

1. Summary

I've chosen to implement a trading strategy that is a twist on the common "Breakout Fading" strategy. Breakouts (referred to as "Gap" in my code and in this document) both up and down (referred to as GapUp and GapDown) movements tend to "fade" or "reverse" when traders (or their algos) need to close out their positions to realize profit or because a stop-loss limit is hit. Commonly, algos and traders have stop orders around the support and resistance levels and, if a breakout breaches these levels, it is where one can expect a "fade" to occur for the breakout. This is, however, not always the case and not a great way to predict when a "fade" will occur or its magnitude.

I've used a simplified scientific formulation to identify a fade and estimate its magnitude. The idea is based on the path a ball takes when it bounces on a surface that absorbs some of its kinetic energy. If a ball is dropped from a height h_0 (with 0 initial velocity) and it takes time t_0 to reach the ground, then (given the coefficient of restitution is ϵ) the ball will bounce back to a height of h_1 ($h_0 \times \epsilon^2$) in time t_1 ($t_0 \times \epsilon$). If I assume h_0 to be the Gap magnitude and t_0 the time taken for the Gap, then the fade will have a magnitude of h_1 and occur within time t_1 . The current implementation using the Bouncing Ball formula is a simplification and the better scientific formulation would be to use the [Damped Oscillation formula](#) (e.g. how shock absorbers work in a car). Here we equate the trend as the falling ball and the floor (or damper) as a combination of the effects of the support/resistance levels and the stop orders from various algorithms. In reality, there could be more than 1 dampers with non-constant damping coefficient, hence the current implementation is a simplification and the results are not optimal.

2. Implementation Logic

The first step is to identify a Fade. The code follows a trend (GapUp or GapDown) till it reverses (here we have h_0 and t_0). Once it reverses and if the reversal/fade is greater than a level (e.g. 15% of h_1), it assumes that a Fade is in progress and books a NEW trade. If the reversal/fade doesn't touch this level, it goes back to monitoring for a new Gap trend.

Using the above theory, the trigger levels of the "Fade" trade can be defined with "Take Profit" level set as h_1 ($h_0 \times \epsilon^2$), "Time to live" (referred to as `killTime` in the code) for the trade as t_1 ($t_0 \times \epsilon$) and "Stop Loss" set as the level where the Fade started (i.e. traded price of NEW trade $- 0.15 \times h_0 \times \epsilon^2$).

Once a NEW trade has been booked, the code stops monitoring for a Gap till a trigger level (either TakeProfit, StopLoss or KillTime) is hit. Once a trigger is hit, a close-out trade is booked and the realized profit or loss for the pair of trades is calculated. The details of the NEW trade and the subsequent close-out trade are captured in the log files (details in README.txt).

3. Implementation Details

In `datamodel.h`, the building blocks (implemented as struct) for tick data, currency pair (with calibrated parameters) and trade (with trigger levels and `parent_id` for the close-out trade to map with the origination trade) are defined.

In `backtest.h/backtest.cpp`, there are 2 classes implemented:

- a. Rewind: It loads up the back-testing data (format of file name and data is provided in `README.txt`), creates tick structs and adds them into a queue.
- b. Replay: Takes the queue of ticks as input, runs the strategies (`gapDownFadeUp` and `gapUpFadeDown`) against the back-testing data and outputs the results (`tradeLog` and P&L files; details in `README.txt`).

In `calc.h/calc.cpp`, 1 class is implemented to handle the P&L calculation and 1 function to handle the output of the P&L results.

In `strategy.h/strategy.cpp`, 2 classes are implemented to handle the 2 strategies.

