, \ldots, n$. The return $R_t$ (belonging to the period $[t-1, t]$) is defined as:

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[1]See e.g. Hofmann (1973) or Dorfleitner and Klein (2002).

[2]See e.g. Pruitt and White (1988), Brock et al. (1992) or Lo et al. (2000).

[3]In most cases historical data are used. Ball et al. (1995) show that this may lead to an "upward bias". Researchers working with historical data sometime face the reproach of missing objectivity. See for example Jegadeesh (2000) or Dorfleitner and Klein (2002).

[4]See e.g. Schmidt (1976) or Malkiel (1996).

[5]Cf. Bankhofer and Hilbert (1999) or Tayler and Allen (1992). Both papers find a high acceptance (about 90%) of TA by practitioners.

[6]This is the standard approach for many practical applications such as performance analysis of mutual funds. See e.g. Fischer (2001).

$$R_t = \frac{K_t - K_{t-1}}{K_{t-1}} = \frac{K_t}{K_{t-1}} - 1 \quad \text{for } t = 1, \ldots, n \,. \tag{1}$$

One period may be a day or a week. The returns are random variables which we analyze ex post. Thus the distribution of the random variables is not relevant in our context.

As a benchmark for the trading strategies considered below we chose the buy-and-hold strategy (B&H). An investor who buys the share at time $0$ and holds it until time $n$ enjoys the overall return

$$R = \prod_{t=1}^{n} (R_t + 1) - 1 \,. \tag{2}$$

The (estimated) volatility of his investment is the standard deviation of the returns:

$$\hat{\sigma} = \sqrt{\frac{n \sum_{t=1}^{n} R_t^2 - \left(\sum_{t=1}^{n} R_t\right)^2}{n(n-1)}} \,. \tag{3}$$

Formula (3) measures the risk of the B&H investment.[7] We assume that an investor uses TA for his investment decisions. His intention is to achieve a lower volatility value than he would have obtained with the B&H strategy. Using TA means that he receives a signal at the beginning of every single period. For simplicity we assume only three kinds of signals:

- A "buy" signal: Induces the investor to buy the share. If he already owns the share, he does nothing.

- A "sell" signal: Induces the investor to sell the share. If he is not invested, he does nothing.

- A "hold" signal (or no signal): The investor does not do anything in any case.

During the time of the investment he may leave and re-enter the market several times. After $n$ periods the investment is over. We denote the returns induced by a certain trading strategy by $\tilde{R}_1, \ldots, \tilde{R}_n$. Formulae (2) and (3) can be applied analogously to calculate the overall return and the volatility of the strategy. In the following we consider three different types of strategies where we derive the returns $\tilde{R}_1, \ldots, \tilde{R}_n$ from the B&H returns $R_1, \ldots, R_n$. The following analysis is based on two simplifying assumptions: 1. We assume a riskless interest rate of zero. Otherwise the investor could face the risk of changing interest-rates while being not invested. 2. We do not consider transaction costs.

## 2.1. Reinvestment Strategy

Using the reinvestment strategy means, that every time the share is (re-) bought the cumulated amount of money is invested. For $t = 1, \ldots, n$ the returns $\tilde{R}_t$ of each single period $t$ are:

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[7]Note that the volatility refers to the time span of one single period.

$$\tilde{R}_t = \begin{cases} R_t, & \text{if invested} \\ \\ 0, & \text{if not invested.} \end{cases}$$

As long as the investor is in the market, the value of his investment changes with the price of the share. During the time he is out of the market, the value of his investment does not change. The latter fact may lead to the conjecture that the volatility of the reinvestment strategy is generally lower than the one of B&H. This is not true, as the following example shows:[8]

Be

$$R_t = a \qquad \text{with } a \neq 0, \qquad t = 1, \dots, n. \tag{4}$$

Then the returns of the investment are

$$\tilde{R}_t = \begin{cases} a, & \text{if invested} \\ \\ 0, & \text{if not invested} \end{cases} \qquad t = 1, \dots, n. \tag{5}$$

Obviously the $\hat{\sigma}$ value of the B&H strategy is $0$ and the estimated volatility of the reinvestment strategy is:

$$\tilde{\sigma} = \sqrt{\frac{m(n-m)}{n(n-1)} a^2}$$

where $m$ is the number of periods in which the investor is in the market. This example proofs that the case $\hat{\sigma} < \tilde{\sigma}$ is possible. Here, the impact of the investment strategy on the volatility is negative.

