The Behavior_Sequenced_Fractal Combinator EA (BSF)

Test Performance Report

C-Analytica

Market Chaotists and Algorithmic Traders

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1. Background

The BSF Combinator EA

The Behavior_Sequenced_Fractal Combinator EA has been designed as an algorithmic platform that trades the market differently from existing **directional** mechanical trading systems. The BSF Combinator works across multiple time frames and markets and is capable of deploying different money management systems depending on investor risk tolerance. This test performance report is intended to inform thinking and not to lead it. The idea is to profile the BSF Combinator's performance results in a way that allows informed opinion and decision-making.

The Trading System

One fitness objective in designing a trading system concerns how closely the **trading algorithm** models the fundamental behavior or nature of the electronically traded market or markets it is designed to trade. Mathematically, the market can be understood exactly as **experienced** by discretionary or human traders in live sessions. Indeed, there is an established body of knowledge about the nature, behavior and mathematical properties of such a dynamical system. Therefore, in praxis, the market may be viewed as a singularity (a single point) rapidly bounced around some limiting space (range) by the buy/sell activity of market participants. As such, the market can be completely explained (modeled) as an iterative system without recourse to any exogenous factors in comprehending outcomes.
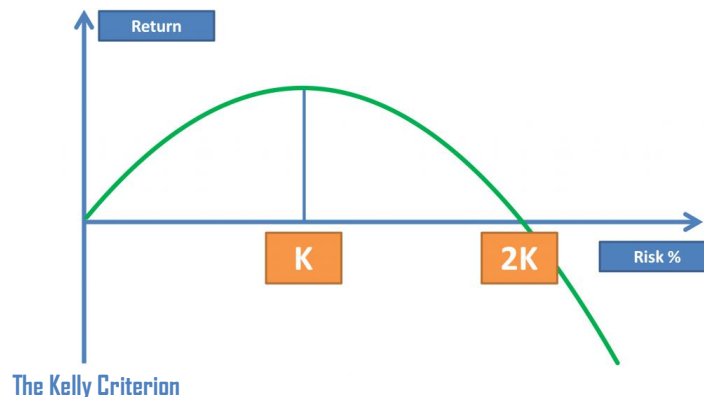
The BSF Combinator EA reads the market as the zigzag of a single point evolving in real-time. A zigzag is a course or line having abrupt alternate left and right turns. This strategy is executed by a complex of signals. The multiplicity of signals dynamically comprehend the three market behaviors (Hurst types or series) recognized by Fractal Geometry. By varying the number, type and frequency of signals depending on the series encountered per interval, the BSF Combinator EA works to minimize **losses** in "choppy" range (anti-persistent series) and to maximise **wins** on encountering persistent series[1]. The consistency with which the BSF Combinator does this while following the complex (fractured or fractal) real-time contour of the market at zero lag, allows the resulting **buy low/sell high** strategy to directly tie in with and become *"weaponized"* by the Money Management System.

The Money Management System

The necessary condition for successful investment and trading is a trading system with positive mathematical expectancy. Any system with positive expectancy (assuming informed money management) is rationally associated with a high probability of returning profits in the long-run.

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[1] The algorithm accepts the win/loss ratio resulting from the series types encountered per interval, i.e. without attempting to optimize for selectiveness in the type of range traded. Trading the market as a chaotic (or iterative) system underpinned by a fractal structure, implies accepting that the variable allows no trends (maintains a fractured course at all times), is non-monotonic (moves up and down going up or down), and is subject to topological mixing (colloquially, extreme volatility or wild swings, sudden price jumps, etc) and therefore indisputably **unpredictable**.

Basically, a trading system is concerned with (and evaluated for) delivering **sustainable** expectancy and risk management. A **money management system**, on the other hand, is concerned with the equally critical question of the quantity put on per trade (that is to say, the fraction of a trading account risked per trade). The crucial issue here is that contrary to the somewhat widely held misconception among investors and traders, the relationship between potential gain and the amount risked per trade is demonstrably non-linear. In other words, it is **NOT** true, for example, that the larger is the amount risked per trade, the larger is the potential gain or loss accumulated in the long-run.

