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CPQF Working Paper Series
No. 31

Size Matters!
How Position Sizing Determines Risk and Return of Technical Timing Strategies

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January 2012

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Working Paper, Version: January 15th, 2012

Abstract

The application of a technical trading rule, which just provides long and short signals, requires the investor to decide upon the exposure to stake in each trade. Although this position sizing (or money management) crucially affects the risk and return characteristics, recent academic literature has largely ignored this effect, leaving reported results incomparable. This work systematically analyzes the impact of position sizing on timing strategies and clarifies the relation to the Kelly criterion, which proposes to bet relative fractions from the remaining gambling budget. Both erratic as well as different relative positions, i.e. fixed proportions of the remaining portfolio value, are compared for simple moving average trading rules. The simulation of parametrized return series allows systematically varying those asset price properties, which are most influential on timing results: drift, volatility, and autocorrelation.

The study reveals that the introduction of relative position sizing has a severe impact on trading results compared to erratic positions. In contrast to a standard Kelly framework, however, an optimal position size does not exist. Interestingly, smaller trading fractions deliver the highest risk-adjusted returns in most scenarios.

Keywords: Kelly Criterion, Money Management, Parameterized Simulation, Position Sizing, Technical Analysis, Technical Trading, Timing Strategy.

JEL Classification: G11

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"[Money Management] — It is not that part of your system that dictates how much you will lose on a given trade. It is not how to exit a profitable trade. It is not diversification. It is not risk control. It is not risk avoidance. It is not that part of your system that tells you what to invest. Instead, [...] it is the part of your trading system that answers the question "How much?" throughout the course of a trade."

Van K. Tharp (2007)

I Introduction

Technical trading rules usually generate a binary series of buy (1) and sell (0) signals, but do not provide information ***how much*** of the trading budget[1] should be invested in every trade. The part of a trading system, which answers this particular question, is called *position sizing* or *money management*. The choice of the money management policy has a severe impact on trading results from both a risk and return perspective. The most basic way to follow a trading rule is *unmanaged positions*, i.e. always to buy or sell one unit (e.g. one share) of the underlying asset.[2] In this case, the position size is *erratic* because it only depends on the share price and leveraging may become very large.[3] To avoid this, two basic money management techniques can be applied: *absolute positions*, i.e. to invest fixed amounts, which is widely preferred by practitioners (Potters & Bouchaud 2005); or *relative positions*, i.e. a fixed proportion of the remaining trading capital as inspired by Kelly (1956).[4] In trading systems, however, the original Kelly idea is modified such that the capital allocation is a dynamic process over time: the investor follows active trading signals and sizes the trading position relative to the remaining trading budget.

Recent academic literature on technical trading, which primarily focuses on the highly controversial issue of benefits from trading rules, spends surprisingly little attention to describe their detailed implemented position sizing. As a consequence, different views exist on the applied position sizes: Fifield, Power & Sinclair (2005), for example, suggest that in previous studies the investor had an unlimited trading budget, whereas Zhu & Zhou (2009) assume that trading positions are restricted to 100% of the remaining trading capital; and Anderson & Faff (2004) suppose that a fixed number of contracts is traded. However, it is more than doubtful that findings from studies with different implementations are comparable. In practice, experienced system developers generally are aware of the dilemma of money management: undersized positions cannot fully exploit the trading rule's potential, but even promising trading strategies may

[1] The trading budget is the value of the actively managed portfolio.

[2] To show that asset price characteristics explain timing success, we applied a trading system with unmanaged positions to analyze the pure influence of the trading rule (Scholz & Walther 2011).

[3] For example, if the remaining trading budget is low and the share price is comparatively high.

[4] In order to achieve an optimal betting strategy, Kelly suggested reinvestment of gainings such that the expected value of the logarithm of the gambling budget is maximized.

generate losses if too much exposure is taken.[5] Traders are prone to another fallacy, though: to integrate highly complex money management rules solely on the basis of backtests (Harris 2002). This practice is methodologically weak and never provides a structured insight into the impact of position sizing on the investment's risk/return profile.

The present study contributes to the literature by revealing the systematic impact of money management on a trading systems' return distribution. The focus thus lies not only on identifying optimal Kelly strategies or on evaluating the wealth levels achieved. Instead, I compare two basic money management implementations applied to the prominent simple moving average trading rule: erratic positions as well as different leveraging levels of relative position sizing. Asset returns are simulated by parametric stochastic processes, with systematic variations of the most influential asset price characteristics: the trend (or drift) μ, the volatility of returns σ, and the first-lag serial autocorrelation parameter φ of an AR(1) process. In contrast to standard backtests, the simulation approach allows to evaluate the return distributions of terminal results as well as the daily return distributions. Both is done by applying a wide range of popular statistical-, return-, risk-, and performance figures.

The study documents a severe impact of money management on the overall success or failure of the trading system and a clear dependence of this impact on the asset price characteristics of the underlying. In most scenarios, smaller relative trading positions deliver comparatively high Sharpe ratios. In fact, the introduction and especially the reduction of relative position sizes offers some kind of protective element: return is sacrificed in order to limit the risks from timing, especially large drawdowns. However, a universal optimal position size as supposed by the Kelly criterion does not exist. This finding contradicts Anderson & Faff (2004), who claim empirical optima based on backtests.

After a brief literature review, Section III explains the methodology in more detail. Section IV presents the simulation results and summarizes the risk and performance implications from managed positions. Section V concludes.

II Literature Review

The idea of optimal position sizing goes back to Kelly (1956), who applied information theory on gambling and proved that the information transfer rate over a channel is equal to the maximum exponential growth rate of a gambler's capital. The original Kelly criterion, however, is not directly applicable in finance since here the outcomes are typically not Bernoulli distributed, in contrast to many gambling games. It can be shown, though, that maximizing the growth rate

[5] For example, consecutive losing trades and drawdowns may consume the initial capital before net profits can be realized.

is formally achieved by maximizing logarithmic utility. In 1959, Latané put forth the idea of maximizing logarithmic utility to get an optimal growth rate in an economic context. In many publications, the U.S. mathematician Edward Thorp adapted the Kelly formula to portfolio selection (e.g. Thorp 1969, 1971, 1980, 2006, 2010, Rotando & Thorp 1992). Other works on the subject further elaborated the concepts and worked out implementable solutions (Browne 1999, Hakansson & Ziemba 1995, MacLean, Ziemba & Li 2005, McEnally 1986, Mulvey, Pauling & Madey 2003, Wilcox 2003*a*,*b*, 2005).

In continuous time, the Kelly criterion has two major beneficial long run properties:[6] the asymptotic growth rate is maximized and the time to reach a given wealth level is minimized (Breiman 1961). Although many scientists consider maximizing the log utility as superior, some economists vigorously argue against the criterion since it neglects individual investing preferences in favor of the optimal growth rate. Paul Samuelson (cf. Samuelson 1969, 1971, 1979, Merton & Samuelson 1974) points out that the application of the Kelly criterion is comparably risky due to potentially highly levered bets. It could indeed be discouraging for investors to follow the Kelly strategy since trading success is not guaranteed if the time horizon is finite and there is a significant potential to interim setback periods (MacLean, Thorp & Ziemba 2010). MacLean, Ziemba & Blazenko (1992) considered the trade-off between *growth* by applying the Kelly criterion and *security* in terms of drawdowns and found that the high wagers of full Kelly bets may lead to an immense reduction of wealth. However, *fractional* Kelly strategies, which lower the fraction of the original Kelly bet proportionally, may help to overcome these issues by lowering volatility and reducing the error-proneness in the edge[7] calculations (MacLean, Sanegre, Zhao & Ziemba 2004, MacLean, Zhao & Ziemba 2009). Admittedly, even those who support Kelly's idea tend to adopt fractional strategies since one of the fundamental insights of Kelly is the fact that overbetting is more harmful than underbetting, since it lowers growth but increases risk (Ziemba 2009).[8] MacLean, Thorp, Zhao & Ziemba (2010) confirm this perception since they find that the full Kelly approach does not stochastically dominate the fractional strategies.

In investment practice, there are many applications for Kelly strategies:[9] to allocate capital between different asset classes (e.g. Heath, Orey, Pestien & Sudderth 1987), to manage the exposure of the risky asset in a portfolio (e.g. MacLean, Thorp, Zhao & Ziemba 2011), as well

[6]Cf. MacLean, Thorp & Ziemba (2010) for an extensive discussion about the "good and the bad properties of the Kelly criterion".

[7]The term *edge* denotes the individual advantage over the general public. The determination of the optimal Kelly bet relies on an estimate of the gambler's edge: in a portfolio context, *edge* describes the individually expected return. In a very simplistic view, the optimal full Kelly bet is the edge divided by the odds (MacLean, Thorp & Ziemba 2010), i.e. depending on the estimates of the asset's drift and volatility.

[8]Kelly assumes that if more risk is taken, then the investor increases the probability of extreme outcomes.

[9]Ziemba (2005) lists famous investors which are suspected to use Kelly strategies, including John M. Keynes and Warren Buffett.

as to size individual positions within a trading system or stocks in a portfolio (e.g. Anderson & Faff 2004). In an empirical study, MacLean et al. (2011) analyze the performance of different Kelly strategies in realistic market scenarios and confirm that in the two asset case (U.S. equity and T-bills with annual re-balancing) there is a trade-off between terminal wealth and risk: the more aggressive the Kelly bet, the higher the moments of the terminal wealth distribution. In contrast to the portfolio selection approach, Anderson & Faff (2004) consider the world of trading strategies, which implies a dynamic allocation process over time. They size the position dependent on the remaining trading capital, following the optimal-f money management policy.[10] Therefore, Anderson & Faff (2004) do not maximize the utility function of the investor but try to find the optimal trading size empirically, assuming that such optimum exists. They base their findings solely on return figures extracted from a backtest of five different future markets, covering a nine-year period. With this backtest approach they find that money management has an important impact on trading rule profitability, which supports the perception of real traders. But, as will be revealed in this study, they were deceived by the incidental sample of their study.

III Methodology

III.1 Parametric Simulation

For the analysis, asset prices are simulated by standard time series models to obtain the entire return distribution of terminal results. The simulation approach furthermore allows to systematically test the influence of different asset price characteristics on the effectiveness of money management and to exclude certain patterns which may occur in empirical data.

A discretized random walk is used to analyze the impact from the drift (or trend) μ and the standard deviation (or volatility) σ on trading results. The model is given as

$$r_t = \ln\left(\frac{S_t}{S_{t-1}}\right) = \left(\mu - \frac{\sigma^2}{2}\right) \cdot \Delta_t + \sigma \cdot \sqrt{\Delta_t} \cdot \varepsilon_t \tag{1}$$

where S_t denotes the stock price at time t, $\Delta_t = 1/250$ a time interval of one day, and ε_t a standard-normal random variable (Glasserman 2003).

Whereas the random walk model creates normally distributed returns, stock market returns typically exhibit some well-known stylized facts such as fat tails, time varying volatility or clustering of extreme returns (McNeil, Frey & Embrechts 2005). This is confirmed by the descriptive statistics of our data sample, where all 35 markets show such non-normality. With respect to trading results, the most influential amongst the stylized facts are autocorrelated

[10] As a practitioner, Ralph Vince published a series of books which deal with Kelly-based money management approaches (cf. Vince 1990, 1992, 1995, 2007). He tries to identify an optimal relative position size f, which is denoted as *optimal-f* and which he assumes will maximize the geometric rate of return.

returns. Statistical tests indicate that short time lags have the strongest impact on future returns (Cerqueira 2006). Therefore, a first-order autoregressive process AR(1) is applied as given by $r_t = \varphi \cdot r_{t-1} + \varepsilon_t$, such that the full model with drift results in

$$r_t = \left(\mu - \frac{\sigma^2}{2}\right) \cdot \Delta_t + \varphi \cdot r_{t-1} + \sigma \cdot \sqrt{\Delta_t} \cdot \varepsilon_t. \tag{2}$$

For every parametric simulation, 10,000 paths were generated, which produced stable results.[11] All paths comprise 2,500 data points, which corresponds to 10 years with 250 trading days. Additionally, a forerun of prices ensures the availability of an SMA value for the first day. The initial underlying asset price is always set at 100 €.

For the parameterization of the stochastic processes, real world data is used from 35 leading global equity indices [cf. table (2)]. The database contains daily closing prices from 1 January 2000 to 31 December 2009 taken from Thomson Reuters. The extremes and averages of drift, volatility, and autocorrelation are put into the parameterized simulations.[12]

III.2 The Simple Moving Average Trading Rule

A trading rule generally converts information from past prices into a digital series of buy and sell signals. In contrast to the portfolio selection problem, the trading rule aims to forecast market movements by indicating rising (1) or falling (0) prices. Accordingly, the exposure is shifted between the risky benchmark, for example a stock market index, and the risk free alternative, i.e. cash. The price path, which is finally generated by the trading rule is referred to as *equity curve* or *active portfolio*.

Simple moving averages as a trading rule are a very popular example in the academic literature. The basic idea is to follow established trends, which are detected by comparing historical price averages with the current price. SMAs have also been applied in our earlier study as an example to verify the impact from asset price parameters on trading success. Hence, this trading rule is also used in this study to ease comparison. The $SMA(d)_t$ on day t is the unweighted average of the previous d asset prices p_i $(i = t-d-1, ..., t-1)$ excluding the present day t:

$$SMA(d)_t = \frac{1}{d} \cdot \sum_{i=t-d-1}^{t-1} p_i. \tag{3}$$

If $p_t \geq SMA(d)_t$, then the system indicates a long position, i.e. holding the risky asset. If $p_t < SMA(d)_t$, then the trading budget is entirely invested in cash. In case a buy or sell signal is triggered, the positions are opened or closed completely.

The practical implementation of an SMA trading rule needs additional specifications (besides money management): in this study, short positions are not allowed, interest on the risk free cash

[11] A simulation with 100,000 paths was also run to verify that the results are stable enough.

[12] It should be noted, though, that the empirical levels of the parameters may not be stable over time.

account as well as dividend payments are not considered, and, in case of levered portfolios, credit rates do not apply. Lending is possible as long as the net position from debt and the portfolio is positive. Nevertheless, leverage may cause losses beyond the initial investment and hence imply the ruin of the investor. If a strategy on a given price path loses the total initial investment then the strategy stops, the terminal value is set to zero and registered as *total loss*. All transactions take place at the very moment when the price of the benchmark is compared to the derived SMA.[13] Sufficient liquidity and an atomistic market are therefore assumed. As SMA intervals, the 5, 10, 20, 38, 50, 100, and 200 day average are applied.[14]

III.3 The Money Management Component

In this study, a trading system with unmanaged positions is compared to relative position sizing, which allows studying the sensitivity of timing results with respect to the money management policy. If one trading unit of the underlying is bought or sold every time, e.g. one stock, then the position size is unmanaged, i.e. erratic. This implies uncontrolled leveraging since the exposure is only dependent on the ratio of stock price and remaining trading budget. The relative position sizing is inspired by Kelly's idea of relative wagers and thus reinvestment of gains. The original Kelly bet follows from maximizing the logarithmic utility function, assuming normally distributed returns and is given as $x_K = \frac{\mu_r - r_f}{\sigma_r^2}$ with mean μ_r and variance σ_r^2 of the risky asset e and the risk-free rate r_f (cf. Merton 1992, MacLean et al. 2011). Following a strict Kelly bet poses various problems, both on the market and on the investor side (shifting input variables, changing risk tolerance and/or utility preferences of investors, non-normal distribution of asset returns, Black Swan events etc.). Therefore, it may be appropriate to lower the full Kelly bet in case of extreme leveraging. If a signal is triggered, feasible portions of 25%, 50%, 75%, 100%, or 125% of the remaining portfolio value are invested in the risky asset. Those fractions are constant over time and not adjusted to new return or volatility estimates.[15]

Once a trade is executed, the position remains unadjusted during the whole course of the trade. After a sell signal is triggered, the position will be closed completely. It is important to note that the timing signals derive from the technical trading rule only. No additional instruments to limit the exposure such as stop-loss levels are applied. These assumptions are meant to ensure, that the pure influence from position sizing is analyzed, not risk management, transaction costs or interest rate sensitivity.

