M&S Consultancy Company

Yale Endowment

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Summary

Based on the proportion of Yale university's ongoing operational and capital budget expenditures on the endowment and the current inflation rate, Yale Endowment's target return is 11% annually. We used the traditional mean-variance optimization method and the Black-Litterman approach to build the portfolio financial model. Since the traditional mean-variance optimization method used the historical data to predict the future, we decided to use the Black-Litterman approach to address this issue by adding our analyst's own judgment and market expectations to change the expected return for every investment product.

In terms of stock analysis, as the stock market recovered, the bull market rose sharply, expecting 5% 10-year expected nominal return. We selected 40 stocks from the seven industries, such as Health Care, Technology, Consumer Discretionary, Consumer Staples, Logistics, Energy/ Clean energy and sustainability, and Electric/ EV, which have the most potential for development in the next three to five years. Besides, as Merck has successively signed supply agreements with the US government and the Singapore government, it is expected that its value will grow even greater in the next few years. Through planning and solving, we found the optimal proportions of each stock in the stock portfolio given the benchmark rate of S&P 500, especially MRK and MSFT accounted for 18.66% and 31.18% respectively.

In terms of bond analysis, as the United States is at risk of high inflation and economic downturn in the next three to five years, we mainly consider global and investment-grade corporate bonds and global Treasury bonds when picking the types of bonds. We downloaded monthly pricing data from 2016-2021 of five bond ETFs with top overall performance rankings that meet our selection criteria from the website State Street. After the correlation test, only three ETFs were finally screened out, which are The SPDR Bloomberg Barclays Convertible Securities ETF (CWB), The SPDR Bloomberg Barclays 1-10 Year TIPS ETF (TIPX), and The SPDR Dow Jones REIT ETF (BWX). Because we thought the REIT ETF's average return will be 0.23% with 0.19% higher than the return calculated based on the results calculated by the traditional mean-variance optimization method, we then apply the Black-Litterman approach to allocate 10.11% in TIPX, 10.88% in BWX, and 79.01% in CWB in the total bond portfolio given the target interest rate of the endowment (11%).

In terms of alternative analysis, the gold price is predicted to gradually fall as uncertainty has decreased since 2021. The low supply of homes in 2021 ensured that many homebuyers were paying top dollar. Commodity prices continued their recovery and are expected to remain close to current levels throughout the year. We downloaded the monthly data from 2016-2021 of all alternative ETFs from the website State Street, and after the correlation test, only two alternative ETFs were picked up, which are The SPDR Gold Shares (GLD) and The SPDR Dow Jones REIT ETF (RWR). By planning and solving, we used the Black-Litterman approach to allocate 14.02% in RWR and 85.98% in GLD given the target interest rate of the endowment (11%).

1 Introduction

The Yale Endowment is managed by Yale's Investment Committee, which tries to support the University by generating high and inflation-adjusted returns. Yale's strategies of building portfolios are based on academic theory, especially the mean-variance analysis, belief in diversification and market judgment.

"There are two objects needed to be the trade-off for the spending policy: (1) supporting today's scholars with annual spending distributions, providing budgets and foundational resources for its schools and (2) preserving that support for generations to come. The Investment office not only sets a long-term spending rate target but also establishes a rule to adjust spending in any year when the endowment market value is changed ("Yale Investments Office" 2021)."

"Yale's endowment earned a 6.8% investment return (net of fees) for the year ending June 30, 2020. The endowment value increased from \$30.3 billion on June 30, 2019, to \$31.2 billion on June 30, 2020. Spending from the endowment, which is the largest source of revenue for the university and supports faculty salaries, student scholarships, and other expenses, for Yale's 2021 fiscal year is projected to be \$2.8 billion, representing approximately 35% of the university's net revenues. Since the US inflation rate is expected to be 2% and Yale Endowment's expected real return is 9%, the nominal return will be 11%. Based on Yale endowment's long-term objectives and constraints, the designed portfolio will focus on domestic equity, bonds and alternatives. ("Investment Return Of 6.8% Brings Yale Endowment Value To \$31.2 Billion" 2021)"

In terms of constraints, Yale targets a minimum allocation of 30% of the endowment to market-insensitive assets (cash, bonds, and absolute return). The university further seeks to limit illiquid assets (venture capital, leveraged buyouts, real estate and natural resources) to 50% of the portfolio.

