An Elementary Approach to GPIF Investment Allocation Optimization: A Basic Risk-Return Evaluation Perspective

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Abstract

This report examines a portfolio optimization methodology based on the investment allocation approach adopted by the Government Pension Investment Fund (GPIF). Employing quadratic programming, we derive optimal investment allocations for Japan, developed countries (excluding Japan), and emerging markets by incorporating market growth rates and variances. The analysis offers valuable insights into enhancing portfolio performance through a balanced approach to expected returns and risk management.

Ⅰ Introduction

In this paper, we examine whether the Government Pension Investment Fund (GPIF) has achieved an optimal allocation of its equity investments, with particular emphasis on the impact of population aging on the stock market. Given Japan's rapidly shifting demographics, it is crucial to assess how an aging population may influence equity returns and investment decisions.

According to GPIF (2024), the annual rate of return since fiscal 2001 has been 4.36%, reaching ¥245,981.5 billion as of the end of fiscal 2023—an increase of ¥153,797.6 billion since fiscal 2001. It also states, "In order to steadily implement management based on the policy asset mix, GPIF purchases and sells (i.e., rebalances) assets in a timely and appropriate manner in response to changes in the economic and market environment so as not to deviate from the asset allocation policy specified in the policy asset mix." The current policy asset mix is as follows: domestic bonds account for 25%, foreign bonds for 25%, domestic equities for 25%, and foreign equities for 25%.

Before analyzing how population aging influences the stock market, we first summarize the publicly disclosed GPIF investment data from 2015 to 2023 (Figure 1). Notably, among foreign investments, the United States holds the largest share, followed by other developed countries.

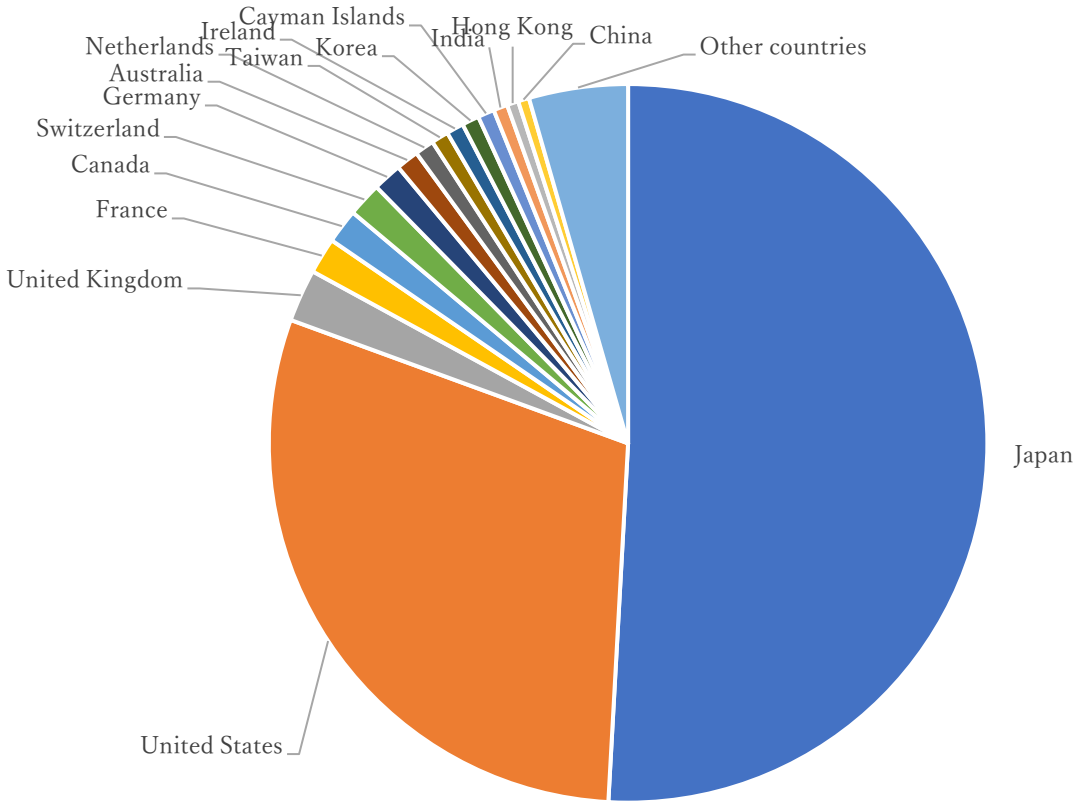

Figure 1: GPIF's Equity Investment Allocation by Country (2015–2023)

This figure summarizes the country-wise equity investment allocation of GPIF based on publicly disclosed data from 2015 to 2023. The share of each country is calculated by summing up the values for the years 2015–2023 and dividing the total for each country by the overall total.

