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THE TRUE DEVIATION OF RETURNS AND PORTFOLIO OPTIMIZATION

"That Works Very Well in Practice, But How Does It Work In Theory?"

EFFICIENCY FRONTIER AND MINIMUM RISK PORTFOLIOS BASED ON THE TRUE DEVIATION OF FINANCIAL RETURNS

As we have argued in our most recent paper, **"A New Way to Measure Risk"**, standard deviation is an uninformative investment metric.

We have therefore replaced it with another measure, the **"Non-Standard" Deviation** or **"True" Deviation**: an adjusted measure of risk which multiplies standard deviation by the ratio between the downside deviation and the upside deviation of returns.

Some straightforward derivative measures useful in assessing investment performance and risk are the **True Sharpe Ratio,** the **True Value at Risk** and **True Value at Gain**, as calculated in the above-mentioned paper.

In this issue we will see if and how True Deviation can replace standard deviation in building optimal portfolios.

When we speak of optimal portfolios, we prefer portfolios that minimize risk, by any measure.

There are two main reasons for doing this: first, by minimizing risk instead of maximizing the risk to return ratio, one minimizes the volatility drag. As we have shown in the past, volatility drag can have a significant negative effect on performance. Second, maximizing the risk to return ratio often results in corner solutions, which is generally not the case with risk minimization.

We will show that using True Deviation (defined in a number of ways) instead of Standard Deviation as risk measure improves significantly the long-term performance of a Minimum Risk portfolio.

"True Deviation" (TD) or "Non-Standard Deviation" (NSD) is an adjusted measure of risk that multiplies standard deviation by the ratio between downside deviation and upside deviation.

This approach is novel according to our knowledge. We have found examples of portfolio optimization based on downside risk. However, we are not aware of any publication or practice applies a measure similar to our True Deviation to portfolio optimization.

The definition of True Deviation allows for several ways to measure downside and upside deviation. Here, we will use three of them.

1. Downside/Upside Deviation, calculated as the standard deviation of losses/gains. This method is the most straightforward and easy to grasp by finance practitioners that do not classify as quants.
2. Lower/Upper Semideviation, calculated as the square root of the sum of squares of positive/negative differences from the mean divided by the number of observations above/below the mean.
   $LSD(x)$[1]$=(E[(x-E(x))^2 * 1_{\{x>E(x)\}}])^{1/2}$
   $USD(x)=(E[(x-E(x))^2 * 1_{\{x\leq E(x)\}}])^{1/2}$
   This is the definition postulated by Wikipedia and Investopedia.
3. Lower/Upper Semideviation, calculated as the square root of the sum of squares of differences from the mean divided by the total number of observations. The advantage of this definition is that the two *semivariances* (not to be confused with the semideviations) add up to the variance of the portfolio.

Using the definitions above we can calculate three measures of risk that differ from Standard Deviation (SD):

- TD1, the non-standard deviation measure based on the 1st definition
- TD2, the non-standard deviation measure based on the 2nd definition
- TD3, the non-standard deviation measure based on the 3d definition.

These three measures can be used to build numerically two-asset efficiency frontiers, which we show in the graph below. Note how the mean returns, calculated as arithmetic averages, are the same, while the measures of return deviation change for each of the two assets.

We build Minimum True Deviation portfolios of two assets: Insch Kintore (daily returns net of 2%-20% fees charged on a daily basis) and XAUUSD (2PM prices, to match the time of daily valuation of Insch Kintore). The data range from 01 July 2010 to 31 January 2017.

Judging by each of the TD measures, Insch Kintore is less risky than it would appear judging by standard deviation. The reason for this finding is the propensity of the program to make large gains and small losses.

