A Comprehensive Approach to AI Quantization Investment Portfolio Construction Take the Happicity Pension Plan Investment Board under Epidemic as an Example

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Abstract: In this paper, a comprehensive approach to professional investment planning is studied to achieve the optimal allocation of defined contribution funds. The Happicity Pension Plan Investment Board is used as an example to demonstrate the reliability and correctness of the data presented in this study. The article first analyses the client's investment objectives and circumstances and then thoroughly examines the client's limits. The original weighted assets were calculated using a bootstrap method combined with historical data. In order to adapt the technique to the current post-COVID-19 investment environment and address some non-quantitative difficulties, a study of underlying risks was used as a qualitative adjustment. AI quantization comes into being and has aroused controversy and discussion. Finally, the CAMP method is used to verify the recommended asset weights. This comprehensive strategy concluded that 60 per cent would be invested in equity assets, 19 per cent in fixed income, 15 per cent in real estate and 6 per cent in alternative assets to meet investment objectives and manage various risks. We take into account increased administration and transaction costs, so this integrated approach is used to maximize the operational efficiency of the portfolio for the benefit of investors.

Keywords: artificial intelligent; investment portfolio construction; comprehensive approach; invest benefit

1 INTRODUCTION

The client's objectives and circumstances for Happicity's defined contribution pension fund for public sector employees are first identified. The main objective of investing is to maximise returns while minimising cash and loss risk to ensure stable income. While being a long-term investment, the portfolio is required to be long-term.

Liquidity requires a modest weighting in the investment profile. Investors must bear minimal management fees and existing portfolios are dominated by highly liquid equity and fixed income markets.

Table 1: Clients' objectives and constraints

Objectives	**Constraints**
Investment horizon	10 year

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Five-year outcome	Greatest possible compound return over the next 5 years
Return target	At least 3% above inflation (CPI) in the long run
Not losing money	Probability of loss: ≤ 10%
Relative target	Tracking error vs comparison group: ≤1.5%p.a.
Illiquidity demand	Illiquid assets: ≤20%
Stability	Cash: ≥1% Short sales: = 0

Potential investment asset classes specified in the study include equities (such as Australian equities, unhedged and hedged world equities, emerging markets), fixed income (such as Australian cash, Australian fixed income, Australian inflation-linked bonds, world fixed income), property and infrastructure (such as listed property, direct property), other alternatives (such as collateralized commodity futures, hedge funds, US private equity).

With bootstrap models, the full portfolio formulation software determines the mean-variance of historical returns from 1992 to 2019. The risk was then controlled with a fundamental risk analysis, with all asset classes selected for less than a year for comparison. Since the ILB index began in 1991, we chose data for December 2019, and the annual interval is in line with the 10-year investment horizon.

2 QUANTITATIVE CONSTRUCTION

2.1 Introduction of Bootstrap Method

Bootstrap is a simple methodology that uses limited historical data to estimate future returns and makes the assumption that all data is distributed independently and identically. Here are the steps:

- Adjust the annual return for the predicted return;
- Determine 5-year mean value, compounded return, tracking error and probability of loss as the summary table;
- While meeting the restrictions, the solver achieves optimal asset allocation.

2.2 The Outcome of the Bootstrap Method

To get the best return of 6.89 per cent, the solver shifts weight from low-yielding assets like AFI, WEI and AC to higher-yielding assets and stocks. The new portfolio adds additional assets, recognizing the need for diversity, but increasing volatility.

The bulk of illiquid assets is HF and DP. In markets affected by a pandemic, HF is preferred for its ability to hedge market risk and profit. DP is also preferred because of its low correlation with stocks and low volatility.

In the equities asset class, while some weighting is transferred to the WE to spread risk, a significant weighting was shifted to AE, leading to a bias against home countries. Other asset classes have nearly hold low proportion and equal weights.

Weight is reasonable for any goal and limit, but we need to rebalance assets.

