Lisbon School of Economics & Management
Universidade de Lisboa

MASTER OF SCIENCE IN

FINANCE

MASTERS FINAL WORK

PROJECT

INVESTMENT POLICY STATEMENT:

NORGES BANK INVESTMENT MANAGEMENT

TIM ŠVRČEK

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PROFESSOR PEDRO RINO VIEIRA

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Abstract

This Investment Policy Statement is specifically designed to accommodate the investment objectives of institutional investor Norges Bank Investment Management's "Government Pension Fund Global". The IPS focuses specifically on the Fixed Income portfolio within the entire fund. The main return objective is to achieve a maximized annual return exceeding the selected benchmark, Bloomberg Global-Aggregate Total Return Index (ticker: LEGATRUU). The risk key risk constraint is set as a maximum expected tracking error of 1.25%, with a leniency allowing the chosen portfolio to exceed this amount for one out of every three years. This key risk constraint, along with other constraints set in the IPS, preserve a low-risk investment profile across the portfolio. The time horizon is perpetual, given the fund's nature and mission.

The investment philosophy focuses on maximizing income generation through a buy-and-hold strategy, a rigorous security selection process focused on maximizing the quality of the selected issuers, and macroeconomic analysis. The strategic asset allocation encompasses the constraints set out by the client and allocates NOK 7.085 trillion to the asset class at the center of this IPS: Fixed Income. The proposed portfolio aims to achieve an annual expected return of 3.5% and a volatility of 0.14%. The proposed portfolio selects 23 securities to invest in.

An in-depth risk evaluation is performed using Value at Risk and Expected Shortfall methodologies, based on historical observations and simulation models. Analysis across multiple confidence levels (1%, 5%, and 10%) suggests the portfolio is well-positioned to endure unfavorable market scenarios, namely to deal with credit risk.

In summary, this Investment Policy Statement outlines a comprehensive strategy that is aligned with the client's goals and limitations, supporting a well-balanced risk-return profile. It functions as a reference point for ongoing investment decisions associated with Government Pension Fund Global, targeting long-term growth and financial stability. The IPS has been structured in accordance with CFA guidelines.

JEL classification:C6; G11;

Keywords: Asset Management; Portfolio Theory; IPS; Institutional Investors

Resumo

Esta Declaração de Política de Investimento foi especificamente concebida para acomodar os objetivos de investimento do investidor institucional Norges Bank Investment Management, no âmbito do “Government Pension Fund Global”. A IPS incide particularmente sobre a carteira de Rendimento Fixo dentro do fundo global.

O principal objetivo de retorno é alcançar um rendimento anual maximizado que supere o índice de referência selecionado, o Bloomberg Global-Aggregate Total Return Index (ticker: LEGATRUU). A principal restrição de risco é definida como um erro de acompanhamento (tracking error) máximo esperado de 1,25%, com uma margem de tolerância que permite que o portefólio ultrapasse este valor um em cada três anos. Esta restrição, juntamente com outras definidas na IPS, visa preservar um perfil de investimento de baixo risco em toda a carteira. O horizonte temporal é perpétuo, tendo em conta a natureza e missão do fundo.

A filosofia de investimento centra-se na maximização da geração de rendimento, através de uma estratégia de buy-and-hold, um processo rigoroso de seleção de títulos com foco na qualidade dos emissores selecionados e análise macroeconómica. A alocação estratégica de ativos respeita as restrições definidas pelo cliente e atribui 7,085 biliões de coroas norueguesas (NOK) à classe de ativos central desta IPS: Rendimento Fixo. O portefólio proposto visa alcançar um retorno anual esperado de 3,5% e uma volatilidade de 0,14%, distribuído por 23 títulos selecionados.

A avaliação de risco é realizada de forma aprofundada, utilizando metodologias de Value at Risk (VaR) e Expected Shortfall (ES), com base em dados históricos e modelos de simulação. A análise em vários níveis de confiança (1%, 5% e 10%) indica que o portefólio está bem posicionado para resistir a cenários de mercado adversos, nomeadamente no que diz respeito ao risco de crédito.

Em suma, esta Declaração de Política de Investimento apresenta uma estratégia abrangente, alinhada com os objetivos e restrições do cliente, promovendo um equilíbrio adequado entre risco e retorno. Serve como referência estratégica para decisões de investimento contínuas relacionadas com o Government Pension Fund Global, com vista ao crescimento sustentável e à estabilidade financeira a longo prazo. A IPS foi elaborada em conformidade com as diretrizes do CFA Institute.

Classificação JEL: C6; G11;

Palavras-Chave: Gestão de Activos; Teoria da Carteira; IPS; Investidores Institucionais

Acknowledgements

This final work represents a two-year journey full of many challenges, lessons learned and achievements, and I would like to express my gratitude to those who supported me along the way to help me get to where I am today.

To Sárinka, I am forever grateful for the sacrifices made and support shown to me during these challenging and stressful past couple of months. Thank you for being my rock – your love and devotion gave me the confidence to keep moving forward and allowed me to focus on this final stage of my academic journey.

Mami a Tati, thank you for the sacrifices made, unconditional encouragement and support throughout my academic journey. I hope I made you proud by making it this far. To my brother and sister, thank you for always being there for me.

To all my friends, thank you for all the support and always being by my side.

Lastly, I would like to express my deepest gratitude to my supervisor, Professor Pedro Rino Vieira, for your insightful guidance and continuous encouragement throughout the past two semesters. Your expertise and feedback were instrumental in shaping this final work.

My heartfelt thank you to all of you,
Tim

Abbreviations

EIM – External Investment Manager

CEO – Chief Executive Officer

ESTR – Euro Short-Term Rate

ES – Expected Shortfall

GDP – Growth Domestic Product

GIPS – Global Investment Performance Standards

GPFG – Government Pension Fund Global

ICR – Interest Coverage Ratio

IPS – Investment Policy Statement

LGD – Loss Given Default

MPT – Modern Portfolio Theory

NBIM – Norges Bank Investment Management

NOK – Norwegian Krone

PD – Probability of Default

ROA – Return on Total Assets

VaR – Value-at-Risk

XGBoost – Extreme Gradient Boosting

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1 Executive Summary

The Investment Policy Statement (IPS) has been developed for Norges Bank Investment Management, the investment management arm of the Norwegian central bank and the manager of the largest sovereign wealth fund in the world. This IPS specifically focuses on the Fixed Income portfolio within the Government Pension Fund Global (GPFG), setting out relevant objectives, guidelines and constraints in order to align with the client's investment profile and appropriately manage their assets.

Given the gravity of the fund and its social purpose, the Governance structure of the fund is hierarchical, including oversight from Norway's Ministry of Finance, the Executive Board of the Norwegian central bank and a Leader Group within NBIM, all supervising and managing the rigorous investment process within the fund. The IPS introduces an External Investment Manager (EIM) elected to assist with the selection, risk and investment management of the Fixed Income portion of the fund. This EIM is set to report quarterly on the performance of the selected portfolio.

The risk and return objectives set out within this IPS highlight the client's low-risk investment profile, with an aim to maximize return at a given risk constraint. This is further highlighted by a strict set of constraints introduced by the fund's Management Mandate. The portfolio is also set not to exceed the expected tracking error measured against a benchmark by over 1.25% for over 1-year in a given 3-year time period. The selected portfolio, aimed at stable income generation, has an expected annual return of 3.5%. The portfolio is created through a rigorous security selection process, aimed at maximizing the credit quality of fixed income security issuers through an Extreme Gradient Boosting algorithm and Vasicek's stochastic interest rate modelling.

In addition to the quarterly portfolio performance reporting, the EIM is set to produce quarterly risk reporting, analyzing the various inherent and external risks which may affect the portfolio's stability and returns. Through tools such as Value-at-Risk, Expected Shortfall and other forms of analysis, the EIM quantifies and characterizes the portfolio's potential threats to the fund's mission.

2 Investment Policy Statement

2.1 Scope and Purpose

2.1.1 Investor Description

This Investment Policy Statement (IPS) is set out to govern and manage specific investments under the Government Pension Fund Global (GPFG). The GPFG is Norway's sovereign wealth fund managed by Norges Bank Investment Management (NBIM), a subsidiary of the Norwegian central bank. The client, NBIM, is responsible for the full operational management of the GPFG. With the fund's value currently sitting around NOK 19 trillion (approximately EUR 1.65 trillion), the GPFG is the largest sovereign wealth fund in the world. The fund was established by the Norwegian Parliament in 1990, and its first capital transfer was made in 1996. NBIM's mission is "safeguarding and building financial wealth for future generations" (Norges Bank Investment Management, 2025), referring to the Norwegian population.

The fund's total investments are divided across four major asset classes: Equities, Fixed Income, Real Estate, and Renewable Energy Infrastructure. These four key asset classes are treated as separate portfolios and consolidated to aggregate the total returns of the fund. This IPS shall only apply to the governance and management of the Fixed Income portfolio within the fund.

The purpose of this IPS is to clearly establish the client's risk and return objectives and outline the methodology, investment policies and other requirements that must be adhered to, in terms of investment and performance management, asset allocation and security selection. Within this IPS, the client will be able to identify all relevant information with regards to the management of the Fixed Income portfolio.

2.1.2 Structure

The management and mandate of the GPFG follows a hierarchical structure, starting with the Norwegian Parliament, whose major responsibility is the passing and amendment of the Government Pension Fund Act (henceforth referred to as "the Act"). The Act outlines the legal framework and management principles of the Sovereign state's two sovereign wealth funds. The Act outlines key principles, to which the funds and their management need to adhere to, mainly in relation to the funds' objectives and purposes, their structure, ethical responsibilities, transparency and accountability, fiscal rule, constraints, and process of amending and adapting current Acts to fit future needs (Norwegian Ministry of Finance, 2020).

Adhering to the requirements set out in the Act, the Norwegian Ministry of Finance is responsible for the creation and enhancement of a Management Mandate (henceforth referred to as "the Mandate"), which thoroughly outlines the guidelines for management of the funds. The Mandate further defines the core requirements and purposes to which all other parties related to managing each fund must adhere to, the key roles and responsibilities of all parties related to the funds' management and specific constraints and stipulations the funds must adhere to in order to safeguard their core mission of generating sustainable wealth for future generations of the Norwegian population whilst maintaining an acceptable level of risk.

Norges Bank, the Norwegian central bank, assumes the responsibility of the management of one of the funds, the GPFG, in adherence to this Mandate. Through Norges Bank's Executive Board, made up of nine members including the Governor of the central bank, the operational

management of the fund is transferred to NBIM. The Executive Board also has the responsibility to ensure that NBIM's management of the fund is "organised in a responsible, efficient and effective manner" (Norges Bank Investment Management, 2025), and may provide recommendations to the Ministry of Finance regarding any necessary changes to the Mandate.

The Chief Executive Officer (CEO) of NBIM has the overall responsibility to implement the requirements defined by the Executive Board and does so through setting internal policies at NBIM and further delegation of required mandates to NBIM's Leader Group. The Leader Group comprises of ten key functions, including the CEO, and is accountable for further delegation of specific tasks and investment directives within their areas of responsibility. The members of the Leader Group and their roles are outlined in the Appendices.

As per Section 1-8. of the Mandate for the GPFG, Norges Bank is authorized to use external managers and outsource operational functions of the fund (Norges Bank Investment Management, 2025). For the purpose of this IPS and with the approval from the Executive Board, NBIM have contacted the External Investment Manager (EIM) to perform managerial functions with respect to the selection, allocation and management of the entire Fixed Income composite of the GPFG fund. The EIM must adhere to and comply with all regulations, requirements, rules, laws, and constraints set out in the IPS, which is constructed in adherence to the Mandate.

2.2 Governance

The governance of the GPFG is shaped by its management's adherence to its social purpose of sustainable financial growth on a going concern. Additionally, the Fixed Income portfolio within the GFPG has three main purposes within the scope of the entire fund; to minimize risk through diluting the fund's overall volatility, to provide liquidity and to earn returns by capturing risk premia in the bond market. Consequently, the investments managed by the EIM should take into consideration their overall purpose of diversification, liquidity provision and return generation, and must therefore have the ability to measure the risks relating to the relevant assets. All scopes of risks arising from investments in Fixed Income markets should be considered and assessed against NBIM's overall risk profile and the metrics used to measure it, namely the tracking error relative to the benchmark.

The EIM is responsible for outlining the investment policy, including all relevant constraints, risk and return objectives, regulations, governance, and other key elements and ensure these pieces of information reflect the client's risk and return profile and the overall mission of the GPFG. Constraints and limits relating to the risk level of the fund are outlined by the Ministry of Finance, while additional specific risk limits are set out by the Executive Board as per the Management Mandate. In step with the organizational structure of the GPFG, the approval and review of the IPS and investment strategy, relating to the Fixed Income composite of the fund, is the responsibility of Norges Bank's Executive Board, with further analysis and consultation from NBIM's CEO.

Upon solicitation from the Executive Board, which may be driven by appeals or directives of the Ministry of Finance, the IPS should be updated by the EIM and submitted for reapproval to the Executive Board. This process may trigger further appeals to the IPS, which the EIM would need to review and implement, before resubmitting the IPS for reapproval. This process may be accompanied by guidance from the

CEO or any other members of the Leadership Group who may have relevant consultations with regards to specific sections of the IPS.

