TRADING & QUANTITATVE RESEARCH REPORT

FOREX PATTERN TRADING

Finding and utilizing the occurrence of price spike reversals

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INTRODUCTION & DEFINITIONS

Exhibit 1: Outline of the paper.

Introduction

Ever since the beginning of financial markets, participants have been trying to utilize price movements to generate profit. The general idea of the markets and the goal of its participants is the same today as in ancient times, though the last decade the asset management industry has been characterized by an increasing use of quantitative strategies. This paper explores and explains how one can apply some of these quantitative strategies in trying to predict price movements by identifying reoccurring patterns in the intraday price changes of the foreign exchange market. On its own, a pattern presents a quite low informational value to the market operator and could even work as a distraction rather than a tool. To find a robust leading indicator of price movement it is therefore of great importance to be critical of the correlations that the market presents, and rigorously reevaluate the assumption of causality, i.e. the assumption that the price movements following a certain pattern are non-random and predictable based on historical data. The results presented in this paper show no clear evidence for a reoccurring non-randomness following the investigated patterns but does suggest a couple of further research opportunities which could potentially lead to such findings. This research is done in collaboration with Century Analytics, a Malmö-based hedge fund management firm, which provided the research subject and the definitions for the analyzed patterns.

Definitions

The investigated patterns in this paper are so called price spike reversals, which are defined in two steps as follows:

1) A price spike occurs when the absolute value of a 15-minute percentage change (from open to close) exceeds the average plus two standard deviations, where the average and standard deviation are based on the 15-minute percentage changes for a rolling period of two months.

2) Following an upward [downward] facing price spike, a price spike reversal occurs if the price returns to the lowest [highest] price that was registered during the preceding spike. The reversal should take place within 30 minutes after the price spike but it ends as soon as the price has fully reverted.

Note: To exclude any overlap between the price spikes and reversals, there must be at least 45 minutes between two consecutive spikes. Additionally, to exclude faulty patterns, all price spikes and reversals that form over a period where data is missing are removed.

The Market and Price Spike Reversals

The price movements of the market reflect the actions of the participants, and the participants act by the price movements. It is in this research assumed that the occurrence of the price spike reversals holds some informational value about the market. It is supposed and later used as a strategy that the price will continue to move in the direction of the reversal in a period after its completion. Price spikes and reversals are examples of the short-term anomalies in the market movements and by analyzing them one can potentially get a better understanding of the driving forces behind the foreign exchange market and exploit these.

Visualization

A visualization of two price spikes and one reversal is presented in Exhibit 2 below. For clarification, the price spikes are highlighted with a light red background and the reversals with a light blue background. When the black line, denoting the absolute 15 minutes percentage change, crosses the 2-months rolling average + 2 standard deviations, it means that the price change during the last 15 minutes is of sufficient magnitude and that a price spike has occurred. In this example it is a downward facing spike and the price should thus return to the highest registered level within 30 minutes for the reversal to be successful. In this case, it happens within 9 minutes after the price spike, which means that the full price spike reversal-pattern has occurred.

It is again important to note that there must be at least 45 minutes between each spike, which is why there is no new spike starting at every occasion where the 15-minute percentage change exceeds the predetermined level in the exhibit below.