2 Capital Market Expectations

2.1 Equity

In the post-COVID-19 world, the long-lasted epidemic is not only a tribulation, but also an excellent investment opportunity in the equity market. As the market recovered from the March decline, the bull market rose sharply, with the S&P 500 Index reaching a new all-time high. According to Morgan Stanley's forecast, The performance of stocks in the next few years may be similar to the one after 2010, the second year of the bull market that began in 2009. BlackRock also lowered its expectations for the U.S. stock market, expecting 5% 10-year expected nominal return from U.S. equities.

2.2 Bond

"According to an analysis from BlackRock, in keeping with lower yields, the firm's 10-year outlook for U.S. aggregate bonds also declined by nearly a percentage point, to 0.8% on a nominal basis. Although JP Morgan is also employing low return assumptions of just 2.5% for U.S. investment-grade corporates, thanks to low starting yields, and even lower returns for U.S. government bonds, it is also enthusiastic about the prospects for emerging-markets hard-currency debt, forecasting a return of 5.2%" (Benz 2021).

"In terms of Interest rate, The Federal Reserve will have to wind down its pandemic-era stimulus programme quickly and raise US interest rates in 2022 in response to higher inflation, according to a poll of leading academic economists for the Financial Times. The US central bank has committed to the current pace of purchases until it sees "substantial further progress" towards average 2 per cent inflation and maximum employment and the first goal has already been met" (Smith 2021).

2.3 Alternative

"Alternative investments are generally uncorrelated with public markets, meaning that adding them to a portfolio can increase diversification and reduce overall portfolio volatility. (Milinchuk 2021) "

"Since 2021, the gold price is predicted to gradually fall as uncertainty has decreased, but volatility is still high. The World Bank predicts the price of gold is expected to decrease from an average of $1775/oz in 2020 to $1400/oz by 2030. ("Gold Price Forecast: 2021, 2022 And Long Term To 2030 - Knoema.Com" 2021)". "Housing prices in 2021 have been skyrocketing, competition has been hotter than ever, and the low supply of homes ensured that many homebuyers were paying top dollar, all while mortgage rates sat near rock bottom. (SRADERS 2021) ". "Commodity prices continued their recovery in the first quarter of 2021 and are expected to remain close to current levels throughout the year, lifted by the global economic rebound and improved growth prospects, according to the World Bank's semi-annual Commodity Markets Outlook. (Press Release 2021)"

3 Asset Allocation Decision

3.1 Equity Selection

In 3-5 years, it is necessary to look for potential in various industries with historically high valuations. However, the stock market within three years will be affected by various factors (such as the Fed's policy), which will be difficult to predict. However there still exist compelling opportunities in value stocks. Sectors with development prospects in the future and the Industry sector allocation of equity investment in the designed portfolio(table1) are as follows.

Table1. 3-5years Equity Investment Allocation

Health Care	Technology	Consumer Discretionary	Consumer Staples	Logistics	Energy/ Clean energy and sustainability	Electric/ EV
25%	20%	10%	10%	5%	10%	20%

- **Health Care**

The aging population and the rapid development of biotechnology make the healthcare industry an attractive option. In the past ten years, this field has led the growth of all other industries, and there is no doubt that this trend will continue in the future. In the next five years, resistant strains of existing diseases may provide growth opportunities for the industry. In addition, COVID-19, as well as pre-existing diseases, may also stimulate drugmakers to produce new treatments during the epidemic. Figure2 shows an overall outlook forecast for the industry, with an average annual growth rate of 3%.