## 2.2. Rebalancing

Another possible investment strategy is to invest a fixed amount of money every time the share is (re)bought.

The calculation of the periodical returns during the investment process is not as easy as in formula (1), because now the cash account is not necessarily equal to zero while the investor is in the market. It is easier to calculate the returns in a recursive way. The periodical returns are now:

$$\tilde{R}_1 = \begin{cases} R_1, & \text{if invested} \\ \\ 0, & \text{if not invested} \end{cases} \tag{6}$$

and for $t > 1$:

$$\tilde{R}_t = \begin{cases} \dfrac{\prod_{i=s+1}^{t}(R_i+1)+\prod_{i=1}^{s}\left(\tilde{R}_i+1\right)-1}{\prod_{i=s+1}^{t-1}(R_i+1)+\prod_{i=1}^{s}\left(\tilde{R}_i+1\right)-1} - 1, & \text{if invested long at time } s < t \\ \\ 0, & \text{if not invested.} \end{cases} \tag{7}$$

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[8]This numerical example is also used by Dorfleitner and Klein (2004).

If the investor has only been long for one single period, i.e. if $s = t - 1$, the return simplifies to:

$$\tilde{R}_t = \frac{R_t}{\prod_{i=1}^{t-1}\left(\tilde{R}_i + 1\right)} \ .$$
(8)

Table 1 shows an example for the calculation of the periodical returns with rebalancing. In this case the risk of the investment strategy is higher than the risk of the B&H strategy.

| Period | Price Share | Return B&H | Invested | Cash | Share | Saldo | Return Strategy |
|---|---|---|---|---|---|---|---|
| 1 | 100 | | Yes | | 100,00 | 100,00 | |
| | | | | | 140,00 | | |
| 2 | 140 | 0,40 | No | 140,00 | | 140,00 | 0,40 |
| | | | | 140,00 | | | |
| 3 | 135 | -0,04 | Yes | 40,00 | 100,00 | 140,00 | 0,00 |
| | | | | 40,00 | 37,04 | | |
| 4 | 50 | -0,63 | No | 77,04 | | 77,04 | -0,45 |
| | | | | 77,04 | | | |
| 5 | 55 | 0,10 | Yes | -22,96 | 100,00 | 77,04 | 0,00 |
| | | | | -22,96 | 190,91 | | |
| 6 | 105 | 0,91 | No | 167,95 | | 167,95 | 1,18 |
| $\hat{\sigma}$ | | **0,57** | | | | | **0,61** |

Table 1. Investment with Rebalancing

## 2.3. Short Strategy

In the last two subsections we assumed that the investor would leave the market (or not enter it) if he received a sell signal. A different scenario is possible, if the investor has the possibility to go short: If he believes in the quality of the signals (which he does, of course, otherwise he would not use TA) going short is rational in the case of a sell signal. Table 2 contains one possible strategy, where the actions are dependent on the signal and the current state of the investment process (short, long or not invested).

There are several possible ways to implement the option of going short. We assume that there exists a futures market for the share. Going short here means that we build up a short position in the futures contract and simultaneously invest an amount of cash equal to the

| signal \ state | short | not invested | long |
|---|---|---|---|
| buy | get not invested | go long | stay long |
| hold | stay short | stay uninvested | stay long |
| sell | stay short | get short | get not invested |

Table 2. A possible short strategy

share price.[9] The returns for a short strategy (based on the reinvestment strategy) of each single period are now ($t = 1, \ldots, n$):

$$\tilde{R}_t = \begin{cases} R_t, & \text{if invested long} \\ \\ \dfrac{2-\frac{K_t}{K_s}}{2-\frac{K_{t-1}}{K_s}} - 1 = \dfrac{2-\prod_{i=s+1}^{t}(R_i+1)}{2-\prod_{i=s+1}^{t-1}(R_i+1)} - 1, & \text{if invested short since } s < t \\ \\ 0, & \text{if not invested.} \end{cases} \quad (9)$$

The case study in section 3. includes an example, where the estimated $\tilde{\sigma}$ value of the short strategy is higher than the corresponding value of the B&H strategy.