Per Section 1-8. of the Management Mandate, the EIM acts as an external manager of the operational functions related to the handling and control of the Fixed Income portfolio within the GPFG. The Executive Board is responsible for setting guidelines for when outsourcing is utilized within the fund; this includes the remuneration structure, performance-related fees, and risk management. NBIM's CEO and Co-Chief Investment Officers of Active Strategies select the external manager and submit them for approval to the Executive Board. Upon approval the Co-Chief Investment Officers of Active Strategies oversee the day-to-day activities of the EIM and assess the performance of the Fixed Income portfolio to determine if any change is necessary, to the extent that, with the approval of the Executive Board, they may discharge the EIM.

The EIM and their team's responsibilities are defined as the operational function of the Fixed Income portfolio. This includes, but is not limited to, asset allocation, security selection, risk measurement and analysis, return and performance measurement, rebalancing, and overall portfolio management, all in adherence to the relevant constraints and regulations outlined in the IPS. Furthermore, prior to execution, the EIM is responsible for presenting and defining any assumptions, calculations, models, and methodologies used during the processes to the Leader Group. The key delegated responsibilities of the Leader Group are highlighted in the Appendices.

As outlined above, risk management and monitoring fall within the responsibilities of the EIM, however the process requires pre-approval from the Chief Governance & Compliance Officer and the Chief Risk Officer, who may also engage in consultations during the portfolio construction process to share their insights and expertise. Furthermore, financial reporting and accurate asset valuation falls under the control of the Leader Group, who publish biannual reports as well as other publications relating to issues directly linked to the management of the fund.

2.3 Investment, Return and Risk Objectives

2.3.1 Investment Objectives

The principal purpose of the assets held within the GPFG is outlined by the fund's mission of preservation of financial wealth for current and future generations of the Norwegian public. The funds, which get invested into the GPFG annually, are derived from multiple different sources, all pertaining to the central government and the fund's returns. These sources are the net cash inflows from petroleum activities within the central government's budget, the net financial transactions from petroleum activities and the GPFG's return on its investments. Cash inflows derived from petroleum activities pertain to dividends received through the government's ownership shares in energy company Equinor ASA (ticker: EQNR). The GPFG is strategically structured to invest exclusively outside of Norway, explicitly excluding industries directly linked to the fund's primary revenue source – crude oil production. This investment approach serves to mitigate the risk of incurring a 'Dutch Disease', a phenomenon where excessive domestic currency appreciation undermines export competitiveness, large adverse growth in a single sector intensifies sectoral imbalances, and the economy grows increasingly dependent on volatile commodity markets (Mendez Ramos, 2020). By strictly imposing this investment approach, the Norwegian government aims to safeguard long-term economic

stability and diversify its economy and sovereign financial well-being away from its core income-generating sector.

A further objective of the GPFG, as outlined by the Norwegian Parliament in the Act, is aimed at growing the central government budget for purposes such as pension contributions under the National Insurance Scheme or stabilizing the economy during crises. These distributions must adhere to the Norwegian Fiscal Policy framework, which states that the transfers from the Fund to the government budget should, over the long-term, follow the expected real return of the Fund, which is currently set at 3%. This framework aims to preserve the core income generated by petroleum activities, whilst allowing for the fund to generate funds to be used by the government for social purposes. As a result, the objectives of the investments made into the GPFG are not only to preserve the original value of the cash inflows from petroleum activities, but also to generate the highest possible returns at an acceptable level of risk.

The Fixed Income portfolio, managed directly by the EIM, plays a major role in these objectives, through the aforementioned three key capacities. Firstly, diluting the volatility of the fund through investment in securities historically classified as low-risk or even risk-free. Secondly, providing liquidity to the fund through investment in highly liquid securities to provide cash to the ultimate beneficiaries, when necessary, whether through pension payments or other forms of economic distributions. Finally, the Fixed Income composite will also be utilized to generate excess returns through exposure to systematic risks inherent in bonds traded on capital markets.

These three capacities underline the rationale behind the EIM's decision to split the Fixed Income composite into four issuer categories: core sovereign bonds, developed sovereign bonds, emerging market sovereign bonds and corporate bonds. The Mandate sets out a list of sovereign issuers, whose issued debt securities must be held above a certain threshold, which are the instruments that fall under the core category. In many theoretical and practical cases, the eligible investments within this category are traditionally used as proxies for risk-free assets due to their backing by governments of major world economies, however for the purpose of this IPS are considered risk-bearing. Given their perceived low-risk profile, the core and developed sovereign bond categories serve to dilute the overall fund volatility. The developed sovereign bond category also minimizes the risk of liquidity gap formation as it entails highly liquid instruments. Finally, the investment into corporate and emerging market sovereign bonds allows for the EIM to capitalize on their higher-return profiles to maximize the fund's overall returns and cash inflows at an acceptable level of risk.

2.3.2 Return and Risk Objectives

The return and risk objectives are closely related to the performance of the benchmark portfolio. As per Section 2-4. of the Management Mandate, the core risk limit is set such that the expected annualized standard deviation of the excess return between the investment portfolio and the benchmark index (henceforth referred to as the "tracking error") does not exceed 1.25% for a period larger than one year in every three years. To realize the GPFG's mission, the return objective is set to generate the greatest possible return, considering this risk constraint. Both of these objectives apply to the GPFG's overall portfolio as well as individual composites, namely the Fixed Income composite managed by the EIM.

The Mandate specifies the Fixed Income benchmark to be a portfolio made up of a large number of selected instruments in the Bloomberg Global Inflation-Linked (Series-L) Bond Index and the Bloomberg Global-Aggregate Total Return Index (ticker: LEGATRUU). The index is set up such that government bonds have a 70% weighting and corporate bonds have the remaining 30%. The sovereign debt instruments are selected based on an GDP-weighted methodology, while the corporate bonds are selected in accordance with Bloomberg's methodology for the LEGATRUU index. NBIM's benchmark remains confidential at this moment and is not publicly disclosed. Additionally, details regarding key information about both Bloomberg indices, such as their holdings, are not publicly disclosed. For an accurate assessment of portfolio performance, the benchmark index should be clearly measurable and accessible to the EIM. Accordingly, the EIM and the CEO have agreed that for the purpose of this IPS, the EIM will use a pre-approved proxy for this benchmark index. The pre-approved proxy instrument will be the iShares Core Global Aggregate Bond UCITS ETF (henceforth referred to as the "iShares index), an ETF created by BlackRock Inc. to track the LEGATRUU index. For closer comparability to NBIM's index, in measuring the historical price performance of the selected benchmark, the EIM agreed to use the historical prices of the LEGATRUU index. All other metrics, including but not exclusively, the weighted average maturity and yield to maturity are taken from the iShares index.

2.3.3 Risk Tolerance of the Investor

The IPS is set to acknowledge the possibility of the portfolio encountering a wide variety of risks associated with investing, including but not limited to liquidity, regulatory, market, credit, interest rate and foreign exchange. Risk is to be measured and analyzed using approved quantitative tools and models set out by the Management Mandate and the Executive Board. Additionally, these risks may affect returns fluctuating over time and support the possibility of negative returns at times. With the establishment of a narrow tracking error of 1.25% to the iShares index every two years in a 3-year period, the Ministry of Finance has outlined a conservative approach to investments. The IPS is designed in a way to accommodate this conservative approach whilst achieving the desired return objective of the highest possible returns.

The fund's investment time horizon is classified as perpetual. This going concern assumption stems from the reality that the ultimate beneficiaries to whom the returns of the fund will be distributed are all current and future generations of the Norwegian public. Effectively, a severe downturn in the fund's performance would result in the destruction of the wealth of the entire nation, which would risk other potential economic consequences, including but not exclusively a recession or severe deflationary pressures. This exposure is driven by the fund's size and purpose, which inherently creates a strict fiduciary duty to the entire Norwegian population. Given the scope of this fiduciary responsibility as well as the fund's mission of safeguarding wealth generated by oil revenues, the client is classified as having a low risk tolerance, whereby investment diversification will be the main driver of risk management. This is applicable to the asset allocation process and the specific security selection process related to the Fixed Income composite of the GPFG.

NBIM is composed of many financial and economic professionals with various specialties who drive the success of the fund's investments and who possess expertise and understanding of the risks associated with economic uncertainties and financial investments, as well as how that may adversely affect portfolio returns. Paired with the gravity of the fund's purpose and the low acceptable risk deviance from the benchmark portfolio, and the highly long-term investment time horizon this classifies the client as risk averse.

The IPS acknowledges this risk profile and is designed in a way to strictly abide by the constraints outlined in the Mandate to minimize the portfolio's overall risk level whilst maintaining maximum returns.

2.3.4 Relevant Constraints

Given the gravity of the fund's purpose, the Ministry of Finance along with the Executive Board have outline constraints that ensure the fund follows through on its mission and is managed in such a way that minimizes risk exposures of the overall Norwegian economy to adverse market events.

As mentioned in section 2.3.1 of this IPS, the fund shall not contain any investments in financial instruments emitted by issuers domiciled in Norway or denominated in NOK. In the event of an economic downturn or crisis within Norway, this constraint mitigates the possibility of an amplification of the consequences of such events, as the country's wealth is held in external regions. To further protect the fund from systemic risk overexposure, the fund shall not contain any investments pertaining to instruments or equity issued by companies classified in the following ICB industries: Oil – Crude Producers and Offshore Drilling & Other Services (London Stock Exchange Group, 2024). This constraint acts as a key diversifying tool to extend the Norwegian economy's growth beyond oil revenue. To maintain social responsibility and transparency, the GPFG is also constrained from holding investments in companies classified as excluded on NBIM's Observation & Exclusion list, currently consisting of 198 companies. The Observation & Exclusion list features a set of core criterions under which companies are assessed and categorized, outlined in Table 1.

Exclusion Criteria	
Severe environmental damage	Unacceptable greenhouse gas emissions
Production of tobacco	Production of nuclear weapons
Gross corruption	Violation of human rights
Serious violations of individuals' rights in situations of war or conflict	Other particularly serios violations of fundamental ethical norms
Production of coal or coal-based energy	Production of cannabis
Production of cluster munitions	Sale of weapons to states in armed conflicts, where the weapons are used in ways that constitute breaches of the international rules on the conduct of hostilities

Table 1 – Criteria for Company Placement on the Observation & Exclusion list (Norges Bank Investment Management, 2024)

Given the significant diversification effects anticipated by the Ministry of Finance, the Mandate establishes strict provisions for the weighting ranges of the four key asset classes. These weighting limits define the Ministry of Finance's tolerance for exposure to the systematic risks inherent in each asset class. The weighting limits are outlined below in Table 2.

Asset Class	Minimum Weight	Maximum Weight
Equities	60.00%	80.00%
Fixed Income	20.00%	40.00%
Real Estate	0.00%	7.00%
Renewable Energy Infrastructure	0.00%	2.00%

Table 2 – Asset class constraints (Norges Bank Investment Management, 2024)

Given the EIM's central focus on the Fixed Income portfolio within the GPFG, the Ministry of Finance has additionally outlined its tolerance for exposure to the systematic risks associated with specific Fixed Income asset sub-classes. These constraints are outlined below in Table 3.

Security Type	Minimum Weight	Maximum Weight
High Yield / Below Investment Grade Bonds (foreign rating BBB- or below)	0.00%	5.00%
Emerging Market Bonds (Corporate & Sovereign)	0.00%	5.00%
Single Issuer Sovereign Bond (foreign rating BBB- or below)	0.00%	3.00%
Core Sovereign Bonds (EU, Germany, France, UK, USA, Japan)	7.50%	100.00%

Table 3 – Fixed Income sub-class constraints (Norges Bank Investment Management, 2024)

The core bonds category entails mandatory holdings of treasury debt instruments emitted by the following issuers: Government of France, Government of Germany, Government of the United Kingdom, Government of Japan, Government of the United States and the European Union (supranational issuer).

The IPS distinguishes between market classifications based on the MSCI Market Classification Framework (MSCI Inc., 2024). The Fixed Income portfolio will only invest in economies classified as developed or emerging markets and will mitigate any holdings of securities issued in frontier or standalone markets to minimize risks of market inaccessibility or low liquidity.

For a comparable initial perception of credit risk between issuers, a credit rating is required prior to any debt instrument investment. To maintain consistency of credit risk measurement, the credit ratings must be published by at least one of the following agencies: S&P Global Ratings, Moody's Ratings or Fitch Ratings. For the purposes of calculating the relevant Fixed Income related metrics, such as yield to maturity or duration, the Actual/360 day-count convention is to be used.

Building upon the investment constraints outlined in the Mandate, the NBIM's Leader group, in consultation with the EIM, has undertaken efforts to further strengthen the fund's risk management framework by setting additional constraints. For liquidity risk management, instruments which do not fall under the core classification must have an amount outstanding equal to or over USD 500,000,000. To enhance the predictability of future income and enable more comprehensive forward-looking analysis, the fund will exclusively invest in fixed-coupon bonds. The Fixed Income portfolio will refrain from using leverage to enhance

returns and will not engage in short-selling due to the strategy's inherent risk of unlimited potential downside.

2.4 Risk Management

The tracking error is the central metric used to assess and manage the Fixed Income portfolio's acceptable risk level. To track the performance of the composite under the EIM's management, the EIM is set to prepare quarterly reports highlighting the Fixed Income composite's performance and asset allocation net market value changes for the purposes of rebalancing the portfolio. The quarterly reports are to be approved by the Executive Board prior to publication by NBIM.

In addition to performance measurement reporting, the EIM acts as a Risk Committee for the corresponding Fixed Income composite under their management. Accordingly, the Risk Committee is responsible for providing monthly risk reports within which key risk metrics are measured and published. The first key risk metric to be reported is the relative performance risk measured as the tracking error of the fund. According to Joshi and Patterson (2013), standard deviation may be used as a proxy to assess the absolute market risk of the portfolio due to its scalability to expected returns and will therefore be published in the risk report as well.