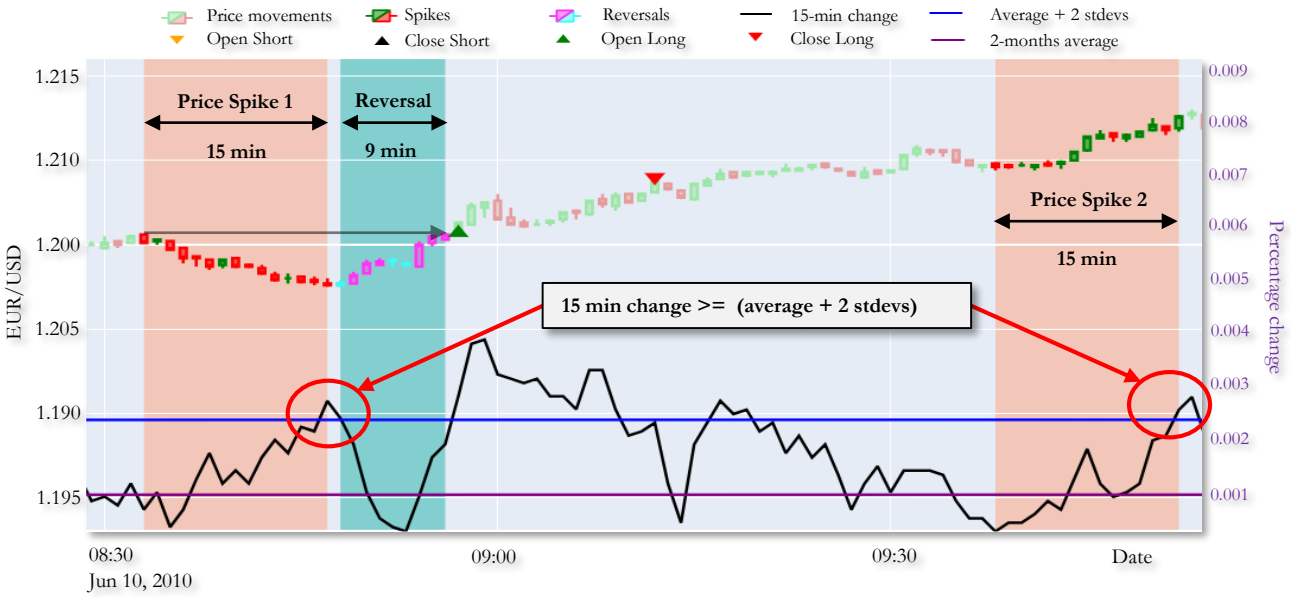

Exhibit 2: Visualization of price spike and price spike reversal definitions. The left y-axis indicates the current EUR/USD exchange rate plotted as candlesticks while the right y-axis shows the "15-min change", "Average + 2 stdevs" and "2-months average" used to find and define the price spikes.

DATA & METHOD

Data

The dataset used in this paper consists of OHLC-values for bid-prices of the EUR/USD exchange rate between 2008-01-01 and 2018-12-31, all in 1-minute resolution. Using only bid-prices is not optimal, but it is a necessity due to a low availability of a long time series of 1-minute resolution data. The long time series is needed in order to find enough patterns for any conclusions to be drawn with reasonable confidence.

The main problem using only bid-prices lies in the back-testing, since ignoring the spread between bid and ask gives the faulty opportunity of buying at cheaper cost than what was actually available at the time. Another risk lies in finding false or offset patterns since the bid-ask spread is likely to increase during periods of high volatility, which also is when the price spikes and reversals are most likely to occur. These risks are deemed acceptable since the research described in this paper does not solely depend on the results from trading and since the general trend in the price movements is assumed to be encapsulated, but the reader should keep this in mind while interpreting the results.

When using historical data there is always a risk of misrepresentation, i.e. the data does not fully show what actually happened. The data used is assumed to be adequate in this manner after the cross validation with other sources. Lastly, the dataset misses the observations at times during the weekends and trading pause periods, but in quantity this is considered justifiable. As described in Definitions section, all patterns ranging over a period that contains missing data are removed in the effort to minimize the issue in question.

Method

The model used in this research is built in Python, using libraries such as Pandas and NumPy for managing the data and Plotly and Seaborn for visualizations. Exhibit 4 below shows a flowchart describing the model and the most relevant steps. Firstly, the data is prepared as described in the previous sections, e.g. by the removal of missing data rows. Secondly, the three parameters used in the definition of the price spikes and reversals are calculated, i.e. the 15 minute percentage change and the 2 months rolling average and standard deviation for the percentage changes. After that, the remaining data (missing the 2 months needed for the calculation of the parameters above) is systematically checked for the price spikes and successful reversals. At the minute following the completion of a reversal a trade is initiated. The statistical results from these trades are the main method used in this paper in order to evaluate whether there indeed is a non-randomness in the market following a price spike reversal. The strategies used in the trading are discussed in the following section and the results are presented thereafter. Each trading position remains open in parallel to the continued search for new spikes and is closed either as it hits the predetermined target level, stop-loss level or until the trading week ends. Since the price movements during the weekend (when no market is open) is not likely to reflect the aftermath of the price spike reversal, all the trades are closed five minutes before the trading week ends and they are marked as suspended.

Exhibit 3: Description of the dataset.