GPIF's investment policy dictates that 50% of its equity investments should be allocated to Japanese stocks and 50% to foreign stocks. Accordingly, the actual holdings of Japanese and foreign equities are maintained at approximately 50% each (Figure 1).

This allocation strategy aligns with GPIF's fundamental principle of diversifying investments across assets, regions, and time to ensure long-term and stable returns. In its basic portfolio, the target allocation ratio for foreign equities is set at 50%. This allocation is part of a broader strategy to mitigate risks and pursue stable returns by diversifying investments across domestic and international bonds and equities.

However, when looking at foreign equities in detail, the majority of investments are

concentrated in the United States. The U.S. accounts for 29.7% of GPIF's total equity investments, which translates to approximately 60% of its foreign equity portfolio. The next largest investment destinations are the United Kingdom and France, with shares of approximately 2.4% and 1.6%, respectively. Compared to the U.S., these allocations are significantly lower.

Is such an investment allocation truly optimal for managing a limited pension fund? From the perspective of diversification—meaning a broader range of investment destinations—one might argue that the portfolio is overly concentrated in the United States. A more balanced allocation across multiple countries could potentially reduce risk and enhance long-term stability.

However, at the same time, it is also possible that this concentration in the U.S. market is justified by the pursuit of maximum returns. The strong performance of the U.S. stock market in recent years may have led to a higher expected return, making it a rational choice for portfolio allocation.

Given these considerations, we seek to analyze the optimal investment allocation by examining key indicators such as growth potential and diversification[1]. By evaluating how different allocation strategies impact risk and return, we aim to determine whether the current investment approach aligns with the best long-term interests of the pension fund.

The decision to increase the allocation of foreign equities to 25% in the 2014 portfolio revision was driven by several key considerations. First, in order to achieve the targeted real investment return of 1.7%, it was necessary to shift toward assets with higher expected returns. Given the persistently low interest rates in Japan and the expectation of

[1] This analysis is a rudimentary study based on optimal investment allocations derived from scores computed from risk and variance according to the classical Markowitz (1952) framework.

rising wages and inflation, domestic bonds alone were insufficient to generate the required returns. Foreign equities, which historically offer higher long-term returns compared to domestic bonds, were seen as a viable option to enhance the portfolio's performance.

Another crucial factor was the need for greater diversification. By increasing the proportion of foreign equities, the portfolio could reduce its reliance on domestic assets and mitigate risks associated with Japan's economic fluctuations. Diversification across different global markets allowed for a more stable risk-return profile, as foreign economies follow different business cycles and market dynamics compared to Japan.

Additionally, the revision aimed to reduce dependence on domestic bonds, which had previously accounted for a substantial portion of the portfolio (60–67%). In a low-yield environment, maintaining such a high proportion of bonds posed risks to the long-term sustainability of pension funds. Shifting a portion of the funds to equities allowed for a better balance between risk and return.

Finally, economic policy considerations also played a role. The 2014 public pension review projected a shift in Japan's economic environment, including an expected exit from deflation and a more dynamic financial landscape. In this context, maintaining a bond-heavy portfolio was deemed inadequate, and an increase in foreign equities was seen as a necessary step to align the investment strategy with anticipated economic conditions.

Thus, the decision to allocate 25% to foreign equities was based on a combination of achieving higher returns, enhancing diversification, reducing reliance on low-yielding domestic bonds, and adapting to Japan's evolving economic outlook[2].

Since the fiscal year 2001, when the Government Pension Investment Fund (GPIF) assumed responsibility for managing pension contributions in the market, it has delivered

[2] For more details, please refer to https://www.gpif.go.jp/gpif/portfolio.html .

strong performance, achieving an average annual return of 4.4% and cumulative profits exceeding 164 trillion yen. One possible driver of these favorable results is the strategic shift toward increasing the allocation of overseas investments to capture higher returns. However, the significant concentration in U.S. assets remains a key concern. Given these factors, this study focuses on evaluating the risk and return characteristics of domestic versus international equities to determine the optimality of the fund's historical asset allocation. To achieve this, a dual-method approach is employed, combining a simplified risk–return scoring system with portfolio optimization techniques that account for home-country bias.