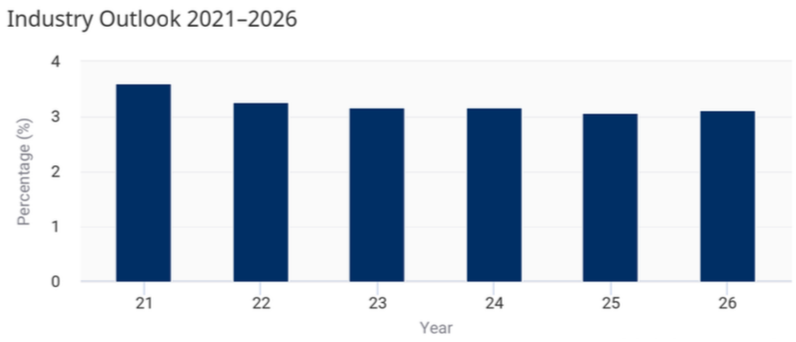

Figure1 Pharmaceuticals & Medicine Manufacturing industry outlook
Source: IBISWorld
Example stocks：MRK, CVS, IDXX, etc.

- **Technology**

The technology industry is at the forefront of the spear of innovation. For decades, technology has shaped the economy. Due to continuous research, this trend seems to continue, and supply chain management (SCM) in the cloud will also be a key trend in the next few years. After a record year 2020, the technology industry continues to attract large amounts of capital from more and more interested investors.
Example stocks：MSFT, NVDA, ORCL, etc.

- **Consumer Discretionary**

Consumer Discretionary Sector, also known as consumer cyclical stocks. During the economic growth stage, the industry's demand for products and services tends to be higher, especially during this period of post-covid-19 time, where consumers' enthusiasm for buying continues to increase.
Example stocks：NKE, BBWI

- **Consumer Staples**

Due to the conservative attitude towards the economy after 2021, investing in consumer staples can be used to reduce the risk of portfolio. The industry in the market that is most resistant to recession, despite the changing market cycles, consumer staples companies have acquired consistent demand for their products. From historical data, during the 2008 financial crisis, consumer staples performed better than all other 10 industries and the overall market.
Example stocks：UL, KHC

- **Logistics**

Industry is growing rapidly all over the world, which is mainly driven by the surge in e-commerce. It is generally expected that continued investor demand will push the ceiling interest rate this year to further compress. Most industry participants believe this is a structural rather than cyclical trend. It reflects structural long-term changes.
Example stocks：FDX, ARCB

- **Energy/ Clean energy and sustainability**

The renewable energy market is very resilient, and in some countries, even increased attention to ESG and sustainability. The United States' renewed commitment to the climate goals of the Paris Agreement, and China and India's commitment to net zero carbon emissions, underscore the power of the clean energy trend. And the future trend of clean energy to replace coal and natural gas in the global power structure is determined. According to JP Morgan's forecast, renewable energy will increase from 7% of global power demand to 56% by 2050.

At the portfolio level, energy investment in equity offers attractive return prospects and significant diversification.
Example stock：CVX

- **Electric/ EV**

The automotive industry is undergoing a radical change, and most automakers believe that the next 10 years will bring more changes than the previous two years. In recent years, the penetration rate of electric vehicles in North America has risen steadily. According to estimates by JP Morgan Research, in September, the total market share of electric vehicles in five European countries was 27.4%, which steadily determined the future development direction of EVs.