Table 2: Outcome of Solver

	AE	***WE, U***	***WE, H***	***EM***	***LP***
Existing	40%	10%	10%	0%	10%
Benchmark	26%	14%	8%	3%	5%
Outcome	50%	22%	0%	1%	0%
	DP	***COM***	***HF***	***PE***	***AFI***
Existing	0%	0%	0%	0%	16%
Benchmark	7%	1%	4%	3%	13%
Outcome	5%	3%	5%	3%	3%
	ILB	***WFI***	***AC***		
Existing	0%	10%	4%		
Benchmark	2%	11%	3%		
Outcome	3%	5%	1%		

Table 3: Outcomes of measurement meeting constraints

Measurement	Constraints	Existing
Mean (t=5) value	Max	1.39
Compounded Return p.a.	Max	6.33%
STD	-	0.3
SD	-	4.77%
Prob of loss （value）	10%	10.31%
TE	1.50%	1.10%
Illiquid weight	20%	
Cash Weight	1%	4%
Measurement	BM	Outcome
Mean (t=5) value	1.38	1.43
Compounded Return p.a.	6.31%	6.89%
STD	0.25	0.34
SD	3.99%	5.23%
Prob of loss （value）	6.69%	10.00%
TE		1.34%
Illiquid weight		13%
Cash Weight	0%	1%

2.3 Limitation

For the bootstrap approach, this assumption is rarely true in practice, so solver functions cannot take it into account. Even if this hypothesis is true, it ignores the effect of sequence correlation, and it is also questionable to study historical data without considering reality.

3 IMPLIED VIEWS

3.1 Introduction of CAPM Method

Risk-free and risk premium returns are predicted by the implied CAPM, which is the link between the expected return of assets and the expected return of risky assets in the securities market. The implied CAPM may be used to assess the bootstrap weight.

- The risk-free rate and risk premium come from the RBA website;
- Using the benchmark, determine the slope of the curve and the adjusted return;
- The actual historical data are averaged and compared with the CAPM model's implied returns;
- Subtracting the difference from the historical data from 1992 to 2019 and adding the difference;
- Re-estimate the weight of each item using the same process as bootstrap, provided the client criteria are met.

3.2 The Outcome of CAPM Method

The CAPM data we utilize is much similar to historical data, and the proportions of other initiatives are identical to our previous analysis. This illustrates that Bootstrap's weight is appropriate, and there will not be a huge difference even if it ignores the risk. However, the highest gap between Bootstrap results and Australian fixed income bonds is 11%. Therefore, to make the data more acceptable, some restrictions should be added and possible adjustments made after considering factors such as the underlying risk.

Table 4: Outcome of CAPM

	AE	*WE, U*	*WE, H*	*EM*	*LP*
Benchmark Portfolio	26%	14%	8%	3%	5%
Adjustments (diff)	16%	13%	-7%	1%	-2%
Re-optimized Portfolio	44%	30%	0%	3%	1%
	DP	*COM*	*HF*	*PE*	*AFI*
Benchmark Portfolio	7%	1%	4%	3%	13%
Adjustments (diff)	-7%	1%	-3%	0%	1%
Re-optimized Portfolio	0%	3%	0%	1%	11%
	ILB	*WFI*	*AC*		
Benchmark Portfolio	2%	11%	3%		

Adjustments (diff)	0%	-11%	-2%
Re-optimized Portfolio	6%	0%	1%

3.3 Limitation

CAPM has several limitations. We assume that CAPM is typically distributed, meaning perfect competition, impossible to achieve. Because trading markets have been volatile, the risk-free rate and risk premium are merely averages of expectations. So the risk-free rate and the risk premium are variables. Beta values are derived using historical data and have no macroeconomic impact, so we prefer the historical data bootstrap rather than the CAPM technique.

4 QUANITATIVE METHODS

4.1 Consideration

4.1.1 Macroeconomic outlook

a) Global Economy:

COVID-19 is causing the worst global recession since 1929, with the world economy expected to contract by 4.75% in 2020, shrinking on every continent. America's real GDP fell by 31.4 per cent in the second quarter, compared to -5 per cent in the first [7]. The underlying reason is the massive loss of employment and production that occurred in April as a result of the abrupt shutdown of most economic activity.

b) Australian Economy:

The Australian economy is also in deep recession, with real GDP falling by 7% in June, the most significant quarterly decline on record. A major economic impact of the crisis is the loss of jobs in sectors such as hotel and catering services. The financial support is expected to boost real GDP by 4.25 per cent from 2020 to 2021, while reducing unemployment by 5% and preventing the loss of almost 700,000 jobs [1].

The stock market is a leading economic indicator. The Australian Reserve Bank cut interest rates twice in March, to 0.25 per cent, and expects to keep them low for a year. In late March, the ASX200 index fell almost 36% to its lowest level since 2012. Australian stock market rebounded 16% in the April quarter as wild swings increased investment risk and dented consumer confidence.

During a pandemic, it is best to invest in fixed-income assets, which provide steady income and are less risky than stocks. It can effectively mitigate losses from stock market risk, reduce volatility, generate regular income, and bring predictable returns.

