Bill and Melinda Gates Portfolio Management

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***Abstract*—This report presents a strategic approach for managing an endowment provided by the Bill and Melinda Gates Foundation, dedicated to supporting pediatric health services in Kampala, Uganda. The primary objective is to ensure financial sustainability for a 10-year period and subsequent years. This report details the calculation of the endowment based on accounting principles, the implementation and expected outcomes of a hybrid investment approach, and the management of the endowment in achieving financial sustainability for this critical humanitarian endowment.**

I. Introduction

This project aims to effectively manage an endowment for a humanitarian venture in Kampala, Uganda, focusing on providing pediatric health services. With the initial funding from the Bill and Melinda Gates Foundation, our objective is to establish a sustainable financial model that will cover the capital expenses for the 10-year need of the program while also ensuring the post-grand period remains financially viable through a quantitatively managed portfolio.

II. Endowment Structure and Capital Expenses

A. Capital and Operating Cost

We have calculated the capital and annual operating expenses for this project as shown in Fig[1]. In order to best serve the children of greater Kampala, our NGO plans to build 15 satellite clinics within a 100-mile radius of Kampala, and a flagship brick-and-mortar facility within Kampala itself. Each of these 16 facilities are to be staffed by 2 full time Doctors and 3 Physician Assistants, all paid the median wages for their position in Kampala, Uganda. Thus, the total operating cost includes the annual wages for all 32 Doctors and 48 PAs, the cost of supplies, and the annual utility rates to operate all 16 facilities. This is a simplified calculation, and it's important to consider that wages and other costs may increase over the ten-year period due to inflation and other factors. Additionally, these calculations assume a constant number of clinics and staffing levels over the ten-year period. The majority of the costs associated with this project are the operating expenses, which are primarily driven by personnel costs and supplies/utilities rate. The capital expenses are also significant, but they are only incurred at the beginning of the project.

Cost	Description	Value($)
Capital Expenses	Construction and equipment	5,000,000
Operating Expenses		
	Total Annual Salary per facility	93,433
	Supplies/Utilities per facility	120,000
	Total Operating expenses per facility	213,433
	Total Operating Cost	3,414,936
Reinvestment Cost	20% of annual operating expenses	682,987

Fig. 1. Capital and Operating Cost

B. Structuring the Endowment

Our strategy is to structure an endowment that will cover the necessary annual operating expenses and the 20 percent yearly reinvestment payment, with the condition that the initial endowment face value must be repaid to the Gates Foundation at the end of the ten-year term. The endowment of $86,568,394 dollars will provide annual payouts to cover operating expenses and the reinvestment payment. At the end of the ten-year term, the full endowment face value will be used to repay the Gates Foundation. Any remaining balance can then be utilized to support ongoing operations beyond the grant period. This structured endowment aims to not only meet the immediate financial needs but also ensure long-term sustainability for the pediatric health services in the greater Kampala, Uganda, area.

The minimum endowment of $86,568,394 was computed using our investment strategy's minimum estimated rate of return of 5.5%, the derivation of which can be found later in the report. With $5,000,000 required for capital expenditures at the start, this was subtracted from the initial amount of the endowment set to be invested. Then starting with that initial $81,568,394 investment, the endowment's valuation from the end of the prior year was assumed to grow by 5.5% annually, with the necessary $3,414,936 annual operating cost and $682,987 reinvestment being deducted from the endowment fund at the end of the year. This was subsequently iterated over the endowment's 10 year duration to find the fund's ultimate value at that time. With the Gates Foundation requiring the initial endowment award to be returned after 10 years, we utilized Excel's Solver feature to compute the necessary startup value for the endowment fund, that after accounting for a 5.5% annual growth rate and the necessary cash flow deductions over the program's duration, yielded the same value. Thus, an initial investment of $86,568,394 was determined to be the minimum initial allocation to ensure our ability to repay the Gates Foundation at after the endowment's 10 year life span. Any initial endowment greater than this figure is projected to yield an ultimate portfolio value in excess of the allocation, with the balance remaining under our NGO's control to use as desired.