- a. The overall logic of the strategy is explained in the above section. The 2 strategies (`gapDownFadeUp` and `gapUpFadeDown`) are currently mirror images of each other and could be implemented as 1 class but they've been implemented separately in case we need to use different calibration parameters for each strategy.
- b. When monitoring for a Gap, instead of comparing each tick (which tends to be volatile hence under-estimates the Gap magnitude and gives a false indication of a Gap reversing), the code uses a smoothing (i.e. uses an average of the last 4 ticks) to monitor a Gap and its reversal. The code also adds a tolerance level (e.g. 0.4 pips) before it assumes a reversal has occurred.
- c. Once a fade/reversal has occurred, the code starts monitoring the fade trend and, if (a) the fade level is hit, (b) the Gap magnitude is greater than a level (so as not to chase small Gaps/Fades) and (c) the fade hasn't already crossed 90% of h_1 (since most of the Fade won't be captured), then we book a NEW trade.
- d. Once a NEW trade is in progress, there is no more monitoring for a Gap till a close-out trigger is hit. The code adjusts the trigger levels based on the tick moves before the trigger level is hit:
 - i. If the price moves in the opposite direction of the fade, the code increases the StopLoss level and reduces the KillTime. Both actions are to reduce the loss on the trade in case the trend continues in the opposite direction
 - ii. If the price moves in the same direction of the fade, the code increases the TakeProfit level and increases the KillTime. Both actions are to increase the profit on the trade in case the trend continues in the same direction
- e. Once a trigger level (TakeProfit, StopLoss or KillTime) is hit, a close-out trade is booked and the variables monitoring the Gap and Fade are reset to 0. When a StopLoss is triggered, the code only resets the Fade variables and continues to monitor the same Gap (i.e. assuming that the Fade was a false positive and that the Gap trend will continue beyond this point).
- f. All trades are booked with a notional of 1,000,000 USD.

4. Back-Testing & Calibration details

Most of my back-testing and calibration of parameters was focussed on USD/JPY. I've used the calibration parameters got from USD/JPY testing to also back-test and generate results for EUR/USD. The same can be extended to other currency pairs. All back-testing has been done on data from the period between Jan to May 2024 and the results have been provided with a currency pair, monthly and strategy breakdown.

The variables that need to be calibrated (per Currency pair) are as below. These calibrated parameters are part of the Currency Pair definition:

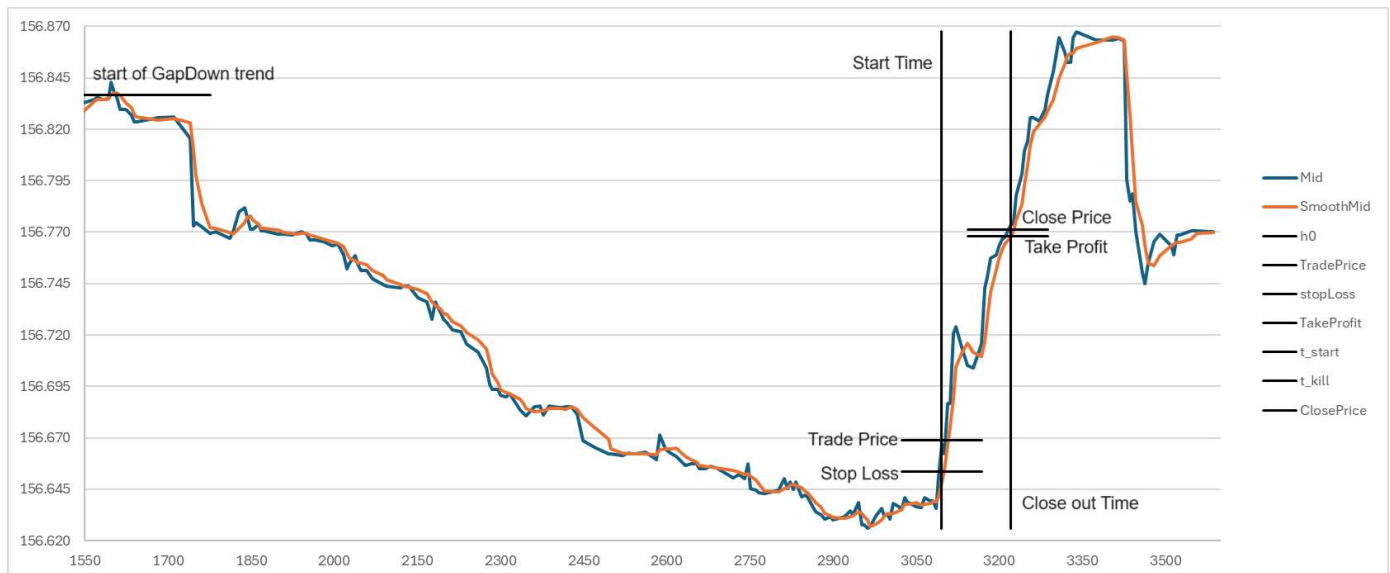
- Coefficient of restitution (ϵ): best results for USD/JPY were got for ϵ between 0.65 and 0.75. Final results are generated using ϵ as 0.70
- Level at which we assume that a Fade is in progress: this is a ratio of h_1 (e.g. 15% of $h_0 \times \epsilon^2$) and the ratio is referred to as jumpCheck in the code. jumpCheck equal to $(1 - \sqrt{\epsilon})$ yielded the best results (i.e. jumpCheck = 0.1633 for $\epsilon = 0.70$).
- Tolerance level (referred to as tolerance in the code): for USD/JPY, a tolerance of 0.4pips yielded best results
- Gap magnitude (referred to as minGap in the code): the best results were got for 10pips for USD/JPY and 8pips for EUR/USD