In addition to these two core risk metrics, the Risk Committee is to report on other risk factors that provide key insights into the portfolio's return driving elements. The risk factors include (1) liquidity coverage measurement to ensure sufficient liquidity in the event of a major cash outflow demand, (2) the potential losses under normal market conditions measured through the Value-at-Risk, (3) adverse tail risk measured through the Expected Shortfall and (4) metrics relative to the benchmark specifically related to fixed income securities such as duration analysis, credit spread and rating exposure. Finally, given the macroeconomic nature of fixed income securities, the EIMs reports should also encompass commentary on economic trends and data which support the rationale for the chosen investment strategy and subsequent investments.

The EIM is aware that potential tax risks associated with holding investments in foreign jurisdictions, however NBIM's tax-exempt status in Norway provides a high likelihood of the fund being eligible for tax exempt status in foreign countries as well. Additionally, NBIM has an internal Governance & Compliance which is focused on specific tax management and financial reporting activities.

Exchange rate risk is to be assumed by the portfolio, as the Ministry of Finance looks to further grow its basket of foreign currencies. The Ministry of Finance may then use this these currencies to adjust the strength of the NOK, based on economic needs.

Given that the ultimate beneficiary of the fund's returns is the Norwegian public, through financial facilitation of the Ministry of Finance, the Norwegian Parliament set out a Fiscal Policy Framework which outlines its ability to utilize the fund's returns on government spending. The framework stipulates that the central government budget shall receive the expected return of the budget and only act at a means of flattening economic fluctuations in times of recession (Norwegian Ministry of Finance, 2023). As the EIM has a duty, within its management of the Fixed Income composite, to provide liquidity for the purposes of necessary cash outflows, the EIM should therefore also provide commentary on the

Norwegian economy’s condition through key economic indicators to assess the sizing of the fund’s cash outflows. This IPS is considered the first quarterly report and includes the risk management elements set out above, in the sections below.

3 Investment Design

3.1 Investment Philosophy

As the EIM takes a defensive stance to align with the client's low-risk profile, it also assumes a related investment philosophy: Buy-and-Hold, a philosophy popularized by investor John C. Bogle and utilized by Benjamin Graham and Warren Buffett. John C. Bogle, who famously founded Vanguard and the concept of index funding, promoted an investment philosophy of long-term, low-cost investing in order to materialize returns through income stability, reinvestment and principal preservation. Although Benjamin Graham and Warren Buffet are more tied to the concept of value investing, a philosophy related to stocks, the principles they introduce through value investing support the Buy-and-Hold strategy as well. Warren Buffet once famously said "*Our favorite holding period is forever*", trying to emphasize the benefits of compounding returns, investing in intrinsic value, and ignoring market noise, specifically for long-term investors, a view shared by John C. Bogle. These three benefits translate into bond investing through coupon reinvestment, high credit quality and avoiding interest rate risk through a Buy-and-Hold philosophy. Furthermore, John C. Bogle emphasizes that this investment philosophy allows for minimizing the transaction costs associated with the frequent selling and buying of securities, stating that "*In investing, you get what you don't pay for.*".

Additionally, considering the current global macroeconomic climate juxtaposed against the client's low-risk profile, the primary strategy elected by the EIM is set to minimize investment risks arising from Fixed Income markets' inherent uncertainties. For this purpose, the EIM is set to utilize an investment philosophy aimed at maximizing the Fixed Income portfolio's stability through careful security selection and stable income generation to satisfy the investment objectives set out in the IPS. The EIM believes that systematic risks pertaining to individual debt issuers represent the most significant threats that are contrary to the interests and mission of the GPFG. Three core areas of analysis aimed at materializing this investment philosophy are outlined as counterparty credit quality, income stability and macroeconomic analysis.

3.1.1 Counterparty Credit Quality

Credit risk poses as a key inherent risk attributable to Fixed Income investing (Adam & Smith, 2022). The perceived credit quality of an issuer directly impacts the likelihood of receiving expected returns of an investment, therefore the EIM is tasked with selecting the highest quality issuers to minimize the probability of these losses. The EIM splits the analysis of perceived credit risk by issuer type, corporate and sovereign, to understand the systematic elements inherent to each in more depth. The ultimate aim of the EIM is to select the highest quality issuers that pose a minimal credit risk. The methods used to analyze the credit risk of each issuer are described in detail in section 3.3 below.

3.1.2 Income Stability

To implement income stability into the Fixed Income portfolio, the EIM seeks to minimize the risk of uncertainty regarding future cash inflows. Through analysis further expanded on below in section 3.2, the EIM has opted to utilize a hold-to-maturity approach to bond investing, focusing on locking in the highest possible yields

today at the acceptable level of risk. The hold-to-maturity approach focuses on income generation, whereby the coupons received from the held assets may serve multiple purposes for the client. Received coupons may be reinvested into capital markets to rebalance the overall fund, gain additional returns, or may be injected into the Norwegian economy through cash distributed to the Ministry of Finance. Through this strategy, the EIM will encompass a more passive approach to investing in Fixed Income securities. This strategy supports the longevous nature of the fund, as it provides the portfolio with ongoing cash inflows over time. Additionally, it provides a hedge against fluctuations in economic factors affecting Fixed Income markets, as the EIM will be able to reinvest coupons into the optimal investments at a future date, which may differ from optimal investments today. Finally, holding assets to maturity mitigates the price fluctuation risk inherent to active portfolio management. The EIM's focus can therefore shift from assessing daily market fluctuations influencing the investments' prices to analysis of the investments' quality in terms of credit and income-generation.

3.1.3 Macroeconomic Analysis

Macroeconomic and financial factors are key drivers of bond performance in the credit and government bond markets alike (Adam & Smith, 2022). Within bond markets there are issuers perceived as risk-free and these issuers have a minimum holding threshold set in the Mandate constraints. The EIM is set to make investments in government bonds beyond solely these 'risk-free' instruments into other developed and emerging market economies and must therefore conduct an analysis of the fiscal strength of each issuer to minimize counterparty risks. The EIM will utilize the Bloomberg (2024) Fiscal Strength methodology to assess individual sovereign issuers' economic strength. The chosen methodology utilizes three economic indicators and six governance strength indicators to rank countries based on their perceived counterparty risk levels. Furthermore, the EIM will analyze the general global macroeconomic climate and monetary policies to understand interest rate movements, both historic and forward-looking, in order to strategically position the Fixed Income portfolio to maximize its returns. Additionally, the EIM will identify and account for any geopolitical uncertainty creating negative investor sentiment and directly impacting fixed income markets.

3.2 Strategic Asset Allocation

Prior to focusing on Fixed Income composite, the EIM is tasked with computing the optimal asset allocation for NBIM's entire GPFG portfolio. The outcome should determine the absolute amount that will be invested into the Fixed Income composite. To compute the optimal asset allocation, the client's risk profile must be considered. The method for strategic asset allocation closely follows Markowitz's (1952) mean variance-optimization methodology, which generates weights for selected securities or portfolios based on their risk or return profile. As outlined above, the client is seen as being risk-averse, due to their low tolerance and appetite for risk, especially given the current market conditions riddled with uncertainty. For this purpose, the EIM has elected to optimize the asset allocations through prioritizing risk minimization. This ensures the entire GPFG portfolio accounts for the investor's risk profile.

To optimize the asset allocation, the EIM selected four major indices within each asset class, with global coverage, to approximate the expected return and risk profiles

for each asset class. The indices selected are: FTSE World Broad Investment-Grade Bond Total Return Index for Fixed Income, MSCI International All Country World Index for Equities, FTSE All-World Real Estate Index for Real Estate, and S&P Global Infrastructure Index for Renewable Energy Infrastructure. The expected returns, volatilities and correlation matrix were generated using Refinitiv Eikon's Asset Allocation and Correlation Matrix tools. Taking into consideration the relevant asset class weighting constraints introduced by the Mandate, the EIM optimized the asset allocation with a target to minimize the expected risk, which in this case is represented by the standard deviation of historical returns. Table 4 outlines the risk and return profile of each index as well the weights attributed based on the optimization process.

Asset Class	Return	Risk	Weighting
Fixed Income	7.13%	6.38%	35.89%
Equities	11.96%	9.88%	60.00%
Real Estate	9.63%	13.58%	4.11%
Infrastructure	21.62%	10.76%	0.00%

Table 4 – Asset Class Index Risk, Return & Optimal Weighting (Author's Calculations)

Through opting to minimize the volatility related to asset allocation, the Investment optimization process places increased importance on the benefits of diversification through allocating weights based on the correlations between the assets. In this case, in order to minimize the risk, there shall be no investments made into Infrastructure as it possesses a high positive correlation coefficient of 0.81 to the asset class with the highest weighting, Equities. The full correlation coefficients are presented in the Appendices.

3.3 Security Selection Process

3.3.1 Current Macroeconomic Environment

A high-level macroeconomic analysis of the current environment within which the Fixed Income composite is to be invested is characterized by uncertainty stemming from multiple sources. The EIM outlines key macroeconomic events and their relation to Fixed Income markets to be monitored.

Firstly, since the re-election of Donald Trump into the oval office, the United States have introduced a plan to implement a series of aggressive trade policies aimed at majority of its global trade partners. These trade policies, namely tariffs, have generated economic uncertainty worldwide (Goldman Sachs, 2025). The imposition of tariffs and reciprocal tariffs are expected to feed into prices consumers pay for goods and services. This can reduce consumer confidence in turn reducing consumption overall, a key driver of economies' economic growth. These tariffs may also deteriorate business confidence which may reduce investment, business expansion plans or have direct effects on unemployment. These effects are currently only theoretical and have not been confirmed to materialize in the economy yet, however they create an uncertainty that drives investor confidence level to a low. If these tariffs trigger cost-push inflation, central banks will likely introduce monetary policy measures, namely hiking interest rates, as countermeasures. Hiking interest rates increases the costs of borrowing which will directly affect: i) businesses which will have downward pressures on profit margins through higher financing costs triggering cost-cutting measures to maintain margins

and ii) consumers with an additional incentive to save disposable income through higher savings returns and reduced consumption through large borrowing costs (i.e. credit cards, mortgages) (Bloomberg LP, 2024). Additionally, the introduction of tariffs and reciprocal tariffs may drive an increase in unemployment, especially within export-driven sectors, as businesses look to cut costs. An increase in unemployment may induce further downward pressures on consumer spending. These scenarios are mainly expected to affect western regions, namely North America and Europe, as major Asian economies, such as China and Japan, currently battle deflationary pressures.

The EIM identifies two key direct effects on Fixed Income markets of this plausible scenario. Firstly, hikes in interest rates would drive bond yields upwards. Through a hold-to-maturity strategy during higher yielding periods the EIM is able to lock in the higher yields through strategic investments. The EIM does, however, identify that since the start of 2025, the Fixed Income market environment is characterized by monetary easing, driving the prices of bonds up and contracting their yields. Given the recent monetary tightening cycle, the EIM is still able to lock in larger returns through investments in high coupon bonds issued during this earlier period, to maximize the income generating component of the portfolio. Additionally, although the EIM's strategy is hold-to-maturity, there are no constraints placed on selling bonds early to lock in returns from bond price hikes, therefore the EIM may still capitalize on these elements if they are deemed attractive enough. Secondly, interest rate hikes would have a direct effect on the performance and possibly the credit quality of corporate issuers, as their costs of financing would increase, and aggregate consumption would decrease. Consequently, the EIM is implementing multiple measures to secure high aggregate credit quality of corporate issuers, to minimize the risk of investing in instruments with a higher than desired probability of default.

Major Asian economies are currently facing large economic pressures because of poor historical monetary management. Firstly, China, a country whose economy is largely dependent on its net exports and government spending, has recently entered a crisis driven by a real estate bubble bursting. China's Gross Domestic Product (GDP) has slowly been dropping, with its year-end 2024 seasonally adjusted GDP growth rate reaching 4.98%, compared to its 20-year average of 7.9% (Refinitiv, 2025). China's recent economic struggle began in 2021 with the default of Evergrande, the largest real estate developer in the nation. The default resulted in multiple severe economic ramifications including a large slowdown in the real estate sector, a deterioration of investor confidence, and a large drop in property value. The economic slowdown triggered trickle effects into local economies, as Evergrande halted many major real estate projects, failing to pay suppliers and shutting down local construction sites. Furthermore, owning property is considered a savings vehicle for consumers in China, therefore a drop in property value meant a drop in the population's accumulated wealth, triggering low consumer confidence. This overall effect caused deflationary pressures across sectors, which then spread into the entire economy. Low investor confidence is further fueled by China's trade tensions with the United States and lack of regulatory and corporate transparency. Moreover, China is also currently driving geopolitical unrest with regards to Taiwan and other South-East Asian countries, to try and secure control over raw materials and goods in major demand, namely semiconductors and rare earth metals (Han et al., 2025).

Apart from China, other major Asian economies are facing economic or political challenges driving investor confidence down as well. Japan's economy been struggling with driving economic growth, with its seasonally adjusted GDP growth rate between at year end 2024 reaching 0.18% (Refinitiv, 2025). This low growth rate can be attributed to multiple factors, including demographic instability with the working-age population shrinking, low productivity growth due to lack of innovation and stagnation in global trade which was once a major driver of Japanese economic success. Furthermore, amongst developed market economies, Japan has the largest Debt-to-GDP ratio of 249.67% (International Monetary Fund, 2023), putting pressure on the nation's ability to meet its debt obligations.