## 3.  Case Study

In this section, we apply the issues discussed above on the findings of Dorfleitner and Klein (2002). The paper investigates the quality of forecasts based on TA. To avoid the reproach of missing objectivity, data stemming from a widely known and accepted stock-investment magazine are used. The empirical survey includes weekly data of the Dow Jones Industrial Average (USA) and the Nikkei 225 (Japan) ranging from August 1995 to August 2001. Every week we have a short-termed (s-t) and a medium-termed (m-t) forecast for the Dow Jones and the Nikkei index. In addition to the investigation of the prediction power, several investment strategies based on the forecasts are analysed. The first four strategies (strategies I to IV in Table 3) reproduce the rational reaction of an investor on TA signals. The next four strategies (strategies V to VIII) use the signals as a contra indicator, i.e. the investor interprets a sell signal as a buy signal and vice versa. Strategies I to VIII are reinvestment strategies as defined above. Finally four short strategies (strategies IX to XII) are considered. Table 3 shows the estimated $\tilde{\sigma}$ values of the different strategies. In five cases the volatility of the strategies is higher than the volatility of the B&H strategy. All of these cases are based on a short strategy on the Dow Jones Index.

Figure 1 shows the cumulated returns of two investment cases on the Dow Jones Index between 07/1995 and 08/2001 on a weekly basis. The first investment is the B&H strategy, the second investment is short strategy IX. The total return of the B&H strategy is much better, but this is not the focus of this paper. Our point of interest is the estimated volatility of these strategies. The Figures 2 and 3 show the returns of both strategies on a weekly basis. Between week 177 and 243 the investor leaves the market and the weekly return of his investment is zero during this time. Between week 58 and 175 he is short and the magnitude of the returns of his investment is much higher than the corresponding magnitude of the B&H strategy. Here, this effect is so strong that the estimated $\tilde{\sigma}$ value is higher than the corresponding value of the B&H strategy. Following the TA-based strategy to invest in the Dow Jones here has a negative impact on the volatility of the investment.

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[9]The "amount of cash" is necessary to calculate a return. Otherwise, with an investment of 0, the return would go to $\pm\infty$.

| investment strategy | | Nikkei | | Dow Jones | |
|---|---|---|---|---|---|
| | | s-t | m-t | s-t | m-t |
| **B&H** | | **0,0293** | | **0,0237** | |
| **rational** | I | 0,0232 | 0,0272 | 0,0133 | 0,0174 |
| | II | 0,0204 | 0,0205 | 0,0162 | 0,0158 |
| | III | 0,0051 | 0,0163 | 0,0075 | 0,0101 |
| | IV | 0,0282 | 0,0278 | 0,0227 | 0,0227 |
| **contra indicator** | V | 0,0171 | 0,0106 | 0,0197 | 0,0162 |
| | VI | 0,0210 | 0,0208 | 0,0174 | 0,0178 |
| | VII | 0,0072 | 0,0090 | 0,0069 | 0,0069 |
| | VIII | 0,0288 | 0,0242 | 0,0225 | 0,0215 |
| **short strategy** | IX | 0,0235 | 0,0278 | **0,0428** | **0,0299** |
| | X | 0,0253 | 0,0263 | 0,0211 | 0,0222 |
| | XI | 0,0261 | 0,0291 | **0,0447** | **0,0320** |
| | XII | 0,0280 | 0,0271 | 0,0237 | **0,0239** |