5. Examples

Below we take a look at 3 examples for the GapDownFadeUp strategy (1 example each for a TakeProfit, Kill and StopLoss close-out event) for USD/JPY to illustrate the behaviour. Details of these examples and 3 similar examples for the GapUpFadeDown strategy can be found in the “documentation” folder.

Example1: Take Profit trigger

Code identifies a GapDown trend (18.3pips in this case) and a FadeUp above required level (17.3% in this case). Since the price trend is in the same direction as the Fade, the TakeProfit level is increased along the way. In this case, the TakeProfit trigger is reached before other triggers and the trade is closed out. The P&L for the pair of trades is USD +650.63.



Example2: Kill (i.e. Time to Live) trigger

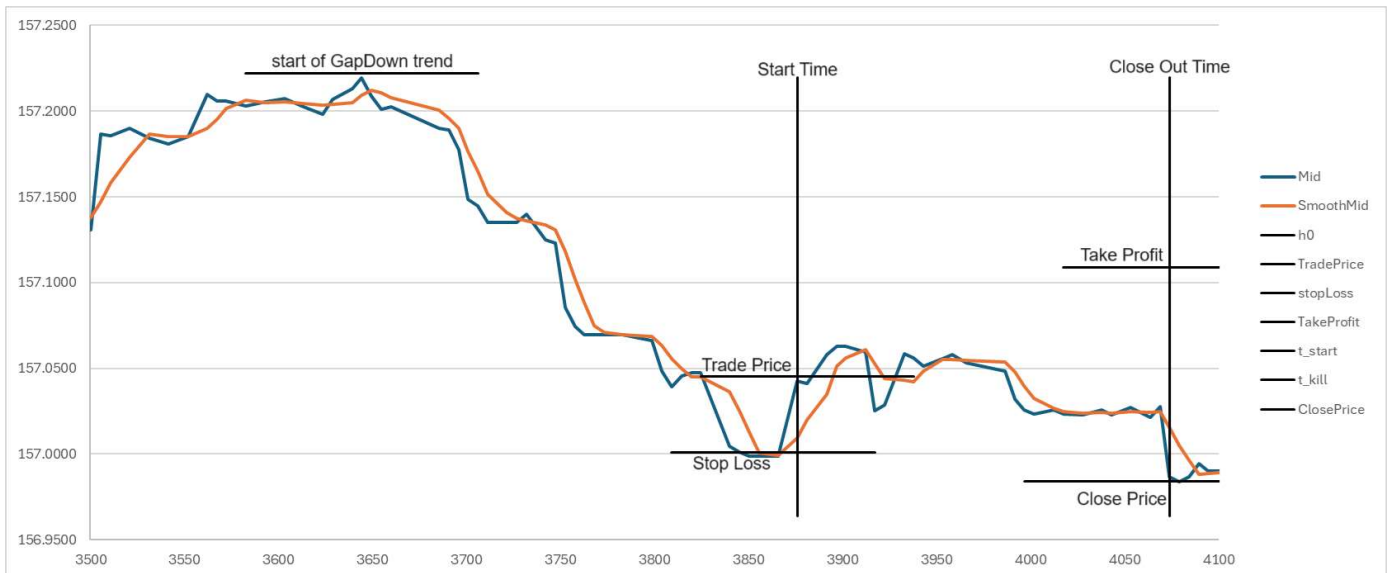
Code identifies a GapDown trend (27.5pips in this case) and a FadeUp above required level (20.6% in this case). Since the price trend is in the same direction as the Fade, the