[13]In practice, one could assume that the price of the midday auction triggers the SMA and the system buys or sells at the very next price.

[14]A test with all in-between levels showed a rather smooth development, hence only seven nodes are used.

[15]In general, parameters could be adjusted dynamically.

III.4 Evaluation Criteria for Trading Systems

The evaluation of an investment's success has to balance *risk* and *return*. While Anderson & Faff (2004) focus on the return component only, this work also considers the risk element. Due to the simulation approach, the distribution of terminal results can be analyzed, which delivers the main findings and describes the investor's real exposure. Standard backtests, which are especially popular in practice, are based on the single historical price path and hence deliver a *pathwise distribution* only and are thus merely an estimate for the terminal result distribution. Particularly if the distributions are skewed and "reshaped", the pathwise distributions may be a biased estimator. Nevertheless, some key figures are path-dependent; in this case, the mean over all generated paths is reported (particularly including total profits, total losses, total net results, and maximum drawdowns.)

For the analysis of the position sizing effect, a broad range of evaluation criteria is applied (the complete set of criteria is listed in table (3)).[16] It turned out that the different measures mostly delivered comparable information. Even measures which are especially designed for highly non-normal (reshaped) distributions do not rank investment alternatives differently than standard measures. While this finding seems to be surprising, it is actually in-line with literature. I therefore focus on total profits, total losses, total net results, the terminal wealth relative (TWR),[17] maximum drawdowns, the (higher) moments of the return distribution, the value-at-risk, the Sharpe ratio, and the expected excess return (compared to a buy-and-hold investment) for the description of timing results.

IV Simulation Results

The results section is structured as follows: first of all, I demonstrate that there is no optimal position size in trading and that empirical optima are just a statistical artifact [subsection IV.1]. Subsequently, the impact of introducing a money management policy in a trading system is revealed. Therefore, in the subsections IV.2 to IV.4, the sensitivity of trading results to position sizing is analyzed, depending on the properties of the underlying asset price process: drift, volatility, and autocorrelation. I apply a trading system with unmanaged (or erratic) positions, which is compared to relative position sizing; trading systems with different levels of relative positions sizing are also compared. The complete set of results is given in tables (4) to (21) in the Appendix. Figures (3) to (8) moreover illustrate the results for the maximum and minimum input variables, found in the empirical dataset (e.g. the maximum and minimum drift). For reasons of clarity and readability, I abstain from graphically displaying the mean

[16] Additional figures can be provided upon request in case of particular interest.

[17] The *terminal wealth relative* is defined as *final balance* divided by *initial account size.*

values of the input variables. Every figure shows six pictures: on the left hand side, the results for the maximum value of the input variable is shown; and on the right hand side the results for the minimum value. Each line in a graph shows the results from one specific position sizing method. The erratic position size as the point of reference is depicted in bold black (marked with squares). It should be noted that the scaling of the graphs may be very different due to the absolute performance differences.

Figures (3), (5), and (7) present the profitability figures (total net results, mean returns, and Sharpe ratios); figures (4), (6), and (8) illustrate the corresponding risk perspective (volatility, maximum drawdowns, and value-at-risk). All path-dependent values represent the average of the 10,000 simulated paths.

Model	Parameter	Max	Mean	Min
Brownian motion with varying drift	μ	**22.6%**	**5.2%**	**-11.6%**
	σ	26%	26%	26%
	Kelly size	334%	77%	-118%
Brownian motion with varying volatility	μ	5.2%	5.2%	5.2%
	σ	**39%**	**26%**	**16%**
	Kelly size	34%	77%	203%
AR(1) with varying autocorrelation	μ	5.2%	5.2%	5.2%
	σ	26%	26%	26%
	φ	**0.201**	**0.025**	**-0.103**
	Kelly size	77%	77%	77%

Table 1: Kelly position sizes. The table displays the Kelly position sizes with respect to the three different scenarios, in which either the drift, the volatility, or the autocorrelation is sensitive. The Kelly size corresponds to the relative amount of risky assets compared to the remaining trading capital. Negative numbers imply short positions.

IV.1 Optimality of Fractions

Considering portfolio selection problems, the Kelly criterion provides optimal position sizes, at least if returns are normally distributed and the investment horizon is infinite. It is thus possible to determine optimal position sizes by applying the Kelly criterion. The question is, whether or not the Kelly formula also allows to find optimal position sizes in trading systems, in which the capital allocation is triggered by trading signals and thus develops as a dynamic process over time. To begin with, the Kelly position sizes for the scenarios analyzed in this study are determined, which are dependent on trend and volatility of the underlying asset. For the Brownian motion, the normality assumption is fulfilled and the application of the Kelly formula is possible in principal. Autocorrelated returns do generally not qualify for Kelly bets, however, the corresponding level for normal distributed returns is used as a reference. The full Kelly wagers are given in table (1), assuming a risk-free rate of 0%.

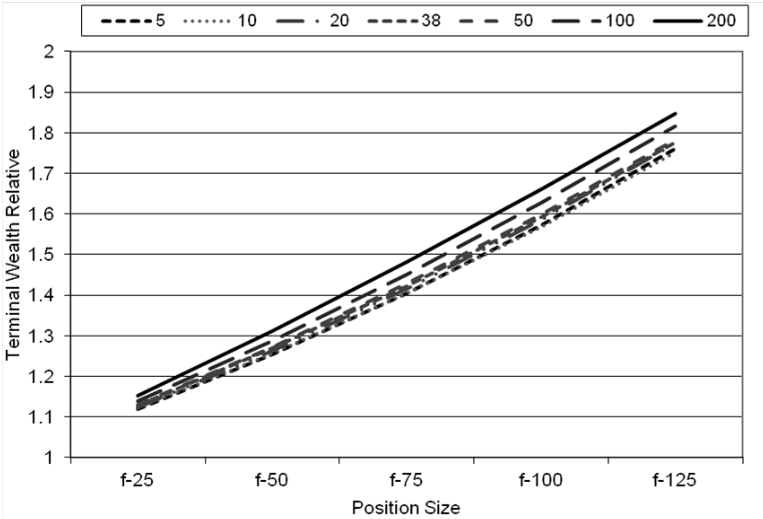

Figure 1: Terminal wealth relative dependent on fraction. The graph displays the dependency between the TWR and the applied fraction of the trading strategy. Every line stands for a different trading rule. Interestingly, there is no optimal terminal wealth relative but a monotone gradient, by contrast to the findings of the classical portfolio application of Kelly fractions. This finding holds for different drift, volatility, and autocorrelation levels in the underlying. The example is based on μ=0.052 and $\sigma = 0.26$.

To test for optimal position sizes, I follow Anderson & Faff (2004) who use the terminal wealth relative (TWR)[18] as success measure and plot the growth rate against the corresponding position size. The highest TWR indicates the best fraction to be used as position size. If an optimal fraction exists then the chart should show an unique peak. Anderson & Faff (2004) indeed identified distinctive concave curves and thus derived optimal fractions. However, their findings are solely based on the one realized price path of the respective underlying. In this study, I carry out the same analysis for each of the 10,000 simulated paths and take the average. Interestingly, for this average, the optimal fraction vanishes and there is a monotone gradient (cf. figure (1)). This finding holds also for the level of the Kelly fraction, which I derived from the underlying processes. Considering the single paths from the simulation, there is indeed a

[18]The analysis was also carried out with the logarithm of the terminal wealth as in MacLean et al. (2011). As expected, this delivers similar findings.

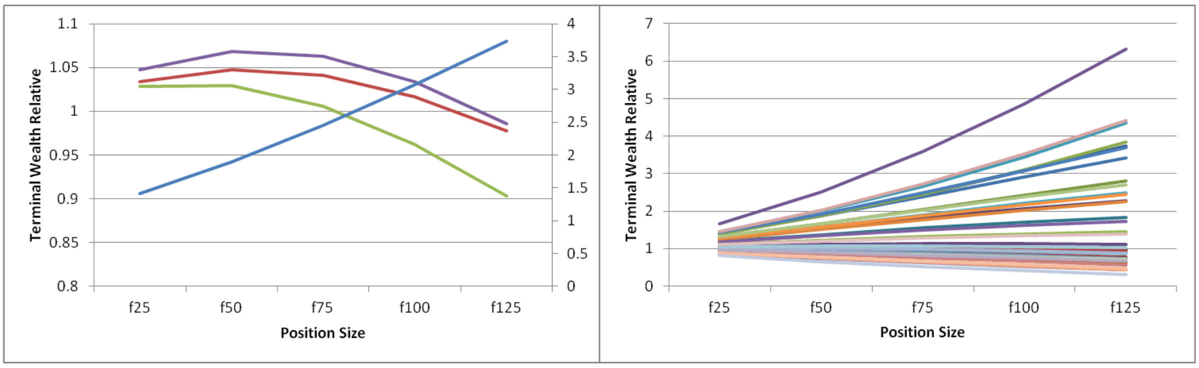

Figure 2: Terminal wealth relative dependent on fraction for single paths. The figure on the left shows some exemplary TWR curves. Some of them are concave, most of them are not. The right-hand figure displays the development of all TWR curves: the low fractions exhibit a lower variance in trading results compared to the levered position sizes. This finding holds for different drift, volatility, and autocorrelation levels in the underlying. The example is based on μ=0.052 and $\sigma = 0.26$ for an SMA(38) trading rule.

significant number of paths, which generate concave TWR curves (cf. figure (2)).[19] But even in case of concave TWR curves, the optimal position size is not the same for every path. First and foremost, those paths are concave, which provide unfavorable characteristics for the trading rule: by definition, in a simulation half of the paths emerge below average with respect to the expected drift and some may even show extremely negative courses. The higher the leveraging, the more sensitive the trading system reacts to the characteristics of the underlying path, i.e. high profits are accompanied by severe losses in the trading account. In case of below average drifts, the system thus generates very poor results for high fractions, as expressed e.g. by low total net result or small hit-ratios. On average, however, these effects cancel each other out and leave a monotone gradient. Ex-ante, there is thus no optimal fraction or position size with respect to the TWR (except for corner solutions). The monotone gradient can be found in all simulations, independent of drift, volatility, and autocorrelation. Put in a nutshell: the empirical optimum of a single path is a statistical artifact.

IV.2 Position Sizing Effects for Different Trend Levels

To analyze the influence of position sizing on trading results, a geometric Brownian motion is used in the first place. I am using this stochastic process to model different market conditions: a bullish setup, represented by the maximum (22.6% p.a.) drift in the dataset; a moderate increasing trend, i.e. the mean (5.2% p.a.) in the sample; and a bearish market, applying the

[19]As an example, take the SMA38 trading rule where about 38% of paths show a concave TWR curve.

minimum drift (-11.6% p.a.) from the sample.[20] All drift levels are combined with the empirical mean volatility level of 26% p.a. Tables (4) to (9) contain the detailed results.

Relative versus Erratic Positions In bull markets, the total net result is always positive and generally highest if no money management component is applied. In bear markets, the outcome of erratic trading positions is negative but on comparable levels as the 100% fraction. If we now compare the erratic strategy with the flock of relative ones by considering the relative position of the black curve (with squares) against the others, we find similar effects for the mean return. But the erratic position is always inferior to the 100% relative position size, independent of the market conditions.

With respect to risk-adjusted returns, however, trading systems with relative position sizing clearly deliver better results than erratic positions. While this clearly holds for bull markets, this is also the case in bear markets on closer examination. For negative returns, the Sharpe ratio is misleading, since higher volatilities reward a higher ratio (Scholz & Wilkens 2006). If the Sharpe ratio is decomposed then it becomes clear that unmanaged positions always raise the volatility of the equity curve, especially for short term SMAs. The reason for the increase is the high and uncontrolled leverage, which may occur if the position size is erratic. Since the short term SMAs trigger more trades, the risk of trading extremely levered positions is higher than in the less reactive long term SMAs. Furthermore, the introduction of (relative) money management improves skewness and kurtosis of the trading system's return distribution [see table (4) to (9) in Appendix]. The maximum drawdowns, by contrast to volatilities, are on high but comparable levels in bear markets, if the 100% and 125% fractions are considered as a reference. In the bullish scenario, the relative position sizing is capable of effectively reducing the risk from drawdowns. In rising markets, the value-at-risk levels again show the riskiness of erratic positions, especially if short term SMAs are applied. The introduction of money management based on relative positions clearly improves the tail risk, except for long SMAs in bullish environments. In bear markets, only the levered f-125% delivers higher tail risks than erratic positions. If compared to the underyling asset, erratic positions lead to similar results as the highly levered (f-125%) portfolio: a small underperformance in terms of expected excess return in bullish markets; and comparatively poor expected excess returns if medium or negative drifts are applied.

Different Leverage Levels Relative positions are assumed to correspond to Kelly strategies, which also recommend constant relative fractions as position sizes. In comparison to the full

[20] To correct for the volatility drag, the drifts μ_e measured in the descriptive analysis must be transformed into $\mu_a = \mu_e + \frac{1}{2} \cdot \sigma^2$ to generate the applied drift levels.

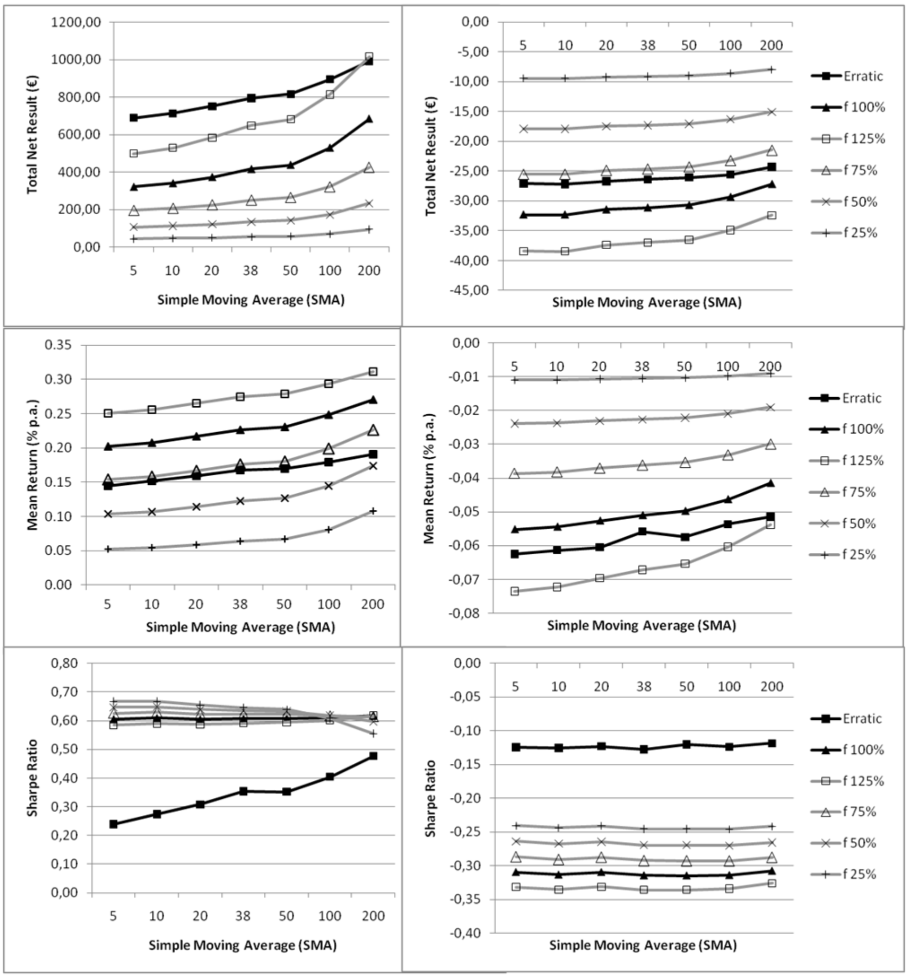

Figure 3: Return figures dependent on drift. The graphs show the total net results, the mean returns, and the Sharpe ratio for managed and unmanaged position sizing. On the left, the results for maximum drift are displayed. On the right, the results for the minimum drift are shown.

