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**A Profitability Analysis on Longer Term Trend-and-Breakout Oriented Trading of Five FOREX Currency Pairs**

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# Abstract

The FOREX market is by some margin the largest financial market in the world, the daily trading volume is north of $6 trillion, with a total world estimated as $2.4 quadrillion.[[1]](#footnote-1) This figure alone dwarfs any stock exchange in existence. In addition to being highly liquid, and somewhat volatile as well as the total market being 17 times larger than global GDP, it is a choice investment for retail traders or individuals, who take a small slice of the market.[[2]](#footnote-2) However, retail traders typically trade the FOREX market in high frequency turnarounds, also called day trading. This is a highly leveraged (and thus highly risky) trading strategy that has both made and lost millions for the retail trader. The largest players in the FOREX market, however, are central banks and large investment firms. While the latter certainly has a desk dedicating to short term/day trading of the FOREX market, there is a great deal of long-term speculation in currency pairs. The most common visualization in this realm is the standard chart, either line or candlestick. Alongside the standard chart, there are many “decorations” like support and resistance lines, various moving averages, etc. These techniques are critical for any technical analysis-oriented approach to predicting the next move of the FOREX market and have large implications on the asset sheets of the aforementioned large players.

# Introduction

The primary motivation of this project is to construct a profitable trading model on a daily plus frequency that is a) profitable in the long run, with a certain degree of reliability; and b) easily usable. For those considerations, we shall attempt to construct a model primarily based on visualization. A model successful in both aspects would have a great deal of carry over into trading and risk management models of central banks and large investment firms. Based on set of visual characteristics that could be quantified we may then construct an execution algorithm. “EAs are automated trading programs designed to buy or sell a predefined amount of securities or FX according to a set of parameters and user instructions. In contrast to other common types of algorithms such as market-making or opportunistic algorithms, the sole purpose of EAs is to execute a trade as optimally as possible.”[[3]](#footnote-3) A multitude of execution algorithm models are already being employed by such large players in the FOREX market. While not the dominant trading strategy, they account for 10-20% of FOREX spot trading or $2-400 Billion daily.[[4]](#footnote-4) While we don’t expect to make some monumental breakthrough that will become widely adopted by large scale FOREX players, at a minimum, it is an exploratory start into visualization-based trading models.

In terms of the available visualizations in this space, we cannot make the case that there is a great deal of variety. There is one predominant visualization type that best fits the type of data than must be inputted into any such model, the time series or line graph. Within this constraint, there are a great deal of variations on this format, the most used is the candlestick chart, which shows for each date in the series, an Open, a Close, a High, and a Low; this chart type is preferred in day-trading oriented models, so we will focus on the traditional line graph as it better captures longer term trends. Each can be overlayed with indicators that are of great use to traders, such as support and resistance lines (often calculated with a Fibonacci retracement), moving average (exponentialy weighted, in particular), volatility indicators, and news events marked at a particular timestamp. Two examples of common visualizations in this field are shown on the below, a simple one constructed in python showing the line chart and EMAs, and one with all the bells and whistles from dailyfx.com

A picture containing text, kite, flying, colorful

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Figure 1 6 Month Chart of EURUSD designed with Matplotlib

Chart, line chart

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Figure 2 EURUSD Chart showing crosses of different moving averages, historical volatility, and resistance lines.

The only real critique of the latter is perhaps the higher computational cost in addition to the fact that it is not as easily exportable and extensible as the python version. For all intents and purposes all of the readily accessible elements of the latter chart such as the EMA’s (exponentially weighted moving averages), their crossover points, and support and resistance levels can be easily replicated in python and thus can be stored as objects, thereby creating a pathway for the translation of visual elements to quantifiable and parametrized data points for a trading model.[[5]](#footnote-5) There are a great many different visual tools that can be employed in such decision-making processes, but these apply mostly to the higher frequency trading segment. Let us, then, operationalize our intent as creating a self-contained visualization-based model that focuses on easy implementation of charting indicators and techniques in python, that can be used to generate profitable entry and exit points in FOREX trades over a medium to long term.

