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Moving Average: How do the ANDOR and ANDAND Strategy Perform in Currency Markets

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Abstract

In this paper, I examine the profitability of a combined simple moving average (SMA) trading strategy named the ANDOR strategy and named the ANDAND strategy. The general problem was that it was unclear how the ANDOR strategy and the ANDAND strategy perform in currency markets. The purpose of this quantitative study was to conduct a comparison between the ANDOR, ANDAND, and SMA trading strategies for their profitability in currency markets, while controlling for three different time units weekly, daily, and hourly. For the methods and analysis the currency market returns, Sharpe ratios, standard deviation per return coefficients (S.R.C), and estimated costs were compared and a combined SMA was computed. A key result was that the ANDOR strategy was superior compared to the ANDAND and a SMA(S) strategy in the tested currency markets, with a average daily return of ($\bar{r}_{ANDOR}$ = 0.58% per day) and a (Sharpe ratio$_{ANDOR}$ = 1.15).

Keywords: Combined moving average; efficient market hypothesis; simple moving average; technical analysis; ANDAND strategy; ANDOR strategy

1. Introduction

One of the most commonly used methodology of technical analysis, to gain excess returns from security trading, is to generate trading signals through moving average (MA) rules in security markets. In the scholarly literature, much has been published to the issue of technical analysis and MA trading strategies. For example, Allen and Taylor (1990) reported on technical and fundamental analyses, while Brock, Lakonishok, and LeBaron (1992) added the edge of stochastic properties of stock returns that were related to the issue of technical analysis. Antoniou, Ergul, Holmes, and Priestley (1997), Blume, Easley, and Hara (1994) analyzed the impact of volume in connection to technical trading. Gencay (1998a) examined the optimization and Gencay (1998b) and Kwon and Kish (2002) assessed the predictability of technical trading rules in their studies. Ready (2002) investigated the profitability of technical trading rules, while Wong, Manzur, and Chew (2003) conducted similar research for the Singapore stock markets. Methhalchi, Chang, and Du (2011) discussed the application of technical trading rules for the NASDAQ index, and Ratner and Leal (1999) assessed the profitability of MA's in the emerging markets of Latin America and Asia. While some researchers have discussed an edge to technical analysis in their publications, most scholarly sources have validated the profitability of technical analysis in different stock markets.

Although most researchers tested the application of MA trading rules in a similar way, by either considering price crossover or double crossover MA signals, Arnold and Rahfeldt (1986, 2008; here after named AR) recommended trading MA signals in a unique way. AR contributed also to the issue of market timing by identifying bull and bear phases through a MA. For the AR strategy, the application of a MA long-term (L) and a MA short-term (S) is relevant for a security. A buy trading signal occurs through the AR strategy, if the asset price crosses both the MA(L, S), and a sell signal or exit signal occurs through the AR strategy, if either one of the MA(L) or the MA(S) is crossed. Chang, Metghalchi, and Chan (2006) tested the AR strategy and the profitability in the Taiwanese stock market. Ren and Ren (2018) found that the AR strategy could be further varied mathematically into four different

trading strategies, renamed these strategies (i.e. maxmax, maxmin et cetera), and tested the outcome for U.S. stock market indices. For example, according to the maxmax strategy, buy and sell signal occurred if both MA(L, S) are crossed by the security price. However for the remaining part of the study, I rename the AR-strategy in ANDOR strategy here after and the MAXMAX strategy in ANDAND strategy here after. The ANDOR and the ANDAND strategies are more in detail discussed in the methodology section.

The following researchers made relevant contributions to the issue of technical analysis, applied to currency markets in their research publications. Sosvilla-Rivero, Andrada-Félix, and Fernández Rodríguez (2002) and Taylor and Allen (1992) reported evidence for the profitability of technical analysis in foreign exchange markets. Taylor and Allen (1992) stressed that MA trading rules rely mostly on visual inspection and fundamental figures are not taken much into consideration for an investment decision. Therefore, currency traders apply MA rules for short-time horizons, while fundamental analysts favor long-time horizons in their trading strategies (Taylor & Allen, 1992). Menkhoff (1997) mentioned that most German foreign exchange traders focus an intra-day, daily, weekly, and monthly time-units when applying technical analysis. While, Abbey and Doukas (2012) investigated through a four factor model the profitability of technical indicators in currency markets. Abbey and Doukas reported that technical indicator trading underperforms in currency markets, when indicator trading is applied by individual currency traders. Further research was required for the profitability of technical indicators applied by professional currency traders (Abbey & Doukas, 2012). In conclusion, short-time horizons are favored when applying MA rules in currency markets, such as intraday or daily time units. The critique from Abbey and Doukas that private investors lose money, when they apply technical indicators seems relevant to mention in connection to the results of a technical analysis study.

The efficiency state of a security market is essential for an investor's investment decision. Osborne (1959, 1962) was one of the first who connected the issue of *Brownian motion* to the stock price movement of a stock market. Osborne (1962) saw that the periodic structure of stock prices, move in a random way. The periodic structure of stock price movement appeared to follow a Brownian motion where stock prices seemed to move randomly. An evolution of the Brownian motion was reported by researchers that introduced the theory of *Random Walk*. Alexander (1964), Almudhaf (2014), Al-Khazali, Ding, and Chong (2007), Beckmann (2002), Jensen and Benington (1970), Jensen and Henington (1970), Jiang and Tian (2012), Levy (1967) all reported relevant findings to the issue of the Random Walk theory. Beckmann (2002) assessed the issue of security speculations under the Random Walk theory; Jiang and Tian (2012) focused in their study on the option market in connection to the Random Walk theory; and Al-Khazali, Ding, and Chong (2007) tested the relation of a variance ratio observed in emerging markets, in connection to the Random Walk theory. From the research to the Brownian motion and to the Random Walk theory, the efficient market hypothesis (EMH) was postulated. Main contributions to the EMH occurred by Balvers, Cosimano, and McDonald (1990), Fama (1965, 1970, 1991, 1998), Jensen (1978), Keane (1986), Malkiel (2003, 2005), Nichols (1993), Renshaw (1984), Yen and Lee (2008). It was Fama (1970) who developed and reported the results of an EMH model with three market efficiency conditions: (a) strong-, (b), semi-, and (c) weak- market efficiency forms. Malhotra, Tandon, and Tandon (2015) tested later on the empirics in Asia-Pacific markets for weak forms of efficient markets. Essentially, it is important for an investor, who invests in security markets, that the market prices do not move completely randomly, or that the markets prices do not at all reflect the private and public available market information. The

common investor requires semi-efficient market conditions when following a trading or investment strategy to generate excess returns.