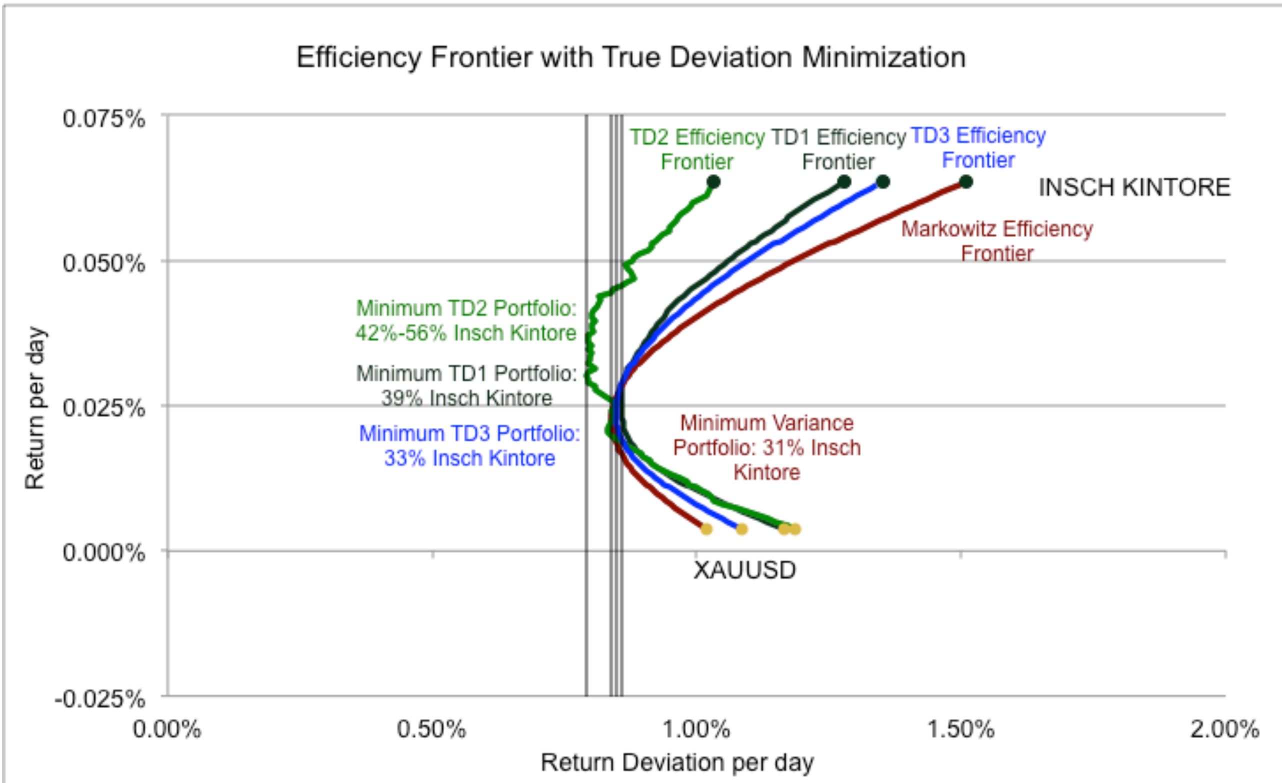
As a result, the optimal allocations of the Minimum Risk portfolio change, from 31% to Insch Kintore in the standard deviation case to 33% in the case of TD3, to 39% in the case of TD1 and to 44% (at the global minimum; there is also a range of local minima between 42% and 56%) in the case of TD2.

We note that, with the exception of TD3, the TD efficiency frontiers are not smooth. They are not coherent[2] or even convex. However, as far as non-coherent measures go, we believe TD to be of value in a world of non-deterministic, uncertain future returns.

Theorists will like TD3. However, practitioners seeking the optimization of a return stream through risk minimization might like the superior return potential of TD1 and TD2. A heuristic portfolio solution may be justified.

[1] https://en.wikipedia.org/wiki/Downside_risk#Examples

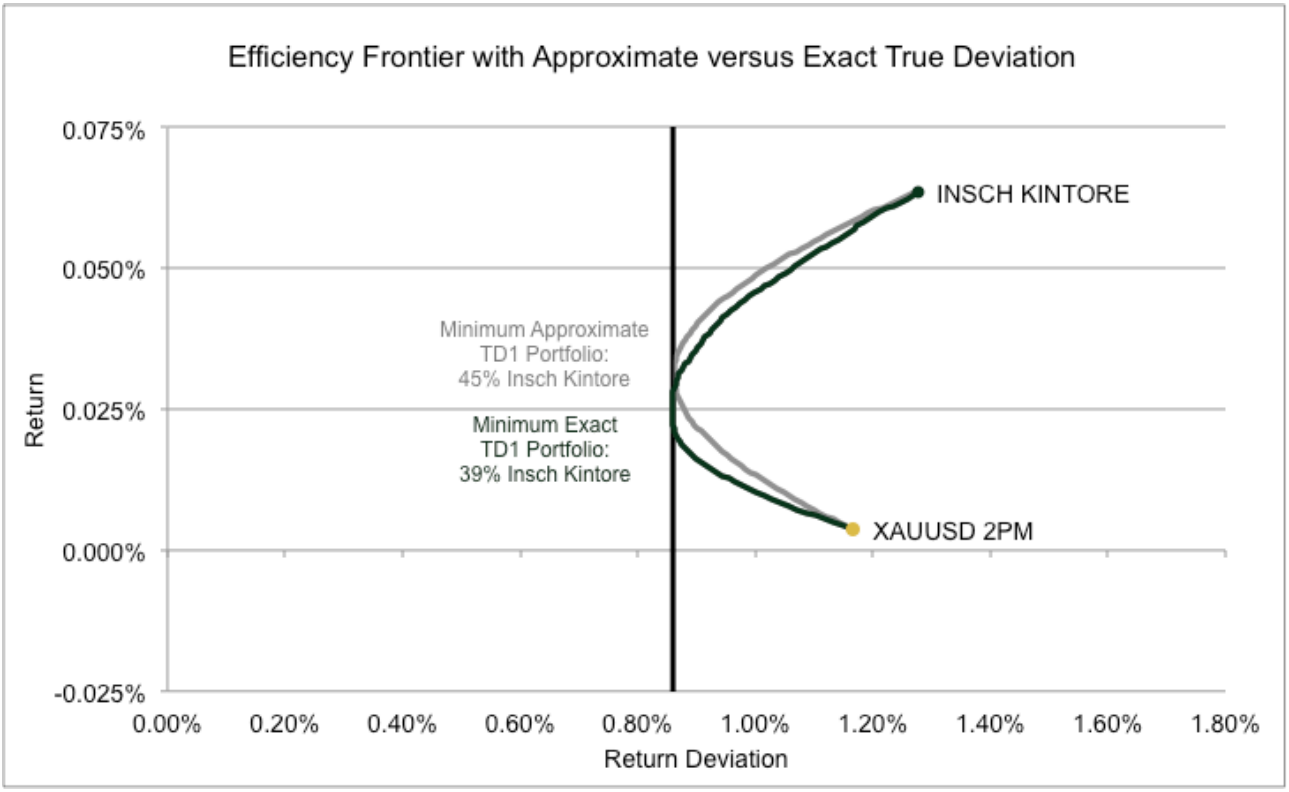
[2] https://en.wikipedia.org/wiki/Coherent_risk_measure