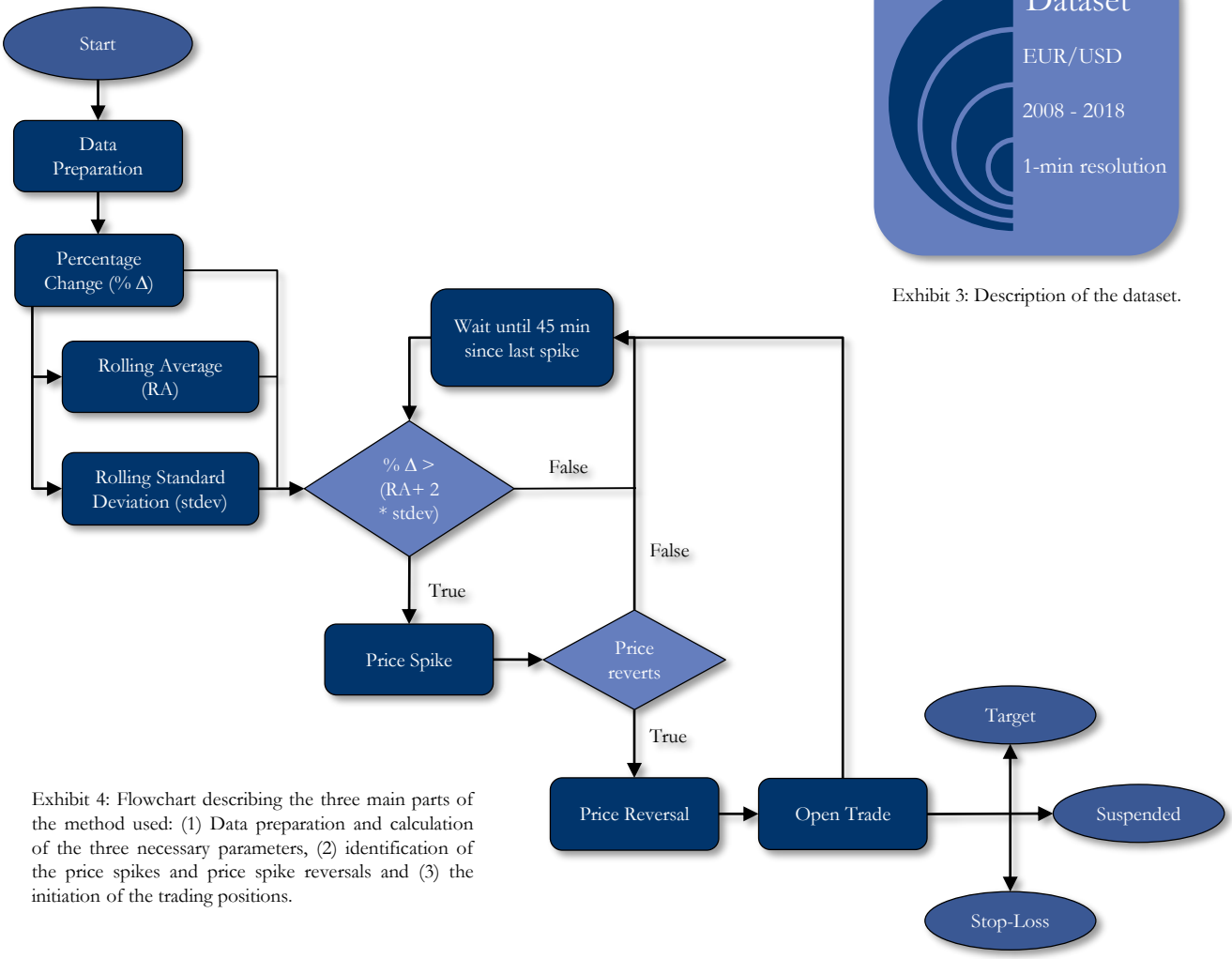

Exhibit 4: Flowchart describing the three main parts of the method used: (1) Data preparation and calculation of the three necessary parameters, (2) identification of the price spikes and price spike reversals and (3) the initiation of the trading positions.