The Kelly Criterion

In the illustration above, the optimal trade size for a given system maps to the peak at K (read 1 Kelly) when the objective or criterion is to maximize long-run return. To the left of the peak, we see that return increases as we increase our risk-exposure. But to the right of the same peak return drops off and decays consistently even as we continue to increase the size put on per trade. Visually, we can see the error in putting on a trade size greater than K given that for any long-run return obtainable between 1 and 2 Kelly, the same can be gained at much lower risk-exposure between 0 and 1 Kelly.

The illustration used is known as the Kelly Criterion. The Kelly formula evolved from a solution to problems of data transmission over telecommunication lines to the most widely used staking strategy among professional gamblers. It is also widely used by professionals in investment and trading (the connection between the three processes being the **uncertainty** of outcome). However, the Kelly Criterion is not the only option available to investment and trading.

There is also Ralph Vince's Optimal f strategy derived from the Kelly Criterion and Ryan Jones more recent fixed ratio strategy as well as other more dated (anti-martingale and martingale) strategies[2]. The point of this overview (with respect to the BSF Combinator EA) is to give context to the considerations that go into the specific design of the money management strategy employed by the EA platform. This is discussed next under the heading "Risk".

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[2] Anti-martingale strategies prescribe increasing risk-exposure only as capital grows and reducing risk-exposure as capital is reduced. Martingale strategies prescribe increasing risk-exposure as losses accumulate and decreasing risk-exposure as wins accumulate. We find no merit in martingale strategies as they reflect criteria directly opposite to our modus which is very much focused on risk containment in balance with exploiting available opportunities for exponential growth.

Risk

In the preceding section, we presented a money management system as a non-linear curve with a peak. The point we wish to emphasize here, is that when you set up to trade a peak, there is a concomitant set of **drawdowns** or temporary losses that a system must survive to reach the optimal net return implied by the trade size employed[3]. Indeed, as we increase trade size from zero toward a peak, the severity of drawdowns tends to increase, and the probability of **surviving** the concomitant set tends to decrease. As such, and given a robust trading system, the risk that is most problematical in any system design is not trade risk (which is easily handled by the risk management setup). The risk that brings on the real challenge concerns the set of drawdowns associated with the trade size employed[4].

As can be seen in the test performance report below, we profile returns over different time scales and markets. Overall, however, the report shows our approach to the required **trade-off** between **risk** and **high-return**. This highlights income growth at a stable percentage drawdown. That effect is implemented by means of a customized fixed ratio strategy. However, the setup is such that it is a trivial matter to switch to either the Kelly Criterion or the Optimal f strategy given acceptance of the estimated risk. This flexibility is strategic, but on the whole, our criterion is the dependability of outcome at a reasonable level of risk.

In spite of the fact that the uncertainty of outcome connects the two, investment and trading are unlike gambling, the critical difference being that gambling creates risk while investment and trading redistribute the risk intrinsic to markets. Further, gambling is a negative expectancy game whereas the investor or trader is almost always involved with positive expectancy. In practice, this distinction and the statistical advantage in investment and trading can quickly disappear. This will be so where there is not the knowledge that one is trading on a curved surface. And also, where one is without at least an approximate understanding of the contour of that surface and one's point or path upon it. It is knowledge of the curve that enables a decision as to criterion and how best to achieve it.

It is useful to mention that the peak on any specific curve is not always comfortable for everyone and may not always be practical or even desirable in certain contexts. As such and as indicated for the Combinator EA, some other criterion may be preferred. However, the most important point that is made in this section, is that knowledge of the curve conveys in no uncertain terms the fact that there is really no such thing as **high returns** with **low risk.** In investment and trading, one simply cannot eat his cake and have it. [5]

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[3] A drawdown reflects one or more loss streaks comprised of one or more loss trades following one another and or interspersed with small wins.

[4] To call drawdowns risk is, of course, unconventional as that term is usually reserved for measures involving the Standard Deviation of the given dataset. But drawdowns is how investors and traders actually experience risk.

[5] Money management is a highly mathematized area of investment and trading (probably one reason why it is not as widely understood and used among investors and traders as its utility would imply). However, in spite of the elegance and breadth of the mathematics involved, it would be wrong to think that application is simply a matter of embedding the relevant mathematical equations and concepts. In practice, there is much scope for judgment involving practical knowledge and experience in trading and investment as well as common sense. For example, sometimes, key parameters have to be determined a posteriori and there is no sense in which such values predict the future with exactitude.