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III. Investment Strategy

Our investment strategy is comprised of two key components: a dynamic trading reallocation approach and an options-based hedge.

A. Selection of Assets

Due to advancements being made in generative artificial intelligence, quantum computing, semiconductor development, etc. we decided to generate a tech portfolio.

In order to understand what equities would generate profits for the endowment, we decided to simulate the price of assets using Geometric Brownian Motion (GBM) is a continuous-time stochastic process model as shown:

$$S(t) = S_0 \exp\left[\left(\mu - \frac{\sigma^2}{2}\right)(t - t_0) + (\sigma\sqrt{t - t_0}) \cdot Z_t(0, 1)\right] \tag{1}$$

Our final portfolio consisted of the following equities: Adobe, AMD, Amazon, Apple, IBM, and Microsoft. We have modeled and simulated the GBM price movement for each of these equities in the 'figs' folder within our primary repository. As an example, here it the simulated GBM for IBM:

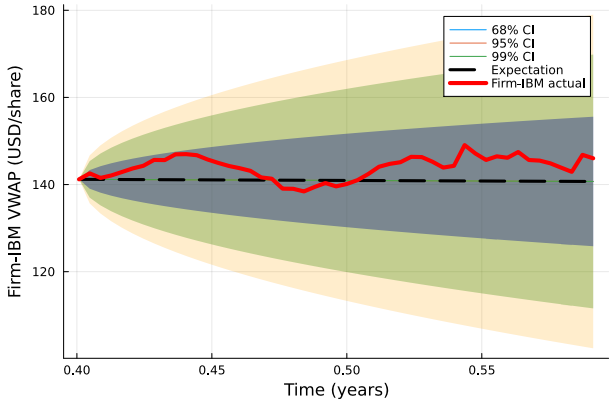

Fig. 2. Geometric Brownian Motion simulation for $IBM

B. Online Reallocation

The reallocation algorithm is how we ensure our portfolio dynamically adjusts to market shifts and sentiment overall. The way that the algorithm works is by balancing risk, maintaining appropriate diversification, and making other quantitative adjustments.

We simulated a series of portfolios and selected an allocation that was well-adjusted to our risk appetite; this was Portfolio 25 as seen below:

The chart indicates that the reallocated portfolio outperforms the actual portfolio as well as the $SPY benchmark, optimizing wealth over time.

C. Covered Call Hedge

Covered calls serve as an effective hedge in the reallocation strategy described above. By holding a long position in the assets being reallocated, selling call options generates premium income, which can offset potential losses in the portfolio. We found this to be critical for our selected assets because our investment strategy is bullish on tech stocks that tend to be more volatile than other equities.

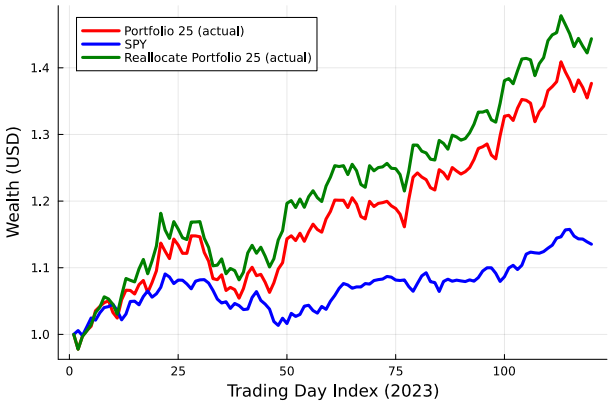

Fig. 3. Excess Return: 0.109091 Risk: 0.210015 — This indicates a 1/2 Std lower bound (-0.105 risk on 0.159 expected return) would beat $SPY at 5.5%.