EV Industry profit growth and outstanding market performance are a good choice to increase portfolio return.
Example stocks：TSLA, F

3.2 Bond Selection

As the United States is at risk of high inflation and economic downturn in the next three to five years, "while emerging markets have entered a new economic cycle, which should bring economic growth and positive returns ("Post-COVID Trends IN Emerging Markets I Blackrock" 2021)", we mainly consider global corporate bonds and global Treasury bonds when picking the types of bonds. When it comes to bond ratings, since the time when the epidemic will end is unpredictable, we prefer to conservatively choose investment-grade bonds (Baa3/BBB-/BBB-or higher using the middle rating of Moody's Investors Service, Inc., Standard & Poor's, Inc. and Fitch Inc., respectively).
We downloaded monthly pricing data from 2016-2021 of five bond ETFs with top overall performance rankings that meet our selection criteria from the website State Street. After the correlation test, only three ETFs were finally screened out, as shown below.

- "The SPDR Bloomberg Barclays Convertible Securities ETF seeks to provide investment results that, before fees and expenses, correspond generally to the price and yield performance of the Bloomberg Barclays US Convertible Liquid Bond Index, which is designed to represent the market of U.S. convertible securities, such as convertible bonds ("CWB: SPDR® Bloomberg Barclays Convertible Securities ETF" 2021)".
- "The SPDR Bloomberg Barclays 1-10 Year TIPS ETF seeks to provide investment results that, before fees and expenses, correspond generally to the price and yield performance of the Bloomberg Barclays 1-10 Year U.S Government Inflation-Linked Bond Index. The benchmark Index is designed to measure the performance of the inflation protected public obligations of the U.S., with an issue size equal to or in excess of $500 million ("TIPX: SPDR® Bloomberg Barclays 1-10 Year TIPS ETF" 2021)".
- "The SPDR Bloomberg Barclays International Treasury Bond ETF seeks to provide investment results that, before fees and expenses, correspond generally to the price and yield performance of the Bloomberg Barclays Global Treasury exUS Capped Index, which is designed to track the fixed-rate local currency sovereign debt of investment grade countries outside the United States ("BWX: SPDR® Bloomberg Barclays International Treasury Bond ETF" 2021)."

3.3 Alternative Selection

We downloaded the monthly data from 2016-2021 of all alternative ETFs from the website State Street, and after the correlation test, only two alternative ETFs were picked up, as shown below.

- “ The SPDR Gold Shares are designed to reflect the performance of the price of gold bullion, less the Trust’s expenses. The spot price for gold bullion is determined by market forces in the 24-hour global over-the-counter (OTC) market for gold. The OTC market accounts for most global gold trading, and prices quoted reflect the information available to the market at any given time. ("GLD: SPDR® Gold Shares" 2021)”
- “The SPDR Dow Jones REIT ETF seeks to provide investment results that, before fees and expenses, correspond generally to the total return performance of the Dow Jones U.S. Select REIT Index, which is designed to provide a measure of real estate securities that serve as proxies for direct real estate investing, in part by excluding securities whose value is not always closely tied to the value of the underlying real estate ("RWR: SPDR® Dow Jones® REIT ETF" 2021).”

4 Final Portfolio

When building the final portfolio financial modeling, we used the traditional mean-variance optimization method and the Black-Litterman approach. Since the traditional mean-variance optimization method used the historical data to predict the future, we preferred to use the Black-Litterman approach to address this issue by adding our analyst's own judgment and market expectations to change the expected return for every investment product.

In terms of stock analysis, we selected 40 stocks from the seven industries with the most potential for development in the future. Based on the proportion of each stock calculated by the traditional mean-variance optimization method, we made some changes to the expected return of companies Merck, Microsoft and Nike. For example, as Merck has successively signed supply agreements with the US government and the Singapore government, it is expected that its value will grow even greater in the next few years. Considering MRK's highest price in history, we shifted the monthly expected return from 0.435% to 1.06%. Through planning and solving, we found the optimal proportions of each stock in the stock portfolio given the benchmark rate of S&P 500, especially MRK and MSFT accounted for 18.66% and 31.18% respectively.