The current situation for the study is that the ANDOR strategy that was investigated by Chang et al. (2006) and the ANDAND MA trading strategy that was introduced by Ren and Ren (2018) were tested in regard of their profitability in stock markets on a daily basis. Chang et al. (2006) analyzed the Taiwanese stock market, while applying the ANDOR strategy on a daily basis. Ren and Ren (2018) introduced the ANDAND strategy as a variation of the AR strategy, while conducting tests for the Dow Jones Industrial Average (DJIA), Standard and Poor's 500 (S&P), and National Association of Security Dealers Automated Quotations (Nasdaq) stock markets also on a daily basis. Both researchers found that the ANDOR strategy was profitable and especially the MA(S) = 5 days and MA(L) = 100 days combination with ($r_{AR5vs100\_Long}$ = .46% daily return for the DJIA; e.g., Ren & Ren, 2018), where *r* stands for the daily return.

The general problem was that it was unclear how the ANDOR strategy and ANDAND strategy perform in different markets, such as the currency markets for example. The currency markets do follow a different trend pattern compared to stock markets and could lead to different results when testing the ANDOR and ANDAND strategies. Since the time units that were tested by Chang et al. (2006) and Ren and Ren (2018) were on a daily basis, the question was raised if a variation of the time units could lead to different return results for the ANDOR and ANDAND strategies.

The specific problem is to understand the profitability of the ANDOR strategy and the ANDAND strategy in currency markets and for different time units. A comparative analysis could bring technical analysis investors new insight to the profitability of the ANDOR strategy and ANDAND strategy. Further, scholarly literature and conducted testing to the ANDOR and ANDAND strategies only existed in my scholarly literature search to stock market data for both strategies, which means that the findings through this study could contribute to the technical analysis literature from a currency market and time unit perspective. From the results of this study, implications can be made to corroborate or contradict Chang et al.'s (2006) and Ren and Ren's (2018) research.

The purpose of this quantitative, comparative study is to test the ANDOR and the ANDAND trading strategies (independent variables) for their profitability regarding currency market returns (dependent variables) while controlling for three different time units weekly, daily, and hourly (control variables).

The research question is: How do the ANDOR strategy and the ANDAND MA trading strategy perform for currency market returns with different time units for technical analysis investors?

Further, two hypotheses are of relevance for the research regarding a possible size effect for the SMA(S, L) number of day setting and the application of Strategy1.

$H_0$1: if smaller SMA(S) number of day values (i.e., 4, 3, 2) are tested, then smaller SMA(S) values are not more profitable than a SMA(5, 150) number of day combination for Strategy 1

$H_1$1: if smaller SMA(S) number of day values (i.e., 4, 3, and 2) is tested, then smaller SMA(S) values are more profitable than a SMA(5, 150) number of day combination for Strategy 1

$H_0$2: if smaller SMA(L) number of day values (i.e., 30, 20, 10) are tested, then smaller SMA(L) values are not more profitable than larger SMA(L) number of day combinations (i.e., 150) for Strategy 1.

$H_1$2: if smaller SMA(L) number of day values (i.e., 30, 20, 10) are tested, then smaller SMA(L) values are more profitable than larger SMA(L) number of day combinations (i.e., 150) for Strategy 1.

In the remaining part of the study, the profitability of different SMA number of day combinations for the ANDOR strategy is examined. Further, an effect is examined that depends on the SMA(S, L) number of day size for the ANDOR strategy. The examination of different time units reviled that smaller time units seemed more profitable to trade the ANDOR strategy compared to large time units. Essentially, a comparison of the ANDOR, ANDAND, and SMA(S) strategy allowed to conclude that a SMA(5, 150) for the ANDOR strategy was superior in the EUR/USD; AUD/USD; USD/CAD currency markets, with for example for the EUR/USD market ($\bar{r}_L + |\bar{r}_S|_{Day}$ = 0.53% per day; see Table 5).

2. Data and methodology

In this section, I define the following settings for the considered sample. To limit the analysis of currency markets, I select for this study the currency pairs: EUR/USD; AUD/USD; USD/CAD. I collect the data for these three pairs from Dukascopy (see https://www.dukascopy.com/swiss/deutsch/marketwatch/historical/), while the currency data represent BID returns. The time period for the currency data ranges from January 1, 2004 until December 31, 2017, which equals to 14 years of data. I collect the data according to three time units or time dimensions: (a) weekly, (b) daily, and (c) hourly. This means that the following number of cases occurs for the dimension weekly returns (n_{week} = 52 weeks x 14 years = 728 cases), daily returns (n_{day} = 250 days x 14 years = 3,500 cases), and hourly returns (n_{hour} = 24 hours x 250 days x 14 years = 84,000 cases). Two sub-periods are formed for the considered time period that range from (Sub_1 = January 1, 2004 until December 31, 2010) and from (Sub_2 = January 1, 2011 until December 31, 2017).

The methodology for the MA trading rules that are tested in this study are subsequently discussed more in detail. In this study, a SMA is computed to determine ANDOR strategy and ANDAND strategy MA trading signals. The equation for the SMA is:

$$SMA = \frac{P_M + P_{M-1} + \ldots + P_{M-(n-1)}}{n} \quad [1]$$

Where, P_M is the price of the currency pair M; and n is the number of days considered for the closing prices. To obtain trading signals from the ANDOR strategy and the ANDAND strategy, a short-term (S) and a long-term (L) SMA are combined for a currency pair. If a currency pairs price crosses above both the SMA(S, L), then a buy signal occurs; if the price crosses below either [both] of the SMA(S) or [and] the SMA(L), then a sell [Short] signal occurs (see Arnold & Rahfeldt, 1986, 2008; Chang et al., 2006; and Ren & Ren, 2018). From this, two relevant MA strategies can be defined that, as mention, I name subsequently: (a) Strategy 1: ANDOR (also known as AR strategy); (b) Strategy 2: ANDAND (also known as MAXMAX strategy); (c) Strategy 3: SMA(S). Depending if only a Long strategy or a Long and Short strategy is pursued for each SMA strategy, then Long, Short, or sell singles occur when:

ANDOR:

Long: If p_t > SMA(S) and p_t > SMA(L);
Sell: If p_t < SMA(S) or p_t < SMA(L);

Short: If p_t < SMA(S) and p_t < SMA(L);
Sell: If p_t > SMA(S) or p_t > SMA(L). [2]