Of course, this entire visualization-based approach to trading of assets, extendable to equities, commodities, futures, and of course currency pairs, is part of a large subset of the collective methods of the technical analysis approach. “Technical analysis is the use of past price behavior and/or other market data, such as volume, to guide trading decisions in asset markets. These decisions are often generated by applying simple rules to historical price data. A technical trading rule (TTR), for example, might suggest buying a currency if its price has risen more than 1% from its value five days earlier. Traders in stock, commodity and foreign exchange markets use such rules widely. “[[6]](#footnote-6) This approach had its beginnings in equity trading, however it has seen widespread adoption in the FOREX trading world. It’s adoption is in large part attributable to a generally shared understanding of trend formation and reversal in currency pricing, best described by Gand: “*Currencies have the tendency to develop strong trends, stronger than stocks in my opinion because currencies reflect the performance of countries.*”.[[7]](#footnote-7) Technical analysis is in large part characterized by rule based trading and charting, on which our project will focus on. Rule based trading is reliant on indicators — a particular rule of interest being Moving Average crossover: “A MA rule compares a short and a long moving average of past prices and generates a buy (sell) signal if the short moving average intersects the long moving average from below (above). For example, one widely used rule, which we write as MA(5, 20), compares a 5-day and a 20-day moving average. ”[[8]](#footnote-8) This rule, and variations on its parameters governed out initial approach which was later broadened in line with alternative trend detection methods.

For the purposes of this project, we decided to focus on 5 of the most commonly traded currency pairs, respective to the US Dollar: the Euro; the Japanese Yen; the British Pound; the Australian Dollar; and the Swiss Franc. These are powerful, stable currencies, the price movements of which are dictated by central banks, large private players acting as whales or market makers, and geopolitical events. Over the time period of our data, nearly 20 years, all currencies show a stable volatility that is ideal for exploitation by a short to medium term trading strategy. Profit in FOREX trades is measured in pips, which is the 4th decimal place of the quoted currency price; an exception is the Yen, in which the pip is the 2nd decimal place. Our initial approach was to find a profit in terms of pips, as leverage and lot sizing plays a significant role in FOREX trading. A standard lot signifies 100,000 units of currency, so the movement of 1 pip in price signifies a change of $10 in the investment. There are smaller lots that can be traded, or multiples of a standard lot. As we went further in our exploration, we decided for simplification purposes to focus on finding ROI for a 1-1 ratio on say $100,000.

The end goal was then to find a visualization-based model that will signal entry and exit points for trades on currency pairs. Our initial approach focused primarily on using intersections of EMA’s as entry and exit points. This was later broadened to create a model that seeks trends and uses trend reversal in conjunction with an EMA to identify entry and exit points for trading.

# Process

Our process started with a visual exploration of the data to better understand its distribution and what if any methods of analysis we could rule out. We thus began with time series charts and boxplots of the five currencies in question. The visualizations below (Figures 3 and 4) indicate a not insignificant volatility over time in all the currencies with a centralized distribution of values according to the boxplot. This indicated that while the price could move considerably from day to day in terms of pips, the price stayed within a well-defined range of a global maximum and minimum, rarely testing and breaking through.

With that in mind we set about finding entry and exit point in the currencies. Our initial course was to look at intersection the EMA’s of different time intervals as entry and exit points. Our research indicated a 5-, 13-, and 30-day EMA’s were the most commonly used for technical analysis of currency pairs, so we explored 3 intersections, that of the actual rate with the 5 day exponentially weighted moving average, that of the 5-day and the 13-day, and the 13-day and the 30-day. Creating a table for each we then set about creating two further columns which would drive our trading model, a signal, and a position column (see Figure 5).

Graphical user interface, application, Word

Description automatically generated

Figure 3 Preliminary Exploration of Trend in Our Currency Pairs

Chart, box and whisker chart

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Figure 4 Preliminary Exploration of Distribution of Pricing in Our Currency Pairs

We operationalized the Signal column as a Boolean indication of whether the shorter span (e.g. 5-day) EMA was higher than the longer span (e.g. 13-day) EMA. The Position column then was the row-wise difference of the Signal column, a Position value of 1 captured a switching from 0 to 1 indicating a buy, and a Position value of -1 captured a switching from 1 to 0 indicating a sell.

Table 1 Functionalized Trade Table of Initial Model

Table

Description automatically generated

On the initial promise of the above tables, we were able to fairly easily generate visualizations indicating buy and sell points. The results of the visualizations were less impressive (see Figure 6). As we can see from the below visualization, our prediction was often “wrong”. That is not to say that the trades themselves were bad entries, but more so characterized by a lack of an exit strategy. Simply put the initial model we had designed fell short of our primary objective, of finding entry and exit points. Our model simply showed where to buy and sell. Regrettably the FOREX market, and for that matter the equity market, isn’t that simple. A trade can be entered both by buying or by selling short, and closed by selling a long position or buying to cover a short. Viewed through an initial lens of strictly buying and selling long, the model and its derivative visualizations lacked promise. When considering the real-world implementation, the entry points provided posed some promise that merited further exploration. We were able to create functions that let us easily produce trade tables like the one in Figure 5 and the visualization in Figure 6 that let us get a fair deal of “data” that let us visualize the shortcomings of our model. Through repetition of these functions over different intersection filters, timeframes, and currency pairs we were able to make a few determinations. The model was consistent for all currency pairs, which meant that improving it by better defining entry vs exit points would translate to profit across the board. By another token, these EMA’s that we had selected might be arbitrary and not necessarily the most optimal choice for one currency over another, so it might be worthwhile to explore optimization of EMA span on a currency-by-currency basis. With these consideration in mind, our objective shifted to a model that could identify a trend, and points of trend reversal as the signal for an entry or exit.