Given the pandemic's disruption to Australia's financial markets, it makes sense to reduce liquidity fund investments. As expected, the Reserve Bank of Australia retains the interest rate at 0.25 per cent, resulting in low financing costs and high revenue costs for Australian liquid cash investors [8].

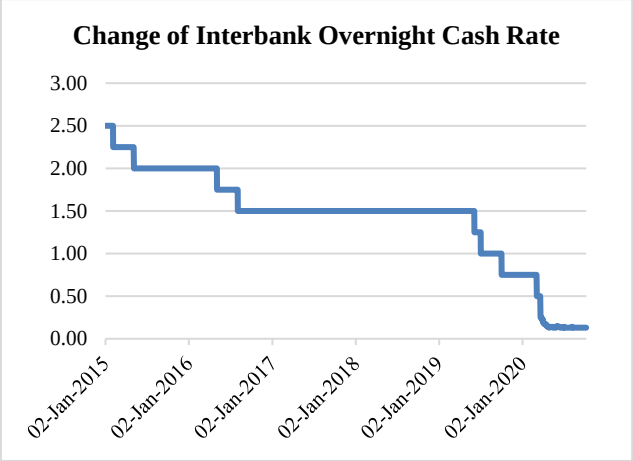

Figure 1. Change of Interbank Overnight Cash Rate

4.1.2 Inflation risk

Until 2020, Australia's inflation rate is about 2%. With the onset of COVID-19 in 2020, leading economic indicators have declined sharply. The Reserve Bank of Australia reported that inflation was -0.3% in the second quarter of 2020. The central bank's loose monetary policy and steady economic recovery are expected to produce a turning point in Australia's inflation rate.

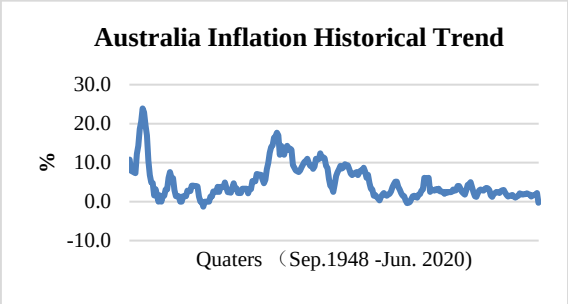

Figure 2: Australia Inflation Historical Trend

4.1.3 Home bias risk

Investors who fail to diversify their portfolios and over-invest in their home countries develop a local bias. Home-country bias exposes portfolios to risk due to the lack of foreign diversification [4]. To avoid home bias, the portfolio should have some variation in the equity and fixed income markets to balance Australian and international investments.

4.1.4 Structural and systematic risk

This type of risk is not dispersible because it comes from external causes beyond the control of anyone organization or individual [3]. While systemic risk in countries has increased rapidly

during the COVID-19 pandemic, recent government regulatory initiatives have helped flatten the risk curve [6].

For the "black swan" extreme event risk: Global GDP is expected to fall by 4.9 per cent in 2020 and 5.4 percent in 2021 [3]. The impact of the COVID-19 pandemic on activity has been greater than expected, and recovery will be slower.

For interest-rate risk: From 0.75 per cent in January 2020 to 0.13 per cent in October 2020, the Reserve Bank of Australia said the interest rate dropped by 0.25 per cent in March 2020, from 0.5 per cent to 0.25 per cent (20th March 2020).

For exchange rate risk: Based on data from the Reserve Bank of Australia, the chart shows volatility and that currency risk is always present and directly affects the return of each investment involved in overseas markets.

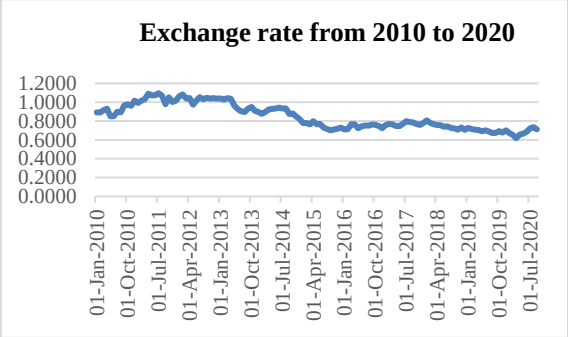

Figure 3: Exchange rate from 2010 to 2020

4.2 Adjustment Decisions

There are drawbacks to using only quantitative methods to allocate assets. Some risks cannot be predicted from previous data, and using only quantitative methods increases the risk of error. So the quantitative approach must be adjusted using a basic risk approach, introducing additional constraints into the portfolio in order to meet the above criteria (AE≤20%, WE, H≥10%, PE≤5%, AFI≥13%, and WFI≥5%).