ANDAND:
Long: If p_t > SMA(S) and p_t > SMA(L);
Short (Sell): If p_t < SMA(S) and p_t < SMA(L). [3]

SMA(S)
Long: If p_t > SMA(S);
Short (Sell): If p_t < SMA(S). [4]

Where p_t is the currency BID price at time *t*; SMA(S) and SMA(L) are the short-term and long-term SMA computed until the last BID price at time *t-1*. In the literature of the ANDOR and ANDAND strategy the following number of day settings are tested for a SMA: (a) SMA(S) = 5 and 10 days; (b) SMA(L) = 50, 100, 150, and 200 days (see Chang et al., 2006; Ren & Ren, 2018). For the weekly MA number of weeks that are commonly tested, the test settings are: (a) SMA(S) = 5, 10 weeks and (b) SMA(L) = 20, 30, 40, 50 weeks (e.g., MA(L); see LeBaron, 1998). And, for the hourly MA number of hours that are commonly tested, the test settings are: SMA(L) = 5, 10, 15, 20 hours. I consider in this study the recommend number of week-, day- and hour- settings for an SMA, applied to the EUR/USD; AUD/USD; USD/CAD. I examine for the planned comparison the two combined SMA trading strategies, ANDOR and ANDAND, in contrast to the results of a simple price crossover for a SMA(S) strategy.

In Table 1, I provide an example how the three MA trading strategies are applied and how Long, Short, or sell signals can occur.

Table 1

p_t in ($)	SMA (S) in ($)	SMA (L) in ($)	Strategy 1 ANDOR			Strategy 2 ANDAND		Strategy 3 SMA (S)	
			Long	Sell	Short	Long	Short	Long	Short
4	5.5	9.5		Short			Short		Short
5	5.5	9.5		Short			Short		Short
6	5.5	9.5		Sell			Short or Long		Long
7	5.5	9.5		Sell			Short or Long		Long
8	5.5	9.5		Sell			Short or Long		Long
9	5.5	9.5		Sell			Short or Long		Long
10	5.5	9.5		Long			Long		Long
11	5.5	9.5		Long			Long		Long

Note. Adapted from "Applying a combined max-min simple moving average trading strategy to market indexes" by L. Ren and P. Ren, 2018, *Economics, Management, and Financial Markets, 13* (2), p. 14. Copyright 2018 by Ulrich R. Deinwallner. p_t is the currency price at time t in dollars; SMA is the simple moving average; ANDAND and ANDOR represent the SMA Short (S) and SMA Long (L) combinations to obtained trading signals, where the price crosses the SMA.

For strategy 1, the price of an asset has to be above [below] both MA(S, L) in order for a Long and Short signal to occur. However, if the asset price crosses one of the SMA(S, L), then a sell signal occurs and the technical investor needs to exit the market. For example, in Table 1 if the asset price p_t is \$6 > \$5.5 SMA(S) and the asset price \$6 < \$9.5 SMA(L), then a sell signal occurs. For strategy 2, the price of an asset always needs to be above [below] both of the MA(S, L) for a trading signal to occur. For example, in Table 1 if the asset price is \$10 > \$5.5 SMA(S) and the asset price is \$10 > \$9.5 SMA(L), then a Long single occurs. If the asset price falls below or rises above one of the SMA(S, L), then the investors stays either invested Long or Short until the prices crosses again both SMA(S, L) for the next trading signal to occur. It is to mention that the investor could also alternatively sell his investment position instead of going Short, which I do not cover in this example.

For a quantitative, comparative research design the different SMA strategies are tested for three different currency pairs and for three different time units in a sequential order. I first examine the results for strategy 1 in the EUR/USD market with two different SMA(S) and four different SMA(L) combinations. Then, I examine a size effect for Strategy 1 in the EUR/USD market with three different SMA(S) and four different SMA(L) combinations. Through the size effect test, I can determine with what SMA(S, L) number of day setting I can proceed for a comparison of Strategy 1, while controlling for three different time units. Finally, I compare all three strategies in all three currency markets with the optimal number of day combination for the SMA's to answer the research question. In the appendix, I provide two sub-period comparisons (Sub_1 and Sub_2) to assess if the final results are robust during different time periods.

In regard of the threats of the external validity, the results only apply for two tested SMA strategies that use two SMA's in connection to an asset price crossover, to drive investment decisions from. In the technical analysis literature many different forms of applying a MA to determine investment decisions have been reported (see Sosvilla-Rivero, Andrada-Félix, & Fernández Rodríguez, 2002; Taylor & Allen, 1992). This can be an aspect to external validity, when generalizing the results for MA based investment decisions and their profitability. Because private investors tend to lose capital when applying MA strategies, the study is for educational reasons, does not represent investment advice, and investors should conduct their own research before investing their capital (see Abbey & Doukas, 2012). Further, only the markets EUR/USD; AUD/USD; USD/CAD in the given time period have

been tested. This means that other currency pairs or other time periods might perform differently, when generalizing the results for the currency markets.

In regard of internal validity, the data source used in this study was Dukascopy and might deviate at some point from data that is used in other studies, such as data from providers like Bloomberg or Reuters. However, Dukascopy data is published and used for investment analysis and should be valid to a large extend.

3. Empirical Findings

Examination of the profitability of different SMA number of day combinations for Strategy 1

The task for the first analysis is to test the profitability of the different SMA(S) and the different SMA(L) number of day combinations for daily EUR/USD data for the Strategy 1. In other words, the objective is to determine the optimal SMA number of day combination for the Strategy 1, when considering daily currency market data. I display the results of the analysis of optimal SMA combinations for the Strategy 1 in Table 2.