South Korea, another major economy in the Asian region, has achieved a relatively low year end 2024 seasonally adjusted GDP growth rate of 2.06% (Refinitiv, 2025). Moreover, during the first quarter of 2025, the seasonally adjusted GDP contracted by 0.2% against expectations of a slight increase (Kim, 2025). Paired with the nation's political instability, triggered by their previous president's abrupt attempt to declare martial law and his subsequent impeachment, as well as further economic uncertainty regarding global trade policy, the EIM has uncertainty.

These elements combined have driven uncertainty regarding investments into the region. The EIM views this uncertainty as misaligned with the investment philosophy or maximizing investment safety. Therefore, investments in securities emitted by corporate issuers domiciled in Asia are only to be invested in if majority of the revenue is sourced from regions outside of Asia, and for sovereign issuers only issuers stipulated by the Mandate as necessary investments, in this case Japan.

Based on available information from public sources such as Reuters, there are multiple major geopolitical conflicts currently occurring in Europe and the Middle East, in addition to increasing geopolitical tensions in Asia. The effects on financial markets typically vary, based on characteristics specific to the countries involved in geopolitical disputes. Moreover, investments in countries actively involved in conflicts may generate adverse economic effects based on unpredictable events, which does not align the NBIM's mission of generating sustainable returns. As a result, the Fixed Income portfolio will not entail any holdings of investments issued by companies or governments domiciled in countries currently actively involved in war or other major military conflicts. This additional constraint conforms to NBIM's additional aim to harness responsible investing that has globally sustainable social impacts (Norges Bank Investment Management, 2025).

Based on S&P's Annual Global Corporate Default & Rating Transition Study (2025), since 2021 there have been rising overall default rates, in line with a rising total amount of global corporate debt outstanding. These default rate increases are driven by defaults in the high-yield debt sector, for bond issuers with a speculative credit rating. A key driver of rising default rates during this period were tightening monetary policies across the globe, increasing companies' overall cost of financing. Although major central governments have been cutting interest rates recently, as highlighted in section 3.3.1.1, given the high degree of global trade tensions, there is a plausible scenario for rate hikes in the near future, which could amplify increasing default rates amongst the lowest credit quality companies. This, consequently, further supports the EIMs decision to focus on investment in high-quality

issuers to prioritize sustainable long-term returns over short-term speculation-generated returns. During the security selection process, the EIM has opted for highly scrutinizing methods of selection, which are expected to generate a list of debt instrument issuers that are considered highly unlikely to default.

3.3.2 Security Selection

The EIM's approach to selecting securities commences with the selection of the highest quality debt instrument issuers. The EIM also identifies differences in the inherent systematic risks attributable to the two debt issuer types key to the Fixed Income portfolio. Adam & Smith (2022), differentiate between the characteristics inherent to sovereign bonds and corporate bonds.

Sovereign bonds are issued primarily to fund government spending when tax revenue is insufficient to cover the targeted expenditure by governments. Government issuers typically issue debt instruments on a frequent basis, and newly issued debt instruments serve as benchmarks for debt instruments domiciled in the issuing government's jurisdiction and at times even for the region in proximity, such as German sovereign bonds. Typically, the interest coverage of sovereign bonds stems from tax revenues or debt roll-overs, in other words issuing new debt to raise funds to cover previous debt obligations. Consequently, to analyze a sovereign or supranational issuer's ability to repay its obligations, it is important to assess the issuer's government surplus or budget deficit as well as the overall debt level and credit standing against peer issuers. Additionally, it is important to assess the issuer's governance effectiveness, to assess the institutional risk posed by various sovereign counterparties based on a set of quantifiable indicators. Based on the MSCI Classification, the selected issuers falling under either the developed or emerging market categories are outlined in Table 5. Within these selections, the issuers which are a part of the core portfolio are included. Although there are minimum weights attributable to these core issuers, they were included in the analysis to compare their fiscal strength ranking against other issuers.

Market	Sovereign Issuer				
Developed Market	Australia	Finland	Israel	Portugal	UK
	Austria	France	Italy	Singapore	USA
	Belgium	Germany	Japan	Spain	
	Canada	Hong Kong	Netherlands	Sweden	
	Denmark	Ireland	New Zealand	Switzerland	
Emerging Market	Egypt	Chile	Hungary	Mexico	Taiwan
	Kuwait	China	India	Peru	Thailand
	Qatar	Colombia	Indonesia	Philippines	Turkey
	Saudi Arabia	Czechia	Korea	Poland	
	Brazil	Greece	Malaysia	South Africa	

Table 5 – List of selected Sovereign Issuers for further analysis (MSCI Inc., 2024)

The EIM has selected the Bloomberg Fiscal Strength methodology, which the data provider uses for calculating weights attributable to sovereign issuers in its benchmark indices, to analyze the Fiscal Strength of each issuer. The methodology will be utilized for ranking the selected issuers in Table 5 based on their perceived relative fiscal strength. The key indicators used to rank the sovereign bonds are outlined in Table 6. The EIM provides a rank to each issuer for each indicator. Following these

individual rankings per indicator, each indicator is allocated a weighting based on the original Bloomberg Fiscal Strength methodology. A weighted average overall ranking is then calculated based on how issuer ranked in each indicator individually, with the issuers then being listed in descending order form highest ranking (largest perceived relative fiscal strength) to lowest.

Indicator	Weighting for overall ranking
Debt as a percentage of GDP	40.00%
Deficit as a percentage of GDP	20.00%
Current Account Balance as a percentage of GDP	20.00%
Governance Strength	20.00%

Table 6 – Bloomberg Fiscal Strength Indicators for Sovereign Issuers (Bloomberg, 2024)

The indicators besides Governance strength are defined in the formulas below. The data collected for these indicators was taken as the latest data available from the World Bank and International Monetary Fund databases.

$$(1)\quad Debt\ \%\ GDP = \frac{Total\ Public\ Debt}{Nominal\ Gross\ Domestic\ Product}$$

$$(2)\quad Deficit\ \%\ GDP = \frac{Budget\ Deficit}{Nominal\ Gross\ Domestic\ Product},$$

where:

$$Budget\ Deficit\ = Government\ Expenditures - Government\ Revenues$$

$$(3)\quad Current\ Account\ Balance\ \%\ GDP = \frac{Current\ Account\ Balance}{Nominal\ Gross\ Domestic\ Product},$$

where:

$$Current\ Account\ Balance\ = (Exports\ -\ Imports)\ +\ Net\ Income\ +\ Net\ Transfers$$

The Governance Strength per issuer is determined based on the World Bank's six governance sub-indicators, outlined in Table 7. These indicators are compiled by the World Bank using a composite methodology that aggregates data from more than thirty data sources provided by survey institutes, think tanks, NGOs, and international organizations. The sub-indicators are percentile rankings within each category relative to all the other surveyed countries in this World Bank analysis. For these sub-indicators, a higher score represents a better rank. Rank is then given an equal weighting per indicator for the aggregation of a weighted average Governance Strength indicator.

Governance sub-indicator	Weighting
Voice & Accountability	16.7%
Political Stability & Absence of Violence	16.7%
Government Effectiveness	16.7%
Regulatory Quality	16.7%
Rule of Law	16.7%
Control of Corruption	16.7%

Table 7 – World Bank Governance Sub-indicators (Bloomberg, 2024)

For comparability and up-to-date analysis, the EIM employs a strict rule of excluding any issuers who have any missing data regarding the indicators or data dated prior to year-end 2023. After collecting the relevant data and calculating the fiscal

strength indicators, the EIM performed the ranking filtration and selected the top fifteen issuers. This top fifteen list was further filtered through issuers deemed excludable based on the macroeconomic analysis described in section 3.3.1. This filtration yielded an exclusion of mainly Asian issuers other than Japan, which is a part of the core classification in the Mandate. Furthermore, given that there is mandatory investment into the core portfolio issuers, these issuers are also excluded from this list, to prevent overexposure. The final list, visible in Table 8, possesses the top twelve issuers, in both developed and emerging markets, who the EIM deems as having an adequate fiscal strength. For the Fixed Income portfolio, the EIM will choose debt instruments exclusively from these issuers to create an appropriate portfolio, however this does not mean that instruments from all these issuers will be selected. The security selection process will be based on the characteristics of the instruments themselves; this list serves as an additional criterion for investment.

Ranking	Market	Country	S&P Rating	National Currency	Symbol
1	Dev.	Denmark	AAA	Danish Krone	DKK
2	Dev.	Switzerland	AAA	Swiss Franc	CHF
3	EM	Kuwait	A+	Kuwaiti Dinar	KWD
4	Dev.	Sweden	AAA	Swedish Krona	SEK
5	Dev.	Ireland	AA	Euro	EUR
6	Dev.	Netherlands	AAA	Euro	EUR
7	EM	Qatar	AA	Qatari Riyal	QAR
8	EM	Saudi Arabia	A	Saudi Riyal	SAR
9	EM	Czechia	AA-	Czech Koruna	CZK
10	Dev.	Australia	AAA	Australian Dollar	AUD
11	EM	Poland	A-	Polish Zloty	PLN
12	EM	Peru	BBB	Peruvian Sol	PEN

Table 8 – Selected Sovereign Issuers (Author's Illustration)

The national currency for each issuer is included, as NBIM requires returns to be calculated in the domestic currencies of each security's issuer. The Ministry of Finance uses the GPFG as a currency basket holding it can use as a tool to manage Norway's exchange rate fluctuations. As a result, the EIM is looking to diversify the Fixed Income portfolio across various currencies, to ultimately diversify the currency basket at disposal to the Ministry of Finance.

Adam & Smith (2022) outline that a key difference between corporate and sovereign debt is the underlying driver for companies to issue debt: maximizing profitability. Additionally, the perception of credit risk with corporate issuers stems less from macroeconomic factors, as in with sovereign issuers, but more from each company's financial performance. This financial performance is somewhat tied to macroeconomic factors as well; however, it also closely connects to how well a company performing operationally, the issuer's capital structure, the value of the company's assets and the purpose of its debt financing. Consequently, the EIM is tasked with identifying the highest credit quality corporate issuers to secure the lowest probability of losses of expected returns. Given the broad investment universe, within which the EIM is permitted to invest in, the issuers need to be filtered through a methodology able to analyze large amounts of data at once. Additionally, in order for the GPFG to maintain a competitive edge against other institutional investors

seeking to maximize their returns at an acceptable risk level, the EIM assessed the possibility of using up-to-date methods of corporate credit quality determination.

Moscatelli et. al (2020) argue that machine learning models, namely random forest and gradient boosting models, provide a more accurate forecasting performance related to credit risk modelling, than traditional statistical models. This is the case especially when publicly available information is used to calculate relevant financial indicators. The better forecasting performance stems from the ability of machine learning models to capture a more precise understanding of the complex relationships between relevant financial indicators and their default outcome. Machine learning also poses a benefit of being developed upon large amounts of data, therefore being able to capture a large investment universe. The EIM has elected to use gradient boosting method called extreme gradient Boosting (XGBoost), as Ye (2023) argues this method is able to reflect the creditworthiness of each individual corporate issuer than a logistical regression more realistically. Additionally, Ye's (2023) findings suggest that the XGBoost model allows for investors to rank the importance of each relevant financial indicator. Ye further argues that the most important indicators to look at pertain to a company's solvency, followed by profitability, operating capacity and capital structure.

As outlined in the IPS, the EIM seeks to minimize the credit risk of each individual counterparty, looking for any additional analysis regarding the safety of investments. In parallel, S&P Global Ratings (2025) indicates that the rising default rates mainly affect non-investment grade bonds through rising interest rates. For this reason, the EIM has opted to select issuers only classified as investment grade, and to further analyze their creditworthiness through running a classification XGBoost model within Ye's (2023) research, to determine the highest quality bonds amongst the non-investment grade classification. Running the XGBoost model will help further understand the corporate issuers' outlook of creditworthiness based on its most recent financial performance and position.

A decision tree is a machine learning model type, which splits input data into smaller and smaller groups using rules in order to give a prediction (Trappenberg, 2020). This type of machine learning model is typically referred to as a weak learner, due to its lower expected accuracy. Gradient tree boosting refers to a machine learning technique combining series of these weak learners to form an overall strong model (Trappenberg, 2020). The strong model accuracy is derived from the iterations of running the weak learners and adding weights to the wrongly predicted outcomes. Gradient boosting refers to minimizing the overall cost function of a model, which typically has many dimensions, to find the optimal algorithm for data prediction. The XGBoost model, introduced by Tianqi Chen in 2016, is a version of a gradient tree boosting model, which optimizes the prediction algorithm through level-wise growth and regularization (both lasso and ridge) (Ye, 2023). The technique's robust regularization helps reduce the model overfitting and reduce its overall complexity, which in turn allows the model to perform at quicker rates to other boosting methods.

To train the XGBoost algorithm the EIM replicated Ye's (2023) method. Prior to running the algorithm, the EIM conducted data collection, filtration and preparation, for the data to be compatible with the selected parameters. Data collected was sourced from Refinitiv Eikon's Advanced Bond and Screener databases. Given the span of the investment universe set out by the Mandate, the EIM trained a model

without excluding any issuers domiciled in specific countries or based on their credit rating. This approach is intended to generate a model which is trained upon global data and can be used in the future as well, when specific issuer characteristics that are deemed not attractive to invest in currently, may be attractive in the future.