Trading Strategies

To capture various aspects of the potential non-randomness following price spike reversals, four slightly different trading strategies are used. For all strategies, a trading position is initiated in the direction of the price spike reversal, at the opening price of the first minute following the reversal. This means that a short position is initiated following a downward facing reversal, and vice versa. The differences between these four strategies are the levels for the target and the stop-loss that are set when the trading position is open. The target is set in the direction of the trade while the stop-loss in the opposite direction and these levels are defined for each strategy as follows:

- **Strategy 1:** The target and stop-loss are set at an equal distance to the opening price. The distance for a long [short] position is calculated as the difference between the opening price and the lowest [highest] price registered during the price spike and price spike reversal, plus one pip.
- **Strategy 2:** The target and stop-loss are set at an equal distance to the opening price, but at half of the distance as described in strategy 1.
- **Strategy 3:** The target is set at a distance to the opening price that is twice the distance between the stop-loss and the opening price. The stop-loss is set at the same distance as described in strategy 1.
- **Strategy 4:** The target and stop-loss are set at an equal and fixed distance of 15 + 1 pip from the opening price.

Note that one pip is added to the distance for all strategies as a measure of securing that the price not only hits the target or the stop-loss but goes beyond it at an executable price level.

Exhibit 5 (below) shows an example of the trade using strategy 1, where the target and stop-loss levels are marked as a green and red line, respectively. In this example a short position is initiated since the price spike reversal is downward facing and the position is closed at its target level during the third minute since the opening of the trade.

Considering the 1-minute resolution of the used data, it is possible that a 1-minute bar includes both the target and stop-loss level. In this case there is no information available concerning, which level is hit first. To solve this issue entirely it would require tick-size the data, but due to a small number of occurrences of this problem our paper deems it sufficient to solve the problem by discarding specified trades.

As with the definition of the price spike and reversal patterns, four described strategies are defined by Century Analytics. The strategies are meant to complement each other, testing slightly different aspects of the potential non-randomness following the patterns. The first three strategies use the main characteristic of each price spike, i.e. its magnitude. Strategy 1 uses the magnitude of the price spike as it is, whereas the second strategy uses a narrower range. Comparing these two one can investigate whether any bias is observable in a wider or shorter range of the time and price. By further comparison to strategy 4, one can gain even deeper insights as to whether the price movements seem to depend on the spike magnitude. The third strategy aims to test if the price movement in the target direction can be utilized beyond the range set by the spike magnitude. By using this set of complementing strategies, it is not necessary for all individual strategies to show significant results – the real valuable conclusions are drawn from the comparison between the results.