Kelly position size, the applied positions are undersized in bull markets (Kelly ratio of 334%) and oversized in bear markets (Kelly ratio of -118%). In markets with the average trend of 5.2% p.a., the applied range of f-25% to f-125% lies near the full Kelly size of f-77% (in terms of portfolio fractions).

Regarding the absolute outcomes in case of positive drifts, the different fractions behave proportional to the drift component: the higher the leveraging, the higher the profits, the losses and hence total net results. If negative drifts apply, however, then all systems lose likewise, with high fractions generating more losses than low fractions. As expected, those findings are also reflected by the mean returns: in bullish markets ($\mu = 0.226$), the mean return of the distribution of terminal results falls as the leverage decreases; if medium drifts apply, then the

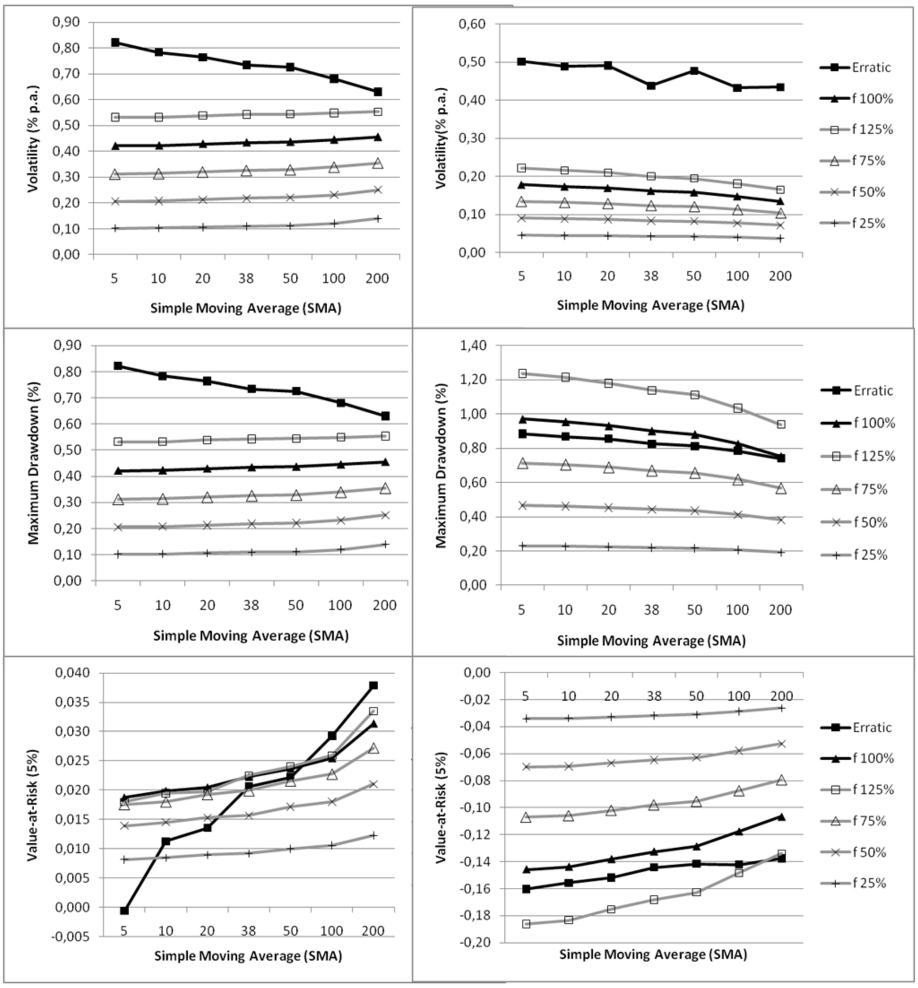

Figure 4: Risk figures dependent on drift. The graphs show the volatility, the maximum drawdowns, and the value-at-risk (5%) for managed and unmanaged position sizing. On the left, the results for maximum drift are displayed. On the right, the results for the minimum drift are shown.

mean return slightly increases for lowered leverage levels; and in case of negative trends, the mean return clearly rises with shrinking leverage. Considering the risk, reducing the fractions effectively lowers volatility, maximum drawdowns and value-at-risk from trading. Especially if the fractions are lowered below 50% then the trading system largely displays less risk than the buy-and-hold approach. Similar findings hold for the higher moments: skewness is improved as leverage is lowered and kurtosis is stable between 2.91 and 4.56. Interestingly, the lower the leverage levels, the broader the kurtosis range. As a result, low fractions generally yield superior Sharpe ratios, independent from the drift level.[21] Regarding the underlying asset as standard of

[21] With the SMA(200) as the only exception in case of positive drifts. Here, the Sharpe ratio is slightly larger for higher levered systems.

comparison, the reduction of leveraging leads to typical protection characteristics: the expected excess returns suffer in bullish markets but flourish in bearish ones.

Conclusions If positive drift levels apply, then the erratic position sizing seems to be the most profitable implementation. In case of negative trends, however, the profit and loss figures lie well within the range given from relative position sizing. The application of relative position sizing in trading systems effectively lowers the risk from timing compared to erratic positions. The exact benefit is dependent on the drift level, though. In general, smaller position sizes have a protection effect, i.e. mean returns are smaller but risk is effectively reduced. Interestingly, the lowest fraction of 25% has generally better Sharpe ratios than highly levered portfolios (f-125%), i.e. leveraging does not pay a risk premium. This finding holds in every market scenario.

IV.3 Position Sizing Effects for Different Volatility Levels

For erratic position sizing, we found a negative impact from rising volatility on trading results (Scholz & Walther 2011). To analyze the sensitivity of trading systems with different position sizes on volatility, a Brownian motion is again applied (with mean drift level of 5.2% p.a.). I check for the maximum (39%), the mean (26%), and the minimum (16%) annual volatility levels given in the empirical dataset.[22] The results from volatility influence can be found in tables (10) to (15) and figures (5) to (6).

Relative versus Erratic Positions If the total net result is considered then the erratic position sizing is amongst the most profitable implementations, no matter how volatile the underlying is. In terms of mean returns, the picture however changes: the erratic position sizing suffers in case of high and medium volatilities of the underlying. This is due to a significant number of total losses if erratic position sizing is applied. Log-returns weigh the impact of a total loss stronger than the P&L of a trading account. Only in case of low volatility levels in the markets, the erratic position sizing generates returns, which are akin to the f-100% and f-125% implementation. Similar findings hold for risk-adjusted returns: trading systems without money management clearly underperform in the given volatility setups. A high volatility level is generally disadvantageous for erratic position sizing under risk aspects: the volatility of the equity curve is higher, the maximum drawdowns are larger, and the value-at-risk (5%) signals a high tail-risk. This is confirmed by skewness as well as kurtosis of the equity curve's return distribution, which reach extreme levels. Here, introducing relative position sizing really adds

[22]To cope with the drag effects, the mean drift of 0.052 was adjusted with $\mu_a = \mu_e + \frac{1}{2} \cdot \sigma_a^2$ (with σ_a^2 being the applied volatility level in the simulation) since I intended to measure the volatility effect on the timing result only, not the mixed influence including effects on the drift component.

value. In case of comparably low volatility levels of the underlying, however, the introduction of a relative money management policy has a minor impact; the risk from erratic positions still approximates the risk from the 125% levered position size and is thus in the upper range.

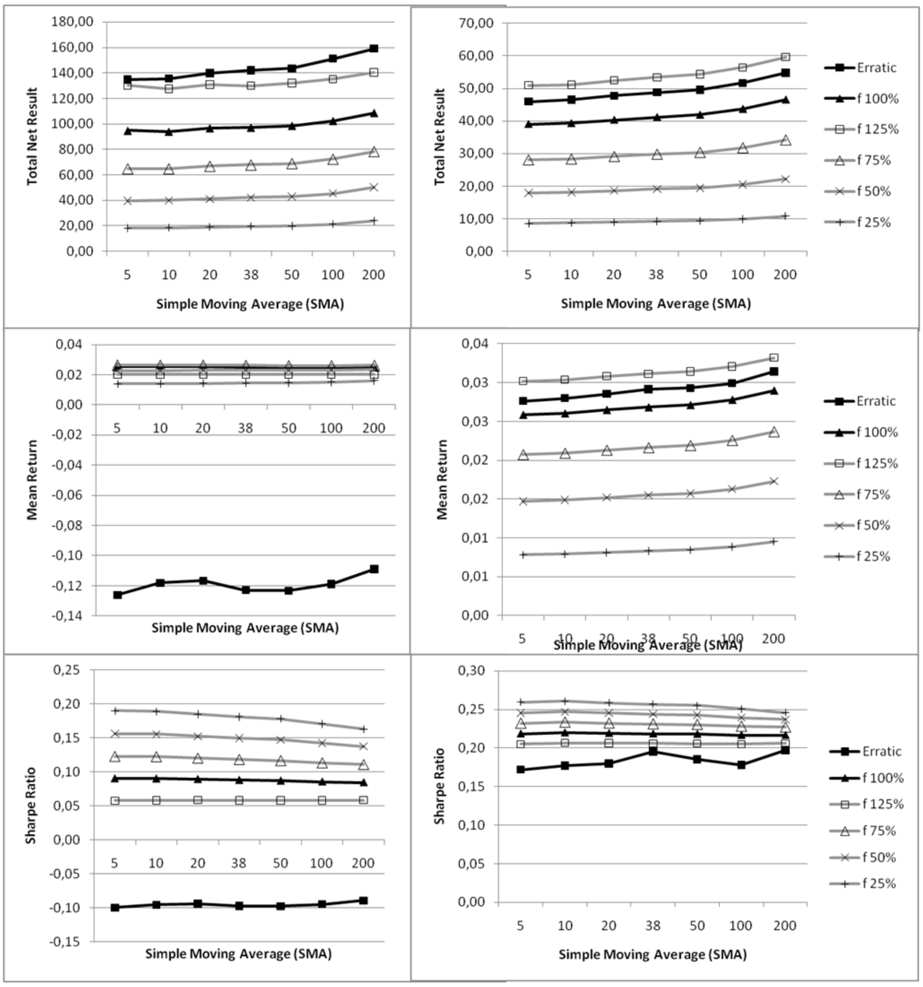

Figure 5: Return figures dependent on volatility. The graphs show the total net results, the mean returns, and the Sharpe ratio for managed and unmanaged position sizing. On the left, the results for maximum volatility are displayed. On the right, the results for the minimum volatility are shown.

Different Leverage Levels The applied levels of leverage may again be compared to the corresponding Kelly wagers. A low volatility environment requires high leveraging (203%), whereas fractions of 34% have to be chosen for high volatilities; for the medium volatility level, a fraction of 77% corresponds to the Kelly size. Except for the highest fractions, those levels are covered by the applied position sizes.

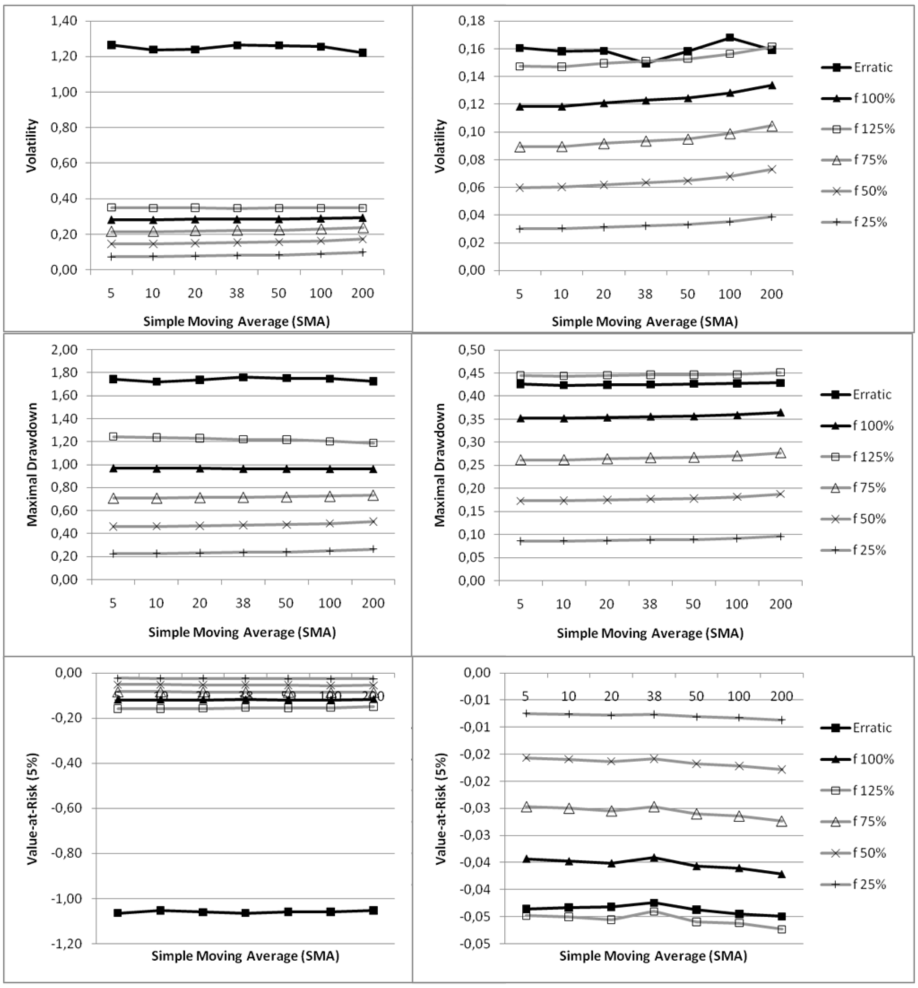

Figure 6: Risk figures dependent on volatility. The graphs show the volatility, the maximum drawdowns, and the value-at-risk (5%) for managed and unmanaged position sizing. On the left, the results for maximum volatility are displayed. On the right, the results for the minimum volatility are shown.

As one would expect, lower fractions decrease the profit potential in the trading account: the total net result, as well as total profits and losses shrink with the position size, independent of volatility levels. This finding is also reflected by the mean returns, which slightly decrease in case of deleveraging.[23] Interestingly, if the risk-adjusted returns are examined then the lower fractions are more appealing: their Sharpe ratios are slightly higher compared to the levered positions. In turbulent markets, these differences are bigger than in calm markets. Since lower

[23]High volatility of the underlying asset generally leads to higher trading profits in absolute terms, but not to higher mean returns. Surprisingly, the strategy's success with relative position sizing is nearly independent from the leverage. This effect arises from the log-return effect. Since the erratic approach produces a high number of paths, which lead to a total loss, it delivers extremely negative return values in the log-return calculation.

fractions yield less returns, the source must be the risk side. Relative position sizing indeed effectively reduces the volatility of the underlying. Downsizing of the position size additionally increases this effect. Moreover, the higher the input volatility, the stronger the reduction effect. This finding is also confirmed by the maximum drawdowns, which may be disastrous in case of high volatility in the underlying returns and highly levered positions sizes. A lower fraction can attenuate the drawdowns to more acceptable levels, especially in highly volatile environments. The value-at-risk levels also indicate the risk reduction by delevered fractions: tail risks slightly decrease if the position size is lowered. With respect to the underlying benchmark, the expected excess returns are rather insensitive to the tested volatility levels.