killTime is increased along the way. In this case, the killTime trigger (i.e. “Time to Live” expires) is reached before the “Take Profit” level is hit and the trade is closed out. Most trades closed-out via the KILL trigger have a profit (see the “breakdown” tables in the next section). The P&L for the pair of trades is USD +387.95.



Example3: Stop Loss trigger

Code identifies a GapDown trend (22.1pips in this case) and a FadeUp above required level (40.6% in this case). Since the price trend is in the opposite direction as the Fade, the killTime is decreased along the way. However, due to a spike the “Close Price” goes below the “Stop Loss” trigger and the trade is closed out. The P&L for the pair of trades is USD -382.20.



6. Results

The P&L results per month (Jan, Feb, Mar, Apr and May), per currency pair (USD/JPY and EUR/USD) and per data type (1sec interval data or tick data) are available in the “results”

folder and Excel files containing the results summary per currency pair is also available in the same folder (P&L results_USDJPY.xlsx and P&L results_EURUSD.xlsx).

Below is a summary of the P&L results from the back-testing of tick data (NOTE: all trades are booked with a 1,000,000 USD notional)

USD/JPY summary:

P&L Summary	GapDown	GapUp	Total
May	4,920	6,903	11,823
Apr	11,878	15,869	27,748
Mar	(2,292)	(2,376)	(4,668)
Feb	1,213	542	1,755
Jan	2,673	(3,228)	(554)
	18,393	17,710	36,103
Avg Return/year	4.41%	4.25%	8.66%

USD/JPY Breakdown:

	GapDown			Total	GapUp			Total
P&L Details	TakeProfit	StopLoss	Kill		TakeProfit	StopLoss	Kill	
May	13,625	(14,546)	5,841	4,920	17,770	(13,346)	2,478	6,903
Apr	34,940	(27,908)	4,847	11,878	35,448	(25,041)	5,462	15,869
Mar	3,519	(6,201)	390	(2,292)	2,214	(5,306)	716	(2,376)
Feb	1,527	(1,356)	1,042	1,213	3,412	(3,452)	582	542
Jan	10,042	(8,144)	776	2,673	6,874	(10,456)	354	(3,228)
	63,652	(58,156)	12,897	18,393	65,719	(57,602)	9,593	17,710

EUR/USD summary:

P&L Summary	GapDown	GapUp	Total
May	498	1,720	2,217
Apr	211	1,650	1,861
Mar	(1,283)	438	(846)
Feb	397	(441)	(44)
Jan	(1,166)	3,415	2,250
	(1,344)	6,782	5,438
Avg Return/year	-0.32%	1.63%	1.31%

EUR/USD breakdown:

	GapDown			Total	GapUp			Total
P&L Details	TakeProfit	StopLoss	Kill		TakeProfit	StopLoss	Kill	
May	1,001	(1,183)	680	498	2,701	(1,440)	459	1,720
Apr	1,220	(869)	(140)	211	3,352	(1,702)	0	1,650
Mar	781	(2,069)	5	(1,283)	1,663	(1,795)	570	438
Feb	1,665	(1,269)	0	397	722	(1,163)	0	(441)
Jan	514	(1,680)	0	(1,166)	4,858	(2,543)	1,101	3,415
	5,181	(7,070)	545	(1,344)	13,295	(8,642)	2,129	6,782