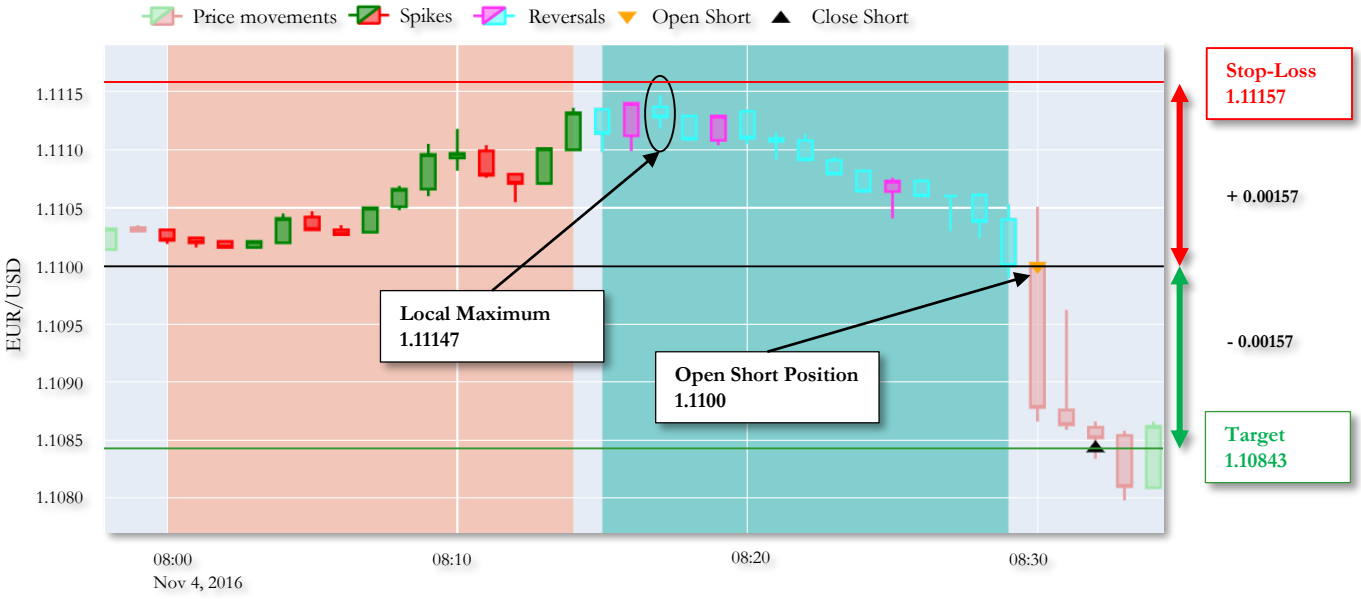

Exhibit 5: Visualization of the trading with the equally distant target and stop-loss levels for strategy 1. After the 15-minute lasting downward sloping price reversal, a short trading position is initiated and successfully closed within 3 minutes.

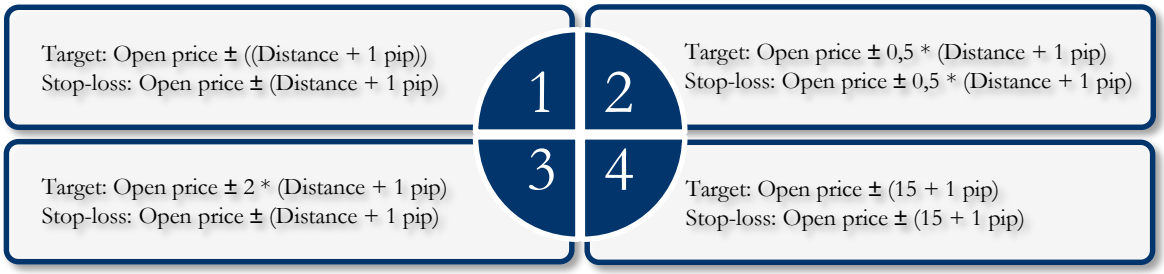

Exhibit 6: Overview of the strategies.

RESULTS

Days in dataset:	Spikes:	Reversals:	Long trades:	Short trades:
2 862	18 203	1 733	846	887

	Strategy 1	Strategy 2	Strategy 3	Strategy 4
Win rate:	48,10%	47,50%	30,60%	47,90%
Long win rate:	48,50%	48,00%	30,00%	47,70%
Short win rate:	47,80%	47,10%	31,10%	48,20%
Average return:	0,0009%	−0,0078%	0,0036%	−0,0038%
Long average return:	0,0032%	-0,0058%	0,0036%	-0,0047%
Short average return:	-0,0013%	-0,0098%	0,0036%	-0,0030%
Average time:	208 min	39 min	420 min	74 min

Exhibit 7: Summary of results for four defined strategies.

Results and Statistics

As shown in Exhibit 7 (above) the dataset contains 18 203 spikes, which is approximately 6,4 spikes per day. Of these, about 9,5% result in successful reversals, which sums up to a total of 1 733 reversals and thus 1 733 trades for each strategy. About half (48,8%) of the trades were long positions, and about half (51,2%) were short positions.

The win rates are roughly the same for strategy 1, 2 and 4, just below 50% and similar for both long and short positions. A lower win rate is, as expected, found for the third strategy, here just above 30%, since the distance to the target is twice the distance to the stop-loss.

Average return for all strategies is around zero percent, negative for strategy 2 and 4, and positive for strategy 1 and 3. It is important to note that these results are without any trading fees or leverage, since the aim is to explore the price movements rather than the potential profit.

The average position length in minutes differs substantially between the strategies, ranging from an average of 39 minutes for the second strategy to an average of 7 hours for the third. This is natural based on the definitions of these strategies, with shorter and longer distances to the target and stop-loss levels.

To examine whether there is any non-randomness in and following the price spike reversal patterns, a couple of parameters are investigated and plotted. Exhibit 8 (top right) shows the distribution of reversal times, i.e. within what amount of minutes a reversal is successful. The definition states that a reversal should take place within 30 minutes after the preceding price spike. Naturally, fewer reversals are successful during the first few minutes and the number of successful reversals is increasing with the increasing time window. On average the reversals take place after about 18,5 minutes.

When comparing the average return of the trades following a reversal of a certain length, no clear correlation can be found. This is shown in Exhibit 9 (bottom right) for strategy 1, but the same conclusion is drawn for the other strategies.