Conclusions If only the total net result is considered, then the erratic positions work fine. The moments of the trading system's return distribution, however, clearly show that relative position sizing is superior: especially if the underlying exhibits high volatility, the money management effectively decreases risks. Only in case of low volatile underlyings, the reduction effect is negligible. Low fractions further reduce the moments but only slightly improve the risk-adjusted returns.

IV.4 Position Sizing Effects for Different Autocorrelation Levels

In order to analyze the relevance of autocorrelation, an AR(1) process is used to generate autocorrelated return series. In all simulations, the drift is set at the empirical mean return level of 5.2% p.a. and the volatility at the empirical mean volatility level of 26% p.a.[24] Three different lag-one autocorrelation levels are examined: the maximum (0.2064), the mean (0.025), and the minimum (-0.1027) of the empirical estimates from the dataset. An overview of the results can be found in tables (16) to (21). Figures (7) and (8) display the findings for the highest and lowest autocorrelation levels.

Relative versus Erratic Positions In highly autocorrelated markets ($\varphi = 0.2064$), erratic positions generate positive total net results, which are similar to those of 50% to 75% fractions. In case of negative autocorrelation, however, the success of erratic positions extremely depends on the moving average window (low total and mean returns for short windows, higher for long ones). The SMA(38) seems to be the pivotal point. Especially short term SMA trading rules are prone to whiplash signals since they respond quickly to the underlying. Erratic positions aggravate this effect by uncontrolled leveraging; hence they are particularly susceptible to repeated loss trades. The mean returns generally confirm these findings; due to the log-return calculation, however,

[24]Once more, the applied drifts have to be corrected with $\mu_a = \mu_e \cdot (1 - \varphi)$; and the volatilities $\sigma_a = \sigma_e^2 \cdot (1 - \varphi^2)$.

erratic positions generate inferior mean returns.[25] If risk-adjusted returns are considered, the picture slightly changes such that the erratic positions generate inferior Sharpe ratios due to lower returns and increased volatility. Looking at the risk measures, erratic position sizing produces extreme risks in the negative autocorrelation scenario: volatility is excessive, maximum drawdowns may be disastrous, and the value-at-risk indicates a very high tail risk. This is again due to the susceptibility to whiplash signals. Consequently, in case of positive autocorrelation, trading systems without position sizing do not cause extended risks. If the trading systems' returns are compared with those from the underlying asset, the expected excess returns imply that the erratic positions are inferior to the money-managed trading systems, no matter which leveraging is applied or which autocorrelation level is used for the simulations.

Different Leverage Levels Although underlyings with autocorrelated returns do generally not qualify to implement Kelly strategies, the corresponding level for normally distributed returns of 77% is used as a reference. That way, the impact on trading results can be analyzed in case Kelly sizing is nevertheless applied by investors.

For positive autocorrelation, the total net result is the higher, the higher the leverage. Especially the short term SMA trading rules benefit, while the long term SMAs are less sensitive due to a smaller number of trades. Higher leveraging is unfavorable for short term SMAs in this scenario, however, long term SMAs even benefit from leveraging since they are less sensitive to whiplash signals. These findings are confirmed by the mean returns of the distribution of terminal results. Independent from the autocorrelation level, a lower leverage improves the Sharpe ratio of the trading system. Compared to the underlying, however, the f-125% trading system delivers the highest expected excess returns against the benchmark if positive autocorrelation applies. The picture changes for negative autocorrelated underlyings and the lower fractions show the least poor expected excess returns. The implementation of a relative money management component effectively controls the risk of the active portfolio: excess volatility against the underlying never occurs, even if highly levered f-125% positions are traded. The skewness improves in the trading portfolio and the kurtosis rises only moderately (4.64), which implies that the number of extreme outcomes is only slighly raised. Lower fractions of the position size moreover reduce the maximum drawdowns and the value-at-risk from timing. The only exception is the value-at-risk for high serial autocorrelation levels in the underlying: here, the short term SMA trading rules benefit if they are combined with highly levered trading positions.

Conclusions In terms of profitability, highly levered portfolios are preferable if markets exhibit positive autocorrelation, while unlevered portfolios are better suited if autocorrelation is

[25] Total net results which imply high losses in the trading account deliver highly negative return figures.

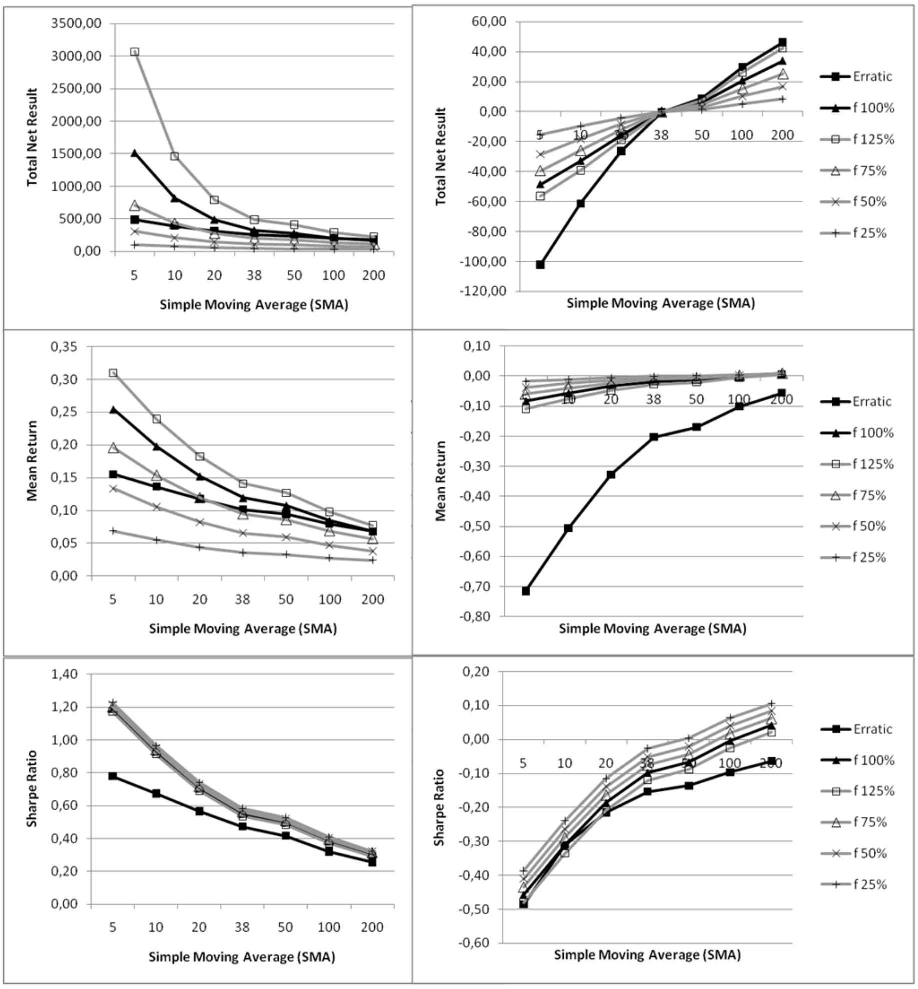

Figure 7: Return figures dependent on autocorrelation. The graphs show the total net results, the mean returns, and the Sharpe ratio for managed and unmanaged position sizing. On the left, the results for maximum autocorrelation are displayed. On the right, the results for the minimum autocorrelation are shown.

negative (this is consistent with the fact that SMA-timing is highly successful in autocorrelated markets but suffers from negative autocorrelation). The effect remains, that in positive autocorrelated markets short term SMAs are preferable (and long term SMAs if negative autocorrelation applies). Risk can be effectively controlled by relative position sizing, especially for lower fractions. Erratic positions are inferior, particularly if markets show negative autocorrelation. The cautious approach with trading lower fractions thus generates the highest risk-adjusted returns.

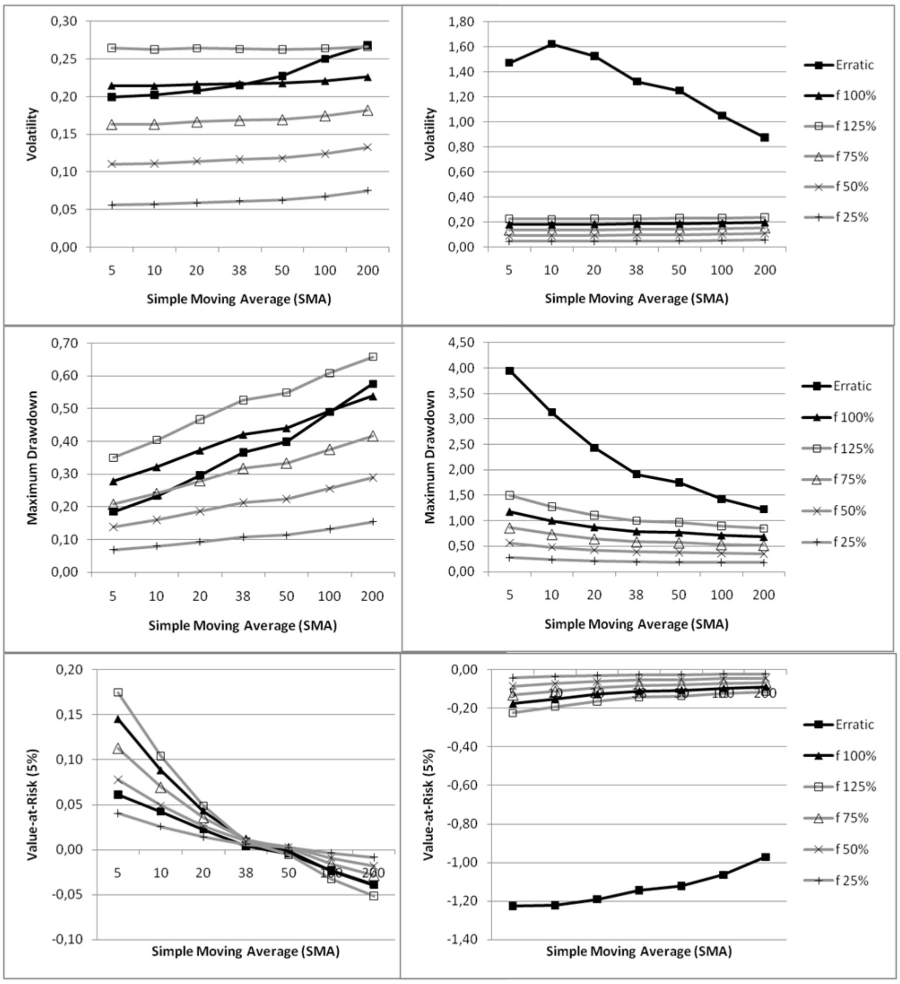

Figure 8: Risk figures dependent on autocorrelation. The graphs show the volatility, the maximum drawdowns, and the value-at-risk (5%) for managed and unmanaged position sizing. On the left, the results for maximum autocorrelation are displayed. On the right, the results for the minimum autocorrelation are shown.

V Conclusions

The study shows that position sizing has a considerable impact on the performance of SMA timing strategies. Academic papers, which spend only little attention to detailed money management, miss an important influencing factor and run the risk of misinterpreting or insufficiently understanding the empirical results. A clear recommendation for optimal position sizes is given by the well known Kelly ratio, which is applicable in gambling and long-term portfolio allocation. However, the application of relative positions in trading systems, is different to the "traditional" Kelly strategies, in which the capital is always invested with a fractional or full Kelly proportion in the risky asset. An active trading strategy proposes investments only for specific time periods according to the signal.

A major finding of the study is that there is no optimal position size in a trading system which is based on the SMA trading rule. By contrast to portfolio optimization, where generally a maximum of the terminal wealth relative can be found, the terminal wealth relative of the trading account is linear and shows no turning point at the Kelly ratio. Findings from other authors, which suggest that there is an optimal position size, rely on single paths of a backtest. This is, however, misleading. If the terminal distribution of total net results is considered, then the concave shape vanishes. Hence, there seems to be no optimal money management approach; the choice is rather dependent on the underlying asset price characteristics. For instance, if the underlying shows positive trends, high serial autocorrelation, and/or low volatility, then erratic or highly levered position management provide fair results. In contrast, if negative drifts, negative autocorrelation, and/or high volatilities apply, then relative position management is the better choice. In any case, the introduction of relative money management effectively reduces the risks in the actively managed portfolio. The exclusive focus on return aspects from money management hence fails to meet the real strong point of relative position sizing and the major distinguishing feature to unmanaged positions. If relative position sizing is implemented, however, then the difference between the diverse fractions is surprisingly small. Interestingly, the lowest fraction f-25% shows the highest Sharpe ratios amongst the tested portions but not the highest returns. In terms of risk-adjusted returns, this confirms Kelly's suggestion that overbetting is more harmful than underbetting. In a nutshell, *all-in* actually seems not to be the wisest investment strategy for investors.

Acknowledgments

I am grateful to Leonard C. MacLean from Dalhousie University and Ursula Walther from Frankfurt School of Finance & Management for helpful discussion and suggestions. The dataset from Thomson Reuters is very much appreciated. Furthermore, I want to thank the members of the Centre for Practical Quantitative Finance and the participants of the 19th Triennial Conference of the International Federation of Operational Research Societies (Melbourne, Australia) for comments and feedback.

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Appendix

Country	Index	RIC	Region	Market Status	Remark
Argentina	MERVAL	.MERV	South America	Frontier Emerging	
Australia	All Ordinaries	.AORD	Oceania	Developed	
Austria	ATX	.ATX	Central Europe	Developed	
Belgium	BEL-20	.BFX	Western Europe	Developed	
Brazil	BOVESPA	.BVSP	South America	Advanced Emerging	BRIC
Canada	S&P TSX 60	.TSE60	North America	Developed	
China	HSCE	.HSCE	East Asia	Secondary Emerging	BRIC
Europe	DJ EuroStoxx 50	.STOXX50E	Europe	Developed	
France	CAC 40	.FCHI	Western Europe	Developed	
Germany	DAX 30	.GDAXI	Central Europe	Developed	
Greece	Athex 20	.ATF	Southeast Europe	Developed	
Hong Kong	Hang Seng	.HSI	East Asia	Developed	
Hungary	BUX	.BUX	Eastern Europe	Advanced Emerging	
India	S&P CXN NIFTY	.NSEI	South Asia	Secondary Emerging	BRIC
Indonesia	JSX Composite	.JKSE	Southeast Asia	Secondary Emerging	Next 11
Italy	MIB 30	.FTMIB	Southern Europe	Developed	
Japan	Nikkei 225	.N225	East Asia	Developed	
Mexico	IPC	.MXX	Central America	Advanced Emerging	Next 11
The Netherlands	AEX	.AEX	Western Europe	Developed	
Pakistan	KSE 100	.KSE	South Asia	Secondary Emerging	Next 11
Peru	Lima General Index	.IGRA	South America	Secondary Emerging	
The Philippines	PSEi	.PSI	Southeast Asia	Secondary Emerging	Next 11
Poland	WIG 20	.WIG20	Eastern Europe	Advanced Emerging	
Russia	RTS	.IRTS	Eastern Europe	Secondary Emerging	BRIC
Saudi Arabia	Tadawul FF Index	.TASI	Arabia	n/a	
Singapore	STI	.FTSTI	Southeast Asia	Developed	
South Africa	JSE Top 40	.FTJ20USD	Africa	Advanced Emerging	
South Korea	KOSPI	.KS11	East Asia	Developed	Next 11
Spain	IBEX 30	.IBEX	Southwest Europe	Developed	
Sweden	OMX Stockholm 30	.OMXS30	Northern Europe	Developed	
Switzerland	SMI	.SSMI	Central Europe	Developed	
Thailand	SET	.SETI	Southeast Asia	Secondary Emerging	
Turkey	ISE 100	.XU100	Arabia	Secondary Emerging	Next 11
U.K.	FTSE 100	.FTSE	Western Europe	Developed	
U.S.A.	S&P 500	.GSPC	North America	Developed	

Table 2: The selection of 35 leading equity indices. The table shows the 35 selected countries as well as their corresponding leading equity index. Moreover, their geographical location is given. All data is taken from Thomson Reuters. RIC denotes the Reuters Instrument Code. The rating of the market status is taken from the FTSE list and divided into 4 classes: developed, advanced emerging, secondary emerging and frontier markets.