2. Performance Results

Risk: 2.5 to 5% Max	Base System	Gold XAUUSD					EURUSD	Silver XAGUSD
		A	B	C	D		E	F
Initial Capital $	$ 17,500	$ 17,500	$ 87,500	$ 175,000	$ 1,400,000		$ 17,500	$ 17,500
Return $	$ 243,568	$ 100,028	$ 500,145	$ 996,324	$ 7,970,686		$ 53,352	$ 252,527
Holding period (in years)	10	4	4	4	4		4	4
CAGR	30%	55%	55%	54%	54%		32%	95%
Z- Score	-1.78	-1.62	-1.62	-1.62	-1.62		0.25	0.51
GHPR	0.59%	1.25%	2.24%	2.69%	4.08%		3.39%	3.35%
Standard Deviation	$ 2,825	$ 2,167	$ 10,834	$ 21,659	$ 173,276		$ 1,509	$ 7,301
LR. Correlation	0.97	0.97	0.97	0.97	0.97		0.98	0.97
System Quality Number (SQN)	4.02	3.73	3.73	3.72	3.72		5.6	3.8
Maximal Drawdown	45%	28%	28%	28%	28%		19%	23%
Expected Payoff	$ 530	$ 654	$ 3,269	$ 6,512	$ 52,096		$ 1,270	$ 7,301
Profit Factor	1.58	2.19	2.19	2.18	2.18		5.58	3.25
Risk of Ruin @48% MDD	1.4%	0.0%	0.0%	0.3%	0.1%		0.0%	0.0%
Risk of Drawdown	11.8%	0.7%	1.0%	0.9%	0.8%		0.0%	1.0%

Note: The Strategy Tester raw dataset for each result reported is available on demand. These are test performance results and not returns that any actual investor attained.

Comments:

a) In the spreadsheet above, we report performance when the algorithm is free to vary the amount risked per trade. The algorithm does so by managing the required increments and decrements between a minimum of 2.5% and a maximum of 5% of the trading account in real-time.

b) In the current and next result, we present performance across two time scales (10 and 4 years), and for three different markets (Gold, Euro, and Silver) on the 4 year scale[6].

c) Also highlighted (i.e. columns A, B, C, and D), is the performance when we scale initial capital from a base value of $ 17,500 to a maximum. In the specific case of the results above, that maximum amount is $ 1.4 million. Beyond that level of capital, given the stated risk parameters, the system would breach the maximum position size (by margin) allowed by the broker under current business terms.

d) Columns A, E and F report result from the Gold, Euro, and Silver markets respectively. For each market, trading parameters are exactly the same. However, results vary considerably with the Silver market outperforming, followed by Gold, with the Euro coming in last in terms of net profit. This ties in with volatility differentials across the three markets. Silver, for instance, is up to 70% more volatile than Gold, and Gold in turn more volatile than the Euro. It is important to note that both Silver and the Euro can be scaled in exactly the same way as is presented in columns A – D for Gold and to the same effect.

In a chaotic system, such as the market, nothing repeats to exactitude twice, the variable is everywhere unstable. Similarly, results can be chimerical and it does require experience and common sense to assure outcomes in which realism is maintained.

[6] The Euro and Silver markets were arbitrarily selected for trading as a part of our walk forward analysis and at the time strictly to validate the BSF Combinator model in terms of **out of sample testing.** We not only gained positive results in both cases for that stated purpose but had favored Gold trading to that point and would now include Silver trading in our portfolio as a direct result of the outcome reported in this document.