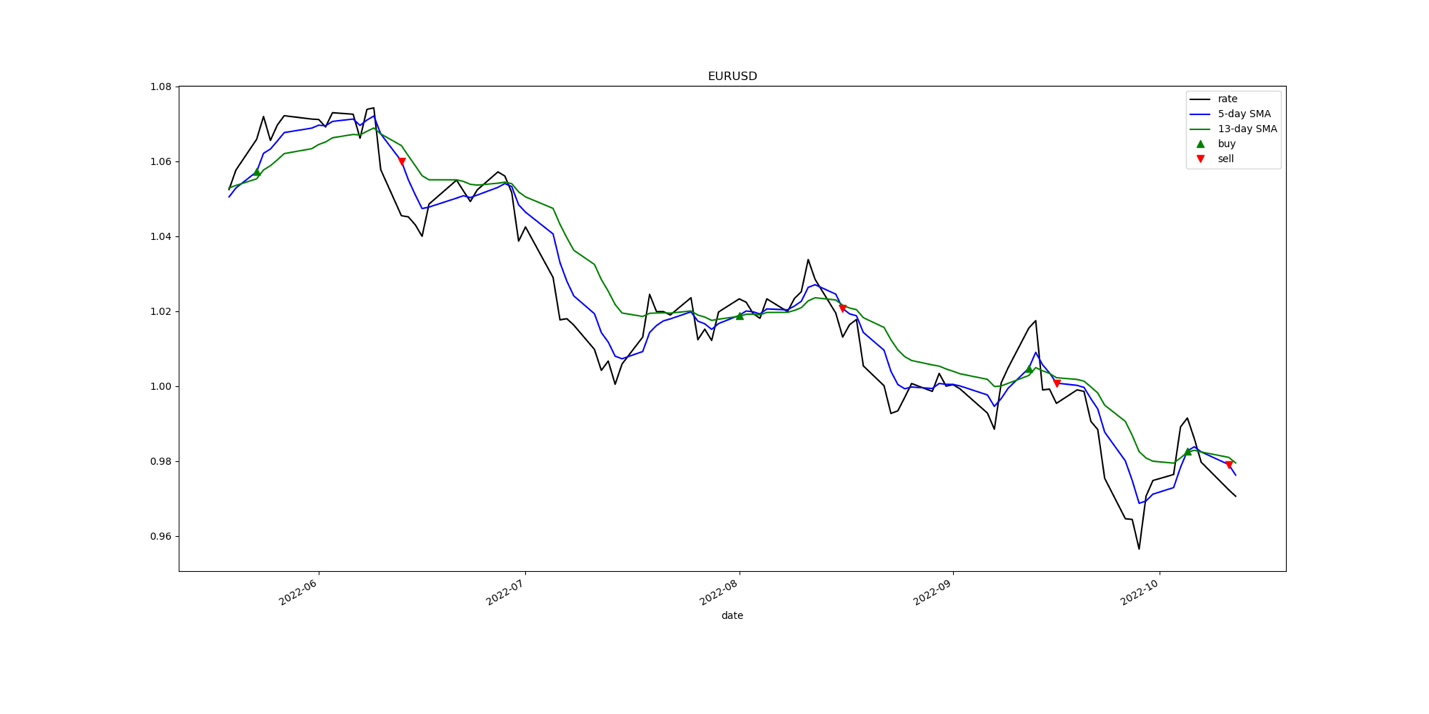


Figure 6 Chart Indicating Our Initial Model’s Entry and Exit Points.

Shape

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Figure 7 Decision process flow chart for logic implemented in ‘ForexTradeFinder’

While the rate fluctuations in currency trading can appear quite random, there are time periods of days or weeks when the rate seems to be generally increasing, or when it seems to be generally decreasing, despite the sawtooth ups and downs from day to day. Whether these are random occurrences or due to complex interactions of incompletely understood events, such trends offer the opportunity for profitable trades. As an alternative method to focusing on crossing points of exponentially weighted means to signal market entry and exit points, we developed an algorithm to take advantage of these trends that makes trade entry decisions based on the appearance of a very short term trend, implementing the adage “buy low, sell high”, and trade exit decisions based on the departure (or ending) of what we believed to be an Up or Down rate trend. We coded this algorithm as the Python function ‘ForexTradeFinder’.

