

Referee Report for "Portfolio Optimization: MAD vs. Markowitz"

I believe that this paper would make a nice addition to the Rose-Hulman Undergraduate Mathematics Journal. It involves topics that many (most) undergraduate students do not see in their studies, and offers some interesting applications and new mathematics. My only concern is that, in its current form, most readers would not get much from the paper. Therefore, I recommend that the paper be accepted for publication but only after a major rewrite is done.

My main issue with this paper is that it seems to be written for an audience that is familiar with financial mathematics and mathematical programming. For example, when the authors discuss the Markowitz model, they immediately talk about the Lagrangian function. While most students have studied Lagrange multipliers in Calculus, they may not have seen the Lagrangian function; this is especially true concerning inequality constraints. Another example is in the section on Solving Markowitz where results from Leunberger are used. It would be nice if the authors provide more background so that the readers can better understand the techniques and ideas being used.

Some specific suggestions:

1. On Page 2, the first paragraph of Section 2 should be rewritten. It is unclear initially what are the "groupings of five" and "the bond".
2. In Section 3(A):
 - (a) In model (3.1) - (3.4) is $x_j \geq 0$?
 - (b) Is M_0 constant?
3. In Section 3(B):
 - (a) Why change variables from x_j to w_j ?
 - (b) What happened to ρ that was in the model (3.1) - (3.4)? Is it related to \bar{r} ?
 - (c) You should note for the reader to which constraint each Lagrange multiplier corresponds.
 - (d) Note that Lagrange multiplier μ is not unrestricted in sign. Also, in the Lagrangian function and in equations (3.5), what about the upper and lower bounds of x_j ?
 - (e) Can you write a closed-form solution using Linear algebra to solve (3.5)? If so, please state it; if not, explain more how to solve such a system.
 - (f) I believe "risk free" should be "risk-free".
 - (g) What is the motivation behind the tangent fund?
 - (h) How does the tangent fund give us a normalized vector of weights?
4. In Section 4(A): Can you better explain what a_{jt} is?
5. In Section 4(B):

- (a) Why did you use Solver to solve MAD but not Markowitz?
- (b) You talk about deriving a tangent fund for MAD and then say "we next needed to maximize the numerator divided by our minimized value from above." Why?

6. Section 6:

- (a) You should state the assumption of normality of stock returns earlier than the concluding remarks.
- (b) In Section 5 (last paragraph) you state there is a difference between MAD and M-V at a 10% significance level, but then state here that there is not difference.