Table 3: Overview of applied evaluation criteria. For the analyses, a rich selection of different evaluation criteria are applied. It turned out that the different criteria pointed largely in the same direction. The results of the study are hence based on the relevant findings only.

Criterion	**Brief Description**
Trade Statistics	
Profits and Losses	
Sum of profits	Accumulated single profit trades of the trading system
Sum of losses	Accumulated single loss trades of the trading system
Total (net) result	Net profit or loss of the trading system
Terminal wealth relative	Total net result divided by initial capital
Biggest win	Biggest single profit trade of the trading system
Biggest loss	Biggest single loss trade of the trading system
Average win trade	Mean of the single profit trades
Average loss trade	Mean of the single loss trades
Average trade	Mean of all trades
Best result	Best timing result over all paths
Worst result	Worst timing result over all paths
Average result	Mean timing result over all paths
Trades	
Number of transactions	Total number of all open and closing transactions
Number of profits	Total number of single profit trades
Number of losses	Total number of single loss trades
Hit ratio	Total number of profit trade divided by total number of trades
Equity Curve Analysis	
All-time-high	Price and point in time of all-time-high
All-time-low	Price and point in time of all-time-low

continued on next page

Criterion	**Brief Description**
Psychological key figures	
Maximal drawdown	Maximal distance between global peak and valley of price path
Mean drawdown	Mean distance between local peaks and valleys of price path
Longest sequence of losses	Longest series of loss trades only
Average duration of a profit trade	Mean time of investment in a profit trade
Average duration of a loss trade	Mean time of investment in a loss trade
Return distribution measures	
Mean of returns	First moment of return distribution
Median of returns	Numeric value separating the probability distribution in two halves.
Skew of returns	Third moment of return distribution
Kurtosis of returns	Fourth moment of return distribution
Risk measures	
Variance	Second moment of return distribution
Volatility	Standard deviation of returns
Expected shortfall	Expresses the expected loss with respect to an individual threshold
Semivariance	Defined as expected squared shortfall
Downside deviation	Square root of the semivariance, which corresponds to “downside” counterpart of the standard deviation
Tracking error	Standard deviation of the difference between the portfolio and benchmark returns
Expected excess measures	(based on terminal distribution, compared to benchmark)
Expected excess return	Expected over-return from timing
Expected excess volatility	Expected higher volatility in the equity curve

continued on next page

Criterion	**Brief Description**
Performance measures	
Sharpe ratio	Ratio of return to standard deviation
Sortino ratio	Ratio of return to downside deviation
Calmar ratio	Ratio of returns to maximum drawdown
Sterling ratio	Ratio of returns to (increased) adjusted maximum drawdown
Information ratio	Ratio of residual return to residual risk
Omega ratio	Ratio of probability-weighted profits to probability-weighted losses with respect to an individual threshold.
RINA index	Combines the total result, the time in the market and mean drawdown to a reward-risk ratio.
Sequence analysis of timing	
Runs analysis	Test if the timing returns are stochastic
Autocorrelation	Serial autocorrelation of first lag of timing returns
Miscellaneous	
Stochastic dominance	Form of stochastic ordering that requires only limited preference assumptions

μ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.259	5	138.37	-94.58	43.79	0.1021	0.0349	0.0524	0.08	3.02	0.0082	0.6673	-0.1897
0.259	10	121.18	-75.21	45.98	0.1033	0.0363	0.0545	0.12	3.01	0.0085	0.6671	-0.1883
0.259	20	107.63	-58.24	49.39	0.1063	0.0384	0.0587	0.20	3.06	0.0090	0.6548	-0.1862
0.259	38	99.12	-44.78	54.34	0.1097	0.0413	0.0640	0.25	3.08	0.0092	0.6454	-0.1833
0.259	50	96.89	-39.77	57.12	0.1117	0.0429	0.0671	0.31	3.16	0.0100	0.6393	-0.1817
0.259	100	97.78	-28.83	68.95	0.1203	0.0491	0.0807	0.51	3.53	0.0106	0.6080	-0.1756
0.259	200	114.12	-20.07	94.05	0.1395	0.0598	0.1077	0.88	4.56	0.0123	0.5552	-0.1648
0.086	5	100.95	-88.96	12.00	0.1464	0.0101	0.0489	0.10	3.04	-0.0148	0.2075	-0.0416
0.086	10	83.13	-71.02	12.12	0.1473	0.0102	0.0493	0.11	3.02	-0.0152	0.2075	-0.0415
0.086	20	67.72	-55.26	12.46	0.1495	0.0104	0.0510	0.18	3.01	-0.0152	0.2044	-0.0413
0.086	38	55.80	-43.01	12.80	0.1522	0.0106	0.0526	0.25	3.06	-0.0150	0.2023	-0.0411
0.086	50	51.41	-38.44	12.96	0.1537	0.0107	0.0538	0.30	3.16	-0.0157	0.1995	-0.0410
0.086	100	42.54	-28.74	13.80	0.1582	0.0112	0.0575	0.47	3.41	-0.0162	0.1955	-0.0405
0.086	200	36.94	-21.79	15.16	0.1664	0.0120	0.0634	0.76	4.21	-0.0169	0.1895	-0.0397
-0.082	5	75.14	-84.60	-9.46	0.2288	-0.0110	0.0456	0.09	3.04	-0.0341	-0.2406	0.1053
-0.082	10	58.33	-67.78	-9.45	0.2270	-0.0109	0.0448	0.12	3.03	-0.0339	-0.2439	0.1053
-0.082	20	43.60	-52.84	-9.24	0.2237	-0.0107	0.0443	0.19	3.06	-0.0329	-0.2409	0.1056
-0.082	38	32.07	-41.23	-9.15	0.2196	-0.0105	0.0429	0.28	3.14	-0.0319	-0.2455	0.1057
-0.082	50	27.85	-36.86	-9.01	0.2162	-0.0103	0.0421	0.33	3.26	-0.0311	-0.2455	0.1059
-0.082	100	18.76	-27.39	-8.63	0.2064	-0.0098	0.0400	0.50	3.51	-0.0287	-0.2460	0.1064
-0.082	200	12.20	-20.16	-7.96	0.1925	-0.0090	0.0372	0.69	4.17	-0.0262	-0.2417	0.1072

Table 4: f-25% trade results of different drift levels. The table shows the trade results of the SMA trading rules with f-25% position sizing dependent on different drifts of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

μ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.259	5	335.11	-228.93	106.18	0.2062	0.0670	0.1035	0.08	3.02	0.0139	0.6468	-0.1576
0.259	10	294.92	-182.95	111.97	0.2080	0.0693	0.1070	0.11	3.00	0.0145	0.6481	-0.1553
0.259	20	263.82	-142.62	121.21	0.2130	0.0728	0.1139	0.18	3.03	0.0153	0.6388	-0.1518
0.259	38	244.93	-110.67	134.26	0.2182	0.0775	0.1221	0.20	3.02	0.0157	0.6346	-0.1471
0.259	50	240.18	-98.70	141.47	0.2210	0.0799	0.1264	0.24	3.05	0.0172	0.6323	-0.1447
0.259	100	244.42	-72.46	171.96	0.2318	0.0891	0.1443	0.33	3.14	0.0180	0.6174	-0.1355
0.259	200	283.71	-51.09	232.62	0.2512	0.1036	0.1737	0.49	3.39	0.0210	0.5965	-0.1210
0.086	5	213.11	-187.70	25.41	0.2976	0.0179	0.0968	0.09	3.04	-0.0315	0.1851	-0.0338
0.086	10	175.19	-149.62	25.56	0.2986	0.0180	0.0972	0.11	3.01	-0.0322	0.1852	-0.0338
0.086	20	142.55	-116.25	26.30	0.3018	0.0183	0.1000	0.16	2.99	-0.0320	0.1828	-0.0335
0.086	38	117.10	-90.22	26.88	0.3053	0.0185	0.1020	0.22	3.02	-0.0315	0.1813	-0.0333
0.086	50	107.72	-80.52	27.20	0.3073	0.0185	0.1037	0.25	3.09	-0.0328	0.1789	-0.0332
0.086	100	88.73	-59.89	28.83	0.3126	0.0192	0.1086	0.38	3.21	-0.0334	0.1767	-0.0326
0.086	200	76.33	-45.08	31.25	0.3222	0.0200	0.1156	0.55	3.54	-0.0346	0.1733	-0.0317
-0.082	5	142.79	-160.71	-17.93	0.4666	-0.0239	0.0905	0.09	3.03	-0.0698	-0.2639	0.0924
-0.082	10	110.69	-128.61	-17.91	0.4618	-0.0237	0.0886	0.11	3.02	-0.0693	-0.2674	0.0925
-0.082	20	82.72	-100.20	-17.49	0.4533	-0.0231	0.0873	0.18	3.04	-0.0669	-0.2644	0.0931
-0.082	38	60.77	-78.10	-17.32	0.4429	-0.0226	0.0840	0.26	3.11	-0.0647	-0.2693	0.0936
-0.082	50	52.74	-69.80	-17.06	0.4350	-0.0222	0.0822	0.29	3.21	-0.0629	-0.2696	0.0941
-0.082	100	35.48	-51.81	-16.33	0.4122	-0.0209	0.0775	0.44	3.38	-0.0579	-0.2702	0.0953
-0.082	200	23.09	-38.17	-15.08	0.3811	-0.0190	0.0716	0.57	3.77	-0.0527	-0.2657	0.0972

Table 5: f-50% trade results of different drift levels. The table shows the trade results of the SMA trading rules with f-50% position sizing dependent on different drift levels of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

μ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.259	5	614.00	-419.14	194.86	0.3124	0.0962	0.1536	0.08	3.02	0.0176	0.6263	-0.1284
0.259	10	542.64	-336.43	206.20	0.3143	0.0993	0.1578	0.10	3.00	0.0180	0.6289	-0.1254
0.259	20	488.61	-263.80	224.81	0.3205	0.1036	0.1665	0.16	3.02	0.0193	0.6220	-0.1210
0.259	38	456.21	-206.16	250.04	0.3262	0.1093	0.1759	0.17	2.99	0.0199	0.6215	-0.1153
0.259	50	448.09	-184.39	263.70	0.3291	0.1122	0.1805	0.19	3.00	0.0216	0.6216	-0.1124
0.259	100	456.76	-136.14	320.61	0.3396	0.1228	0.1992	0.24	3.02	0.0227	0.6166	-0.1018
0.259	200	521.34	-95.77	425.56	0.3552	0.1386	0.2259	0.30	3.08	0.0272	0.6135	-0.0860
0.086	5	337.66	-297.25	40.42	0.4538	0.0235	0.1439	0.09	3.04	-0.0502	0.1630	-0.0283
0.086	10	276.96	-236.51	40.45	0.4541	0.0235	0.1439	0.10	3.01	-0.0510	0.1631	-0.0283
0.086	20	225.08	-183.44	41.65	0.4571	0.0238	0.1472	0.15	2.98	-0.0502	0.1614	-0.0280
0.086	38	184.25	-141.92	42.33	0.4600	0.0239	0.1489	0.19	2.99	-0.0493	0.1604	-0.0279
0.086	50	169.24	-126.45	42.80	0.4618	0.0239	0.1507	0.22	3.05	-0.0513	0.1584	-0.0279
0.086	100	138.66	-93.54	45.12	0.4653	0.0245	0.1555	0.32	3.12	-0.0518	0.1575	-0.0273
0.086	200	118.06	-69.82	48.23	0.4729	0.0252	0.1619	0.44	3.28	-0.0528	0.1558	-0.0265
-0.082	5	203.73	-229.25	-25.51	0.7137	-0.0386	0.1347	0.08	3.03	-0.1071	-0.2867	0.0776
-0.082	10	157.74	-183.24	-25.51	0.7046	-0.0382	0.1316	0.11	3.02	-0.1060	-0.2905	0.0780
-0.082	20	117.84	-142.70	-24.86	0.6891	-0.0371	0.1292	0.16	3.04	-0.1021	-0.2872	0.0791
-0.082	38	86.50	-111.12	-24.62	0.6702	-0.0362	0.1238	0.24	3.09	-0.0981	-0.2922	0.0801
-0.082	50	75.02	-99.29	-24.27	0.6568	-0.0354	0.1209	0.27	3.18	-0.0955	-0.2925	0.0809
-0.082	100	50.41	-73.63	-23.21	0.6184	-0.0331	0.1132	0.40	3.30	-0.0876	-0.2927	0.0831
-0.082	200	32.83	-54.30	-21.47	0.5676	-0.0299	0.1040	0.49	3.57	-0.0795	-0.2874	0.0863

Table 6: f-75% trade results of different drift levels. The table shows the trade results of the SMA trading rules with f-75% position sizing dependent on different drift levels of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

μ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.259	5	1008.18	-687.59	320.59	0.4209	0.1228	0.2027	0.07	3.02	0.0188	0.6058	-0.1018
0.259	10	893.95	-553.85	340.10	0.4223	0.1263	0.2072	0.09	3.00	0.0199	0.6095	-0.0983
0.259	20	809.47	-436.41	373.06	0.4290	0.1311	0.2169	0.14	3.00	0.0205	0.6047	-0.0935
0.259	38	758.01	-342.57	415.44	0.4342	0.1375	0.2265	0.15	2.97	0.0223	0.6069	-0.0871
0.259	50	744.52	-306.79	437.73	0.4366	0.1406	0.2309	0.16	2.97	0.0237	0.6088	-0.0840
0.259	100	755.29	-226.29	529.00	0.4451	0.1517	0.2485	0.18	2.96	0.0255	0.6105	-0.0729
0.259	200	840.30	-157.04	683.26	0.4555	0.1675	0.2707	0.18	2.96	0.0314	0.6187	-0.0571
0.086	5	475.92	-418.70	57.22	0.6152	0.0268	0.1903	0.09	3.04	-0.0708	0.1410	-0.0249
0.086	10	389.30	-332.39	56.91	0.6141	0.0268	0.1895	0.09	3.00	-0.0714	0.1413	-0.0250
0.086	20	315.94	-257.31	58.63	0.6158	0.0271	0.1929	0.14	2.98	-0.0699	0.1402	-0.0247
0.086	38	257.61	-198.40	59.21	0.6167	0.0271	0.1939	0.17	2.97	-0.0684	0.1398	-0.0247
0.086	50	236.28	-176.45	59.82	0.6176	0.0270	0.1955	0.20	3.02	-0.0710	0.1382	-0.0247
0.086	100	192.46	-129.76	62.70	0.6174	0.0276	0.1994	0.28	3.07	-0.0710	0.1385	-0.0241
0.086	200	162.03	-95.98	66.06	0.6209	0.0282	0.2043	0.36	3.15	-0.0720	0.1379	-0.0236
-0.082	5	258.69	-291.01	-32.32	0.9705	-0.0552	0.1785	0.08	3.03	-0.1459	-0.3093	0.0610
-0.082	10	200.02	-232.35	-32.33	0.9555	-0.0544	0.1738	0.10	3.01	-0.1439	-0.3131	0.0618
-0.082	20	149.41	-180.87	-31.46	0.9313	-0.0526	0.1701	0.15	3.03	-0.1382	-0.3095	0.0636
-0.082	38	109.61	-140.76	-31.15	0.9020	-0.0510	0.1624	0.23	3.08	-0.1326	-0.3143	0.0652
-0.082	50	95.01	-125.74	-30.73	0.8820	-0.0498	0.1583	0.25	3.15	-0.1288	-0.3145	0.0664
-0.082	100	63.79	-93.16	-29.38	0.8257	-0.0463	0.1475	0.36	3.24	-0.1176	-0.3139	0.0699
-0.082	200	41.56	-68.78	-27.22	0.7531	-0.0415	0.1350	0.43	3.45	-0.1066	-0.3074	0.0747

