**PROJECT ONE: MAKING INVESTMENT DECISIONS BASED ON DATA**

*One important application of statistics is analyzing data from Finance. In this assignment, you have the opportunity to earn points by making investment decisions that maximize return while minimizing risk, based on available data.*

**Background.** Finance theory states that there is a tradeoff between return and risk: “risk-free” investments, like 10-year Treasury bonds, provide a low but guaranteed rate of return; by contrast, “risky” investments in equities (like investing in the stock market) can provide higher long-run average returns, but at the risk of some negative returns. Finance theory also says that it is impossible to sustain high returns with no risk: if shares for a company were consistently providing abnormally high percentage returns relative to their risk, then investors would buy shares in that company, driving up the share price, and thus lowering the percentage return relative to the (new, higher) share price. Diversification can reduce risk, to some extent: having a broad portfolio of investments can yield higher return and pose lower risk than individual investments in the portfolio, because positive performance on some investments can offset the negative performance of others (as long the securities are not perfectly correlated). Still, there is a limit to the benefit of diversification, since all stocks are subject to “systemic risks” [risks that affect the entire “system”]: such risks can not be diversified away, since by definition the risks affect all stocks.

**The opportunity.** You are a fund manager and partial investor with “Ten Classic Advisors” (TCA), a fund that manages $1.4 million in client funds. (The fund includes $50,000 of your personal wealth; so if the fund does well, you benefit financially as well.) You have been given the opportunity to invest in the “First Federal Yin, Ltd.” (FFY) Fund. You have been some information about FFY:

* a prospectus from FFY providing detailed information
* a summary of trades from FFT, collated from past statements to shareholders (while FFY’s trading strategy is proprietary, the statements are a matter of record)
* a spreadsheet containing monthly returns for FFY (expressed as percentage change from previous month’s value) since its inception in 9/1999. For reference, the spreadsheet also contains monthly returns for the S&P500 as a whole (^GSPC) and monthly returns for “risk-free” investments in 10-year Treasury Bonds (^TNX).

The research department at TCA has also compiled for you monthly returns for 100 “large cap” stocks from the S&P500.

**The analysis**. A junior analyst at TCA has recommended that you not invest in FFY. The analyst makes the following claims:

* **FFY is worse than the S&P500**, because for “the majority” of months, the monthly return for the S&P500 exceeded the corresponding monthly return for FFY
* **FFY is worse than risk-free investments**, because FFY has had “several” months with negative return, whereas risk-free investments never lost money
* **FFY is worse than large cap companies**, because FFY had an average monthly return of only 0.8%, whereas the “average” large-cap company had a monthly return of over 1.0%
* **FFY could have annual loss exceeding several percent**, because 1% of the time, the return for FFY was –0.34%, which is a loss of 12\*(–0.34%) = –4.1% on an annual basis; so there is a 1% chance that FFY could lose more than 4% over a 12-month time period
* **FFY provides no diversification benefit to any portfolio**, because FFY has a non-zero correlation with returns for the S&P500 and a non-zero correlation with risk-free returns

Based on these analyses, the analyst recommends that you tell clients that FFY is too high a risk and provides too low a return relative to its risk. The analyst recommends that you classify FFY as a “strong sell.” This view is somewhat controversial, though, since one of the senior partners recommends investing in FFY. The partner says that FFY offers a high return relative to its variability, especially for investors who plan to have time horizons of 12 months or longer.

**Your assignment has three tasks:**

* **To evaluate the junior analyst’s numerical claims**
* **To provide an evaluation of FFY as an investment**
* **To construct an investment strategy to maximize earnings (and homework points)**

**Part one (5 points).** You have been asked to review the junior analyst’s numerical claims.

1. For what percentage of the 215 months was the monthly return for the FFY greater than that month’s return from the S&P500? (This measures *how often* FFY outperformed the S&P500.)
2. Knowing *how often* an investment is profitable does not give information on *how* profitable that investment is. The **Compound Annual Growth Rate** (**CAGR**) for an investment measures the average rate of growth of an investment for a period of time; CAGR can be calculated as either

CAGR = (ending balance / starting balance)(1 / investment duration in years) – 1, or

= [(1+r1)(1+r2)…(1+rn)] (1 / investment duration in years) – 1

where r1, r2, … are the various returns. For the 215 months from 9/1999 to 7/2017, what was the CAGR for FFY? (For reference, over this same time period the CAGR for risk-free investments was 5.52% and the CAGR for the S&P500 for the same time period was 6.34%; you can verify these values from the available data.)