To visualize the high level decision making process flow in ForexTradeFinder, we prepared a process flow chart – an effective data visualization method to explain the logic in a dynamic decision making processes (Figure A). The data input to this function is a time series – an ordered column of dates (starting from the past and moving toward the present), with the corresponding currency exchange rate in number of US dollars equivalent to one unit of foreign currency. The algorithm moves sequentially through the dates (rows), and uses If / Elif / Else statements to answer a series of questions and make a trade action decision for that day. In Figure 7, the questions that need to be answered are shown in the diamond shaped boxes, and are the following:

1. *“For prior row does trend\_on\_off == off?”*

The question being asked here, is whether at a given date, we already have made a BUY or a SELL trade action, considering ourselves to be in an UP or a DOWN trend. If a trend is ON, the answer to this question is ‘No’. If we have NOT committed the money to a trade action yet, then the trend is ‘off’ and the answer to this question is ‘Yes.’ A ‘Yes’ answer leads to the next questions, of whether we think a trade entry should be initiated today.

1. *“Does it appear that an UP trend should be started?”*

Different logic could be applied to answer this question, but the logic that we apply in ForexTradeFinder is the following. If the rate on the date being analyzed is higher than that of the previous date, and if we would be “buying low” with what we expect room for the rate to increase compared to a historical trend, then an UP trend has started and we enter a trade with a Buy. The function allows a variation of this, based on the value of the parameter ‘MinForTrend’, so that rather than just looking at 2 sequential dates to start a trade, 3 sequential dates are considered. But what comparison can we make to assess whether it would be “buying low”? While different approaches are possible, the approach used in ForexTradeFinder is to ask whether the rate at the date in question is lower than some exponentially weighted mean (calculated using some user defined span). If the rate is lower than the exponential weighted mean, that suggests it is low versus some historical measure, with room to increase, supporting trade entry with a buy.

1. *“Does it appear that a DOWN trend should be started?”*

A mirror image of the question above, this asks whether If the rate on the date being analyzed is lower than that of the previous date, and if we would be “selling high” with what we expect room for the rate to decrease compared to a historical trend. If this is the case then a DOWN trend has started and we enter a trade with a Sell.

4) *“Is an UP trend On? (Entered with Buy)”*

This question checks if we have already committed with a Buy, thinking that an UP trend is in progress.

5) *“Should UP trend continue?”*

If we are in an UP trend, should we continue? If we continue, we do not exit with a Sell, and we simply proceed to evaluate the next date. The logic that determines if we should continue is that if the current rate remains above a local support line defined by the trend highest minimums, we are still in an UP trend. If the current rate goes below the trend highest minimum, then the UP trend is considered broken or ended, and we exit with a Sell. The local support line defined by the trend highest minimum is adjusted higher as the rate moves higher, thus limiting the possible loss of gains when the rate starts to move lower.

6) *“Should DOWN trend continue?”*

If we are in an DOWN trend, should we continue? If we continue, we do not exit with a Buy, and we simply proceed to evaluate the next date. The logic that determines if we should continue is that if the current rate remains below a local support line defined by the trend lowest maximums, we are still in a DOWN trend. If the current rate goes above the trend lowest maximum, then the DOWN trend is considered broken or ended, and we exit with a Buy. The local support line defined by the trend lowest maximum is adjusted lower as the rate moves lower, thus limiting the possible loss of gains when the rate starts to move higher.

A span must be chosen to calculate the exponential weighted mean that serves as a gatekeeper on initiating trades and applies the logic of “buy low, sell high”. What span is the best, and is it different for different currencies? To study this question, we applied ForexTrendFinder with different choices of span, in the range of 4 – 21 days, to each of the five currencies being examined. We found that there appears to be a different optimal span for each of the five different currencies (Figure 8). Therefore, exponential weighted mean span becomes a tunable parameter for this algorithm.