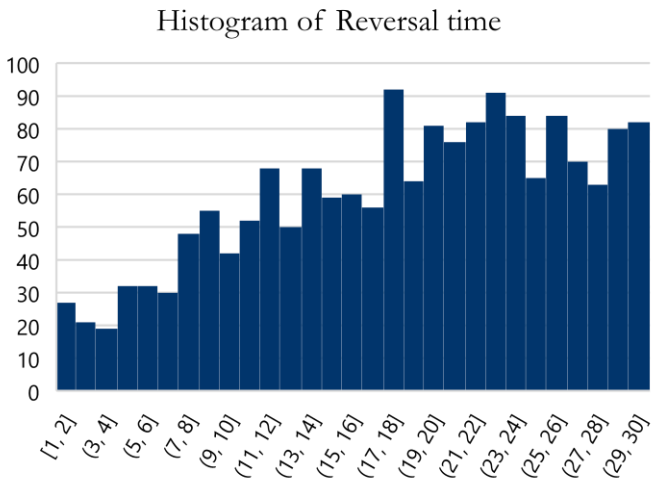

Exhibit 8: Distribution of reversal times.

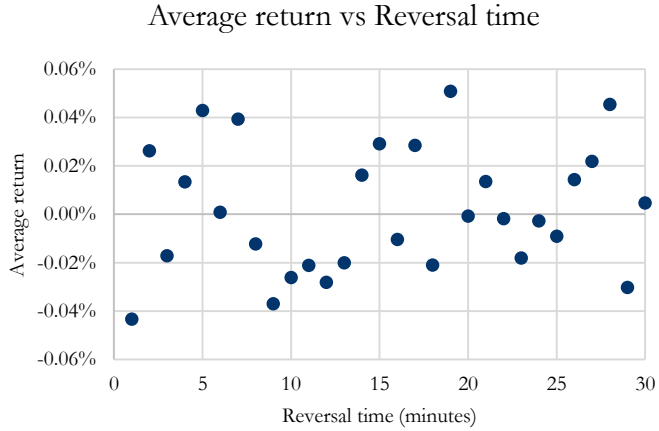

Exhibit 9: The average returns for each set of reversal times, visualization of strategy 1.

MORE RESULTS & CONCLUSIONS

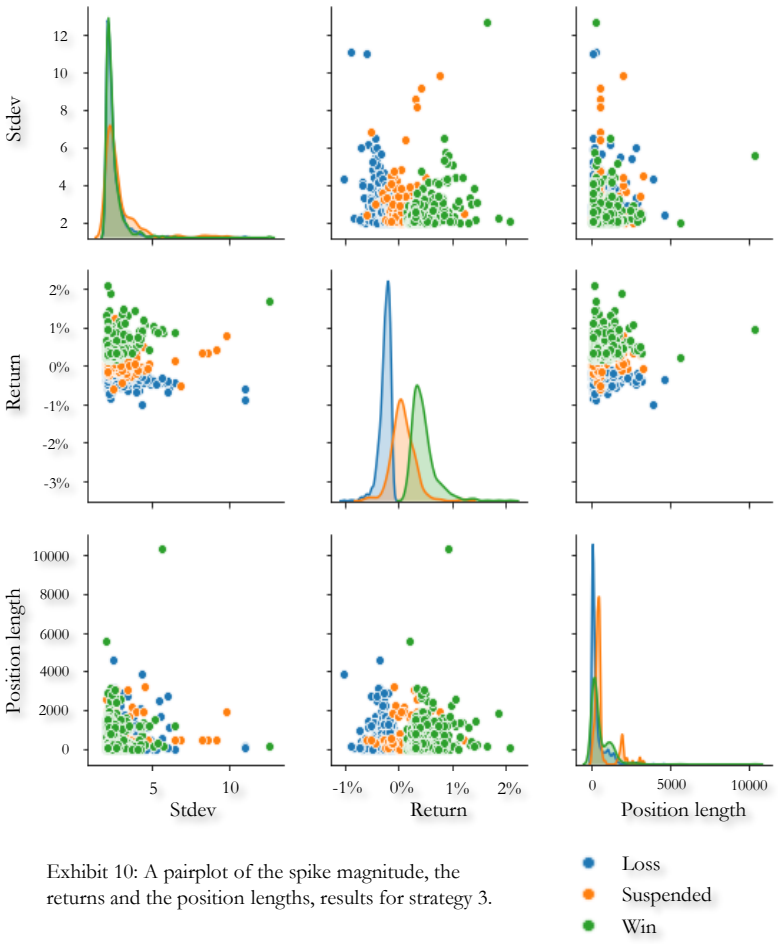

Exhibit 10: A pairplot of the spike magnitude, the returns and the position lengths, results for strategy 3.