Remark: TD1 and TD2 cannot be calculated through a closed-form formula for any portfolio weightings. As an illustration, see the graph below, where TD1 is calculated exactly in the dark green line and is a portfolio-weighted average, thus an approximation, in the grey line.

For this reason, one should not use shortcuts in calculating the efficiency frontier. If this is important to you, you might prefer to use TD3.

In the next section, we check and compare the performances of these minimum risk portfolios.



MONTHLY STATISTICS FOR THE MINIMUM RISK PORTFOLIOS

Just as we expected, minimum risk portfolios based on the True Deviation measures outperform the Minimum Risk portfolio based on standard deviation. (See the table on the next page).

There are improvements in average compounded return and total return, in True Deviation, in return/True Deviation, in skewness, in both the standard deviation of gains and that of losses, in Value at Risk, in the average tail loss, and in the largest drawdown.

The improvements are practically everywhere.

Our analysis was limited to two assets. Many numerical portfolios can be built from a larger number of assets to test the idea. However, we are confident in the superiority of the True Deviation approach, in any of the three definitions proposed, in building optimal portfolios.

The intuition behind this is obvious: a large deviation of gains and a small deviation of losses is desirable. The use of standard deviation penalizes an asset that provides large gains and small losses by reducing its allocation in a Minimum Risk portfolio. The True Deviation measure corrects for this unfair penalty and thus results in more profitable portfolio allocations.

Besides producing profitable portfolio allocations, True Deviation is easy to understand and calculate – more so than the Omega measure, for example. We hope it gains popularity within the finance industry.

Combinations between Insch Kintore* and XAUUSD						
% Allocated to Insch Kintore	0%	31%	33%	39%	44%	100%
Average Return p.m.	-0.03%	0.42%	0.44%	0.52%	**0.58%**	1.13%
Average Return p.a.	-0.38%	5.12%	5.45%	6.41%	**7.19%**	14.46%
Cumulative Return	-2.47%	38.91%	41.79%	50.53%	**57.94%**	143.29%
Standard Deviation p.m.	5.29%	**4.30%**	**4.30%**	4.34%	4.42%	7.61%
Standard Deviation p.a.	18.34%	14.91%	**14.90%**	15.02%	15.32%	26.36%
True Deviation p.m. (TD1)	4.75%	2.25%	2.15%	2.05%	**1.95%**	2.94%
Return/Standard Deviation p.m.	-0.02	0.10	0.10	0.12	**0.13**	0.15
Return/True Deviation p.m.	-0.01	0.19	0.21	0.25	**0.30**	0.38
Avg. return positive months	4.54%	**4.21%**	3.98%	4.15%	4.05%	6.67%
Avg. Return negative months	-4.01%	-2.29%	-2.36%	**-2.21%**	-2.30%	-3.75%
Skewness	0.13	1.03	1.08	1.20	**1.29**	1.74
Excess Kurtosis	-0.43	**1.97**	2.12	2.44	2.59	4.63
Std Dev of Gains	3.28%	3.74%	3.79%	3.95%	**4.09%**	7.36%
Std Dev of Losses	2.94%	1.95%	1.90%	1.87%	**1.80%**	2.85%
Historical VAR (5%)	-8.21%	-5.16%	-5.09%	-4.88%	**-4.71%**	-8.80%
Average Tail Loss (5%)	-10.79%	-7.62%	-7.51%	-7.20%	**-6.95%**	-9.81%
Largest Drawdown	-41.81%	-16.87%	-15.09%	**-12.31%**	-12.85%	-27.74%
TD Version	-	SD	TD3	TD1	TD2	-

*Net of 2%-20% fees, monthly data from Jan.2010 to Jan.2017

Bold fonts in the table above stand for the most favorable value among the minimum risk portfolios. The fact that the SD and TD1 measures are not minimized by the respective TD version used in the portfolio allocation is explained by using monthly instead of daily data. A heuristic approach is therefore justified also for this reason.

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Insch Capital Management SA conducts investment research across a broad range of financial and commodity markets.

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