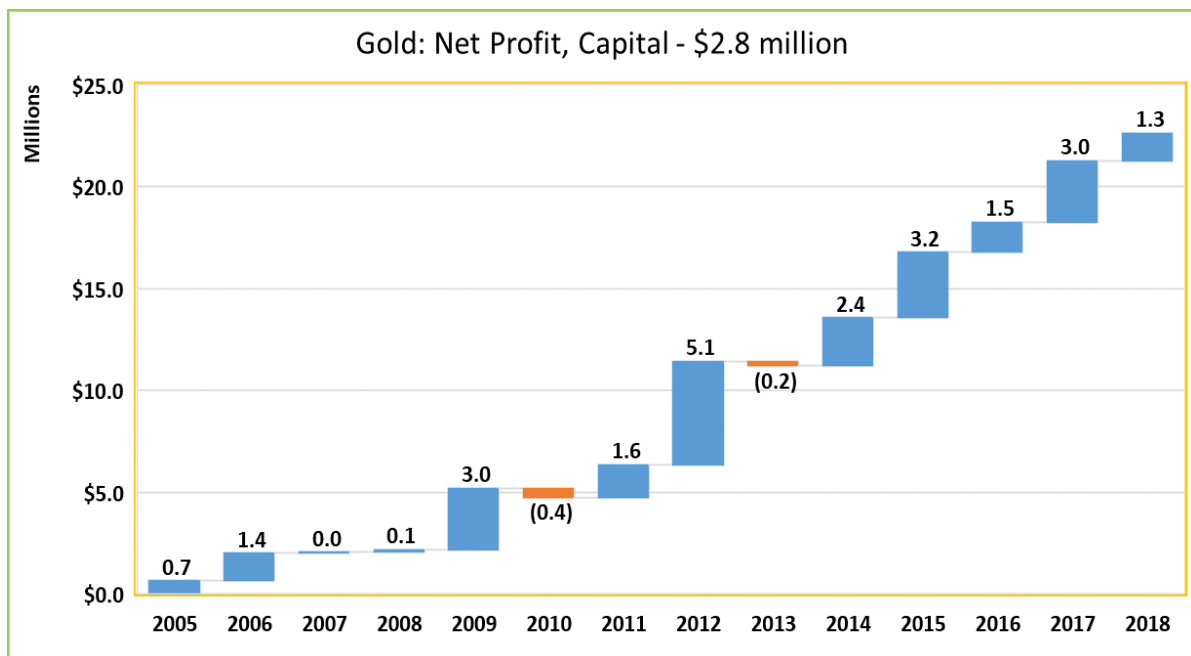| Risk: 2.5% Max	Base System		Gold XAUUSD					EURUSD	Silver XAGUSD
			A	B	C	D		E	F
Initial Capital $	$ 17,500		$ 17,500	$ 87,500	$ 175,000	$ 1,400,000		$ 17,500	$ 17,500
Return $	$ 126,910		$ 53,995	$ 269,974	$ 537,843	$ 4,302,793		$ 30,156	$ 135,622
Holding period (in years)	10		4	4	4	4		4	4
CAGR	22%		33%	33%	32%	32%		15%	67%
Z- Score	-1.78		-1.62	-1.62	-1.62	-1.62		0.25	0.51
GHPR	0.46%		0.92%	1.85%	2.29%	3.67%		2.41%	2.65%
Standard Deviation	$ 1,425		$ 1,155	$ 5,774	$ 11,542	$ 92,340		$ 773	$ 3,866
LR. Correlation	0.97		0.96	0.96	0.96	0.96		0.99	0.98
System Quality Number (SQN)	4.15		3.78	3.78	3.77	3.77		6.02	3.85
Maximal Drawdown	32%		21%	21%	21%	21%		12%	19%
Expected Payoff	$ 276		$ 353	$ 1,765	$ 3,516	$ 28,123		$ 718	$ 1,634
Profit Factor	1.60		2.19	2.19	2.18	2.18		6.18	3.20
Risk of Ruin @48% MDD	0.00%		0.0%	0.0%	0.0%	0.0%		0.0%	0.0%
Risk of Drawdown	0.00%		0.0%	0.0%	0.0%	0.0%		0.0%	0.0%

Note: The Strategy Tester raw dataset for each result reported is available on demand. These are test performance results, not returns that any actual investor attained.

e) Similar to the preceding spreadsheet, the spreadsheet here reports performance when the algorithm fixes the amount risked per trade at 2.5% of the trading account. Otherwise, the results here reflect the exact same trading conditions as in the previous result sheet. However, the return is lower because the amount put on per trade is approximately halved for the underlying trades.

f) Across both result sheets, we measure return in terms of Compound Annual Growth Rate **(CAGR)**.

g) The System Quality Number **(SQN)** operates to rate a system (see footnote for details)[7]. It is a measure very similar to the **Sharpe Ratio** but deemed more apt in this case where it directly serves to recommend a system or otherwise. As can be observed, it is relatively insensitive to net profit, and more focused as it were, on the geometry of the underlying curve and the system's path upon it in terms of trade opportunities, the size and sign of average P&L and risk.

h) Across both result sheets, **risk** may be more formally considered in terms of the **Standard Deviation** measured for each result. For example, at 2 or even 3 SDs to the downside, all results remain very positive.

i) The **Risk of Ruin** (RoR) is evaluated at a fixed capital level (48% in all cases) and measures the probability of such a large capital loss (in which case the system would have 52% of capital left for recovery). This is important considering the fact of asymmetrical leverage associated with drawdowns.