More Results

To further examine parameters that could potentially explain the price movements, the returns of the trades are compared to the position lengths and to the magnitude of the spikes, measured as the amount of standard deviations by which the 15-minute percentage change exceeds the average. Exhibit 10 (left) shows the plots for each pair of parameters, as well as the distributions for each single parameter. The results shown are for strategy 3 (with the double the distance to the target level) and the trades are color-coded based on their outcome. The losing trades are blue, the winning trades are green, and the suspended trades are orange.

There is no clear correlation between any of the three pairs, i.e. the returns does not seem to change in accordance with the magnitude of the spike nor with the position length, and the position length does not seem to change in with the magnitude of the spike. Although the results shown in the exhibit are for strategy 3, the same conclusions hold for the other strategies as well.

Looking at the distributions of the returns shown in the middle plot of the exhibit, one can see that the returns of the suspended trades are rather normally distributed, but also that the right tail of the returns for the winning trades is fat. This is natural due to the definition of the third strategy and encapsulates what the strategy aims to test – whether it is possible to follow the price movement in the direction of the trade for a longer range.

The previously presented results indicate that trading according to the strategies presented, following price spike reversals, is not likely to produce any significantly positive returns. As a complementary analysis to the trading, the returns following reversals are examined in detail. Exhibit 11 (below) shows the probability density of obtaining a certain return after a certain number of minutes after the reversal, as well as the overall distributions of the returns in the first 100 minutes following a successful upwards facing reversal. The distribution (chart on the right side of the exhibit) indicates that the returns are overall normally distributed. However, looking at the probability density (main plot) it seems that slightly negative returns are the most probable and that this effect is increasing with time. This result goes against the way how the strategies in this paper are implemented and it could partly explain the mediocre returns and win rates.

Conclusions

With an occurrence of about 6 times a day in the EUR/USD exchange rate, price spikes seem to be a relatively common market phenomena, whereas the reversals are more uncommon (approximately 1,7 reversals a day). The conclusion from examining these patterns based on the past price data, price spike reversals seem to be quite random, although it is not possible to conclude that they are indeed random. A comparison between the results for the strategies 1, 2 and 4 show no distinct differences apart from the average position length. On the other hand, there seems to be a potential for higher returns by setting the target further away as in strategy 3. This could be taken even further by implementing a strategy with a trailing stop-loss and no target, where the stop-loss is set at the opening of the trade and if the price moves in the direction of the trade then the stop-loss level follows. By utilizing the trailing stop-loss rather than a fixed level, one could potentially capture the bigger price movements in a profitable way.

Several questions remain for further research, one being why price spikes and reversals occur and whether there exists any exogenous leading indicators. Another question is whether the definitions and strategies used in this paper could be optimized to better encapsulate a yet hidden non-randomness in the markets. One could also try including additional parameters that could potentially screen out the good trading opportunities from the bad ones.

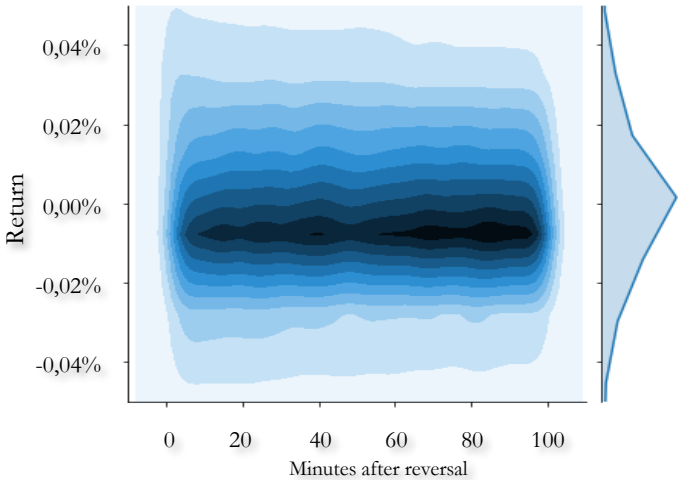

Exhibit 11: The probability density and distribution of obtaining certain 1-minute returns a certain number of minutes after an upward facing reversal.

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