Initially, the EIM searched for all bonds in the Refinitiv Eikon Advanced Bond database with an asset status classified as 'In Default' for the period 2021-2024 (henceforth referred to as the 'data collection period'). The same was then done for bonds classified with an asset status classified as 'Active', for the data collection period. This data yielded a list of debt instruments that have either been defaulted on or not within the data collection period. Through filtering the data and excluding any duplicates of issuers, the EIM was able to identify and label each individual corporate issuer who was either in default or not in the data collection period, as well as the periods in which this status occurred. Subsequently, this list of issuers was uploaded to Refinitiv Eikon's Screener application to collect variables relevant to the specific financial indicators. The total list of financial indicators upon which the XGBoost algorithm is trained is outlined in Table 9. The collected variables correspond to the financial year within which the issuers reach an asset status of in default or active.

Category	Financial Indicators
Profitability	X1: Gross sales margin X2: Net sales margin X3: Net operating margin X4: Total net asset margin X5: Return on total assets (ROA)
Cash Flow	X7: Net cash flow from operating activities ÷ operating income
Capital Structure	X8: Gearing ratio X9: Current assets ratio X10: Non-current assets ratio
Solvency	X11: Current ratio X12: Quick ratio X13: Net cash flow from operating activities ÷ total liabilities X14: EBITDA ÷ total liabilities
Operating Capacity	X15: Inventory turnover rate X16: Accounts payable turnover rate (including notes payable) X17: Accounts receivable turnover rate (including notes receivable) X18: Fixed asset turnover rate X19: Current asset turnover ratio X20: Total asset turnover ratio
Growth Capacity	X21: Net assets growth rate year-over-year X22: Total assets growth rate year-over-year X23: Net profit growth rate year-over-year X24: Operating profit growth rate year-over-year

Table 9 – Selected Financial Indicators (Ye, 2023)

Given the low availability of data related to the variables needed to calculate X6 in Ye's (2023) original algorithm, as well as its low perceived feature importance, outlined by in the same study, the EIM decided to omit this indicator from the algorithm. Variable X6 is a company's Sales cash ratio, calculated by dividing the cash collected from sales adjusted by discounts and other offers by the total sales. Once these indicators were extracted, the dataset was then filtered to exclude any issuers who were missing data for over

three indicators. For the remaining financial indicators for which there was missing data, this gap was filled using the sample mean as in Ye (2023). Additionally, following Ye's (2023) data pre-processing methodology, a three-standard deviation rule was applied, to eradicate large outlier inputs outside of three standard deviations to the mean.

This final list used to train the XGBoost algorithm accumulated 591 total issuers, of which 493 were classified as not in default and 98 were classified as in default. Given this imbalance in the ratio of defaulted to non-defaulted issuers, Ye's (2023) model utilizes the SMOTE method to make the data distribution more equal. Principally, a k-nearest neighbor method is used to generate synthetic defaulted data inputs. Furthermore, a maximum-minimum method of normalization was applied to all the financial indicators, in order to improve the model's performance. The algorithm uses a random selection process to split the sample data set into training data and testing data. This means that for each iteration of the model, there are unique data sets used to train the model and test the model. This method allows for a more robust model outcome, where through large numbers of iterations of the model, each is trained slightly differently, therefore can give a slightly different outcome for the actual data set. The EIM ran 10,000 simulations of the algorithm, each with this randomizing feature, and can therefore select the issuers who score no default in all simulations to determine which issuers have the lowest credit risk. This number of simulations was chosen to benefit from the law of large numbers as well as maintain computational efficiency given the resources available. To train the model the EIM replicated the tuning hyperparameters to Ye's (2023). These hyperparameters are outlined in Table 10. The created algorithm is defined as a binary classifier, whereby it classifies each issuer as either a 0 (no default predicted) or 1 (default predicted).

Hyperparameter	Value	Description
Learning rate	0.01	The weight of each model generated by each iteration
Number of estimators	79	Number of weak learners used
Maximum depth	5	Maximum depth of the tree
Minimum child weight	1	Sum of weights of the smallest samples in the child nodes
Gamma	0.0	Descent value of the loss function required for further partitioning at the leaf nodes
Column sample by tree	0.6	Proportion of feature sampling to the entire feature set when building the tree
Subsample	0.8	Proportion of subsamples used to train the model to the entire dataset
Regularized alpha	0.1	Penalty for regularization term

Table 10 – XGBoost Algorithm Tuning Parameters (Ye, 2023)

The EIM generated a list of eligible issuers to analyze through with the algorithm by utilizing the Moody's Orbis database to generate a list of companies with investment grade ratings. This list yielded 774 global companies and their corresponding ISIN codes. With these ISIN codes, the EIM was able to upload this list of companies to the Refinitiv Eikon Screener to tool to extract the same financial indicators as for the training and testing dataset. The EIM enforced a stricter exclusion rule on issuers with missing data, with any missing data point disqualifying an issuer from being eligible to be invested in. The final filtered list yielded 545 investment-grade companies and the corresponding financial indicators based on the latest, year-end FY24 financial data.

This dataset was evaluated using the trained XGBoost model. As previously stated, the algorithm was run on the dataset 10,000 times, with 79 estimators generated during each

iteration, totaling 790,000 weak learners used to output a prediction for each company in this dataset. The result were 10,000 binary classifications for each issuer. The EIM selected the issuers for which the XGBoost algorithm output zero for every single iteration. The total number of global issuers with an output of zero was 338.

Historical interest coverage ratios (ICR) for the past 5 years were calculated for each of the 338 companies. Coverage is considered a key credit analysis measure, demonstrating an issuer's ability to meet its obligations to lenders (Adam & Smith, 2022). To further filter this dataset, the EIM grouped the issuers by their GICS Industry Groups, in order to diversify the portfolio across multiple sectors. Moreover, the various ICR values for each issuer are more comparable on a sector basis, as industries differ in margin profiles. In each industry group, the issuers were ranked from largest 5-year average ICR to smallest, for an additional safety measure to minimize the probability of the issuer's defaulting on their loans. The top two issuers in each sector were selected, to generate a filtered list of 42 corporate debt issuers for further analysis. These 42 issuers were uploaded to Refinitiv Eikon's Advanced Bond Search tool to generate a list of all the debt instruments outstanding from each issuer. This dataset of debt instruments was filtered for instruments issued at least 2 years ago or earlier, to be able to analyze historical data for each issuer. Additionally, this dataset was further filtered by applying the liquidity constraint set up by the EIM of a minimum of EUR 500,000,000 amount outstanding. These filters yielded a list of 257 securities from 26 issuers. Based on the earlier macroeconomic analysis, this list of 25 issuers was cleaned of any issuers domiciled in excluded regions, except for those with majority of their revenue sourced from outside these regions. This further filtered the list down to 21 issuers, outline in Table 11.

Issuer	GICS Industry Group	Domicile
International Business Machines Corp	Software & Services	USA
Weyerhaeuser Co	Equity Real Estate Investment Trusts (REITs)	USA
Target Corp	Consumer Staples Distribution & Retail	USA
Roche Holdings Inc	Pharmaceuticals, Biotechnology & Life Sciences	Switzerland
Johnson & Johnson	Pharmaceuticals, Biotechnology & Life Sciences	USA
Advanced Micro Devices Inc	Semiconductors & Semiconductor Equipment	USA
Amazon.com Inc	Consumer Discretionary Distribution & Retail	USA
Microsoft Corp	Software & Services	USA
Colgate-Palmolive Co	Household & Personal Products	USA
Toyota Motor Corp	Automobiles & Components	Japan
Wolters Kluwer NV	Commercial & Professional Services	Netherlands
LVMH Moet Hennessy Louis Vuitton SE	Consumer Durables & Apparel	France
Investor AB	Financial Services	Sweden
Henkel AG & Co KGaA	Household & Personal Products	Germany
Wendel SE	Financial Services	France
Renesas Electronics Corp	Semiconductors & Semiconductor Equipment	Japan
Covivio SA	Equity Real Estate Investment Trusts (REITs)	France
ITV PLC	Media & Entertainment	UK
Abb Ltd	Capital Goods	Switzerland
Kubota Corp	Capital Goods	Japan
Sony Group Corp	Consumer Durables & Apparel	Japan

Table 11 – Selected Corporate Issuers (Author's Illustration)

As mentioned earlier the core issuers, outlined in Table 12, were announced in the Mandate.

Sovereign Issuer
United States of America (Government)
European Union
France, Republic of (Government)
Japan (Government)
Germany, Federal Republic of (Government)
United Kingdom of Great Britain & Northern Ireland (Government)

Table 12 – Selected Core Issuers (Ministry of Finance, 2024)

At this stage the EIM has a full list of eligible debt instrument issuers, from which it may choose in order to generate an appropriate Fixed Income portfolio. As per Martellini, Priaulet & Priaulet (2003), the current yield may be used as a proxy to assess the bonds' coupon yield against the current price of the bond. The current yield provides the EIM with insights into a bond's perceived annual cash income relative to its current price level. In other words, how large of an income an investor can expect, given how expensive the bond is today. Based on the complexity of the issuer selection process aimed at selecting the highest quality issuers in terms of credit risk, the EIM now focuses on the income-generating element inherent in debt instruments. The current yield is used by the EIM in order to rank each debt instrument per individual issuer by their perceived income generating ability.

Additionally, Fabozzi (2013) outlines the higher risk assumption when investing in longer-term bonds, typically driving their yields higher than their short-term counterparts. Long-term holding time periods create a larger timeframe for adverse effects that may affect an issuer's credit rating as well as the amount of reinvestment risk the investor faces. This risk profile aligns with the EIM's philosophy aimed at maximizing income. Since the issuers chosen are already perceived to have no credit risk, relative to all the other issuers, the Fixed Income portfolio needs to gain exposure to other types of risks to generate excess returns to the benchmark. The EIM therefore seeks to make investments into debt instruments with tenors greater than one year, to capitalize on this income generating characteristic over the long-term.

The specific security selection takes both concepts into consideration and yields securities in each of the four issuer classifications based on the highest income generating capacity relative to the price level and being able to maintain this income generation for longer periods at once. The results of the selected securities is outlined in Table 13.

ISIN	Issuer	Type	Currency	Coupon Rate	Frequency	Maturity	Tenor	Rating
GB00BT7J0241	Great Britain & Northern Ireland	Core	GBP	5.375%	Semi	31-Jan-56	30.6	AA
US912810UL07	United States Treasury	Core	USD	5.000%	Semi	15-May-45	19.9	AA+
EU000A4EA8Y7	European Union	Core	EUR	3.750%	Annual	12-Oct-45	20.3	AA+
FR001400WYO4	Republic of France	Core	EUR	3.600%	Annual	25-May-42	16.9	AA-
DE000BU3Z047	Federal Republic of Germany	Core	EUR	2.500%	Annual	15-Feb-35	9.7	AAA
JP1400181R57	Japan	Core	JPY	3.100%	Semi	20-Mar-65	39.8	A+
US007903BG12	Advanced Micro Devices Inc	Corp.	USD	4.393%	Semi	1-Jun-52	27.0	A
US594918BM55	Microsoft Corp	Corp.	USD	4.750%	Semi	3-Nov-55	30.4	AAA
US19416QEJ58	Colgate-Palmolive Co	Corp.	USD	4.000%	Semi	15-Aug-45	20.2	A+
XS2592516210	Wolters Kluwer NV	Corp.	EUR	3.750%	Annual	3-Apr-31	5.8	A-
US892331AD13	Toyota Motor Corp	Corp.	USD	3.669%	Semi	20-Jul-28	3.1	A+
US771196AU61	Roche Holdings Inc	Corp.	USD	7.000%	Semi	1-Mar-39	13.7	AA
US87612EAF34	Target Corp	Corp.	USD	7.000%	Semi	15-Jul-31	6.1	A
US962166BR41	Weyerhaeuser Co	Corp.	USD	7.375%	Semi	15-Mar-32	6.8	BBB
CH0557778815	Confederation of Switzerland	Dev.	CHF	1.250%	Annual	28-Jun-43	18.0	AAA
DK0009924615	Kingdom of Denmark	Dev.	DKK	2.250%	Annual	15-Nov-33	8.4	AAA
NL0015001RG8	Kingdom of the Netherlands	Dev.	EUR	3.250%	Annual	15-Jan-44	18.6	AAA
IE000LQ7YWY4	Ireland	Dev.	EUR	2.600%	Annual	18-Oct-34	9.3	AA
US715638DY59	Republic of Peru	EM	PEN/USD	7.300%	Semi	12-Aug-33	8.2	BBB-
CZ0001006969	Czech Republic	EM	CZK	6.200%	Annual	16-Jun-31	6.0	AA-
PL0000116851	Republic of Poland	EM	PLN	5.000%	Annual	25-Oct-34	9.4	A-
QA000ZLNP0B9	State of Qatar	EM	QAR	5.250%	Semi	3-Sep-28	3.2	AA

Table 13 – Selected Securities (Author's Illustration)

The EIM also identifies a necessity to further diversify the portfolio to resemble the benchmark index more closely. Although the selected 22 securities may be considered as diversified enough for smaller portfolios, the EIM expects NBIM to invest the equivalent of total value of the fund reported in NBIM's 2024 Annual Report, which is equal to NOK 19.742 trillion. Based on an overall allocation of 35.89% to Fixed Income, this would mean NOK 7.085 trillion invested in the composite. This would assume a very large exposure to a small number of issuers, relative to the investment size. Consequently, the EIM has determined that a minimum investment should be made into the benchmark security as well, to indirectly diversify overexposure to single issuers. The investment would be made directly into the iShares index and would allow for easier portfolio rebalancing in the event of a breach of the tracking error or other relative risk limits. The weighted average coupon rate for the iShares index is 2.82% and a weighted average tenor of 8.3 years.