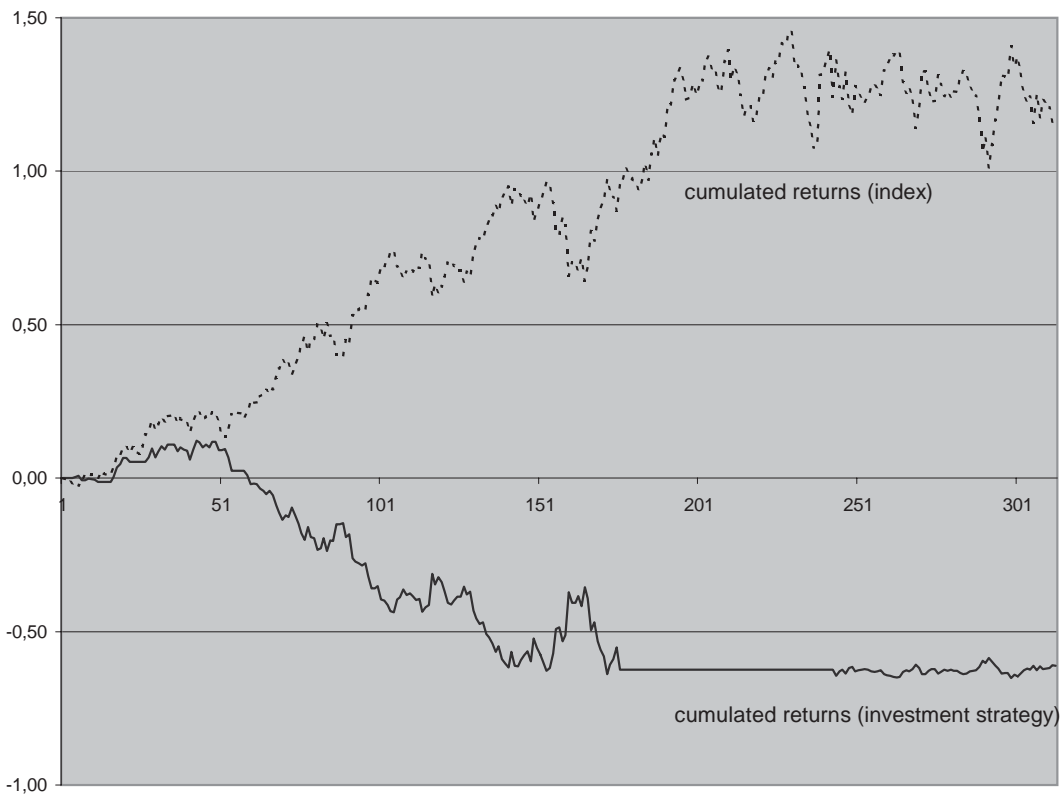Table 3. Estimated $\tilde{\sigma}$ values of different investment strategies