Table 7: f-100% trade results of different drift levels. The table shows the trade results of the SMA trading rules with f-100% position sizing dependent on different drift levels of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

μ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.259	5	1563.71	-1065.28	498.43	0.5319	0.1469	0.2509	0.07	3.01	0.0180	0.5853	-0.0778
0.259	10	1389.53	-860.16	529.37	0.5323	0.1506	0.2553	0.09	2.99	0.0195	0.5899	-0.0740
0.259	20	1263.82	-680.28	583.53	0.5387	0.1558	0.2654	0.13	3.00	0.0197	0.5869	-0.0689
0.259	38	1183.40	-534.80	648.60	0.5425	0.1624	0.2746	0.13	2.96	0.0225	0.5913	-0.0622
0.259	50	1160.36	-478.85	681.51	0.5440	0.1655	0.2784	0.13	2.96	0.0240	0.5946	-0.0591
0.259	100	1164.54	-350.62	813.92	0.5492	0.1766	0.2938	0.13	2.94	0.0259	0.6012	-0.0480
0.259	200	1254.57	-237.96	1016.61	0.5533	0.1919	0.3109	0.10	2.91	0.0335	0.6172	-0.0327
0.086	5	629.30	-553.27	76.03	0.7823	0.0281	0.2360	0.08	3.04	-0.0929	0.1191	-0.0236
0.086	10	513.09	-438.01	75.08	0.7789	0.0280	0.2343	0.08	3.00	-0.0933	0.1196	-0.0237
0.086	20	415.75	-338.37	77.39	0.7781	0.0283	0.2374	0.13	2.97	-0.0912	0.1193	-0.0234
0.086	38	337.50	-259.91	77.59	0.7757	0.0283	0.2371	0.15	2.96	-0.0888	0.1194	-0.0234
0.086	50	309.11	-230.76	78.36	0.7753	0.0282	0.2385	0.17	3.01	-0.0918	0.1182	-0.0236
0.086	100	250.20	-168.61	81.59	0.7697	0.0289	0.2410	0.24	3.04	-0.0912	0.1197	-0.0229
0.086	200	208.15	-123.48	84.67	0.7672	0.0293	0.2438	0.30	3.08	-0.0919	0.1201	-0.0225
-0.082	5	308.29	-346.72	-38.43	1.2370	-0.0735	0.2217	0.08	3.03	-0.1861	-0.3316	0.0427
-0.082	10	238.06	-276.52	-38.46	1.2149	-0.0723	0.2154	0.10	3.01	-0.1833	-0.3354	0.0440
-0.082	20	177.80	-215.18	-37.38	1.1800	-0.0696	0.2102	0.15	3.02	-0.1753	-0.3312	0.0466
-0.082	38	130.39	-167.40	-37.00	1.1384	-0.0671	0.2000	0.21	3.07	-0.1682	-0.3357	0.0491
-0.082	50	112.95	-149.48	-36.53	1.1111	-0.0654	0.1947	0.23	3.13	-0.1627	-0.3357	0.0509
-0.082	100	75.78	-110.69	-34.91	1.0346	-0.0604	0.1808	0.33	3.20	-0.1483	-0.3340	0.0558
-0.082	200	49.42	-81.82	-32.40	0.9383	-0.0537	0.1649	0.38	3.37	-0.1341	-0.3259	0.0625

Table 8: f-125% trade results of different drift levels. The table shows the trade results of the SMA trading rules with f-125% position sizing dependent on different drift levels of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

μ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.259	5	2159.46	-1470.79	688.67	0.8221	0.1442	0.6041	-4.44	27.06	-0.0006	0.2388	-0.0804
0.259	10	1869.79	-1156.94	712.85	0.7835	0.1523	0.5547	-4.72	32.13	0.0113	0.2745	-0.0723
0.259	20	1628.97	-877.74	751.23	0.7647	0.1593	0.5168	-4.76	34.70	0.0135	0.3082	-0.0653
0.259	38	1451.60	-657.33	794.26	0.7339	0.1674	0.4740	-4.77	38.02	0.0206	0.3532	-0.0572
0.259	50	1391.14	-575.09	816.05	0.7257	0.1693	0.4810	-4.79	37.69	0.0222	0.3519	-0.0554
0.259	100	1281.59	-386.87	894.72	0.6811	0.1795	0.4437	-4.84	43.84	0.0293	0.4046	-0.0451
0.259	200	1227.34	-236.33	991.01	0.6303	0.1909	0.4009	-4.26	41.82	0.0378	0.4762	-0.0337
0.086	5	600.61	-528.46	72.15	0.9290	-0.0046	0.6620	-4.47	24.45	-0.1308	-0.0069	-0.0563
0.086	10	493.86	-421.35	72.51	0.9229	-0.0023	0.6394	-4.56	25.67	-0.1301	-0.0037	-0.0541
0.086	20	401.42	-326.78	74.64	0.9195	0.0005	0.6196	-4.71	27.85	-0.1240	0.0007	-0.0513
0.086	38	329.26	-253.44	75.82	0.9177	0.0012	0.6138	-4.73	28.23	-0.1266	0.0019	-0.0506
0.086	50	302.55	-226.14	76.41	0.9242	-0.0004	0.6340	-4.72	27.95	-0.1337	-0.0006	-0.0522
0.086	100	247.47	-167.10	80.36	0.9188	-0.0004	0.6447	-4.61	26.70	-0.1325	-0.0006	-0.0521
0.086	200	207.99	-123.39	84.59	0.8977	0.0054	0.5960	-4.81	30.10	-0.1200	0.0090	-0.0464
-0.082	5	215.16	-242.28	-27.12	0.8842	-0.0625	0.5013	-6.28	46.42	-0.1602	-0.1247	0.0537
-0.082	10	167.48	-194.68	-27.20	0.8689	-0.0613	0.4881	-6.37	47.65	-0.1557	-0.1257	0.0549
-0.082	20	125.45	-152.16	-26.71	0.8547	-0.0605	0.4905	-6.42	48.36	-0.1518	-0.1233	0.0558
-0.082	38	92.71	-119.09	-26.38	0.8253	-0.0558	0.4378	-7.06	59.72	-0.1443	-0.1275	0.0604
-0.082	50	80.61	-106.68	-26.07	0.8123	-0.0575	0.4771	-6.85	54.90	-0.1416	-0.1205	0.0588
-0.082	100	54.96	-80.54	-25.58	0.7848	-0.0536	0.4323	-7.21	62.44	-0.1421	-0.1240	0.0626
-0.082	200	36.81	-61.11	-24.30	0.7402	-0.0514	0.4341	-7.18	60.53	-0.1377	-0.1185	0.0648

Table 9: Unsized trade results of different drift levels. The table shows the trade results of the SMA trading rules with unmanaged position sizing dependent on different drift levels of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

σ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.39	5	155.25	-137.08	18.17	0.2249	0.0140	0.0737	0.10	3.04	-0.0237	0.1896	-0.0353
0.39	10	127.79	-109.38	18.40	0.2268	0.0141	0.0747	0.14	3.04	-0.0240	0.1886	-0.0352
0.39	20	104.10	-85.14	18.96	0.2312	0.0143	0.0775	0.20	3.05	-0.0246	0.1847	-0.0349
0.39	38	85.85	-66.29	19.56	0.2364	0.0146	0.0805	0.29	3.13	-0.0249	0.1808	-0.0347
0.39	50	79.14	-59.23	19.91	0.2395	0.0147	0.0824	0.35	3.27	-0.0256	0.1778	-0.0346
0.39	100	65.65	-44.38	21.27	0.2493	0.0151	0.0888	0.55	3.64	-0.0267	0.1705	-0.0341
0.39	200	57.66	-33.74	23.92	0.2653	0.0161	0.0987	0.90	4.61	-0.0269	0.1627	-0.0332
0.26	5	100.95	-88.96	12.00	0.1464	0.0101	0.0489	0.10	3.04	-0.0148	0.2075	-0.0416
0.26	10	83.13	-71.02	12.12	0.1473	0.0102	0.0493	0.11	3.02	-0.0152	0.2075	-0.0415
0.26	20	67.72	-55.26	12.46	0.1495	0.0104	0.0510	0.18	3.01	-0.0152	0.2044	-0.0413
0.26	38	55.80	-43.01	12.80	0.1522	0.0106	0.0526	0.25	3.06	-0.0150	0.2023	-0.0411
0.26	50	51.41	-38.44	12.96	0.1537	0.0107	0.0538	0.30	3.16	-0.0157	0.1995	-0.0410
0.26	100	42.54	-28.74	13.80	0.1582	0.0112	0.0575	0.47	3.41	-0.0162	0.1955	-0.0405
0.26	200	36.94	-21.79	15.16	0.1664	0.0120	0.0634	0.76	4.21	-0.0169	0.1895	-0.0397
0.16	5	62.25	-53.64	8.61	0.0856	0.0078	0.0301	0.09	3.05	-0.0075	0.2594	-0.0419
0.16	10	51.53	-42.80	8.73	0.0859	0.0079	0.0304	0.11	3.01	-0.0076	0.2606	-0.0418
0.16	20	42.24	-33.27	8.97	0.0870	0.0081	0.0313	0.16	2.98	-0.0078	0.2586	-0.0416
0.16	38	35.09	-25.86	9.23	0.0884	0.0083	0.0324	0.22	3.03	-0.0077	0.2567	-0.0414
0.16	50	32.47	-23.07	9.40	0.0890	0.0084	0.0331	0.24	3.08	-0.0081	0.2552	-0.0413
0.16	100	27.14	-17.22	9.92	0.0914	0.0088	0.0353	0.39	3.20	-0.0083	0.2506	-0.0409
0.16	200	23.81	-12.98	10.83	0.0957	0.0095	0.0388	0.57	3.62	-0.0087	0.2457	-0.0402

Table 10: f-25% trade results of different volatility levels. The table shows the trade results of the SMA trading rules with f-25% position sizing dependent on different volatility levels of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

σ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.39	5	336.42	-296.83	39.59	0.4609	0.0227	0.1452	0.09	3.04	-0.0518	0.1561	-0.0266
0.39	10	276.24	-236.35	39.89	0.4627	0.0227	0.1462	0.12	3.03	-0.0520	0.1552	-0.0266
0.39	20	224.60	-183.49	41.11	0.4685	0.0229	0.1502	0.17	3.02	-0.0527	0.1523	-0.0264
0.39	38	184.44	-142.33	42.10	0.4746	0.0229	0.1535	0.24	3.06	-0.0532	0.1493	-0.0264
0.39	50	169.66	-126.85	42.81	0.4785	0.0229	0.1558	0.28	3.13	-0.0541	0.1470	-0.0264
0.39	100	139.65	-94.28	45.37	0.4889	0.0231	0.1629	0.41	3.28	-0.0556	0.1420	-0.0261
0.39	200	121.06	-70.97	50.09	0.5046	0.0237	0.1728	0.62	3.64	-0.0554	0.1375	-0.0255
0.26	5	213.11	-187.70	25.41	0.2976	0.0179	0.0968	0.09	3.04	-0.0315	0.1851	-0.0338
0.26	10	175.19	-149.62	25.56	0.2986	0.0180	0.0972	0.11	3.01	-0.0322	0.1852	-0.0338
0.26	20	142.55	-116.25	26.30	0.3018	0.0183	0.1000	0.16	2.99	-0.0320	0.1828	-0.0335
0.26	38	117.10	-90.22	26.88	0.3053	0.0185	0.1020	0.22	3.02	-0.0315	0.1813	-0.0333
0.26	50	107.72	-80.52	27.20	0.3073	0.0185	0.1037	0.25	3.09	-0.0328	0.1789	-0.0332
0.26	100	88.73	-59.89	28.83	0.3126	0.0192	0.1086	0.38	3.21	-0.0334	0.1767	-0.0326
0.26	200	76.33	-45.08	31.25	0.3222	0.0200	0.1156	0.55	3.54	-0.0346	0.1733	-0.0317
0.16	5	129.52	-111.58	17.94	0.1728	0.0147	0.0599	0.09	3.05	-0.0157	0.2456	-0.0350
0.16	10	107.13	-88.97	18.16	0.1732	0.0149	0.0602	0.10	3.00	-0.0160	0.2469	-0.0348
0.16	20	87.76	-69.10	18.66	0.1750	0.0152	0.0619	0.15	2.97	-0.0163	0.2453	-0.0345
0.16	38	72.79	-53.64	19.15	0.1770	0.0155	0.0635	0.20	3.00	-0.0159	0.2439	-0.0342
0.16	50	67.31	-47.81	19.50	0.1779	0.0157	0.0647	0.21	3.05	-0.0168	0.2428	-0.0340
0.16	100	56.08	-35.58	20.51	0.1814	0.0163	0.0680	0.34	3.11	-0.0172	0.2395	-0.0334
0.16	200	48.91	-26.69	22.22	0.1876	0.0173	0.0731	0.46	3.33	-0.0178	0.2369	-0.0324

Table 11: f-50% trade results of different volatility levels. The table shows the trade results of the SMA trading rules with f-50% position sizing dependent on different volatility levels of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