2 Data Analysis

Based on the investment balance data published by GPIF at the end of each fiscal year, the data were aggregated by country. For each investment-target country, the market capitalization of its largest equity market was retrieved via an API from Yahoo Finance, using February 1 as the reference date. If the market was not in session on February 1, the first available value within the subsequent five-day period was used as the representative market capitalization. The annual growth rate of this market capitalization was then calculated and treated as the return. A scoring system incorporating both return and variance was subsequently applied to determine the optimal allocation ratio. The dataset spans from 2013 to 2025. It is important to note that although GPIF's investment portfolio is assumed to cover 61 countries, market data were successfully obtained for only 26 countries, representing approximately 42.6% of the total.

Table 1 summarizes the countries for which market data were successfully obtained, as well as those for which the data were unavailable. In this analysis, although data were obtained for fewer than half of the countries, the share of the investment amount covered by

these data averaged 97.1% over the period. This suggests that we have effectively acquired data for nearly all of the countries in which the GPIF invested during that timeframe.

Countries with available data	Countries or area with unavailable data
Australia, Austria, Belgium, Brazil, Canada, China, France, Germany, Hong Kong, India, Indonesia, Ireland, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, New Zealand, Singapore, Spain, Switzerland, Thailand, Turkey, United Kingdom, United States	Bermuda, Cayman Islands, Chile, Colombia, Czech Republic, Denmark, Egypt, Faroe Islands, Finland, Greece, Guernsey, Hungary, Isle of Man, Israel, Jersey, Kuwait, Liberia, Luxembourg, Marshall Islands, Mauritius, Norway, Pakistan, Panama, Papua New Guinea, Philippines, Poland, Portugal, Puerto Rico, Russian Federation, Qatar, Saudi Arabia, South Africa, Sweden, Taiwan, United Arab Emirates,

Table 1: Summary of Countries by Data Availability for Market Capitalization

This table categorizes the 61 targeted countries based on whether market capitalization data were available. Data were obtained for 26 countries (approximately 42.6%).

Country	Optimal Weight	Country	Optimal Weight
Australia	5.65%	Korea	0.01%
Austria	2.30%	Malaysia	1.27%
Belgium	4.67%	Mexico	0.91%
Brazil	0.65%	Netherlands	0.93%
Canada	5.22%	New Zealand	12.88%
China	1.45%	Singapore	2.70%
France	5.88%	Spain	2.83%
Germany	6.44%	Switzerland	8.40%
Hong Kong	1.44%	Thailand	1.25%
India	3.26%	Turkey	0.00%
Indonesia	0.01%	United Kingdom	3.99%
Ireland	5.39%	United States	11.31%
Italy	3.61%		
Japan	7.53%		

Table 2: Growth-Variance Optimal Allocation Model

This table shows the optimal investment allocations, calculated as the normalized ratio of average growth rate to variance, with negative scores (e.g., Turkey) set to zero.

The optimal investment allocation for each country is determined using a scoring method, in which the ratio of the average market capitalization growth rate to its variance serves as the score. However, if a country's score is negative (as observed for Turkey), it is set to zero, effectively excluding that country from the investment pool. The normalized scores represent the optimal investment proportions. The results are summarized in Table 2.

Table 2 presents the optimal investment allocations calculated without accounting for home-country bias. According to these results, New Zealand should receive the highest allocation, followed by the United States as the second-largest allocation.

Following the GPIF approach, the portfolio is rebalanced so that Japan receives exactly 50% of the total allocation, with the remaining 50% allocated exclusively to foreign markets. These countries are further categorized into developed and emerging markets, and the optimal allocations for each are computed accordingly. The results are summarized in Table 3.

Country	Optimal Weight	Country	Optimal Weight
Australia	3.05%	Korea	0.01%
Austria	1.24%	Malaysia	0.69%
Belgium	2.52%	Mexico	0.49%
Brazil	0.35%	Netherlands	0.50%
Canada	2.82%	New Zealand	6.96%
China	0.78%	Singapore	1.46%
France	3.18%	Spain	1.53%
Germany	3.48%	Switzerland	4.54%
Hong Kong	0.78%	Thailand	0.67%
India	1.76%	Turkey	0.00%
Indonesia	0.01%	United Kingdom	2.16%
Ireland	2.91%	United States	6.12%
Italy	1.95%		
Japan	50.00%		

Table 3: GPIF Home-Bias Optimal Allocation Model

This table presents the optimal allocations after adjusting the portfolio to allocate 50% to Japan and 50% to other countries, with the latter further divided into developed and emerging markets.