3.4 Portfolio Composition

3.4.1 Forward-Looking Expected Returns & Risk

The EIM elected a forward-looking approach to measuring the expected return. Within the context of the hold-to-maturity strategy selected, there are certain risks which do not directly affect the Fixed Income portfolio under this assumption. This relates mainly to price fluctuations, as holding the instruments to maturity would result in receiving the

nominal par amount for all the securities. Additionally, given the rigorous issuer selection process, the bonds are assumed to have negligible credit risk, therefore no assumed probabilities of losses in the future. On the other hand, there are certain risks which are amplified with a hold-to-maturity strategy, namely reinvestment risk (Fabozzi, 2013). This refers to the returns that can be achieved by reinvesting coupons received rather than letting them sit as idle cash. The EIM assumes that coupons received will be invested in debt-related instruments, therefore keeping their Fixed Income nature.

In line with NBIM's elected return measurement methodology, the EIM uses the Global Investment Performance Standards (GIPS) to measure total returns over specific time periods. Fabozzi (2013) further defines the total return as the total future income received assumed to be invested at a particular reinvestment rate. This total income is then transformed into a total return rate by subtracting price paid for the bond and dividing that amount by the price of the acquisition of the bond. By annualizing this total return rate, the investor is able to get an expected annual return of the bond, which can differ based on the assumption of the rate at which the coupons are reinvested. Were the investor to calculate the instrument's internal rate of return, whereby they assume the reinvestment rate is the annualized total return rate, this would result in the yield to maturity, a heavily relied upon metric in Fixed Income markets. The EIM, however, understands the limitations of yield to maturity, namely the very strong assumption that the reinvestment rate will remain flat across the entire investment horizon.

The EIM attempts a more dynamic approach at modelling the total returns of each individual selected investment. Adam & Smith (2012) describe a one-factor equilibrium model which may be used to attempt to predict shifts in the yield curve. This model is known as the Vasicek model, a mathematical model used to describe how interest rates change over time. The fundamental formula for interest rate movements is outlined below.

$$(4)\quad dr_t = a(b - r_t)dt + \sigma dW_t\ ,$$

where:

$r_t = short\ term\ interest\ rate\ at\ time\ t$

$a = speed\ of\ mean\ revesion\ (daily)$

$b = long\ term\ average\ interest\ rate\ (mean\ level)$

$\sigma = volatility\ of\ interest\ rate\ movements\ (daily)$

$dW_t = random\ term\ (Brownian\ motion)$

The Vasicek model is applied by the EIM to the expected income generated by each of the selected securities. As the bonds pay periodical coupons, the Vasicek model is applied at each coupon payment date and the maturity to calculate the total achievable income, were the coupons to be invested at the selected short rate. The EIM selected the Euro Short Term Rate (ESTR) as the short rate. The is the official risk-free overnight interest rate for the euro area, published by the European Central Bank. The overnight index swap rate on this rate is considered the achievable risk-free rate for institutional investors is used as such in the optimization of the Fixed Income portfolio.

The Vasicek model parameters were estimated based on 3-year historical daily ESTR values. Through a regression of the absolute daily interest rate change against the original absolute interest rate, the EIM was able to get estimates for parameters: a equal to

0.463% and b equal to 3.453%. Furthermore, this method enabled the EIM to estimate the σ at 0.060%. With these parameters, the EIM was able to simulate the forward-looking daily ESTR for everyday until the latest payment date attributable to the longest-term security selected, which was the Japanese sovereign bond in March 2065. For the modeling process to remain robust, the EIM generated 5,000 simulations of the ESTR daily interest rate paths until March 2065. Each coupon from each security was then compounded by the attributable interest rate every day, to gain a comprehensive view of how the total income may differ over various interest rate simulations. For each of the 5,000 simulations a total return was calculated along with the annualized rate, in other words a synthetic yield to maturity modelled incorporating interest rate shifts.

One key identified limitation to this approach, is the assumption of investments into the ESTR rate, which may yield lower returns than if the coupons were reinvested into other risk-free benchmark rates or even risky securities instead. However, the EIM assumes this method as a conservative approach which allows the consideration, to a certain level, of possible forward-looking interest rate movements, and incorporating that into the expected return. The sample standard deviation of the annualized total return rates is utilized as the main measure of risk, otherwise considered the forward-looking expected volatility. This method is utilized for all the selected securities, and the annualized rate is used to compare the securities and optimize the portfolio, due to the metrics allowance for comparability. This method is also used to calculate the expected total return and volatility of the benchmark index, within which the EIM intends to invest a portion of the portfolio. Given that the benchmark index security is an ETF made up of a bunder of debt securities, the EIM made additional assumptions to comparably model the security. At the time of analysis, the price of the Bloomberg Global-Aggregate Total Return index was USD 488. The iShares index ETF, which attempts to follow this benchmark index as closely as possible provided 2 other key inputs: i) the weighted average coupon rate of 2.82% and ii) the weighted average maturity of 8.3 years. The price of the index is assumed to grow at a 1.2% growth rate until the maturity, which is equivalent to the index's 20-year historical price growth rate. The price is therefore expected to be redeemed at USD538, comparable to the principal redeemable at a bond's maturity. Since there is an assumed payment date of the principal in
8.3 years, the coupon payment dates are assumed to be annual and reverse calculated. Under these assumptions the EIM can estimate the expected annualized total return rate and volatility which are comparable to the other selected securities. The overall results are outlined below in Table 14.

ISIN	Category	Expected annualized total return	Expected annualized volatility
US007903BG12	Corp.	4.923%	0.024%
US594918BM55	Corp.	4.644%	1.273%
US19416QEJ58	Corp.	5.015%	0.631%
XS2592516210	Corp.	3.815%	0.087%
US892331AD13	Corp.	4.924%	0.047%
US771196AU61	Corp.	4.982%	0.439%
US87612EAF34	Corp.	5.346%	0.173%
US962166BR41	Corp.	5.445%	0.198%
CH0557778815	Dev. Sov.	0.987%	0.126%
DK0009924615	Dev. Sov.	2.786%	0.092%
NL0015001RG8	Dev. Sov.	3.421%	0.363%
IE000LQ7YWY4	Dev. Sov.	3.303%	0.124%
US715638DY59	EM Sov.	6.079%	0.261%
CZ0001006969	EM Sov.	4.593%	0.159%
PL0000116851	EM Sov.	5.666%	0.241%
QA000ZLNP0B9	EM Sov.	5.115%	0.064%
GB00BT7J0241	Core Sov.	4.550%	1.322%
US912810UL07	Core Sov.	4.599%	0.615%
EU000A4EA8Y7	Core Sov.	3.788%	0.488%
FR001400WYO4	Core Sov.	3.822%	0.344%
DE000BU3Z047	Core Sov.	2.936%	0.116%
JP1400181R57	Core Sov.	3.281%	1.185%
LEGATRUU	Bench.	1.864%	0.023%

Table 14 – Forward-Looking Return & Risk profiles of Selected Assets (Author's Calculations)

3.4.2 Portfolio Optimization

The EIM elected to use mean-variance theory introduced by Harry Markowitz (1952). This method of portfolio optimization generated a mathematical foundation for Modern Portfolio Theory (MPT), whereby an investor can derive an optimal portfolio given their inherent risk profile. The model assumes that investors aim to maximize their returns for a given acceptable level of risk, which varies by investor. This assumption direct aligns with NBIM's mission of generating sustainable long-term returns at an acceptable level of risk. Markowitz's (1952) theory further assumes that risk is measured by the variance of returns.

Within this theory, the investor's goal is to optimize the portfolio that gives the highest return for a given level of risk or the least risk for a given level of return.

$$(5)\quad Expected\ Return\ of\ the\ Portfolio = E(R_p) = \sum_{i=1}^{n} w_i * E(R_i),$$

$$(6)\quad Variance\ (Risk)\ of\ a\ portfolio = \sigma_p^2 = \sum_{i=1}^{n}\sum_{j=1}^{n} w_i * w_j * Cov(R_i, R_j),$$

$$(7)\quad Covariance\ between\ Returns = Cov(R_i, R_j) = \rho_{ij} * \sigma_i * \sigma_j,$$

where:

$n = Number\ of\ assets\ in\ the\ portfolio$

$E(R_i) = Expected\ Return\ of\ the\ Asset$

$w_i, w_j = weights\ of\ assets\ i\ and\ j\ (subject\ to: sum\ of\ all\ weights = 1)$

$\rho_{ij} = correlation\ coefficient\ between\ assets\ i\ and\ j$

$\sigma_i, \sigma_j = standard\ deviations\ of\ assets\ i\ and\ j\ (calculated\ as\ the\ square\ root\ of\ variance)$

William Sharpe further extended Markowitz's theory by attempting to evaluate whether a given portfolio is good or bad based on its return and risk (Joshi & Patterson, 2013). This then led to the creation of the Sharpe ratio, outlined in the formula below.

$$(8)\quad Sharpe\ Ratio = \frac{R_p - R_f}{\sigma_p},$$

where:

$R_p = Expected\ return\ of\ the\ portfolio$

$R_f = Risk - free\ rate$

$\sigma_p = Standard\ deviation\ of\ portfolio\ returns$

One of the other key elements of the mean-variance theory, is the assumption of being able to diversify portfolio risk away based on how the underlying securities co-fluctuate. This can be measured by the covariance of assets.

To maintain consistency, the EIM estimates the covariances between the individual assets on a forward-looking basis. The correlation is estimated using the 5,000 simulated annualized return rates. The covariance is calculated using the forward-looking volatility of annualized returns. The variance-covariance matrix of all the securities is outlined in Table A1.

The selected securities are split into their corresponding issuer type classifications. The aim is the creation of four sub-portfolios, given the various constraints introduced by the Mandate based on the different issuer types. Each sub-portfolio is individually optimized to maximize the risk-adjusted return indicated by the Sharpe ratio. The relevant variance-covariance values are utilized to calculate the portfolio risk. The risk-free rate is assumed to be the 15-year overnight index ESTR Swap rate, equal to 2.586%. This is the fixed interest rate to lock in a 15-year swap against ESTR, in other words the rate at which the market expects the ESTR to be in 15 years. This time period was chosen due to the average tenor of the selected securities. The EIM does not use a more traditional risk-free asset, such as United States Treasury debt security, due to the illustrated reinvestment risk these securities pose. Additionally, the sovereign issued debt is subject to credit rating changes, as was evident with Moody's downgrading the United States' sovereign credit rating from Aaa to Aa1 in May.

The results are outlined in Table 15 below, with the specific attributed weightings to each security outlined in the Appendices.

Sub-Portfolio	E[R]	σ
Core sovereign	4.005%	0.596%
Developing sovereign	3.031%	0.125%
Emerging Market sovereign	5.214%	0.088%
Corporate	4.894%	0.221%
LEGATRUU Proxy	1.864%	0.023%

Table 15 – Sub-portfolio Risk & Return Profiles (Author's Calculations)

3.5 Expected Performance

To find the optimal overall portfolio, the EIM calculated a new variance-covariance matrix attributable to the sub-portfolios, outlined the Appendices. Within the final portfolio optimization process includes constraints mentioned above. The core sub-portfolio has a minimum weighting of 7.5%. The emerging market sub-portfolio has a maximum weighting of 5%. The rest of the sub-portfolios, including the benchmark, were given a 5% minimum weighting to maintain a diversified overall portfolio covering a wide range of different issuers and issuer types. The risk and return characteristics of the final portfolio are outlined in Table 16.

E[R]	3.5%
Portfolio Variance	0.0000019445
Portfolio σ	0.14%
Sharpe Ratio	6.64

Table 16 – Final Portfolio Risk & Return Profile (Author's Calculations)

The volatility measure used for the optimization is targeted towards the key risk to which NBIM is exposed to with the hold-to-maturity portfolio, which is the reinvestment risk. Given the EIM's conservative approach, opting for a pessimistic outlook on reinvestments through investing in an overnight rate which typically yields lower returns due to its perceived safety, the volatilities get minimized and the investments seem risk-free. The other key risk to which the investor is exposed to is credit risk, which has mainly been eliminated through the rigorous issuer selection process. The full profile of the characteristics of the final portfolio are outlined in the figure and table below.

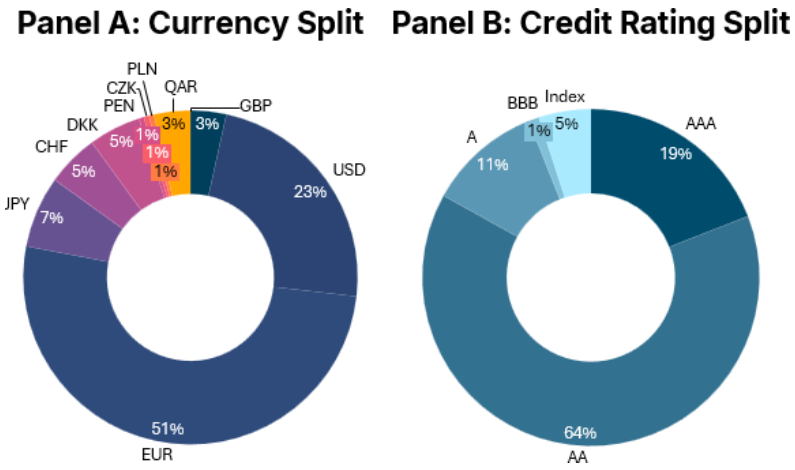

Figure 1 - Final Portfolio Characteristics (Author's Illustration)

Weighted Average Price (dirty, ask)	98.645
Weighted Average Coupon	3.34%
Weighted Average Tenor	15.00
Weighted Average YTM	6.56%
Weighted Average Macauley Duration	10.70
Weighted Average Modified Duration	10.42

Table 17 – Final Portfolio Characteristics (Author's Calculations)

Given the hold-to-maturity strategy selected by the EIM, the calculation of the expected returns based on price fluctuations becomes a naïve metric to assess the portfolio's performance and is only to be recorded as a backward-looking metric within the fund's official financial reports.