- Decrease AE from 50% to 20% (peer: 26 %)

The results of the original solver achieve maximum returns under these constraints, but it exposes risky portfolios to undiversified and home-biased risk. Therefore, the share of AE investments needs to be reduced to increase the international diversification of the portfolio;

- Increase WE,H from 0% to 10% (peer: 8 %)

Diversifying portfolios by increasing exposure to hedged global equities will also mitigate risk. Historical data on the exchange rate show a reasonably consistent pattern despite the volatility, as shown in the RBA chart;

- Increase PE from 3% to 5% (peer: 3 %)

American private equity is a high-risk and high-return asset, which is suitable for high net worth individuals and institutional investors seeking high returns [5]. The US private equity index climbed steadily over the decade, from 1217.82 in 2010 to 5577.7 in 2019 [5]. Increasing the proportion can increase the portfolio's return;

- Increase AFI from 3% to 13% (peer:13%)

From 2015 to 2019, the Reserve Bank of Australia reported a modest variation in the 10-year government bond yields. The 10-year Treasury bond yield reduced in 2020 due to the COVID-19 epidemic, but its return and risk are still low, so it is recommended to increase AFI investment.

Table 5: Comparison of asset allocations between portfolios

	Exist	**Compare**	**Solver Output**
AE	40%	26%	50%
WE, U	10%	14%	22%
WE, H	10%	8%	0%
EM	0%	3%	1%
LP	10%	5%	0%
DP	0%	7%	5%
COM	0%	1%	3%
HF	0%	4%	5%
PF	0%	3%	3%
AFI	16%	13%	3%
ILB	0%	2%	3%
WFI	10%	11%	5%
AC	4%	3%	1%
	Recommend	**Change compare to solver**	**Change compare to existing**
AE	20%	-30%	-20%
WE, U	18%	-4%	8%
WE, H	10%	10%	0%
EM	12%	11%	12%
LP	14%	14%	4%
DP	2%	-3%	2%
COM	1%	-2%	1%
HF	0%	-5%	0%
PF	5%	2%	5%
AFI	13%	10%	-3%
ILB	0%	-3%	0%
WFI	5%	0%	-5%
AC	1%	0%	-3%

5 OTHER CONSIDERATION

The original and adjusted fees are 0.354 per cent and 0.260 per cent. The adjusted management fee is 0.094 per cent, representing a low-cost combination. Except for activating alternatives DP, HF, and PE, we chose passive assets because their management fees are cheaper than active assets. The adjusted portfolio returned 7.13 per cent, compared with the original portfolio's

return of 6.86 per cent. However, the management fee is only a tiny part of the firm's total investment pool. Let us look at the maximum return in past conditions.

Table 6: Asset allocations adjusted by management fee

	AE	***WE, U***	***WE, H***	***EM***
Fee schedule	0.10%	0.10%	0.10%	0.20%
Planned	50%	22%	0%	1%
Original Fee	0.050%	0.022%	0.000%	0.001%
Adjusted Planned	20%	18%	10%	12%
Adjusted Fee	0.020%	0.018%	0.010%	0.024%
	LP	***DP***	***COM***	***HF***
Fee schedule	0.15%	1.20%	0.25%	2.50%
Planned	0%	5%	3%	5%
Original Fee	0.000%	0.057%	0.007%	0.126%
Adjusted Planned	14%	2%	1%	0%
Adjusted Fee	0.020%	0.027%	0.002%	0.000%
	PE	***AFI***	***ILB***	***WFI***
Fee schedule	2.50%	0.10%	0.10%	0.15%
Planned	3%	3%	3%	5%
Original Fee	0.076%	0.003%	0.003%	0.007%
Adjusted Planned	5%	13%	0%	5%
Adjusted Fee	0.116%	0.013%	0.000%	0.008%
	AC	***SUM***		
Fee schedule	0.15%			
Planned	1%			
Original Fee	0.002%	0.137%		
Adjusted Planned	1%			
Adjusted Fee	0.002%	0.122%		

6 CONCLUSIONS

In this paper, we change an introductory investment weighting so that the adjusted data fully meets the firm's constraints and also meets the preferred profit criteria. we 've come to a conclusion that traditional quantization and AI quantization are desirable strategic models. Moreover, both of them have their own characteristics of investment. Understanding these characteristics can help us avoid risks in the investment process and reduce unnecessary losses. To this end, the Happy Pension Plan Investment Committee must adjust its portfolio over time and as external conditions change. Therefore, this comprehensive approach maximizes the operating efficiency of the investment portfolio for investors.

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