In terms of bond analysis, we have selected three investment grade bond ETFs, such as The SPDR Bloomberg Barclays Convertible Securities ETF (CWB), The SPDR Bloomberg Barclays 1-10 Year TIPS ETF (TIPX), and The SPDR Dow Jones REIT ETF (BWX). Because we thought the REIT ETF's average return will be 0.23% with 0.19% higher than the return calculated based on the results calculated by the traditional mean-variance optimization method, we then apply the Black-Litterman approach to allocate 10.11% in TIPX, 10.88% in BWX, and 79.01% in CWB in the total bond portfolio given the target interest rate of the endowment (11%).

In terms of alternative analysis, we choose two alternative ETFs, such as The SPDR Gold Shares (GLD) and The SPDR Dow Jones REIT ETF (RWR). By planning and solving, we used the Black-Litterman approach to allocate 14.02% in RWR and 85.98% in GLD given the target interest rate of the endowment (11%).

Below is our final portfolio modeling:
Table 2: Performance for each asset

	Equity		Alternative		Bond	
	short sales allowed (optimized)	black litterman	optimized	black litterman	optimized	black litterman
Portfolio mean	3.66%	2.10%	0.59%	0.59%	0.65%	1.25%
Portfolio sigma	3.59%	3.29%	4.35%	4.37%	2.12%	4.37%
sharpe ratio	101.65%	63.36%	13.11%	13.11%	29.75%	28.21%

Table 3: Asset Allocation

	optimized	black litterman
Equity	10%	1.82%
Alternative	37%	47.69%
Bond	50%	47.50%
Cash	3%	3.00%
sum	100.00%	100.00%
Portfolio annual return	11%	11%

Since the Black-Litterman approach is more scientific than the traditional mean-variance optimization method by fixing the issue to use the historical value to predict the future, we decided to apply the black litterman method to build our final portfolio and allocate our asset 1.82% in Equity, 47.69% in Alternative, 47.50% in Bond, and 3.00% in Cash to meet our endowment's target return 11% annually.

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Appendices

Appendix A: Equity Selection

	Expected benchmark returns, no opinions	Analyst opinion, delta, δ		**Monthly returns adjusted for opinions**		**Opinion-adjusted optimized portfolio**	Portfolio benchmark, no opinions
JNJ	0.731%	0%		0.984%		3.42%	5.20%
MRK	0.435%	0.565%		1.061%		18.66%	2.54%
LLY	0.520%	0%		0.768%		1.78%	2.70%
ABBV	0.769%	0%		0.970%		1.56%	2.37%
AMGN	0.684%	0%		1.025%		0.98%	1.49%
TMO	0.709%	0%		0.991%		1.82%	2.77%
ILMN	0.878%	0%		1.290%		0.50%	0.76%
IDXX	0.667%	0%		0.910%		0.43%	0.65%
UNH	0.703%	0%		0.922%		2.99%	4.55%
CVS	0.673%	0%		0.999%		0.90%	1.36%
REGN	0.423%	0%		0.545%		0.49%	0.75%
RMD	0.375%	0%		0.560%		0.31%	0.47%
MSFT	1.086%	0.41%		1.584%		31.18%	26.73%
ORCL	0.670%	0%		0.887%		1.98%	3.02%
FTNT	0.926%	0%		1.255%		0.39%	0.60%
NLOK	0.647%	0%		1.019%		0.12%	0.18%
NVDA	1.901%	0%		2.304%		4.18%	6.36%
INTC	0.669%	0%		0.856%		1.77%	2.69%
AVGO	0.956%	0%		1.206%		1.62%	2.47%
AMD	1.781%	0%		2.486%		1.00%	1.53%
XLNX	0.722%	0%		0.954%		0.30%	0.46%
NOW	0.907%	0%		1.183%		1.01%	1.54%
HPQ	0.819%	0%		1.024%		0.26%	0.40%
ETSY	1.290%	0%		1.593%		0.21%	0.32%
MCD	0.495%	0%		0.677%		1.47%	2.23%
NKE	0.781%	0.22%		1.202%		5.57%	2.86%
DPZ	0.504%	0%		0.678%		0.14%	0.22%
BBWI	1.275%	0%		1.422%		0.14%	0.21%
PG	0.354%	0%		0.526%		2.74%	4.17%
PM	0.816%	0%		1.053%		1.21%	1.84%
UL	0.359%	0%		0.542%		1.13%	1.72%
KHC	0.955%	0%		1.134%		0.36%	0.55%
NWL	0.817%	0%		1.080%		0.08%	0.12%
FDX	1.103%	0%		1.455%		0.48%	0.73%
ARCB	0.907%	0%		1.161%		0.02%	0.03%
HUBG	0.612%	0%		0.804%		0.02%	0.03%
CVX	0.862%	0%		1.167%		1.63%	2.48%
TSLA	3.568%	0%		4.135%		6.28%	9.55%
RACE	0.761%	0%		0.989%		0.42%	0.63%
F	0.618%	0%		0.745%		0.46%	0.70%