A full call to ForexTradeFinder is made as in the following example:

**ForexTradeFinder(a\_dataframe = forex\_rates[[‘date’, ‘euro\_to\_usd]],**

**CurrencyName = ‘Euro’,**

**StartPlotDate = pd.to\_datetime(‘2004-01-01’),**

**EndPlotDate = pd.to\_datetime(‘2004-04-30’),**

**MinForTrend = 2,**

**EWM\_span = 7)**

Chart, line chart

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Figure 8 Screening optimization of the parameter EWM\_span for five currencies over a timeframe

# Results

The ForexTradeFinder function was called on the data for each of the five currencies of interest. The function identified Entry and Exit dates for Buy and Sell trade actions. It calculated an overall cumulative gain or loss from trading using the algorithm described over a period of about 19 years (Jan 2004 – Nov 2022). I produced histograms and a scatter plot for this 19 year timeframe, characterizing the profitability and duration of individual trade actions, and also produced a time series chart for a specified short time period, illustrating the calculations of the function. For the time series chart, the timeframe of four months resulted in a nice, readable plot. The function could be modified if desired to output many time series plots to cover the entire timeframe, but we felt that this was not needed.

Table 2 summarizes the computed number of trade actions (over the 19 years) for each of the five currency types, and the overall factor change (gain or loss). Using Euro as an example, the overall factor gain was approximately 1.73. This means that for 100,000 USD dedicated to Euro trading starting in Jan 2004, following this algorithm one would have 173,000 USD at the end of 2022. This is NOT a particularly good annual rate of return, and requires significant work for many trades. The apparent degree of randomness, the high level of risk, and the modest level of average return from trading in these currencies was a bit of a surprise learning to us from our work on this project.

Table 2 Number of trades and cumulative gain or loss for each of the five currencies paired with USD.

|  |  |  |
| --- | --- | --- |
| Currency | Number of Trades | Cumulative Factor Gain (or Loss) |
| Euro | 594 | 1.73 |
| Yen | 559 | 1.58 |
| Pound | 600 | 1.75 |
| Australian Dollar | 546 | 1.54 |
| Swiss Franc | 598 | 1.78 |

The following 15 figures (Figures 9-ABC through 13-ABC) are the example timeseries plot (with local support lines, longer-term exponential weighted mean support line, trade entry and trade exit dates), the distributions of individual trade profitability and trade duration as histograms, and a scatterplot of individual trade profitability by trade duration, for each of the five currencies examined.

*Figure 9-ABC. EuroGraphical user interface, chart

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*Chart, histogram

Description automatically generatedChart, scatter chart

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*Figure 10-ABC. Yen*

*Chart

Description automatically generated*

*Chart, histogram

Description automatically generated*

*Chart, scatter chart

Description automatically generated*

*Figure 11-ABC. Pound*

*Graphical user interface, chart

Description automatically generated*

*Chart, histogram

Description automatically generated*

*Chart, scatter chart

Description automatically generated*

*Figure 12-ABC. Australian Dollar*

*Graphical user interface, chart

Description automatically generated*

*Chart, histogram

Description automatically generated*

*Chart, scatter chart

Description automatically generated*

*Figure 13-ABC. Swiss Franc*

*Graphical user interface, chart

Description automatically generated*

*Chart, histogram

Description automatically generated*

*Chart, scatter chart

Description automatically generated*

# Conclusions

The approach embodied in the ForexTradeFinder function, of identifying suspected UP or DOWN trends and initiating a Buy or Sell based on data from a small number of recent days and a “buy low, sell high” criterion of some sort, and identifying exit dates by detecting departure from UP or DOWN trends, seems to have some value. As implemented for this project, there remains much opportunity for further experimentation and optimization. In particular, a way to further minimize the number of ‘false starts’ on trades, where we anticipate a trend that does not persist or reverses quickly, would be helpful. In this project, despite overall modest gains that could be achieved, a consistent approximately two-thirds of trades initiated led to a net loss. A way to reduce the number of wrong trades, refraining from entering a trade until there is stronger evidence for a successful outcome, without missing the profit opportunities, is a desirable goal but may or may not be possible.

With these potentially promising results as well as the limitations of the work in mind, it would be a fair assessment that the project creates, at a minimum a strong foundation for a trading model as described in our introductory objectives. Despite the fact two-thirds of our trades generated a loss, we still showed a net total cumulative gain. We can make the model more profitable either by finding a way to minimize loss either in magnitude or frequency, or by increasing profitability. The former should certainly be an area of higher focus, as the model is able to identify a reversal of an erroneous new “trend” and exit. Minimizing the number of erroneous trends identified and/or time to correct and exit would create a strong, highly efficient final model.

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4. “FX Execution Algorithms and Market Functioning - Bank for International ...,” accessed October 14, 2022, https://www.bis.org/publ/mktc13.pdf. [↑](#footnote-ref-4)
5. As per “Technical Analysis Indicators: Pathway towards Rewarding Journey” by B. Garg, EMA crossover points of convergence and divergence are one of the most reliable indicators in a profitable trading model. This indicator is perhaps the most widely used technical indicator in FOREX trading.

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