The payoff diagram for this strategy caps the upside of the stock while having a theoretically unlimited downside.

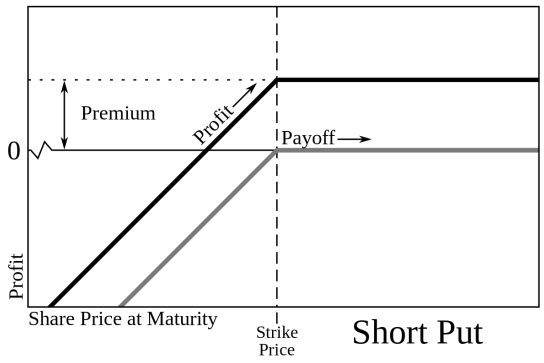

Fig. 4. Short put/covered call payoff diagram

To select assets that would be best for selling calls, we decided to calculate a modified version of the Sharpe Ratio by omitting the risk-free rate. This allowed us to get a measure of return per unit of risk for each asset.

$$S_a^* = \frac{\mu_a}{\sigma_a} \tag{2}$$

From here we imported a table that gave us parameters for risk. Using this data, we decided to focus on selling calls on the tickers with a lower modified Sharpe ratio given that they yielded lower returns for the respective risk we were taking on [MSFT, AMD, AAPL, ADBE].

From here, we went on to purchase 100 shares of each of the underlying and developed a process for selecting optimal contracts to purchase. We decided to model the historic options data by seeing which contracts historically expired OTM. From here, we calculated the confidence level for each contract and its's odds of getting exercised (assuming the prices were normally distributed). An example of one of the tables generated is here:

Date Date	Ticker String	MarketPrice Float64	StrikePrice Float64	Std Float64	Percentage Float64
2023-06-05	MSFT	335.94	345.0	0.112533	8.95996
2023-06-05	MSFT	335.94	365.0	0.360952	28.1864
2023-06-05	MSFT	335.94	350.0	0.174638	13.8636
2023-06-05	MSFT	335.94	355.0	0.236743	18.7144
2023-06-05	MSFT	335.94	360.0	0.298847	23.4943

Fig. 5. Interpretation: For a MSFT call with a $365 strike, approximately 28% of the data falls within ±0.36 standard deviations of the mean

The probabilities for getting executed on for each of the contract on average can be seen in Fig 6.

Ticker String	AverageExerciseProbability Float64
ADBE	12.0085
AMD	27.9886
MSFT	20.2106
AAPL	28.5885

Fig. 6. As a note, these figures may be skewed due to lack of recency-weighing as it takes into account data from lots of contracts.

Using this, we simulated the results of investing in an optimally allocated set of underlying and selling calls on those assets. The final returns for each strategy and the combination can be seen in Fig 7.

CoveredCallYield Float64	ReallocationYield Float64	OverallYield Float64
1.8802	1.44369	1.44448

Fig. 7. Yield is respective to the initial investment.

Overall, this strategy functions as a hedge for our reallocation portfolio.

IV. Findings and conclusion

In conclusion, this report outlines the calculation for account expenses and a hybrid investment strategy for a healthcare fund in Uganda funded by the Bill and Melinda Gates Foundation. We were very pleased with the results of our strategy. Utilizing an estimated $86.5MM endowment from the Gates Foundation, our reallocation strategy performed optimally with an expected value that beat $SPY by est. 30% and a lower bound of 0.5 Std which beat $SPY 5.5%. Our covered calls strategy on its own returned 88% and provided a secure cushion for volatile movements in our reallocation strategy. For future research, we would like to resolve biases in our models due to recency-weighting and focusing on time-focused data rather than daily data. We are excited to examine markets with further accuracy in the future and hope this report is useful in your journey within financial markets.

V. Data and model availability

The model equations were implemented in Julia (v.1.9.3). The model code is available at https://github.com/arunxbh/CHEME-5660-Final-Project-F23

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