Table 2

Results for SMA Strategy 1 applied to the EUR/USD daily returns, during 2004 -2017

Currency	*Strategy 1*	$\bar{r}_L$	S_L	n_L	n_{TL}	$\bar{r}_S$	S_S	n_S	n_{TS}	$\bar{r}_L/S_L$	$S_L/\bar{r}_L$	$\bar{r}_S/S_S$	$S_S/\bar{r}_S$	$\bar{r}_L+\lvert\bar{r}_S\rvert$
EUR/USD	SMA (5, 50)	0.25	0.45	1686	385	-0.28	0.47	1499	366	0.56	1.80	-0.60	-1.68	0.53
EUR/USD	SMA (10, 50)	0.19	0.47	1845	276	-0.21	0.49	1676	268	0.40	2.47	-0.43	-2.33	0.40
EUR/USD	SMA (5, 100)	0.24	0.43	1653	390	-0.28	0.48	1365	342	0.56	1.79	-0.58	-1.71	0.52
EUR/USD	SMA (10, 100)	0.19	0.45	1777	265	-0.21	0.49	1507	259	0.42	2.37	-0.43	-2.33	0.40
EUR/USD	**SMA (5, 150)**	**0.24**	**0.42**	**1632**	**379**	**-0.29**	**0.49**	**1291**	**307**	**0.57**	**1.75**	**-0.59**	**-1.69**	**0.53**
EUR/USD	SMA (10, 150)	0.18	0.44	1739	249	-0.22	0.51	1416	229	0.41	2.44	-0.43	-2.32	0.40
EUR/USD	SMA (5, 200)	0.23	0.41	1597	372	-0.29	0.49	1261	298	0.56	1.78	-0.59	-1.69	0.52
EUR/USD	SMA (10, 200)	0.18	0.43	1674	248	-0.23	0.51	1356	214	0.42	2.39	-0.45	-2.22	0.41
Cumulative Average														
EUR/USD	**SMA (5, 50-200)**	**0.24**	**0.43**	**1642**	**382**	**-0.29**	**0.48**	**1354**	**328**	**0.56**	**1.78**	**-0.59**	**-1.69**	**0.53**
EUR/USD	SMA (10, 50-200)	0.19	0.45	1759	260	-0.22	0.50	1489	243	0.41	2.42	-0.43	-2.30	0.40
EUR/USD	SMA (5, 50-100)	0.25	0.44	1670	388	-0.28	0.48	1432	354	0.56	1.80	-0.59	-1.70	0.53
EUR/USD	SMA (5, 150-200)	0.24	0.42	1615	376	-0.29	0.49	1276	303	0.57	1.77	-0.59	-1.69	0.53

Note. $\bar{r}_L$ is average daily return in percent , where L stand for Long and S is Short . S_L is the standard deviation in percent . n_L is the number of days that Long (Short) period occured. Where n_{TL} (n_{TS}) represent only the amount of Long (Short) trades that occured during the given time period (i.e., 3 Long trades x 2 buy and sell actions = 6 trades in total). $\bar{r}_L / S_L$ represents the Sharpe ratio without the risk free rate adjustement. $S_L / \bar{r}_L$ is the standard deviation per average return coefficent (S.R.C.). $\bar{r}_L + \lvert\bar{r}_S\rvert$ are the average returns in percent for a combined Long and Short trading strategy.

From Table 2, I can find that for the cumulative average SMA(S), the SMA(5, 50-200) with ($\bar{r}_L + \lvert\bar{r}_S\rvert$ = 0.53% daily average return) is more profitable in the EUR/USD market compared to the SMA(10, 50-200) with ($\bar{r}_L + \lvert\bar{r}_S\rvert$ = 0.40% daily average return). This finding of Table 2 corroborates Chang et al.'s (2006) reported results. Chang et al. (2006) also see a MA(5) as more profitable in stock markets, compared to a MA(S) with a larger number of day values. In comparison of the cumulative average SMA(L), there seems no larger difference if a SMA(50) or a SMA(150) is applied in regard of the profitability of Strategy 1. The average returns, the volatility, and the Sharpe ratio for Strategy 1 seem equally similar distributed for a SMA (5) and a SMA(L) with a 50 or a 150 number of day combination.

Examination of the profitability of SMA(S, L) small and large number of day combinations for Strategy 1

For the next test, the objective lies on the examination of different time units, where weekly, daily, hourly data are tested. However, through the results of Table 2 it was unclear if maybe

a size effect can occur for the further examination of weekly, daily, hourly data, which lead the two following hypothesis (*H*); $H_1$1: if smaller SMA(S) number of day values (i.e., 4, 3, 2) are tested, then smaller SMA(S) values are more profitable than a SMA(5, 150) number of day combination for Strategy 1; and $H_1$2: if smaller SMA(L) number of day values (i.e., 30, 20, 10) are tested, then smaller SMA(L) values are more profitable than larger SMA(L) number of day combinations (i.e., 150) for Strategy 1. To investigate these relations is relevant, in order to observe if an effect exists for the profitability of smaller tending SMA number of day values, and to determine the SMA setting for a comparison of the Strategy 1 results with different time units. Therefore, the next two questions to answer are: (a) are smaller number of day values for the SMA(S) and for the SMA(L) also profitable to trade for daily data? (b) what SMA setting is recommendable to select for a comparison of weekly, daily, hourly time unit data?

Table 3

Results for Strategy 1 varied by MA(S) and MA(L) applied to the EUR/USD daily returns, from 2004 - 2017

Currency	*Strategy 1*	$\bar{r}_L$	S_L	n_L	n_{TL}	$\bar{r}_S$	S_S	n_S	n_{TS}	$\bar{r}_L/S_L$	$S_L/\bar{r}_L$	$\bar{r}_S/S_S$	$S_S/\bar{r}_S$	$\bar{r}L + \lvert\bar{r}S\rvert$
MA(S, L) = small versus large														
EUR/USD	SMA (5, 150)	0.24	0.42	1632	379	-0.29	0.49	1291	307	0.57	1.75	-0.59	-1.69	0.53
EUR/USD	SMA (3, 150)	0.33	0.42	1333	564	-0.39	0.48	1073	463	0.79	1.27	-0.81	-1.23	0.72
EUR/USD	SMA (2, 150)	0.43	0.39	1093	643	-0.52	0.45	875	538	1.10	0.91	-1.16	-0.87	0.95
MA(S, L) = small versus small														
EUR/USD	SMA (2, 30)	0.48	0.44	1111	664	-0.52	0.44	1032	642	1.09	0.92	-1.18	-0.85	1.00
EUR/USD	**SMA (2, 20)**	**0.50**	**0.45**	**1137**	**677**	**-0.53**	**0.44**	**1090**	**665**	**1.11**	**0.90**	**-1.20**	**-0.83**	**1.03**
EUR/USD	SMA (2, 10)	0.50	0.43	1414	849	-0.52	0.42	1361	829	1.16	0.86	-1.24	-0.81	1.02
Cumulative Average														
EUR/USD	SMA (small, large)	0.33	0.41	1353	529	-0.40	0.47	1080	436	0.82	1.31	-0.85	-1.26	0.73
EUR/USD	**SMA (small, small)**	**0.49**	**0.44**	**1221**	**730**	**-0.52**	**0.43**	**1161**	**712**	**1.12**	**0.89**	**-1.21**	**-0.83**	**1.02**

Note. $\bar{r}_L$ is average daily return in percent, where L stand for Long and S is Short. S_L is the standard deviation in percent. n_L is the number of days that Long (Short) period occured. Where n_{TL} (n_{TS}) represent only the amount of Long (Short) trades that occured during the given time period (i.e., 3 Long trades x 2 buy and sell actions = 6 trades in total). $\bar{r}_L$ / S_L represents the Sharpe ratio without the risk free rate adjustement. S_L /$\bar{r}_L$ is the standard deviation per average return coefficent (S.R.C.). $\bar{r}_L$ + | $\bar{r}_S$| are the average returns in percent for a combined Long and Short trading strategy.