1. Even if a security has a positive return on average, it is possible that some returns will be lower (or may even be negative). One measure of variability in returns is the standard deviation; another is the inter-quartile range. For the 215 months, what was the inter-quartile range for the monthly returns for FFY?
2. For what percentage of the 215 months was the monthly return for FFY less than zero?
3. The **Value at Risk** estimates the worst-case return for an investment over a period of time given “normal market conditions”, where “normal market conditions” are conditions other than the worst 1% of that investment’s returns (i.e., VaR is the worst-case for the top 99% of cases). The junior analyst noted, correctly, that 1% of the returns were –0.34% or worse (this can be verified from the data using the =PERCENTILE( [..], 0.01) command in Excel), and from this the analyst concluded that the VaR for FFY over a 12-month time period could be –4%. In the data, there were 204 “consecutive 12 month periods”, from “9/1999 to 8/2000” to “8/2016 to 7/2017.” Fill in the blank: “Based on the data, for 99% of the consecutive 12-month time periods, a 12-month investment in FFY earned *at least* \_\_\_%.” (For reference, the comparable VaR for risk-free investments for the same 204 time periods was 4.81%, which you can verify from the available data.)
4. For any security, a question of interest is how often the return exceeds the risk-free rate. One way to summarize this value is the **Sharpe ratio**, which is like a Z-score comparing average return for an investment to a “mean” equal to the risk-free rate. For each of the 215 FFY values, subtract the risk-free rate from that month’s return (so the first “adjusted return” for FFY would have a value of –0.353%, the second would be 0.402%, etc). Then, take the average of the 215 differences, and divide that by the standard deviation of the 215 differences. What is the resulting ratio?
5. If monthly values for “return for FFY minus risk free rate” followed a normal distribution, what percentage of the time would you expect the monthly return for FFY to exceed the risk-free rate for that month? (Hint: use the Sharpe ratio as a Z-score.)
6. Each of the 100 stocks had an average monthly return for the 215 months (for example, ABT had an average monthly return of 1.177%, ADSK had an average monthly return of 1.564%, etc.). What was the range for the 100 averages?
7. What was the correlation between monthly returns for FFY and monthly returns for the S&P500?
8. What percentage of returns for FFY were greater than or equal to 0.0% but less than 0.5%?

**Part two (5 points)**. You have been asked to evaluate FFY as a medium-term (five-year) investment. What do you recommend about FFY, and why?

* Begin with a recommendation of either “sell” (or “strong sell”), “hold”, or “buy” (or “strong buy”)
  + A “sell” recommendation indicates that investors should sell a stock, because the underlying company and/or relevant market conditions will be unfavorable for the stock in the subsequent period of time; it is a condemnation of a stock. A “strong sell” is a more urgent condemnation than “sell.”
  + A “hold” recommendation is to neither buy nor sell a security, because the underlying company and/or security is expected to perform at the same pace as the market. This rating is better than sell but worse than buy, meaning that investors who own the security shouldn’t sell but shouldn’t buy more, and investors who don’t already own the security shouldn’t purchase it.
  + A “buy” recommendation indicates that investors should buy a stock, because the security is expected to outperform the average market return and/or return of comparable stocks in the same sector or industry; it is an endorsement of a stock. A “strong buy” is a more emphatic recommendation than “buy.”
  + (For more information on the terms “strong sell”, “hold”, and “strong buy”, see <http://www.investopedia.com>)
* Then, provide the reason(s) for your recommendation on the indicated sheet in the space provided; you may cut and paste charts and graphs if you think them helpful. Your analysis rationale should address whether the investment seems to provide high returns (or high returns relative to its risk). If you recommend “buy”, you should explain why FFY seems to be a better investment than other available choices (and why the junior analyst is incorrect); if you recommend “sell”, you should explain why FFY does appears worse than other available choices (and whether or not you concur with the junior analyst’s reasoning); if you recommend “hold”, you should explain why FFY seems to be about the same as other available choices (and how the junior analyst’s analysis relates to your conclusion).

**Part three (nominally 5 points, but could be worth more)**. You have the opportunity to invest $1.4 million for a five-year period. For this part of this assignment, you start with 5.0 “homework points” to invest, where each “point” is worth $280,000.

You would like to make as much money for your clients (and for yourself) as possible by the end of five years. Liquidity is not an issue: clients will not need this money for five years. You will earn points based on how much money you make, but the points awarded will be reduced based on the risk of your investment. Your investment choices are:

* Cash
* An actively managed trading fund (First Federal Yin Fund, FFY\*)
* A passive fund tracking the stock market (the S&P500 as a whole ,^GSPC)
* Risk-free investments (10-year Treasury bonds, ^TNX)
* Ownership in some number (possibly zero) of “large cap” companies

\*Note: per the prospectus, only $50,000,000 of FFY is being issued. For the purposes of this assignment, the $50M is the total amount available to both sections of DSO 545. Shares in FFY are considered “sold” to a student when that student’s emailed answer with investment options is received (not when the email was sent); shares of FFY are “sold” on a first-come, first-served basis, based on the timestamp of when the email is received. **Once all shares of FFY have been “sold” to other students between both classes, FFY will not be available as an investment option.** There is no “guaranteed amount” of FFY available to a student or to a section.