Table 3 presents the optimal investment allocations for each country after incorporating home-country bias and categorizing non-Japanese markets into developed and emerging groups. Under this framework, the United States' allocation has increased to 6.12%, slightly exceeding the 5% threshold. However, given that data for nearly half of the target countries were unavailable, this limitation must be taken into account. Even with this constraint, the United States' allocation would likely be capped at approximately 10% at most, making the roughly 30% allocation suggested by Figure 1 appear excessive.

Country	Optimal Weight	Country	Optimal Weight
Australia	1.39%	Korea	0.00%
Austria	0.57%	Malaysia	0.31%
Belgium	1.15%	Mexico	0.22%
Brazil	0.16%	Netherlands	0.23%
Canada	1.29%	New Zealand	3.17%
China	0.36%	Singapore	0.67%
France	1.45%	Spain	0.70%
Germany	1.59%	Switzerland	2.07%
Hong Kong	0.35%	Thailand	0.31%
India	0.80%	Turkey	0.00%
Indonesia	0.00%	United Kingdom	0.98%
Ireland	1.33%	United States	30.00%
Italy	0.89%		
Japan	50.00%		

Table 4: Japan-US Priority Hybrid Reallocation Model

Japan is assigned 50%, the USA 30%, and the remaining 20% is distributed among other countries based on their respective scores.

Accordingly, we calculate the allocations by intentionally assigning 50% to Japan and 30% to the United States, with the remaining allocation determined based on the scores. The results are summarized in Table 4. In this configuration, since Japan and the United States account for 80% of the total allocation, countries with low scores, such as Indonesia and Korea, receive an optimal investment proportion of 0.0%.

Although Japan's allocation is set at 50%, the criteria for distributing the remaining

portion among foreign markets remain open to debate. As a basis for comparison, we consider two models for allocating the residual 50%: (i) one that divides foreign countries into developed and emerging markets, and (ii) one that categorizes countries into those with advanced aging and those with relatively younger populations. The results of these models are compared with the previous analysis and are summarized in Table 5 and Table 6, respectively.

In this framework, despite a greater number of countries being classified as developed, investments are distributed equally between the developed and emerging groups. Consequently, the relative allocation for developed countries becomes lower, while that for emerging markets is higher. This approach results in India's allocation exceeding 10%, whereas the United States' allocation, which was initially of particular interest, falls to a relatively low 3.34%.

Country	Optimal Weight	Country	Optimal Weight
Australia	1.67%	Korea	0.00%
Austria	0.68%	Malaysia	4.02%
Belgium	1.38%	Mexico	0.27%
Brazil	2.07%	Netherlands	0.28%
Canada	1.54%	New Zealand	3.81%
China	4.58%	Singapore	0.80%
France	1.74%	Spain	0.84%
Germany	1.90%	Switzerland	2.48%
Hong Kong	0.43%	Thailand	3.95%
India	10.34%	Turkey	0.00%
Indonesia	0.04%	United Kingdom	1.18%
Ireland	1.59%	United States	3.34%
Italy	1.07%		
Japan	50.00%		

Table 5: Optimal Allocations with Developed/Emerging Market Grouping Model

This table summarizes the investment allocations after dividing non-Japanese markets into developed and emerging groups. Equal weight is assigned to each group, while individual country allocations within each group are determined based on scores derived from return rates and variances.

Finally, we examine the impact of demographic trends. Aging rates for each country were obtained from the World Bank's "Population ages 65 and above, total (% of total population)"

data. A cluster analysis was performed over the study period to classify countries into high-aging and low-aging groups, with equal investment allocated to each group. As in the previous analysis, within each group the allocation is determined based on the score derived from return rates and variances. The results are presented in Table 6.

Under this scheme, Singapore—experiencing low rates of aging—is classified in the low-aging group and consequently receives a high allocation, while India continues to maintain a high allocation as before.

Country	Optimal Weight	Country	Optimal Weight
Australia	1.74%	Korea	0.00%
Austria	0.71%	Malaysia	2.76%
Belgium	1.44%	Mexico	1.97%
Brazil	1.42%	Netherlands	0.29%
Canada	1.61%	New Zealand	3.98%
China	3.14%	Singapore	5.87%
France	1.82%	Spain	0.88%
Germany	1.99%	Switzerland	2.60%
Hong Kong	0.44%	Thailand	2.71%
India	7.09%	Turkey	0.00%
Indonesia	0.03%	United Kingdom	1.23%
Ireland	1.66%	United States	3.49%
Italy	1.11%		
Japan	50.00%		

Table 6: Optimal Allocations by Aging Rate Clusters Model

This table presents the investment allocations obtained by clustering countries according to their aging rates (using World Bank data for population aged 65 and above). Equal weight is given to each cluster, with individual country allocations within each cluster determined by return-variance scores.