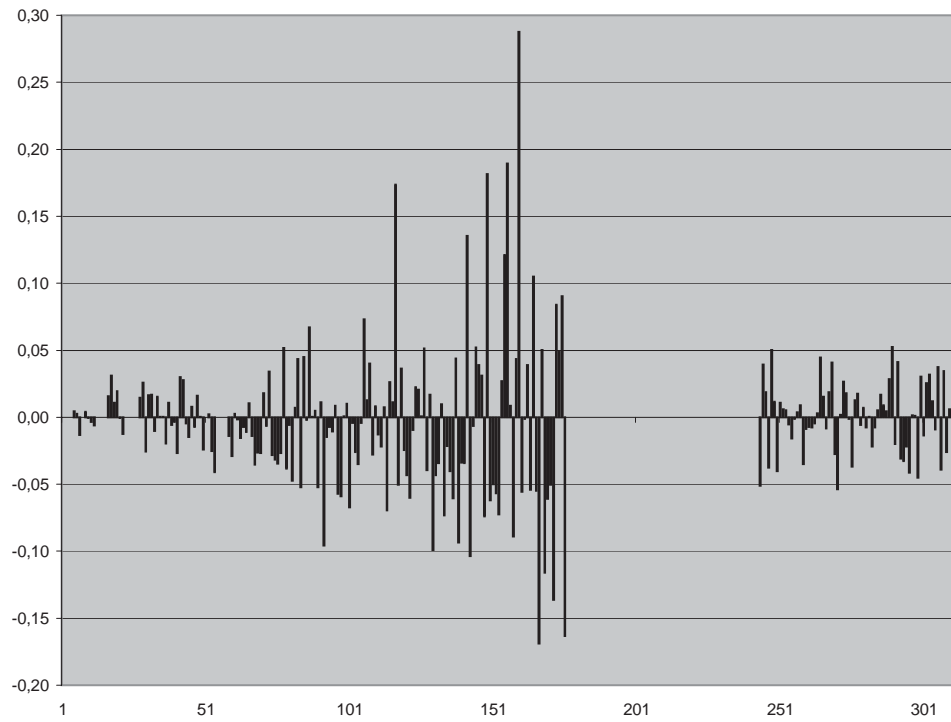Figure 1. Cumulated returns Dow Jones and short strategy
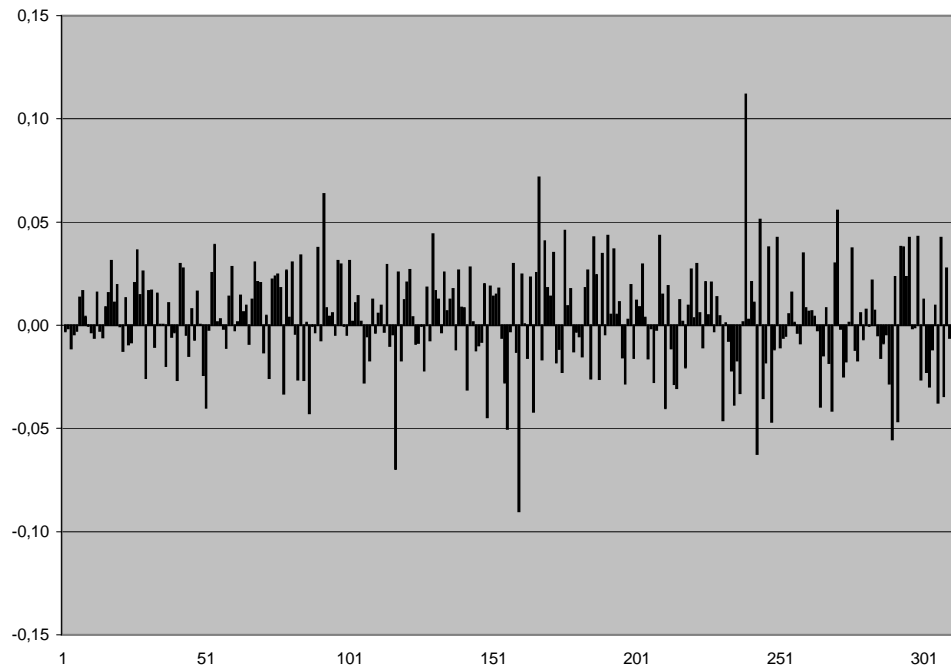
Figure 2. Weekly returns of a short strategy



Figure 3. Weekly returns of the index (= B&H strategy)

## 4.    Conclusion

We examined three different types of investment strategies that one can follow when leaving and re-entering the market on the base of TA trading signals. We focused on the risk dimension of the investment measured by the volatility of periodical returns. It could be shown by counter examples that each of the investment strategies can lead to a higher volatility compared to the B&H investment. Our case study also showed, that this effect can occur, but mostly it did not do so, i.e. TA was successfull at risk reduction. We did not take the expected return dimension into account. In the case study this dimension is also not apt to clearly justify the use of TA.

Summarizing, we state that TA as a method of risk management is at least dangerous, since it can damage the performance of the investment whereas the risk reduction effect is not granted.

In this paper we focused on investment strategies based on technical analysis. Most of our findings also hold for any other investment strategy which forces the investor to leave and re-enter the market from time to time (e.g. fundamental analysis).

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