The EIM also calculates the total return of the portfolio over its entire lifetime assuming no reinvestment, to understand the pure cash income expected to flow into the fund because of holding these investments. The time period is assumed to be from the latest issue on June 2nd 2025 until the final maturity of the longest-term bond March 20th 2065. The dirty prices for each bond are calculated to determine the actual price to be paid to invest into the selected securities. In this period, the Fixed Income portfolio is expected to have total cash inflows, including par value at maturity, equal to NOK 10.754 trillion, assuming no reinvestment of the coupons. The total return over the approximate 40-year period given an initial investment of NOK 7.085 trillion is expected to be 52.8%. This total return would result in an expected compound annual growth rate of 1.1%. The entire cash inflow schedule is available in Figure 2.

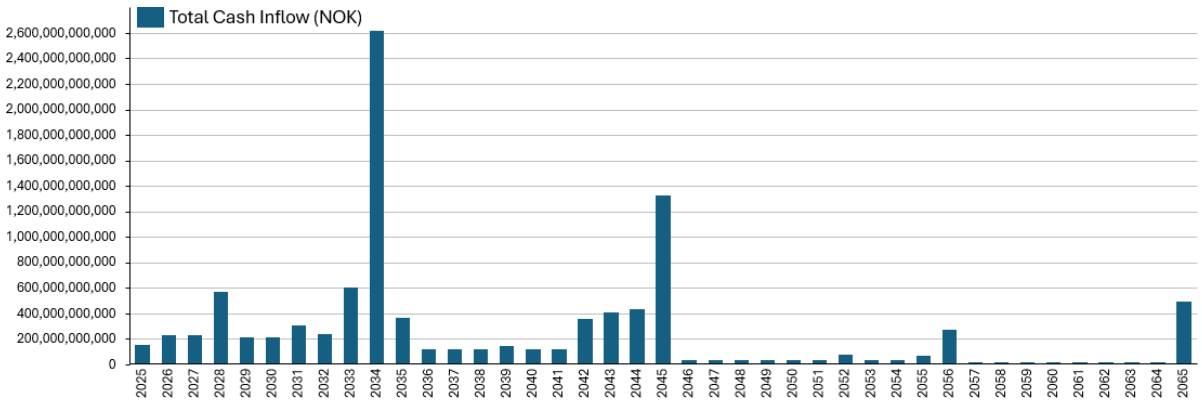

Figure 2 - Total Cash Inflow Schedule (Author's Illustration)

When comparing the total income generated to the benchmark, to mitigate incomparability due to the different principal payments, the EIM compares the total coupon income generated by investing into the chosen portfolio versus the benchmark portfolio during the benchmark's tenor of 8.3 years, assuming no reinvestment. The benchmark portfolio would generate a total of NOK 1.428 trillion, equivalent to an annual coupon rate of 2.52%, while the chosen portfolio would generate NOK 2.015 trillion at an average annual coupon rate of 3.43%.

3.6 Risk Management

3.6.1 Liquidity Risk Analysis

The GPFG is a tool utilized by the Norwegian central government to manage domestic economic fluctuations. The Ministry of Finance looks to minimize the use of the proceeds from the fund during economic expansion in order to have a maximal amount of financial resources during economic downturns. Additionally, given the size of the Fund's total holdings, any necessary major selloffs could create a gap in the market and have auxiliary consequences such as large price drops. Consequently, the EIM computes the Fixed Income portfolio's coverage of the fund's estimated total annual cash outflows directed toward the Ministry of Finance. The estimated withdrawals are based on the Ministry of Finance's average annual 10-year historical withdrawal amount. This amount is equal to NOK 68.65 billion. Given the weighted average coupon rate of the final portfolio of 3.34% received against a total principal equal to NOK 7.085 trillion, this would annually yield coupon cash equal to NOK 236.64 billion for the weighted average portfolio tenor of 12.9 years. These amounts would result in an expected outflow coverage of 3.45x. The coupon yield is therefore large enough to cover the expected withdrawals without creating a necessity for selling off any assets in the portfolio or the GPFG. This eliminates further liquidity risks pertaining to large asset sell-offs creating potential gaps and drops in the market.

3.6.2 Value-at-Risk Analysis

The traditional Value-at-Risk (VaR) measures demonstrating the potential loss the portfolio may make within a given time-period and confidence interval. In other words, the EIM expects a (1 – Confidence Interval)% chance the VaR will equal to or land below the output value (Joshi & Patterson, 2013). This measure illustrates the potential changes in market value of the portfolio due to price fluctuations. Within the computations, the EIM assumes a 1-day VaR, to reflect the active monitoring of the fund's value. Additionally, the EIM calculated a VaR for 3 confidence intervals: 95%, 99% and 99.9%. The VaR may be computed using three distinct methods: i) historical VaR computed based on historical fluctuations of the portfolio's market value, ii) Monte Carlo VaR which simulates large number of potential future scenarios, and iii) parametric VaR which assumes that portfolio returns follow a normal distribution and uses the portfolio's mean return and volatility to calculate potential losses (Joshi & Patterson, 2013). To compute the historical VaR, the EIM utilizes the 1-year weighted average daily price return of each security. The price return is calculated by the return on price movements plus the accumulated interest for the day, in order to account for both, return elements inherent to debt instruments. These returns are sorted from smallest (largest daily loss) to largest (largest daily gain) and multiplied by the total portfolio value of NOK 7.085 trillion to estimate the absolute daily losses and gains and the VaR values are determines using the relevant confidence levels. The EIM assumes a geometric Brownian motion with normal distribution of returns for the Monte Carlo VaR calculation. The historical mean and standard deviation are calculated on the same dataset used for the Historical VaR. The EIM produced 500,000 simulations to calculate the distribution of returns. The parametric VaR is calculated assuming the portfolio's returns follow a normal distribution, utilizing the corresponding Z-scores of the assumed tail probabilities to estimate the potential losses. The results for these three methods are outlined in Table 18.

Confidence Level	Historical VaR (NOK)	Monte Carlo VaR (NOK)	Parametric VaR (NOK)
95.0%	41,416,893,064	41,718,851,184	41,814,184,142
99.0%	59,194,790,446	58,867,368,289	59,018,609,616
99.9%	102,796,952,111	78,132,611,804	78,302,987,790

Table 18 – Historical, Monte Carlo & Parametric VaR (Author's Calculations)

Given the hold-to-maturity strategy implemented for the Fixed Income composite, the EIM also selected an alternative metric to evaluate a more relevant risk the portfolio faces. Credit VaR is a quantitative metric used to calculate the possible decline in a credit portfolio's value over a given time-period and confidence level as a result of credit events, namely defaults. It focuses on losses resulting from counterparty default risk, as opposed to traditional VaR which measures on price fluctuations.

The EIM used a set of assumptions to compute the portfolio's 1-year Credit VaR at the 99.9% confidence level. Firstly, the EIM collected market data relating to the probabilities of default (PD) associated with each bond in the final portfolio. These probabilities were calculated as the average probabilities of default between 1981-2024 of each bond credit rating, based on S&P Global Ratings (2025). Secondly, the losses given default (LGD) are assumed to equal the Bank for International Settlements regulatory LGDs outlined in their IRB approach to estimating risk weighted assets for credit risk. Each issuer's default event is modelled using a Bernoulli trial and defaults are assumed to be independent across obligors. Finally, the exposures at default are assumed to be the par value of each bond. The EIM performed a Montecarlo simulation through utilizing this Bernoulli distribution, to model the possible Credit VaR values over 10,000 paths for each issuer. The result was a Credit VaR equal to NOK 28.55 million, meaning that given the 99.9% confidence level (a highly extreme event), the portfolio could lose up to this amount. The EIM considers this amount to be very small, relative to the size of the Fixed Portfolio.

3.6.3 Expected Shortfall Analysis

The EIM understands that a key limitation to the VaR metrics is not illustrating the gravity of losses beyond the selected confidence level. Consequently, the EIM elected to further administer risk analysis relating to the expected losses of the portfolio value through calculating the Expected Shortfall (ES), which averages losses beyond the VaR to measure adverse tail risk. The Expected Shortfall is computed utilizing the dataset from all three VaR metrics calculated in section 3.6.1. The results are outlined in Table 19.

Confidence	Historical ES (NOK)	Monte Carlo ES (NOK)	Parametric ES (NOK)	Credit ES (NOK)
95.0%	54,960,221,102	52,269,961,798	52,363,102,436	*n/a*
99.0%	80,316,604,312	67,584,805,054	67,573,341,847	*n/a*
99.9%	117,297,666,551	84,979,159,945	85,292,304,144	95,575,770

Table 19 – Expected Shortfall (ES) Calculations (Author's Calculations)

3.6.4 Tracking Error Analysis

As outlined in the Mandate, the Fixed Income portfolio's tracking error may exceed 1.25% relative to the benchmark for a limited time-period. This leniency allows for the fund to maximize potential returns, whilst still maintaining the ability to closely track the benchmark

over the long-term. Given the EIM's alternative approach to calculating returns of the portfolio due to the elected hold-to-maturity strategy, the tracking error is computed against multiple metrics of return.

Firstly, the return metric used to optimize the Fixed Income portfolio is the annualized expected total return rate, estimated using the Vasicek model to simulate interest rate movements at which coupons can be invested. The tracking error based on this return measure illustrates the excess return expected to be received by receiving coupons from each of the selected bonds and re-investing them at the ESTR rate relative to the same approach for investing into the iShares index. The deviations used to calculate the tracking error were the differences in annualized return rates achieved by the portfolio and the iShares index over each of the 5,000 simulated interest rate paths, outlined in Figure 3. These deviations were squared, summed, and divided by the number of simulations minus one, assuming these are sample standard deviations. This result was squared to generate an expected tracking error of 1.65%.

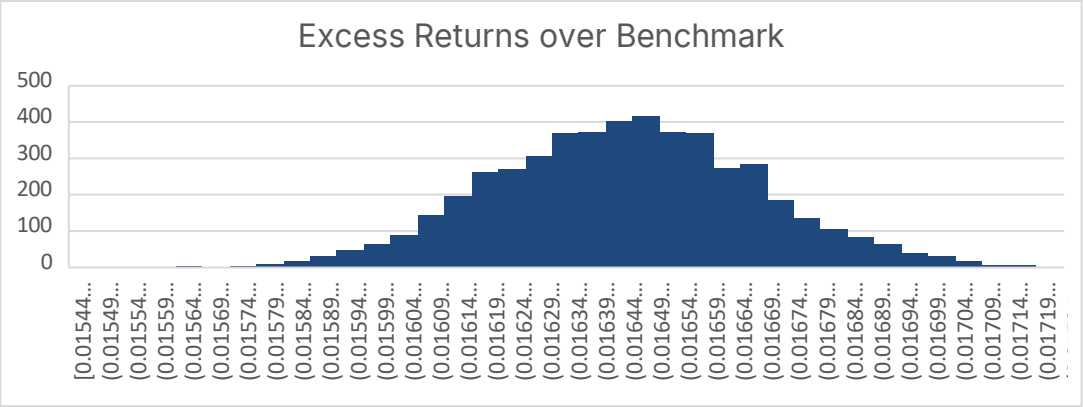

Figure 3 - Annualized Expected Total Return Deviation Distribution (Author's Illustration)

Alternatively, the EIM recognizes the necessity of reporting the values of the fund's holdings, whereby the returns are measured based on the market value of NBIM's holdings. For this purpose, the EIM calculated a secondary tracking error with regards to the total return generated by the final portfolio without assuming a hold-to-maturity strategy. The expected return of the portfolio is estimated using 1-year daily historical price fluctuations adjusted for the daily accumulated interest. To calculate the tracking error, the EIM derived the daily deviations of returns between the final portfolio and the benchmark, illustrated in Figure 5. Repeating the same computation used for the annualized expected total return, the result is a daily tracking error. For comparability, the tracking error is annualized to result in 0.35%, which is within the Mandate's level. This version of the tracking error is the official metric used by the Ministry of Finance and NBIM to evaluate any necessity for rebalancing the portfolio. Therefore, the EIM has successfully created a portfolio not expected to be rebalanced, whilst generating an excess expected total return above the threshold set out by the Mandate.

3.6.5 Risk Matrix

To systematically assess and manage the key risk exposures within the Fixed Income portfolio, the EIM uses a risk matrix methodology. The matrix offers a qualitative assessment and visualization of key risks according to their probability of occurrence and possible influence on the performance of the portfolio. The Investment

Committee identified nine relevant risks and events which would have direct effects on the portfolio, outlined below.

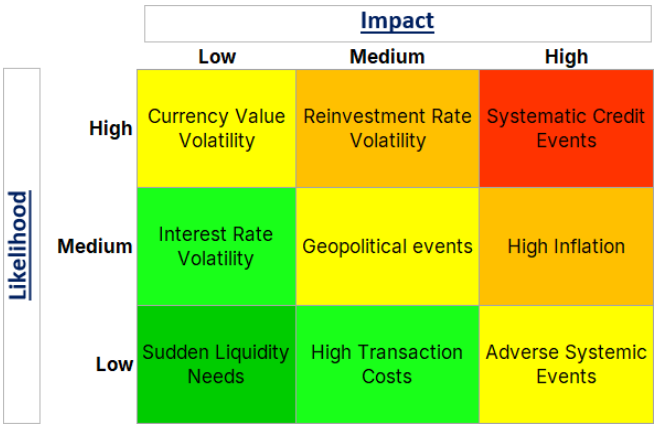

Figure 4 – Risk Matrix Qualitative Assessment (Author's Illustration)

Geopolitical risk poses a threat to the portfolio through multiple channels. Firstly, the Ministry of Finance may impose constraints on countries that are eligible to be invested in, which may affect the current or future holdings of the portfolio. Additionally, geopolitical conflicts may result in long-lasting economic consequences which may then directly affect various industries and businesses within them. The EIM seeks to mitigate this risk through diversification across regions and constant macroeconomic analysis to identify key regions that are increasing in the likelihood of entering some geopolitical conflict.