From the results in Table 3, I can observe the effect that the smaller the SMA(S, L) number of day settings become, the larger the SMA(S, L) returns get. When applying the Strategy 1 to the EUR/USD currency returns, a saturation of maximizing the Long and Short strategy returns occurs for a SMA(2, 20) number of day setting. In specific, the returns range for SMA(S, L) [small, large] combinations from [0.53 – 0.95% daily average return], and for SMA(S, L) [small, small] combinations from [1 - 1.03% daily average return] for a Long and Short trading Strategy 1. The number of trades in Table 3 revealed that an investor is required with a SMA(S, L) [small, small] number of day setting to enter and exit the market at a higher trading frequency rate (i.e., SMA(2, 10) = 1,678 Long and Short Trades x 2 buy and sell order = 3,356 trades during / 14 years / 12 months = circa 20 trades per month or almost every day a trade). For the settings of a SMA for a comparison of weekly, daily, hourly time unit data it is recommendable to proceed with a SMA(5, L) number units (i.e. week, day, hour) combination.

Examination of the profitability of SMA number of day combinations for Strategy 1 and for different time units.

I will proceed in my further examination for the different time unit results: (a) for the hourly data, with a SMA(5, L) and a large (L) number of hours setting for the analysis of Strategy 1;

and (b) for the weekly data, I will consider a SMA(5, L) with a (L) setting of LeBaron's (1998) MA number of week recommendations for the analysis of Strategy 1. The reason is that the average return per trade is most profitable for a SMA(S, L) [small, large] number of day setting (i.e., $\bar{r}_L+|\bar{r}_S|_{SMA(5,\ 150)}$ is 0.53% return / 686 Trades = 0.00077% return per trade; compared to $\bar{r}_L+|\bar{r}_S|_{SMA(2,\ 10)}$ is 1.02% return / 1,678 trades = 0.0006% return per trade) according to Table 3. Further, if a SMA(S, L) [small, large] combination is considered, then lower transaction costs will occur because fewer trades occur compared to a SMA(S, L) [small, small] combination. For private investors, larger SMA settings can be more practicable to trade because less trading signals occur on a daily basis.

Table 4

Daily returns for Strategy 1 applied to the EUR/USD for week, day, hour time units, from 2004 -2017

Currency	*Strategy 1*	$\bar{r}_L$	S_L	n_L	n_{TL}	$\bar{r}_S$	S_S	n_S	n_{TS}	$\bar{r}_L/S_L$	$S_L/\bar{r}_L$	$\bar{r}_S/S_S$	$S_S/\bar{r}_S$	$\bar{r}_L+\lvert\bar{r}_S\rvert$
Week (W)														
EUR/USD	**SMA (5, 50)**	**0.14**	**0.41**	**237**	**67**	**-0.18**	**0.62**	**201**	**51**	**0.34**	**2.93**	**-0.29**	**-3.44**	**0.32**
EUR/USD	SMA (5, 40)	0.14	0.43	246	68	-0.17	0.61	204	47	0.33	3.07	-0.28	-3.59	0.31
EUR/USD	SMA (5, 30)	0.15	0.46	255	72	-0.17	0.60	219	52	0.33	3.07	-0.28	-3.53	0.32
EUR/USD	**SMA (5, 20)**	**0.15**	**0.46**	**270**	**78**	**-0.18**	**0.58**	**236**	**63**	**0.33**	**3.07**	**-0.31**	**-3.22**	**0.33**
Day (D)														
EUR/USD	**SMA (5, 150)**	**0.24**	**0.42**	**1632**	**379**	**-0.29**	**0.49**	**1291**	**307**	**0.57**	**1.75**	**-0.59**	**-1.69**	**0.53**
EUR/USD	SMA (5, 50)	0.25	0.45	1686	385	-0.28	0.47	1499	366	0.56	1.80	-0.60	-1.68	0.53
Hour (H)														
EUR/USD	**SMA (5, 200)**	**1.46**	**0.58**	**25685**	**7162**	**-1.50**	**0.61**	**24861**	**7062**	**2.52**	**0.40**	**-2.46**	**-0.41**	**2.96**
EUR/USD	SMA (5, 150)	1.48	0.59	26278	7369	-1.50	0.61	25407	7215	2.51	0.40	-2.46	-0.41	2.98
EUR/USD	SMA (5, 100)	1.49	0.60	27167	7615	-1.51	0.61	26275	7396	2.48	0.40	-2.48	-0.40	3.00
EUR/USD	**SMA (5, 50)**	**1.50**	**0.60**	**29063**	**8103**	**-1.52**	**0.61**	**28211**	**7972**	**2.50**	**0.40**	**-2.49**	**-0.40**	**3.02**
Cumulative Average														
EUR/USD (W)	SMA	0.15	0.44	252	71	-0.18	0.60	215	53	0.33	3.03	-0.29	-3.45	0.32
EUR/USD (D)	SMA	0.25	0.44	1659	382	-0.29	0.48	1395	337	0.56	1.78	-0.59	-1.68	0.53
EUR/USD (H)	SMA	1.48	0.59	27048	7562	-1.51	0.61	26189	7411	2.50	0.40	-2.47	-0.40	2.99

Note. $\bar{r}_L$ is average daily return in percent, where L stand for Long and S is Short. The weekly returns were transformed in daily returns by the equation $(1 + r\ \text{EXP}\ (1/5)) - 1$. The hourly returns were transformed in daily returns by the equation $(1 + r\ \text{EXP}\ 24) - 1$. S_L is the daily standard deviation in percent. n_L is the number of weeks, or days, or hours that Long (Short) period occured. Where n_{TL} (n_{TS}) represent the amount of Long (Short) of singular trades that occured during the given time period (i.e., 3 Long trades x 2 buy and sell actions = 6 trade actions in total). $\bar{r}_L$ / S_L represents the Sharpe ratio without the risk free rate adjustement . S_L /$\bar{r}_L$ is the standard deviation per average return coefficent (S.R.C.). $\bar{r}_L+|\bar{r}_S|$ are the average returns in percent for a combined Long and Short trading strategy.