Appendix B: Bond Selection

Black Litterman - Bond				
Anticipated benchmark return	0.92%	<-- =11%/12		
Current T-bill rate	0.02%			
Normalizing factor	4.69	<-- {=(B2-B3)/MMULT(MMULT(B8:D8,B12:D14),TRANSPOSE(B8:D8))}		
	TIPX	BWX	CWB	
Market cap (million $)	908.56	977.9	7100.32	
Benchmark proportions	10.1%	10.9%	79.0%	
Variance-covariance matrix				
	TIPX	BWX	CWB	With normalizing factor
TIPX	0.0001	0.0001	0.0001	0.07%
BWX	0.0001	0.0008	0.0003	0.18%
CWB	0.0001	0.0003	0.0029	1.13%
Check: The expected return of the benchmark?	0.92%	<-- {=MMULT(B8:D8,F12:F14)}		
Optimal portfolio				
TIPX	10.11%	<-- {=MMULT(MINVERSE(B12:K21),M12:M21-B3)/SUM(MMULT(MINVERSE(B12:K21),M12:M21-B3))}		
BWX	10.88%			
CWB	79.01%			
Sum of proportions	100.0%			

Appendix C: Alternative Selection

Black Litterman - Alternative									
Anticipated benchmark ret	0.92%								
Current T-bill rate	0.02%								
Normalizing factor	3.84	<-- {=(B2-B3)/MMULT(MMULT(B8:C8,B12:C13),TRANSPOSE(B8:C8))}							
	RWR	GLD							
Market cap (million $)	1831.57	55455.3							
Benchmark proportions	3.2%	96.8%							
Variance-covariance matrix									
	RWR	GLD			With normalizing factor				
RWR	0.0049	-0.0001			0.03% <-- {=(MMULT(B12:C13,TRANSPOSE(B8:C8))*B4)+B3}				
GLD	-0.0001	0.0025			0.95%				
Check: The expected return of the benchmark?	0.92%	<-- {=MMULT(B8:D8,F12:F14)}							
Additional check: Optimal portfolio									
RWR	3.20%	<-- {=MMULT(MINVERSE(B12:C13),F12:F13-B3)/SUM(MMULT(MINVERSE(B12:C13),F12:F13-B3))}							
GLD	96.80%								
Sum of proportions	100.0%								
	Expected benchmark returns, no opinions	Analyst opinion, delta, δ		Returns adjusted for opinions			Opinion-adjusted optimized portfolio		Portfolio benchmark, no opinions
RWR	0.03%	0.19%	RWR	0.23%	<-- =A25+B12/$B$12*$B$25		14.02%	GM	3.20%
GLD	0.77%	0.00%	GLD	0.77%	<-- =A26+B13/$B$12*$B$25		85.98%	HD	96.80%
expected RWR return	0.225%			0.23%		sum	100.00%		