σ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.39	5	547.61	-482.74	64.87	0.7089	0.0264	0.2150	0.09	3.04	-0.0837	0.1229	-0.0229
0.39	10	448.19	-383.28	64.92	0.7090	0.0263	0.2151	0.11	3.02	-0.0837	0.1223	-0.0230
0.39	20	363.51	-296.65	66.86	0.7135	0.0264	0.2191	0.15	3.00	-0.0840	0.1204	-0.0229
0.39	38	296.93	-229.04	67.89	0.7171	0.0262	0.2214	0.20	3.01	-0.0843	0.1182	-0.0231
0.39	50	272.57	-203.61	68.96	0.7199	0.0261	0.2234	0.23	3.06	-0.0854	0.1166	-0.0232
0.39	100	222.31	-149.92	72.39	0.7258	0.0260	0.2292	0.33	3.15	-0.0866	0.1134	-0.0233
0.39	200	189.84	-111.49	78.35	0.7353	0.0262	0.2365	0.48	3.32	-0.0854	0.1108	-0.0231
0.26	5	337.66	-297.25	40.42	0.4538	0.0235	0.1439	0.09	3.04	-0.0502	0.1630	-0.0283
0.26	10	276.96	-236.51	40.45	0.4541	0.0235	0.1439	0.10	3.01	-0.0510	0.1631	-0.0283
0.26	20	225.08	-183.44	41.65	0.4571	0.0238	0.1472	0.15	2.98	-0.0502	0.1614	-0.0280
0.26	38	184.25	-141.92	42.33	0.4600	0.0239	0.1489	0.19	2.99	-0.0493	0.1604	-0.0279
0.26	50	169.24	-126.45	42.80	0.4618	0.0239	0.1507	0.22	3.05	-0.0513	0.1584	-0.0279
0.26	100	138.66	-93.54	45.12	0.4653	0.0245	0.1555	0.32	3.12	-0.0518	0.1575	-0.0273
0.26	200	118.06	-69.82	48.23	0.4729	0.0252	0.1619	0.44	3.28	-0.0528	0.1558	-0.0265
0.16	5	202.20	-174.14	28.06	0.2617	0.0207	0.0893	0.09	3.05	-0.0247	0.2320	-0.0290
0.16	10	167.09	-138.75	28.33	0.2618	0.0209	0.0896	0.10	3.00	-0.0250	0.2334	-0.0288
0.16	20	136.77	-107.66	29.11	0.2639	0.0213	0.0917	0.14	2.96	-0.0255	0.2322	-0.0284
0.16	38	113.24	-83.44	29.80	0.2661	0.0216	0.0936	0.18	2.99	-0.0247	0.2312	-0.0281
0.16	50	104.62	-74.30	30.33	0.2669	0.0219	0.0950	0.19	3.03	-0.0260	0.2304	-0.0278
0.16	100	86.88	-55.10	31.77	0.2705	0.0226	0.0989	0.30	3.06	-0.0264	0.2281	-0.0272
0.16	200	75.28	-41.12	34.16	0.2771	0.0237	0.1044	0.38	3.18	-0.0274	0.2270	-0.0260

Table 12: f-75% trade results of different volatility levels. The table shows the trade results of the SMA trading rules with f-75% position sizing dependent on different volatility levels of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

σ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.39	5	793.47	-698.72	94.76	0.9698	0.0255	0.2832	0.08	3.04	-0.1196	0.0900	-0.0238
0.39	10	646.72	-552.76	93.96	0.9664	0.0253	0.2819	0.10	3.01	-0.1190	0.0898	-0.0239
0.39	20	522.88	-426.22	96.66	0.9671	0.0254	0.2852	0.13	2.99	-0.1193	0.0890	-0.0239
0.39	38	424.42	-327.30	97.12	0.9651	0.0251	0.2856	0.17	2.99	-0.1181	0.0877	-0.0242
0.39	50	388.83	-290.21	98.61	0.9654	0.0249	0.2869	0.20	3.03	-0.1190	0.0868	-0.0244
0.39	100	313.85	-211.51	102.34	0.9628	0.0248	0.2904	0.27	3.08	-0.1195	0.0853	-0.0245
0.39	200	263.60	-155.07	108.53	0.9625	0.0248	0.2942	0.39	3.17	-0.1168	0.0842	-0.0245
0.26	5	475.92	-418.70	57.22	0.6152	0.0268	0.1903	0.09	3.04	-0.0708	0.1410	-0.0249
0.26	10	389.30	-332.39	56.91	0.6141	0.0268	0.1895	0.09	3.00	-0.0714	0.1413	-0.0250
0.26	20	315.94	-257.31	58.63	0.6158	0.0271	0.1929	0.14	2.98	-0.0699	0.1402	-0.0247
0.26	38	257.61	-198.40	59.21	0.6167	0.0271	0.1939	0.17	2.97	-0.0684	0.1398	-0.0247
0.26	50	236.28	-176.45	59.82	0.6176	0.0270	0.1955	0.20	3.02	-0.0710	0.1382	-0.0247
0.26	100	192.46	-129.76	62.70	0.6174	0.0276	0.1994	0.28	3.07	-0.0710	0.1385	-0.0241
0.26	200	162.03	-95.98	66.06	0.6209	0.0282	0.2043	0.36	3.15	-0.0720	0.1379	-0.0236
0.16	5	280.71	-241.68	39.04	0.3523	0.0259	0.1184	0.09	3.05	-0.0343	0.2185	-0.0238
0.16	10	231.69	-192.38	39.31	0.3519	0.0261	0.1185	0.09	3.00	-0.0348	0.2199	-0.0237
0.16	20	189.48	-149.10	40.38	0.3539	0.0265	0.1209	0.14	2.96	-0.0352	0.2192	-0.0232
0.16	38	156.58	-115.36	41.22	0.3558	0.0268	0.1228	0.16	2.97	-0.0341	0.2185	-0.0229
0.16	50	144.55	-102.62	41.92	0.3563	0.0271	0.1243	0.18	3.01	-0.0357	0.2181	-0.0226
0.16	100	119.58	-75.84	43.75	0.3591	0.0278	0.1282	0.27	3.02	-0.0360	0.2167	-0.0219
0.16	200	102.92	-56.28	46.64	0.3649	0.0289	0.1337	0.32	3.09	-0.0371	0.2166	-0.0208

Table 13: f-100% trade results of different volatility levels. The table shows the trade results of the SMA trading rules with f-100% position sizing dependent on different volatility levels of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

σ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.39	5	1079.28	-949.19	130.09	1.2446	0.0201	0.3502	0.08	3.03	-0.1591	0.0575	-0.0291
0.39	10	875.02	-747.53	127.50	1.2358	0.0200	0.3470	0.09	3.01	-0.1579	0.0578	-0.0292
0.39	20	704.74	-573.82	130.91	1.2302	0.0203	0.3490	0.12	2.98	-0.1570	0.0581	-0.0290
0.39	38	567.87	-437.89	129.97	1.2197	0.0201	0.3469	0.15	2.97	-0.1544	0.0579	-0.0292
0.39	50	519.39	-387.37	132.02	1.2163	0.0200	0.3473	0.17	3.00	-0.1552	0.0577	-0.0292
0.39	100	414.40	-279.20	135.20	1.2019	0.0202	0.3479	0.23	3.04	-0.1542	0.0580	-0.0291
0.39	200	341.90	-201.49	140.41	1.1887	0.0203	0.3477	0.32	3.09	-0.1494	0.0584	-0.0290
0.26	5	629.30	-553.27	76.03	0.7823	0.0281	0.2360	0.08	3.04	-0.0929	0.1191	-0.0236
0.26	10	513.09	-438.01	75.08	0.7789	0.0280	0.2343	0.08	3.00	-0.0933	0.1196	-0.0237
0.26	20	415.75	-338.37	77.39	0.7781	0.0283	0.2374	0.13	2.97	-0.0912	0.1193	-0.0234
0.26	38	337.50	-259.91	77.59	0.7757	0.0283	0.2371	0.15	2.96	-0.0888	0.1194	-0.0234
0.26	50	309.11	-230.76	78.36	0.7753	0.0282	0.2385	0.17	3.01	-0.0918	0.1182	-0.0236
0.26	100	250.20	-168.61	81.59	0.7697	0.0289	0.2410	0.24	3.04	-0.0912	0.1197	-0.0229
0.26	200	208.15	-123.48	84.67	0.7672	0.0293	0.2438	0.30	3.08	-0.0919	0.1201	-0.0225
0.16	5	365.51	-314.56	50.95	0.4447	0.0302	0.1473	0.08	3.05	-0.0448	0.2050	-0.0195
0.16	10	301.27	-250.12	51.15	0.4435	0.0304	0.1470	0.09	2.99	-0.0451	0.2066	-0.0193
0.16	20	246.13	-193.62	52.51	0.4450	0.0308	0.1495	0.13	2.96	-0.0456	0.2062	-0.0189
0.16	38	202.95	-149.52	53.43	0.4461	0.0311	0.1511	0.15	2.96	-0.0440	0.2060	-0.0186
0.16	50	187.21	-132.88	54.33	0.4460	0.0314	0.1527	0.16	3.00	-0.0459	0.2058	-0.0183
0.16	100	154.26	-97.82	56.44	0.4473	0.0321	0.1563	0.24	3.00	-0.0462	0.2052	-0.0176
0.16	200	131.81	-72.15	59.66	0.4515	0.0332	0.1612	0.28	3.04	-0.0473	0.2059	-0.0165

Table 14: f-125% trade results of different volatility levels. The table shows the trade results of the SMA trading rules with f-25% position sizing dependent on different volatility levels of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

σ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.39	5	1130.35	-995.49	134.86	1.7440	-0.1261	1.2656	-1.70	4.45	-1.0641	-0.0996	-0.1753
0.39	10	928.60	-793.09	135.51	1.7213	-0.1181	1.2388	-1.77	4.76	-1.0530	-0.0954	-0.1674
0.39	20	754.43	-614.55	139.88	1.7382	-0.1167	1.2396	-1.79	4.82	-1.0600	-0.0941	-0.1659
0.39	38	618.04	-476.03	142.02	1.7596	-0.1230	1.2631	-1.73	4.61	-1.0637	-0.0974	-0.1723
0.39	50	567.49	-423.97	143.52	1.7524	-0.1233	1.2628	-1.73	4.58	-1.0594	-0.0976	-0.1726
0.39	100	463.28	-312.00	151.29	1.7480	-0.1189	1.2556	-1.76	4.75	-1.0594	-0.0947	-0.1681
0.39	200	387.92	-228.89	159.03	1.7247	-0.1089	1.2214	-1.84	5.14	-1.0526	-0.0892	-0.1582
0.26	5	600.61	-528.46	72.15	0.9290	-0.0046	0.6620	-4.47	24.45	-0.1308	-0.0069	-0.0563
0.26	10	493.86	-421.35	72.51	0.9229	-0.0023	0.6394	-4.56	25.67	-0.1301	-0.0037	-0.0541
0.26	20	401.42	-326.78	74.64	0.9195	0.0005	0.6196	-4.71	27.85	-0.1240	0.0007	-0.0513
0.26	38	329.26	-253.44	75.82	0.9177	0.0012	0.6138	-4.73	28.23	-0.1266	0.0019	-0.0506
0.26	50	302.55	-226.14	76.41	0.9242	-0.0004	0.6340	-4.72	27.95	-0.1337	-0.0006	-0.0522
0.26	100	247.47	-167.10	80.36	0.9188	-0.0004	0.6447	-4.61	26.70	-0.1325	-0.0006	-0.0521
0.26	200	207.99	-123.39	84.59	0.8977	0.0054	0.5960	-4.81	30.10	-0.1200	0.0090	-0.0464
0.16	5	331.04	-285.03	46.00	0.4263	0.0276	0.1606	-6.52	184.51	-0.0436	0.1720	-0.0221
0.16	10	273.68	-227.14	46.54	0.4235	0.0280	0.1581	-4.84	112.00	-0.0433	0.1771	-0.0217
0.16	20	223.89	-176.12	47.77	0.4244	0.0285	0.1586	-4.74	118.88	-0.0432	0.1800	-0.0212
0.16	38	185.30	-136.52	48.78	0.4249	0.0291	0.1493	-1.52	39.06	-0.0424	0.1952	-0.0206
0.16	50	171.08	-121.52	49.57	0.4265	0.0293	0.1581	-3.82	103.84	-0.0437	0.1853	-0.0204
0.16	100	141.60	-89.91	51.69	0.4278	0.0299	0.1681	-5.43	150.12	-0.0445	0.1780	-0.0198
0.16	200	121.08	-66.28	54.80	0.4287	0.0314	0.1593	-1.29	34.88	-0.0450	0.1973	-0.0183

Table 15: Unsized trade results of different volatility levels. The table shows the trade results of the SMA trading rules with unmanaged position sizing dependent on different volatility levels of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

φ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.2	5	190.89	-88.50	102.39	0.0688	0.0689	0.0561	0.10	3.03	0.0403	1.2279	0.0175
0.2	10	142.65	-66.52	76.13	0.0798	0.0550	0.0570	0.14	3.04	0.0258	0.9653	0.0035
0.2	20	107.02	-49.45	57.57	0.0934	0.0437	0.0590	0.22	3.06	0.0142	0.7409	-0.0077
0.2	38	83.03	-37.38	45.64	0.1073	0.0357	0.0612	0.31	3.13	0.0058	0.5831	-0.0158
0.2	50	74.85	-33.09	41.76	0.1135	0.0329	0.0625	0.38	3.27	0.0024	0.5269	-0.0185
0.2	100	59.21	-24.35	34.86	0.1319	0.0275	0.0673	0.58	3.63	-0.0038	0.4091	-0.0239
0.2	200	49.88	-18.49	31.38	0.1543	0.0242	0.0753	0.93	4.64	-0.0086	0.3221	-0.0272
0.025	5	109.11	-88.85	20.26	0.1284	0.0172	0.0496	0.10	3.04	-0.0082	0.3471	-0.0345
0.025	10	88.77	-70.41	18.36	0.1334	0.0156	0.0501	0.12	3.03	-0.0102	0.3117	-0.0362
0.025	20	71.60	-54.50	17.11	0.1390	0.0144	0.0518	0.18	3.02	-0.0116	0.2790	-0.0373
0.025	38	58.56	-42.26	16.30	0.1444	0.0137	0.0535	0.25	3.07	-0.0125	0.2555	-0.0381
0.025	50	53.81	-37.72	16.09	0.1469	0.0134	0.0547	0.30	3.18	-0.0133	0.2453	-0.0384
0.025	100	44.27	-28.15	16.11	0.1539	0.0132	0.0585	0.48	3.44	-0.0146	0.2254	-0.0386
0.025	200	38.29	-21.34	16.95	0.1640	0.0135	0.0646	0.78	4.26	-0.0157	0.2086	-0.0383
-0.1	5	74.25	-89.77	-15.52	0.2765	-0.0179	0.0464	0.08	3.03	-0.0417	-0.3864	-0.0696
-0.1	10	64.02	-73.65	-9.63	0.2367	-0.0112	0.0468	0.10	3.02	-0.0354	-0.2397	-0.0629
-0.1	20	54.29	-58.57	-4.29	0.2094	-0.0055	0.0483	0.16	3.01	-0.0300	-0.1148	-0.0573
-0.1	38	46.14	-46.22	-0.07	0.1926	-0.0013	0.0498	0.22	3.04	-0.0261	-0.0265	-0.0530
-0.1	50	43.00	-41.49	1.50	0.1882	0.0002	0.0510	0.25	3.12	-0.0250	0.0036	-0.0515
-0.1	100	36.41	-31.31	5.09	0.1803	0.0035	0.0543	0.40	3.31	-0.0229	0.0640	-0.0482
-0.1	200	32.18	-23.73	8.44	0.1791	0.0063	0.0594	0.66	3.97	-0.0214	0.1055	-0.0454

Table 16: f-25% trade results of different autocorrelation levels. The table shows the trade results of the SMA trading rules with f-25% position sizing dependent on different lag-1 autocorrelation levels of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