In Table 4, I present daily returns for the week-, day-, and hour- results for an easier comparison. I can find from Table 4, that depending on the time unit that is traded with Strategy 1 in the EUR/USD market, the average returns seemed to improve (decrease) for example ranging for weekly until hourly data with [0.32% until 2.99% average daily return]. This means that the profitability can make a difference depending in what time unit the Strategy 1 is traded. Further, I consider two factors for the selection of the optimal SMA setting: (a) the Sharpe ratio and (b) the costs that were approximated through the trading amounts and that were applied to a Long and Short trading strategy results. The highest Sharpe ratio and lowest costs for the weekly data indicated selecting the SMA(5, 50) combination with a ($\text{Sharpe ratio}_{SMA(5,\ 50)}$ = 0.63), while the costs were 16% lower compared to the highest trading amount. The highest Sharpe ratio and lowest costs for the hourly data indicated selecting the SMA(5, 200) combination, with a ($\text{Sharpe ratio}_{SMA(5,\ 200)}$ = 4.98) and 12% lower costs compared to the highest trading amount. Similar to Chang et al (2006), I will select for the subsequent strategies and currency pairs comparisons the SMA(5, 150) combination on a daily data basis because: (a) the trading of Strategy 1 with daily data is in regard of the costs and for the average return per trade more profitable compared to the trading of Strategy 1 with hourly data; and (b) the Sharpe ratio for trading of Strategy 1 with

weekly data is outperformed by the Sharpe ratio for trading Strategy 1 with daily data with [0.62 versus 1.15 Sharpe ratios].

Examination of the profitability of SMA number of day combinations for different Strategies and for different currency markets.

In the next examination the performance of Strategy 1 with the found optimal settings is of interest for daily data, in comparison to Strategy 2, Strategy 3, and for two other different currencies pairs.

Table 5

Daily returns for Strategy 1 until 3 applied to the AUD/USD, EUR/USD, USD/CAD, from 2004 -2017

Currency	*Strategy*	$\bar{r}_L$	S_L	n_L	n_{TL}	$\bar{r}_S$	S_S	n_S	n_{TS}	$\bar{r}_L/S_L$	$S_L/\bar{r}_L$	$\bar{r}_S/S_S$	$S_S/\bar{r}_S$	$\bar{r}_L+\lvert\bar{r}_S\rvert$
Strategy 1														
AUD/USD	SMA (5, 150)	0.30	0.47	1672	388	-0.38	0.78	1248	310	0.64	1.57	-0.49	-2.05	0.68
EUR/USD	SMA (5, 150)	0.24	0.42	1632	379	-0.29	0.49	1291	307	0.57	1.75	-0.59	-1.69	0.53
USD/CAD	SMA (5, 150)	0.27	0.49	1402	335	-0.25	0.41	1465	344	0.55	1.81	-0.61	-1.64	0.52
Strategy 2														
AUD/USD	SMA (5, 150)	0.06	0.58	2760	98	-0.07	0.84	2155	97	0.10	9.67	-0.08	-12.00	0.13
EUR/USD	SMA (5, 150)	0.05	0.47	2725	77	-0.06	0.57	2190	76	0.11	9.40	-0.11	-9.50	0.11
USD/CAD	SMA (5, 150)	0.05	0.55	2427	76	-0.05	0.48	2488	77	0.09	11.00	-0.10	-9.60	0.10
Strategy 3														
AUD/USD	SMA (5)	0.31	0.58	2578	597	-0.34	0.68	2337	597	0.53	1.87	-0.50	-2.00	0.65
EUR/USD	SMA (5)	0.25	0.44	2520	607	-0.26	0.45	2395	606	0.57	1.76	-0.58	-1.73	0.51
USD/CAD	SMA (5)	0.25	0.46	2425	591	-0.25	0.44	2489	592	0.54	1.84	-0.57	-1.76	0.50
Cummulative Strategy Returns														
Strategy 1		**0.27**	**0.46**	**1569**	**367**	**-0.31**	**0.56**	**1335**	**320**	**0.59**	**1.71**	**-0.56**	**-1.79**	**0.58**
Strategy 2		0.05	0.53	2637	84	-0.06	0.63	2278	83	0.10	10.02	-0.10	-10.37	0.11
Strategy 3		0.27	0.49	2508	598	-0.28	0.52	2407	598	0.55	1.82	-0.55	-1.83	0.55
AUD/USD		0.22	0.54	2337	361	-0.26	0.77	1913	335	0.43	4.37	-0.36	-5.35	0.49
EUR/USD		**0.18**	**0.44**	**2292**	**354**	**-0.20**	**0.50**	**1959**	**330**	**0.42**	**4.30**	**-0.42**	**-4.31**	**0.38**
USD/CAD		0.19	0.50	2085	334	-0.18	0.44	2147	338	0.40	4.88	-0.43	-4.33	0.37

Note. $\bar{r}_L$ is average daily return in percent, where L stand for Long and S is Short. Strategy (S) represents small and (L) is large value. The weekly returns were transformed in daily returns by the equation $(1 + r\,\text{EXP}\,(1/5)) - 1$. The hourly returns were transformed in daily returns by the equation $(1 + r\,\text{EXP}\,24) - 1$. S_L is the daily standard deviation in percent. n_L is the number of weeks, or days, or hours that Long (Short) period occured. Where n_{TL} (n_{TS}) represents the amount of Long (Short) of singular trades that occured during the given time period (i.e., 3 Long trades x 2 buy and sell actions = 6 trade actions in total). $\bar{r}_L / S_L$ represents the Sharpe ratio without the risk free rate adjustement. $S_L / \bar{r}_L$ is the standard deviation per average return coefficent (S.R.C.). $\bar{r}_L + |\bar{r}_S|$ are the average returns in percent for a combined Long and Short trading strategy.