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[7] SQN = SQRT(N)*AVG(of N P&L)/Std Dev (of N P&L). Ratings: 1.4 – 1.9 below average, 2.0 -2.4 average, 2.5 – 2.9 good,3.0 -5.0 excellent, 5.1 – 6.9 superb, 7 and > superlative.

3. In - Production Prescriptions and Notes on Methodology

BSF Combinator 14 Year P&L Profile

Note: These are test performance results, not returns that any actual investor attained.

Comments:

a) In the Step Chart above, we present the trading result of the BSF Combinator over the entire period of available historical data, when the algorithm fixes the amount risked per trade at 2.5% of the trading account.

b) The trading method used differs from that in the two preceding reports as this particular method trades the BSF Combinator year by year, i.e. on a no reinvestment basis. However, for the years following a loss (2011 and 2015), capital is reduced at the beginning of the period to reflect the exact balance left from the loss year.

c) The trading capital deployed is exactly double the limits in the D columns of the two result sheets prior and reflects the fact that for the risk parameter employed, the maximum position size (by margin) allowed by the broker is not breached[8],

d) The primary purpose of the reporting here is to allow some sense of what this "long-term" view of the Combinator's trading implies especially in terms of the risk when the minimum holding period is 3 to 4 years. Apart from indicating "long-term" profitability over the historical period traded, it also shows the underlying capacity for recovery in the event of a loss and the limited depth of the most severe realized drawdowns over the test period.

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[8]This, of course, is also true of the second spreadsheet where the $1.4 million limit was not the result of taking care not to exceed the maximum position size allowed. Rather the result of our decision to align the two results in terms of format. The current result bears this out even when trading is not on a continuous or reinvestment basis as was the case with the second result. Clearly, at 2.5% risk and lower, it does take a much longer time to reach the brokers limiting trade size than at higher trade size.

In Conclusion

I. The proposition in investment and trading is as simple as we have laid out above. First, a trading system that demonstrates positive expectancy. Second, a money management system that not only positively exploits exponential growth, but one that is backed by a capital structure designed to take into account the risk brought on by the trade size employed. Knowledge of the curve implies that we have a reasonably risk focused setup.

II. Risk of course is experienced with greater emotional intensity than reward and risk tolerance varies considerably across investors.

III. As such, the Combinator EA is designed as a platform that can cater to different investor risk dispositions. We have indicated that the system retains the flexibility of going with investors that may wish to assume a more aggressive stance than the trade sizes put on in this report. At the same time, it can go with investors seeking more conservative risk and income than reported here. Indeed, the system has a built in function that allows us to tailor a hard stop at some predetermined level of absolute drawdown, for yet a third segment. We can call this segment the ultra conservative segment.

IV. This means that for such an investor, with say $2.8 million invested, and wishing no more than a 10% loss on initial capital, that routine can be effected. While the probability of ruin combined with GHPR numbers for each result reported (and the step chart above), suggest that such a tack would more likely turn out to be a type I error (given that with accumulating capital the probability of ruin decreases significantly), such a mindset might validly calculate that regardless of those numbers, the preference is to take only a onetime shot at the associated return for that level of investment[9].

V. Risk is by far of more concern than reward, return can only be realized where a system survives the unique set of unavoidable drawdowns associated with the amount put on per trade. The design and the development of the BSF Combinator EA, reflects exactly this thinking[10].

Samuel Ikwue
December 14, 2018

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[9] A type I error is rejecting a hypothesis that should be accepted – the hypothesis in this case being that such a loss is temporary and recoverable. The error can only be made after the fact and It is the least cost error type an investor can make in these types of situations since the cost is simply any profits forgone (the regret factor).

[10] Trading and investment involves substantial risk of loss and nothing that has been presented in this report is to suggest that test performance is a predictor of future outcome. The purpose of testing is to determine if a strategy is profitable when traded on historical data and to select the best setup in that outcome for trading in the open market..