**Leveraging.** As an option, you may “borrow” homework points to increase the amount of money available for investment. Part one and part two of this assignment are worth a combined total of 10.0 points, and the conversion rate is $280,000 per homework point; so if you “borrow” 10 points, you may borrow up to (10 points) \* ($280,000 per point) = $2.8M for investment in addition to the $1.4M. The details of borrowing are as follows;

* You choose to borrow some amount $**x** (where **x** < $2.8 million)
* You agree to pay (0.003)\*($**x**) each month for 60 months
* At the end of five years, you pay back $**x**

You do not have to borrow money; the advantage of borrowing is that, for the duration of the loan, you earn returns on the borrowed amount in addition to your own money. This process, of using debt to magnify returns, is sometimes called “leveraging”. For example, for the 215 months between 9/1999 and 7/2017, USB had a monthly return of 3.24%. For simplicity, consider an investment that returns a fixed rate of 3.24% per month:

* Without leveraging, $1.4M at 3.24% per month for 60 months 🡪 $1.4M \* (1.0324)60 = $ 9.5M 🡪 **net gain of $8.5M** on $1.4M
* With leveraging, borrowing $1.4M: Borrow $1.4M (so have $2.8M to invest), have ending balance of $2.8M \* (1.0324)60 🡪 $18.97M, pay (0.003)(60)($1.4M) = $0.25M in interest, repay $1.4M in principal 🡪 **net gain of $17.3M** on $1.4M
* With leveraging, borrowing $2.8M: Borrow $2.8M (so have $4.2M to invest), earn $4.2M \* (1.0324)60 🡪 $28.5M, pay (0.003)(60)($2.8M) = $0.50M in interest, repay $2.8M in principal 🡪 **net gain of $25.15M** on $1.4M

(This is a simplified form of leveraging; the “3X FFY” mentioned in the prospectus uses a more complicated formula based on paying monthly interest equal to the risk-free rate + 0.1%.)

**The assignment.** Your grade will be based on how much money you make on a risk-adjusted basis after five years. First, you will begin by deciding how much, if any, you wish to borrow; you may borrow up to $2.8M. Second, you will then declare your investment position using the spreadsheet provided; you may invest in as many or as few options as you wish. (Investing in multiple stocks is not necessary to earn full credit on this part of the assignment; some single-choice investment options are capable of earning full credit.)

(\*If a student wishes to purchase FFY, he/she must specify an alternative investment, in case FFY sells out to other students; in those cases, “unspent” dollars on FFY will be invested in the specified alternative.)

You should provide an estimate for how much money you think you will make for the clients, and some estimate of the volatility.

**Grading.** You start with $1.4M, and you choose a portfolio; at the end of sixty months, the ending balance of your portfolio will be 1.4M + X, where X is the net gain or net loss after sixty months in millions of dollars. The points for part three will be assigned as follows:

* The net gain/loss each month (in dollars) will be calculated for 60 months; call these net gains xi. Note that the total net gain/loss X = x1 + … + x60.
* Define s to be the standard deviation (in dollars) of the xi’s.
* The “variability-adjusted net gain/loss” is defined as G = X / [1 + (s / $14,500) ].
* **Your will earn/lose 1 point for every $50,000 of net gain/loss in G:**

**points earned = (G / $50,000)**

Example A: if an investment pays a fixed value of $4,000 per month, the total gain after 60 months would be 60 x $4,000 = $240,000 with zero variability; so the points earned would be (240,000) / (50,000) = 4.80.

Example B: if an investment pays a fixed value of $8,000 every other month (and zero otherwise), the total gain after 60 months would be 30 x $8,000 = $240,000 with standard deviation of s = $4034; so G = 240,000 / [1 + (4034/14,500)] = $187,766, and the points earned would be (187,766) / (50,000) = 3.76. Notice that, even though the total cash is the same, the higher variability means that the investment is less valuable on a “variability-adjusted” basis.

If you earn more than 5.0 points on a “variability-adjusted” basis, you will be earning “bonus points” that can be used will offset points lost elsewhere on this homework assignment (in the real world, if you make enough money, people forgive errors in reasoning; note that people give less credit for large volatility than steady gains, and this is reflected in the scoring). Conversely, if you have negative points (for example, by losing too much money or by having loans that are not paid back), this will count against points earned in other sections (in the real world, if you lose too much money, people tend to care about the results more than the reasons, even with perfect explanations).

Good luck. When you have decided on your investment choices, email your spreadsheet to [tony\_statman@yahoo.com](mailto:tony_statman@yahoo.com), with subject line “DSO 545 Project 01 for (Last name, First name)” where you type your name instead of “(Last name, First name)”. Once your email is received, it will be recorded; in case of dispute over timing (e.g., for purposes of who gets shares of FFY), the allocation is based on the date in which the email is received.