From Table 5 and for the results of a Long and Short trading strategy, I can find that Strategy 1 was the most profitable strategy to trade in comparison to Strategy 2 and Strategy 3 with a ($\text{Sharpe Ratio}_{\text{Strategy1}} = 1.15$). The EUR/USD market had the highest value for the ($\text{Sharpe Ratio}_{\text{EUR/USD}} = 0.84$) in comparison to all other tested markets and when trading all strategies. However, the Sharpe ratios for all markets, the EUR/USD, AUD/USD, and USD/CAD, were about ($\text{Sharpe ratio}_{\text{all_currency_pairs}} = $ circa 0.8) when all strategies were traded, which means that in comparison no significant differences occurred at a 1% alpha level in regard of the risk and return relation. An investor could have traded each market with the same strategy and would have obtained similar Sharpe ratios due to the optimal SMA(5, 150) setting. In comparison of the costs (approximated by the trading amount) for each Strategy, Strategy 2 exhibited the lowest amount of trades ($\text{Trades}_{\text{Strategy2}} = 167$), while Strategy 3 had the highest amount of trades with ($\text{Trades}_{\text{Strategy3}} = 1{,}197$). Essentially, Strategy 2 was not very profitable to trade with an average return of ($\bar{r}_L + |\bar{r}_S|_{Strategy2} = 0.11\%$ per day) in comparison to all other strategies. Strategy 1 exhibited comparable metrics to Strategy 3; but, the costs were 43% lower when trading Strategy 1. In connection to the highest Sharpe ratio and the lowest transaction costs, Strategy 1 seemed to outperform the other Strategies in all of the tested currency markets.

In the appendix (A), I provide a sub-period comparison to Table 5with Table A1 and Table A2. Table A1 represents the results for Sub_1 and Table A2 represents the results for the Sub_2. In both time periods, the Strategy 1 seemed to be superior compared to Strategy 2 and to Strategy 3. During Sub_1 the Sharpe ratio of all strategies tested in the AUD/USD market was lower with a (Sharpe $ratio_{AUD/USD}$ = 0.76) compared to the other markets. However, all other result values from the sub-period comparison in Table A1 and in Table A2 seemed inconspicuous.

4. Conclusion

The following can be concluded to answer the research question: How do the ANDOR strategy and the ANDAND MA trading strategy perform for currency market returns with different time units for technical analysis investors?

According to the EMH, I found that the currency markets exhibited a semi-efficient distribution and excess returns were possible through the application of the ANDOR and the ANDAND strategy. In some time units the ANDOR and the ANAND strategy worked better compared to other time units, where rapid buy and sell signals occurred. Rapid buy and sell signals especially occurred in case of smaller time units such as hourly data due to the aspect that more data was processed, which means that market trends or oscillations that affected the strategies started and ended more frequently.

The ANDOR strategy was more profitable compared to the other two strategies that were tested (ANDAND strategy and SMA(S) strategy). The average return of the ANDOR strategy for a Long and Short trading strategy and in comparison to all tested strategies was ($\bar{r}_L+|\bar{r}_S|_{Strategy1}$ = 0.58% per day) and had a slight better risk and reward relation compared to the other strategies of (Sharpe ratio $_{Strategy1}$ = 1.15), during 2004 until 2017, in the EUR/USD, AUD/USD, and USD/CAD markets according to Table 5. The optimal number of day setting for the ANDOR strategy was SMA(5, 150).

The first main insight from the study was that the smaller the short and the long number of day values are, the more profitable the ANDOR strategy could get, also reported in Table 3. However, smaller MA number of day values for the ANDOR strategy impacted the total number of trades that occurred, and this aspect could diminish the profitability of the obtained returns. Therefore, I tested according to the compared metrics (i.e., best risk and return relation and lowest costs) and under the premise that the investment strategy is most convenient for private investors, I can find that the optimal ANDOR strategy number of day combination is SMA(5, 150). A sub-period comparison did not show in general significant differences between [2004-2010 and 2011-2017].

The second main insight was that the smaller the time unit is, then the more profitable the ANDOR strategy becomes. This means that for example the ANDOR strategy returns for the EUR/USD markets were in comparison [$\bar{r}_L+|\bar{r}_S|_{Week}$ = 0.32% per day; $\bar{r}_L+|\bar{r}_S|_{Day}$ = 0.53% per day; versus $\bar{r}_L+|\bar{r}_S|_{Hour}$ = 2.98 % per day] for the time period 2004 until 2017. Therefore, the time unit had an effect on the profitability of the ANDOR strategy returns.

The third main insight was that a SMA(5) strategy on a daily basis would be almost equally profitable to trade for an investors in regard of the risk and return relation, with ($\bar{r}_L+|\bar{r}_S|_{SMA(5)}$ = .55% per day) and a minimal lower (Sharpe $ratio_{SMA(5)}$ = 1.10) according to Table 5. However, the total number of trades or the transaction costs would be twice as high with [ANDOR Strategy = 687 Trades; versus SMA(5) = 1,196 Trades] for the time period 2004

until 2017. In consequence, the transaction costs made a difference between the profitability of trading an ANDOR strategy or a simple SMA(S) strategy.

In regard of positive social change, the findings corroborate the profitability assumptions for the ANDOR and ANDAND strategy in currency markets. New insight was found through a time unit variation and a number of day settings variation for the ANDOR and ANDAND strategy. The findings allow currency market investors to be aware of a time unit and a number of day variation-effect, when applying the ANDOR strategy. Further research could be conducted for the performance of the ANDOR strategy in commodity markets.

Appendix

Table A1

Daily returns for Strategy 1 until 3 applied to the AUD/USD, EUR/USD, USD/CAD, from 2004 -2010