φ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.2	5	571.23	-264.44	306.79	0.1381	0.1334	0.1104	0.09	3.02	0.0779	1.2147	0.0827
0.2	10	388.72	-181.04	207.68	0.1600	0.1056	0.1113	0.12	3.03	0.0489	0.9532	0.0547
0.2	20	271.20	-125.09	146.10	0.1864	0.0823	0.1142	0.19	3.03	0.0261	0.7299	0.0319
0.2	38	199.58	-89.77	109.81	0.2128	0.0654	0.1169	0.26	3.06	0.0093	0.5737	0.0156
0.2	50	176.58	-77.98	98.60	0.2240	0.0593	0.1183	0.31	3.14	0.0029	0.5185	0.0099
0.2	100	134.26	-55.15	79.10	0.2556	0.0470	0.1242	0.46	3.30	-0.0092	0.4034	-0.0014
0.2	200	109.23	-40.50	68.74	0.2893	0.0380	0.1329	0.67	3.68	-0.0180	0.3205	-0.0089
0.025	5	239.21	-194.68	44.53	0.2603	0.0314	0.0982	0.09	3.04	-0.0185	0.3254	-0.0198
0.025	10	192.46	-152.61	39.86	0.2700	0.0281	0.0987	0.11	3.02	-0.0221	0.2902	-0.0231
0.025	20	153.91	-117.06	36.85	0.2802	0.0251	0.1013	0.17	3.00	-0.0247	0.2582	-0.0256
0.025	38	124.83	-90.05	34.78	0.2893	0.0231	0.1035	0.22	3.02	-0.0265	0.2355	-0.0274
0.025	50	114.31	-80.08	34.23	0.2933	0.0223	0.1052	0.26	3.10	-0.0281	0.2259	-0.0280
0.025	100	93.22	-59.24	33.98	0.3035	0.0206	0.1102	0.39	3.23	-0.0302	0.2078	-0.0289
0.025	200	79.65	-44.44	35.21	0.3165	0.0193	0.1173	0.57	3.55	-0.0322	0.1940	-0.0290
-0.1	5	136.64	-165.15	-28.51	0.5644	-0.0384	0.0922	0.07	3.03	-0.0850	-0.4104	-0.0896
-0.1	10	121.32	-139.58	-18.26	0.4821	-0.0250	0.0926	0.09	3.01	-0.0724	-0.2642	-0.0762
-0.1	20	105.50	-113.80	-8.29	0.4248	-0.0141	0.0951	0.14	3.00	-0.0615	-0.1392	-0.0649
-0.1	38	91.22	-91.36	-0.14	0.3883	-0.0058	0.0972	0.19	3.01	-0.0535	-0.0509	-0.0567
-0.1	50	85.49	-82.47	3.02	0.3783	-0.0032	0.0990	0.21	3.06	-0.0512	-0.0205	-0.0537
-0.1	100	73.08	-62.82	10.26	0.3587	0.0024	0.1036	0.33	3.17	-0.0468	0.0407	-0.0475
-0.1	200	64.75	-47.82	16.93	0.3505	0.0063	0.1100	0.49	3.45	-0.0435	0.0838	-0.0425

Table 17: f-50% trade results of different autocorrelation levels. The table shows the trade results of the SMA trading rules with f-50% position sizing dependent on different lag-1 autocorrelation levels of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

φ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.2	5	1323.89	-611.89	712.01	0.2079	0.1959	0.1632	0.09	3.02	0.1128	1.2009	0.1445
0.2	10	809.80	-376.67	433.14	0.2407	0.1537	0.1635	0.11	3.02	0.0695	0.9402	0.1023
0.2	20	520.87	-239.78	281.09	0.2796	0.1195	0.1665	0.17	3.01	0.0357	0.7176	0.0681
0.2	38	361.50	-162.45	199.05	0.3173	0.0948	0.1685	0.22	3.01	0.0109	0.5625	0.0433
0.2	50	313.40	-138.26	175.14	0.3330	0.0861	0.1696	0.27	3.08	0.0016	0.5077	0.0347
0.2	100	228.23	-93.65	134.58	0.3753	0.0689	0.1747	0.38	3.17	-0.0159	0.3943	0.0174
0.2	200	178.90	-66.33	112.57	0.4162	0.0570	0.1821	0.53	3.35	-0.0284	0.3131	0.0056
0.025	5	394.20	-320.62	73.58	0.3960	0.0444	0.1460	0.09	3.04	-0.0307	0.3039	-0.0074
0.025	10	313.33	-248.37	64.96	0.4098	0.0392	0.1459	0.10	3.01	-0.0358	0.2689	-0.0125
0.025	20	248.29	-188.71	59.58	0.4238	0.0354	0.1490	0.15	2.99	-0.0397	0.2376	-0.0164
0.025	38	199.54	-143.90	55.64	0.4354	0.0325	0.1509	0.19	2.99	-0.0419	0.2156	-0.0192
0.025	50	182.11	-127.51	54.60	0.4402	0.0315	0.1526	0.22	3.06	-0.0444	0.2064	-0.0203
0.025	100	147.11	-93.41	53.69	0.4510	0.0299	0.1575	0.33	3.13	-0.0469	0.1897	-0.0219
0.025	200	124.03	-69.30	54.72	0.4636	0.0291	0.1639	0.45	3.28	-0.0493	0.1775	-0.0227
-0.1	5	189.12	-228.54	-39.41	0.8636	-0.0596	0.1374	0.07	3.03	-0.1299	-0.4341	-0.1114
-0.1	10	172.65	-198.63	-25.98	0.7364	-0.0397	0.1376	0.08	3.01	-0.1109	-0.2882	-0.0914
-0.1	20	153.84	-165.89	-12.05	0.6463	-0.0229	0.1406	0.13	2.99	-0.0942	-0.1629	-0.0746
-0.1	38	135.26	-135.46	-0.21	0.5877	-0.0106	0.1427	0.17	2.99	-0.0821	-0.0745	-0.0623
-0.1	50	127.47	-122.95	4.53	0.5710	-0.0063	0.1447	0.18	3.03	-0.0787	-0.0437	-0.0580
-0.1	100	109.99	-94.51	15.48	0.5367	0.0027	0.1495	0.28	3.10	-0.0716	0.0182	-0.0490
-0.1	200	97.62	-72.19	25.42	0.5183	0.0097	0.1557	0.39	3.24	-0.0665	0.0625	-0.0420

Table 18: f-75% trade results of different autocorrelation levels. The table shows the trade results of the SMA trading rules with f-75% position sizing dependent on different lag-1 autocorrelation levels of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

φ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.2	5	2803.14	-1293.24	1509.91	0.2785	0.2545	0.2145	0.08	3.02	0.1451	1.1866	0.2030
0.2	10	1524.58	-708.16	816.42	0.3219	0.1982	0.2139	0.10	3.02	0.0879	0.9265	0.1467
0.2	20	897.35	-412.21	485.14	0.3730	0.1524	0.2164	0.16	3.00	0.0432	0.7045	0.1010
0.2	38	584.23	-262.31	321.92	0.4215	0.1194	0.2170	0.20	2.99	0.0107	0.5500	0.0679
0.2	50	495.63	-218.45	277.17	0.4411	0.1078	0.2175	0.23	3.04	-0.0013	0.4956	0.0564
0.2	100	344.60	-141.25	203.35	0.4925	0.0847	0.2209	0.33	3.09	-0.0235	0.3832	0.0332
0.2	200	259.67	-96.29	163.38	0.5386	0.0685	0.2260	0.44	3.18	-0.0394	0.3031	0.0171
0.025	5	578.65	-470.29	108.36	0.5358	0.0545	0.1929	0.09	3.04	-0.0450	0.2825	0.0027
0.025	10	453.92	-359.69	94.23	0.5532	0.0476	0.1921	0.10	3.01	-0.0514	0.2478	-0.0042
0.025	20	356.24	-270.55	85.69	0.5702	0.0424	0.1950	0.14	2.98	-0.0564	0.2172	-0.0094
0.025	38	283.48	-204.40	79.09	0.5830	0.0384	0.1961	0.17	2.97	-0.0586	0.1957	-0.0134
0.025	50	257.81	-180.43	77.38	0.5881	0.0370	0.1977	0.20	3.03	-0.0618	0.1869	-0.0148
0.025	100	206.16	-130.81	75.34	0.5977	0.0346	0.2016	0.29	3.08	-0.0646	0.1715	-0.0172
0.025	200	171.33	-95.88	75.45	0.6076	0.0331	0.2064	0.37	3.15	-0.0670	0.1605	-0.0186
-0.1	5	233.34	-281.91	-48.57	1.1746	-0.0833	0.1821	0.07	3.03	-0.1765	-0.4574	-0.1350
-0.1	10	218.64	-251.56	-32.92	0.9997	-0.0567	0.1818	0.08	3.01	-0.1509	-0.3118	-0.1084
-0.1	20	199.46	-215.05	-15.59	0.8743	-0.0344	0.1849	0.12	2.98	-0.1282	-0.1861	-0.0861
-0.1	38	178.26	-178.54	-0.29	0.7912	-0.0182	0.1866	0.15	2.97	-0.1120	-0.0974	-0.0699
-0.1	50	168.96	-162.93	6.03	0.7668	-0.0125	0.1887	0.16	3.01	-0.1072	-0.0663	-0.0642
-0.1	100	147.11	-126.37	20.74	0.7153	-0.0007	0.1929	0.24	3.06	-0.0977	-0.0034	-0.0524
-0.1	200	130.70	-96.79	33.91	0.6843	0.0083	0.1980	0.32	3.14	-0.0898	0.0418	-0.0434

Table 19: f-100% trade results of different autocorrelation levels. The table shows the trade results of the SMA trading rules with f-100% position sizing dependent on different lag-1 autocorrelation levels of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

φ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.2	5	5690.18	-2619.96	3070.22	0.3497	0.3099	0.2645	0.08	3.02	0.1746	1.1719	0.2585
0.2	10	2728.11	-1265.42	1462.69	0.4039	0.2396	0.2626	0.09	3.01	0.1039	0.9122	0.1881
0.2	20	1460.17	-669.22	790.95	0.4669	0.1825	0.2642	0.15	2.99	0.0489	0.6906	0.1310
0.2	38	887.65	-398.26	489.39	0.5257	0.1412	0.2631	0.18	2.96	0.0091	0.5367	0.0897
0.2	50	736.07	-324.17	411.90	0.5489	0.1268	0.2628	0.21	3.01	-0.0057	0.4825	0.0753
0.2	100	487.24	-199.52	287.71	0.6081	0.0979	0.2639	0.29	3.05	-0.0325	0.3711	0.0465
0.2	200	352.35	-130.68	221.67	0.6579	0.0777	0.2662	0.38	3.09	-0.0515	0.2917	0.0262
0.025	5	797.97	-647.99	149.98	0.6798	0.0624	0.2390	0.08	3.04	-0.0608	0.2612	0.0107
0.025	10	617.08	-488.81	128.26	0.7004	0.0538	0.2373	0.09	3.00	-0.0685	0.2267	0.0020
0.025	20	479.38	-363.79	115.58	0.7196	0.0472	0.2398	0.13	2.98	-0.0744	0.1968	-0.0046
0.025	38	377.44	-272.12	105.32	0.7327	0.0422	0.2397	0.15	2.96	-0.0769	0.1760	-0.0096
0.025	50	342.06	-239.28	102.78	0.7375	0.0404	0.2409	0.18	3.01	-0.0803	0.1676	-0.0114
0.025	100	270.58	-171.58	99.00	0.7443	0.0373	0.2433	0.25	3.05	-0.0834	0.1534	-0.0144
0.025	200	221.48	-124.14	97.34	0.7499	0.0353	0.2460	0.31	3.07	-0.0855	0.1434	-0.0165
-0.1	5	270.63	-326.90	-56.27	1.4973	-0.1087	0.2263	0.07	3.02	-0.2245	-0.4804	-0.1604
-0.1	10	259.86	-299.01	-39.15	1.2724	-0.0755	0.2253	0.07	3.01	-0.1922	-0.3350	-0.1272
-0.1	20	242.52	-261.45	-18.93	1.1091	-0.0477	0.2283	0.11	2.98	-0.1637	-0.2089	-0.0994
-0.1	38	220.22	-220.62	-0.39	0.9992	-0.0274	0.2291	0.14	2.96	-0.1431	-0.1198	-0.0792
-0.1	50	209.93	-202.41	7.52	0.9660	-0.0204	0.2312	0.14	2.99	-0.1369	-0.0882	-0.0721
-0.1	100	184.38	-158.35	26.03	0.8952	-0.0057	0.2344	0.21	3.04	-0.1245	-0.0243	-0.0574
-0.1	200	163.91	-121.56	42.35	0.8496	0.0052	0.2378	0.26	3.08	-0.1141	0.0217	-0.0465

Table 20: f-125% trade results of different autocorrelation levels. The table shows the trade results of the SMA trading rules with f-125% position sizing dependent on different lag-1 autocorrelation levels of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

φ	SMA	Tot. Prof.	Tot. Loss	Tot. Result	Max DD	Mean Rtrn	Vola	Skew	Kurt	VaR(5%)	Sharpe	Exp.Exc.Retrn
0.2	5	907.96	-419.77	488.19	0.1854	0.1551	0.1993	0.51	3.22	0.0610	0.7785	0.1037
0.2	10	731.83	-340.14	391.68	0.2332	0.1364	0.2023	0.53	3.26	0.0424	0.6742	0.0849
0.2	20	582.47	-267.65	314.82	0.2961	0.1177	0.2081	0.57	3.31	0.0226	0.5658	0.0663
0.2	38	469.31	-210.27	259.04	0.3664	0.1015	0.2149	0.57	3.34	0.0037	0.4722	0.0501
0.2	50	428.41	-188.52	239.89	0.3993	0.0948	0.2274	-0.72	22.76	-0.0044	0.4169	0.0433
0.2	100	344.50	-140.75	203.75	0.4896	0.0799	0.2501	-1.79	36.88	-0.0228	0.3194	0.0284
0.2	200	285.46	-105.41	180.05	0.5756	0.0679	0.2681	-1.98	36.19	-0.0385	0.2533	0.0165
0.025	5	631.79	-513.69	118.10	0.6387	0.0465	0.3816	-6.55	65.38	-0.0531	0.1219	-0.0052
0.025	10	517.94	-410.07	107.87	0.6871	0.0385	0.4206	-6.26	56.01	-0.0641	0.0915	-0.0133
0.025	20	419.70	-318.52	101.18	0.7353	0.0322	0.4393	-5.92	50.29	-0.0737	0.0734	-0.0195
0.025	38	343.44	-247.42	96.01	0.7752	0.0263	0.4718	-5.74	45.82	-0.0848	0.0557	-0.0255
0.025	50	315.27	-220.77	94.50	0.7997	0.0227	0.5001	-5.60	42.67	-0.0935	0.0454	-0.0290
0.025	100	257.22	-163.40	93.81	0.8343	0.0158	0.5574	-5.15	34.87	-0.1043	0.0284	-0.0359
0.025	200	215.77	-120.87	94.90	0.8395	0.0157	0.5477	-5.17	35.74	-0.1026	0.0286	-0.0361
-0.1	5	491.74	-593.99	-102.26	3.9456	-0.7154	1.4721	0.60	1.69	-1.2249	-0.4860	-0.7672
-0.1	10	410.06	-471.41	-61.35	3.1302	-0.5057	1.6219	-0.25	1.29	-1.2220	-0.3118	-0.5574
-0.1	20	337.77	-364.07	-26.30	2.4333	-0.3278	1.5259	-0.96	2.16	-1.1906	-0.2148	-0.3795
-0.1	38	280.31	-280.86	-0.55	1.9101	-0.2032	1.3222	-1.64	4.04	-1.1438	-0.1536	-0.2549
-0.1	50	258.74	-249.83	8.91	1.7521	-0.1698	1.2488	-1.88	4.96	-1.1216	-0.1360	-0.2215
-0.1	100	213.72	-183.98	29.74	1.4253	-0.1011	1.0506	-2.56	8.38	-1.0640	-0.0963	-0.1529
-0.1	200	181.18	-134.84	46.34	1.2240	-0.0559	0.8761	-3.28	13.41	-0.9713	-0.0638	-0.1076

Table 21: Unsized trade results of different autocorrelation levels. The table shows the trade results of the SMA trading rules with unmanaged position sizing dependent on different lag-1 autocorrelation levels of the underlying benchmark. The profit and loss figures are in € with respect to an initial investment of € 100.

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