Table 6 summarizes the expected return rates and the expected scores—computed based on these return rates and variances—under each of the policy-driven investment allocations presented thus far. According to these results, the allocation based on the GPIF Home-Bias tends to yield both higher expected returns and higher expected scores compared to the allocation determined solely by optimal scores. This is likely because incorporating Home-Bias helps to mitigate variance while simultaneously achieving higher returns. Notably,

the expected returns and scores attained through the population growth–based allocation—a primary motivation of this study—are improved relative to the results obtained when grouping countries into developed and emerging markets.

It is undeniable that, since the optimal investment allocations in this analysis are calculated based on ex-post realized returns, achieving the most desirable investment allocation remains challenging. Nevertheless, the finding that setting investment allocations according to aging demographics rather than grouping countries into developed and emerging markets is preferable is a noteworthy result.

Model	Expected Rate of Return	Expected Total Score
Growth-Variance Optimal Allocation Model	10.51%	0.494
GPIF Home-Bias Optimal Allocation Model	11.03%	0.892
Japan-US Priority Hybrid Reallocation Model	13.08%	1.957
Optimal Allocations with Developed/Emerging Market Grouping Model	10.96%	0.317
Optimal Allocations by Aging Rate Clusters Model	10.64%	0.418

Table 7 **Comparison of Allocation Models: Expected Returns and Total Scores**

This table summarizes the expected rate of return and the total score calculated for each allocation model.

Finally, we summarize the expected return rates and total scores derived from the optimal investment allocation models examined thus far. These values are presented in Table 7. As shown in the table, the hybrid investment policy—centered on Japan and the United States, with the remainder allocated to other countries—currently adopted by the GPIF achieves the highest expected return rate and total score. This finding suggests that, rather than determining allocations solely based on scores, concentrating investments to some extent on specific countries can lead to higher returns and scores.

Meanwhile, when comparing the grouping of countries into developed/emerging markets versus grouping them based on the degree of population aging, the

developed/emerging grouping yields a higher expected return rate, whereas the aging-based grouping produces a higher total score. Depending on which metric is considered more desirable, if a higher total score is preferred, these results imply that investing in countries with lower aging rates may be more advantageous than investing in those with advanced aging.

3 Conclusion

In this study, we developed an optimal investment allocation model that aligns with the GPIF's strategic framework. Specifically, Japan's allocation is fixed at 50% of the portfolio, while the remaining 50% is allocated among developed (excluding Japan) and emerging markets based on a scoring mechanism derived from each market's growth rate and variance. Utilizing quadratic programming, the model optimizes the balance between expected returns and associated risks.

The results indicate that the hybrid approach—combining a fixed allocation for Japan with score-based allocations for foreign markets—yields superior expected return rates and total scores compared to models that rely solely on score-based methods. Additionally, when comparing different grouping strategies, the analysis shows that grouping foreign markets into developed and emerging categories tends to produce higher expected returns, whereas grouping by aging demographics results in a higher overall score. This suggests that concentrating investments in selected countries, rather than distributing them uniformly based solely on computed scores, may lead to enhanced portfolio performance.

Furthermore, the success of the hybrid model underscores the potential benefits of integrating strategic investment biases, such as a home bias favoring Japan and the United States, with rigorous quantitative optimization. By mitigating portfolio variance and capitalizing on higher return opportunities, this approach offers a compelling alternative to

purely theoretical allocation methods. However, it is important to note that the reliance on ex-post return data presents challenges in predicting future performance, and further refinement through dynamic risk assessments and additional market indicators is warranted.

Overall, the findings support the adoption of a hybrid investment strategy that combines fixed national allocations with flexible, score-based adjustments for foreign markets. This integrated approach provides a robust framework for optimizing portfolio performance and may serve as a valuable guide for future research in portfolio optimization strategies.

References

Government Pension Investment Fund. 2024. *Annual Report – Fiscal Year 2023*. Tokyo: Government Pension Investment Fund.

Markowitz, H. (1952), Portfolio Selection, The Journal of Finance, Vol. 7, No. 1, pp. 77-91.