Currency	*Strategy*	$\bar{r}_L$	S_L	n_L	n_{TL}	$\bar{r}_S$	S_S	n_S	n_{TS}	$\bar{r}_L/S_L$	$S_L/\bar{r}_L$	$\bar{r}_S/S_S$	$S_S/\bar{r}_S$	$\bar{r}_L+\lvert\bar{r}_S\rvert$
Strategy 1														
AUD/USD	SMA (5, 150)	0.31	0.49	976	203	-0.48	1.05	475	116	0.63	1.58	-0.46	-2.19	0.79
EUR/USD	SMA (5, 150)	0.25	0.44	864	191	-0.31	0.55	541	119	0.57	1.76	-0.56	-1.77	0.56
USD/CAD	SMA (5, 150)	0.33	0.63	506	124	-0.27	0.44	895	197	0.52	1.91	-0.61	-1.63	0.60
Strategy 2														
AUD/USD	SMA (5, 150)	0.07	0.62	1537	40	-0.09	1.13	821	39	0.11	8.86	-0.08	-12.56	0.16
EUR/USD	SMA (5, 150)	0.05	0.49	1462	26	-0.07	0.63	896	25	0.10	9.80	-0.11	-9.00	0.12
USD/CAD	SMA (5, 150)	0.07	0.70	858	39	-0.06	0.53	1500	40	0.10	10.00	-0.11	-8.83	0.13
Strategy 3														
AUD/USD	SMA (5)	0.35	0.67	1322	279	-0.41	0.84	1036	277	0.52	1.91	-0.49	-2.05	0.76
EUR/USD	SMA (5)	0.27	0.48	1214	283	-0.27	0.48	1144	282	0.56	1.78	-0.56	-1.78	0.54
USD/CAD	SMA (5)	0.29	0.56	1112	273	-0.28	0.50	1245	275	0.52	1.93	-0.56	-1.79	0.57
Cummulative Strategy Returns														
Strategy 1		**0.30**	**0.52**	**782**	**173**	**-0.35**	**0.68**	**637**	**144**	**0.57**	**1.75**	**-0.54**	**-1.86**	**0.65**
Strategy 2		0.06	0.60	1286	35	-0.07	0.76	1072	35	0.10	9.55	-0.10	-10.13	0.14
Strategy 3		0.30	0.57	1216	278	-0.32	0.61	1142	278	0.53	1.87	-0.54	-1.87	0.62
AUD/USD		0.24	0.59	1278	174	-0.33	1.01	777	144	0.42	4.12	-0.34	-5.60	0.57
EUR/USD		**0.19**	**0.47**	**1180**	**167**	**-0.22**	**0.55**	**860**	**142**	**0.41**	**4.45**	**-0.41**	**-4.18**	**0.41**
USD/CAD		0.23	0.63	825	145	-0.20	0.49	1213	171	0.38	4.61	-0.43	-4.08	0.43

Note. $\bar{r}_L$ is average daily return in percent, where L stand for Long and S is Short. Strategy (S) represents small and (L) is large value. The weekly returns were transformed in daily returns by the equation $(1 + r\,\text{EXP}\,(1/5)) - 1$. The hourly returns were transformed in daily returns by the equation $(1 + r\,\text{EXP}\,24) - 1$. S_L is the daily standard deviation in percent. n_L is the number of weeks, or days, or hours that Long (Short) period occured. Where n_{TL} (n_{TS}) represents the amount of Long (Short) of singular trades that occured during the given time period (i.e., 3 Long trades x 2 buy and sell actions = 6 trade actions in total). $\bar{r}_L / S_L$ represents the Sharpe ratio without the the risk free rate adjustement. $S_L / \bar{r}_L$ is the standerd deviation per average return coefficent (S.R.C.). $\bar{r}_L + |\bar{r}_S|$ are the average returns in percent for a combined Long and Short trading strategy.

Table A2

Daily returns for Strategy 1 until 3 applied to the AUD/USD, EUR/USD, USD/CAD, from 2011 -2017

Currency	*Strategy*	$\bar{r}_L$	S_L	n_L	n_{TL}	$\bar{r}_S$	S_S	n_S	n_{TS}	$\bar{r}_L/S_L$	$S_L/\bar{r}_L$	$\bar{r}_S/S_S$	$S_S/\bar{r}_S$	$\bar{r}_L+\lvert\bar{r}_S\rvert$
Strategy 1														
AUD/USD	SMA (5, 150)	0.28	0.44	686	185	-0.32	0.54	773	194	0.64	1.57	-0.59	-1.69	0.60
EUR/USD	SMA (5, 150)	0.23	0.39	768	188	-0.27	0.44	750	188	0.59	1.70	-0.61	-1.63	0.50
USD/CAD	SMA (5, 150)	0.23	0.38	896	211	-0.21	0.34	570	147	0.61	1.65	-0.62	-1.62	0.44
Strategy 2														
AUD/USD	SMA (5, 150)	0.05	0.51	1223	58	-0.06	0.60	1334	58	0.10	10.20	-0.10	-10.00	0.11
EUR/USD	SMA (5, 150)	0.05	0.44	1263	51	-0.06	0.50	1294	51	0.11	8.80	-0.12	-8.33	0.11
USD/CAD	SMA (5, 150)	0.04	0.44	1569	37	-0.04	0.39	988	37	0.09	11.00	-0.10	-9.75	0.08
Strategy 3														
AUD/USD	SMA (5)	0.28	0.46	1256	319	-0.29	0.50	1301	320	0.61	1.64	-0.58	-1.72	0.57
EUR/USD	SMA (5)	0.23	0.41	1306	324	-0.25	0.42	1251	324	0.56	1.78	-0.60	-1.68	0.48
USD/CAD	SMA (5)	0.22	0.36	1313	318	-0.21	0.36	1244	317	0.61	1.64	-0.58	-1.71	0.43
Cummulative Strategy Returns														
Strategy 1		**0.25**	**0.40**	**783**	**195**	**-0.27**	**0.44**	**698**	**176**	**0.61**	**1.64**	**-0.61**	**-1.65**	**0.51**
Strategy 2		0.05	0.46	1352	49	-0.05	0.50	1205	49	0.10	10.00	-0.11	-9.36	0.10
Strategy 3		0.24	0.41	1292	320	-0.25	0.43	1265	320	0.59	1.69	-0.59	-1.71	0.49
AUD/USD		0.20	0.47	1055	187	-0.22	0.55	1136	191	0.45	4.47	-0.42	-4.47	0.43
EUR/USD		0.17	0.41	1112	188	-0.19	0.45	1098	188	0.42	4.09	-0.44	-3.88	0.36
USD/CAD		0.16	0.39	1259	189	-0.15	0.36	934	167	0.44	4.76	-0.43	-4.36	0.32

Note. $\bar{r}_L$ is average daily return in percent, where L stand for Long and S is Short. Strategy (S) represents small and (L) is large value. The weekly returns were transformed in daily returns by the equation $(1 + r \text{ EXP } (1/5)) - 1$. The hourly returns were transformed in daily returnrs by the equation $(1 + r \text{ EXP } 24) - 1$. S_L is the daily standard deviation in percent. n_L is the number of weeks, or days, or hours that Long (Short) period occured. Where n_{TL} (n_{TS}) represents the amount of Long (Short) of singular trades that occured during the given time period (i.e., 3 Long trades x 2 buy and sell actions = 6 trade actions in total). $\bar{r}_L / S_L$ represents the Sharpe ratio without the the risk free rate adjustement. $S_L / \bar{r}_L$ is the standerd deviation per average return coefficent (S.R.C.). $\bar{r}_L + |\bar{r}_S|$ are the average returns in percent for a combined Long and Short trading strategy.

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