Adverse systemic events, such as the collapse of an industry, may affect specific assets within the portfolio's current or future holdings and lead to increased industry-wide defaults or other credit scenarios. The EIM minimizes this risk through diversification across industries and issuers.

Systematic credit events, such as company may directly lead to losses in the portfolio through lost income. The EIM manages this risk through a rigorous security selection process and constant held issuer monitoring as they report financial and macroeconomic indicators.

Reinvestment risk directly impacts the portfolio as it is the driver of each asset's total yield to the investor through the reinvestment of coupons. This risk is managed through diversifying the held assets' tenors to spread the reinvestment over various periods of the economic cycle.

High sudden liquidity needs by the Ministry of Finance can damage the portfolio's returns as it can lead to a need to sell off investments prior to their maturity, not allowing them to maximize their expected cash inflows and potentially selling off at low prices due to the interest rate environments. This risk is managed through investments into highly liquid assets of above EUR 500 million in amount outstanding.

High inflation may erode the economic value of the income earned by the portfolio and is mitigated by investments into investment into relatively high yielding securities (i.e. through selecting securities with the highest current yield).

High interest rate volatility may indirectly affect the portfolio. During high-rate environments, the investor may suffer opportunity costs related to higher yielding newly issued securities. On

the other hand, during low-rate periods the investor may suffer an opportunity cost form not selling assets with hiked prices. The EIM manages this risk through applying stochastic interest rate models to the expected performance of each security.

Currency risk may mainly impact the portfolio due to Norway's macroeconomic environment, which may push the Ministry of Finance to intervene into the NOK's valuation. This may be done through setting additional constraints on the portfolio's holdings and is mitigated through diversifying the currencies held.

High transactions costs directly affect the portfolio by eroding the real returns. The EIM Mitigates these risks by minimizing the transaction volume through a hold-to-maturity strategy.

Appendix

Table A1 Client Risk Profile

Client Name	Norges Bank Investment Management
Fund Name	Government Pension Fund Global
Location	Oslo, Norway
Total Investment Amount	NOK 19.742 trillion (NOK 7.085 trillion is allocated to Fixed Income).
Return Objective	Maximize return for the given risk level
Risk Objective	<1.25% expected tracking error for 1 out of every 3 years
General Objective	Maximize returns within the appropriate risk level to safeguard and build financial wealth for future generations.
Time Horizon	Perpetual (Going Concern Fund)

Figure A1 Norges Bank Investment Management Leadership Group

Table A2 Correlation Matrix – Asset Classes

		Bonds	Real Estate	Infrastructure	Equities
		.FTWBIGUSDT	.FTAWORLDS35U	.SPGTINTR	.MIWD00000PUS
Bonds	.FTWBIGUSDT	1.000	0.049	0.178	0.133
Real Estate	.FTAWORLDS35U	0.049	1.000	0.135	0.133
Infrastructure	.SPGTINTR	0.178	0.135	1.000	0.807
Equities	.MIWD00000PUS	0.133	0.133	0.807	1.000

Table A3 Variance-Covariance Matrix – Asset Classes

		Bonds	Real Estate	Infrastructure	Equities
		.FTWBIGUSDT	.FTAWORLDS35U	.SPGTINTR	.MIWD00000PUS
Bonds	.FTWBIGUSDT	0.004	0.000	0.001	0.001
Real Estate	.FTAWORLDS35U	0.000	0.018	0.002	0.002
Infrastructure	.SPGTINTR	0.001	0.002	0.012	0.009
Equities	.MIWD00000PUS	0.001	0.002	0.009	0.010

Table A4 Sovereign Issuer Selection Rankings – Bloomberg Methodology

Final Ranking	Market	Country	Wavg. Ranking
1	Dev.	Denmark	6.4
2	Dev.	Switzerland	7.0
3	EM	Kuwait	8.0
4	Dev.	Sweden	8.4
5	EM	Taiwan	8.6
6	Dev.	Ireland	8.6
7	Dev.	Netherlands	9.6
8	EM	Qatar	11.8
9	Dev.	Hong Kong	12.0
10	EM	Saudi Arabia	12.8
11	EM	Czech Republic	15.2
12	Dev.	Australia	16.8
13	Dev.	Germany	17.2
14	EM	Poland	18.2
15	EM	Peru	18.6
16	EM	Korea	19.6
17	Dev.	Singapore	20.4
18	EM	Indonesia	20.6
19	Dev.	Israel	21.8
19	EM	Malaysia	21.8
21	EM	Chile	22.8
22	Dev.	Austria	23.6
23	EM	Hungary	24.0
24	Dev.	New Zealand	24.2
25	Dev.	Finland	24.6
26	EM	Thailand	24.8
27	Dev.	Spain	25.6
28	EM	Turkey	27.0
29	Dev.	Portugal	28.2
30	EM	China	29.4
31	Dev.	Japan	29.8
32	EM	Mexico	29.8
33	Dev.	Canada	30.4
34	Dev.	Belgium	31.2
35	Dev.	UK	31.6
36	EM	Colombia	31.6
37	EM	South Africa	31.8
38	EM	Brazil	32.0
39	Dev.	Italy	32.6
39	EM	Philippines	32.6
41	Dev.	France	33.4
42	EM	India	33.8
43	Dev.	USA	37.0
44	EM	Egypt	39.0
45	EM	Greece	40.8

Table A5 Correlation Matrix – Individual Selected Securities

	US007903BG12	US594918BM55	US19416QEJ58	XS2592516210	US892331AD13	US771196AU61	US87612EAF34	US962166BR41	CH0557778815	DK0009924615	US715638DY59	CZ0001006969	PL0000116851	QA000ZLNP0B9	NL0015001RG8	IE000LQ7YWY4	GB00BT7J0241	US912810UL07	EU000A4EA8Y7	FR001400WYO4	DE000BU3Z047	JP1400181R57
US007903BG12	1.000	0.893	0.724	0.152	0.089	0.460	0.160	0.180	0.633	0.241	0.230	0.158	0.279	0.088	0.656	0.279	0.885	0.704	0.731	0.586	0.291	0.681
US594918BM55	0.893	1.000	0.624	0.118	0.071	0.390	0.123	0.137	0.540	0.191	0.181	0.121	0.223	0.070	0.563	0.223	0.998	0.607	0.629	0.500	0.233	0.782
US19416QEJ58	0.724	0.624	1.000	0.215	0.105	0.645	0.227	0.254	0.905	0.338	0.324	0.223	0.392	0.105	0.937	0.391	0.621	0.987	0.999	0.839	0.410	0.475
XS2592516210	0.152	0.118	0.215	1.000	0.469	0.343	0.986	0.903	0.267	0.682	0.709	0.990	0.589	0.497	0.235	0.592	0.122	0.208	0.215	0.247	0.548	0.091
US892331AD13	0.089	0.071	0.105	0.469	1.000	0.148	0.481	0.396	0.128	0.288	0.291	0.518	0.244	0.994	0.102	0.246	0.075	0.094	0.106	0.097	0.211	0.060
US771196AU61	0.460	0.390	0.645	0.343	0.148	1.000	0.364	0.419	0.751	0.559	0.535	0.355	0.643	0.153	0.713	0.641	0.392	0.644	0.641	0.796	0.671	0.296
US87612EAF34	0.160	0.123	0.227	0.986	0.481	0.364	1.000	0.944	0.282	0.723	0.751	0.997	0.625	0.505	0.248	0.628	0.126	0.220	0.227	0.263	0.583	0.094
US962166BR41	0.180	0.137	0.254	0.903	0.396	0.419	0.944	1.000	0.318	0.825	0.856	0.927	0.717	0.417	0.282	0.719	0.141	0.248	0.254	0.305	0.673	0.109
CH0557778815	0.633	0.540	0.905	0.267	0.128	0.751	0.282	0.318	1.000	0.414	0.398	0.276	0.470	0.129	0.986	0.469	0.539	0.910	0.897	0.959	0.488	0.412
DK0009924615	0.241	0.191	0.338	0.682	0.288	0.559	0.723	0.825	0.414	1.000	0.992	0.706	0.933	0.301	0.376	0.935	0.193	0.334	0.336	0.412	0.894	0.153
US715638DY59	0.230	0.181	0.324	0.709	0.291	0.535	0.751	0.856	0.398	0.992	1.000	0.733	0.902	0.305	0.361	0.905	0.184	0.320	0.322	0.395	0.862	0.146
CZ0001006969	0.158	0.121	0.223	0.990	0.518	0.355	0.997	0.927	0.276	0.706	0.733	1.000	0.610	0.541	0.242	0.613	0.125	0.215	0.223	0.255	0.567	0.093
PL0000116851	0.279	0.223	0.392	0.589	0.244	0.643	0.625	0.717	0.470	0.933	0.902	0.610	1.000	0.254	0.432	1.000	0.225	0.388	0.390	0.472	0.989	0.177
QA000ZLNP0B9	0.088	0.070	0.105	0.497	0.994	0.153	0.505	0.417	0.129	0.301	0.305	0.541	0.254	1.000	0.103	0.256	0.074	0.094	0.106	0.098	0.222	0.059
NL0015001RG8	0.656	0.563	0.937	0.235	0.102	0.713	0.248	0.282	0.986	0.376	0.361	0.242	0.432	0.103	1.000	0.431	0.561	0.941	0.929	0.926	0.452	0.429
IE000LQ7YWY4	0.279	0.223	0.391	0.592	0.246	0.641	0.628	0.719	0.469	0.935	0.905	0.613	1.000	0.256	0.431	1.000	0.225	0.387	0.389	0.470	0.988	0.176
GB00BT7J0241	0.885	0.998	0.621	0.122	0.075	0.392	0.126	0.141	0.539	0.193	0.184	0.125	0.225	0.074	0.561	0.225	1.000	0.604	0.627	0.499	0.235	0.789
US912810UL07	0.704	0.607	0.987	0.208	0.094	0.644	0.220	0.248	0.910	0.334	0.320	0.215	0.388	0.094	0.941	0.387	0.604	1.000	0.983	0.844	0.406	0.461
EU000A4EA8Y7	0.731	0.629	0.999	0.215	0.106	0.641	0.227	0.254	0.897	0.336	0.322	0.223	0.390	0.106	0.929	0.389	0.627	0.983	1.000	0.832	0.408	0.479
FR001400WYO4	0.586	0.500	0.839	0.247	0.097	0.796	0.263	0.305	0.959	0.412	0.395	0.255	0.472	0.098	0.926	0.470	0.499	0.844	0.832	1.000	0.493	0.382
DE000BU3Z047	0.291	0.233	0.410	0.548	0.211	0.671	0.583	0.673	0.488	0.894	0.862	0.567	0.989	0.222	0.452	0.988	0.235	0.406	0.408	0.493	1.000	0.183
JP1400181R57	0.681	0.782	0.475	0.091	0.060	0.296	0.094	0.109	0.412	0.153	0.146	0.093	0.177	0.059	0.429	0.176	0.789	0.461	0.479	0.382	0.183	1.000

Table A6 Core Issuers – Variance-Covariance Matrix

	GB00BT7J0241	US912810UL07	EU000A4EA8Y7	FR001400WYO4	DE000BU3Z047	JP1400181R57
GB00BT7J0241	0.00017484160	0.00004911755	0.00004043237	0.00002272990	0.00000360833	0.00012356336
US912810UL07	0.00004911755	0.00003777883	0.00002946499	0.00001785996	0.00000290208	0.00003357128
EU000A4EA8Y7	0.00004043237	0.00002946499	0.00002379915	0.00001396946	0.00000231452	0.00002767734
FR001400WYO4	0.00002272990	0.00001785996	0.00001396946	0.00001185775	0.00000197433	0.00001557844
DE000BU3Z047	0.00000360833	0.00000290208	0.00000231452	0.00000197433	0.00000135419	0.00000251962
JP1400181R57	0.00012356336	0.00003357128	0.00002767734	0.00001557844	0.00000251962	0.00014033872

Table A7 Developing Sovereign Issuers – Variance-Covariance Matrix

	CH0557778815	DK0009924615	NL0015001RG8	IE000LQ7YWY4
CH0557778815	0.00000159287	0.00000047917	0.00000451840	0.00000073194
DK0009924615	0.00000047917	0.00000083963	0.00000125112	0.00000105985
NL0015001RG8	0.00000451840	0.00000125112	0.00001317701	0.00000193687
IE000LQ7YWY4	0.00000073194	0.00000105985	0.00000193687	0.00000153096

Table A8 Emerging Market Sovereign Issuers – Variance-Covariance Matrix

	US715638DY59	CZ0001006969	PL0000116851	QA000ZLNP0B9
US715638DY59	0.00000679058	0.00000304217	0.00000565496	0.00000050923
CZ0001006969	0.00000304217	0.00000253366	0.00000233592	0.00000055119
PL0000116851	0.00000565496	0.00000233592	0.00000578499	0.00000039137
QA000ZLNP0B9	0.00000050923	0.00000055119	0.00000039137	0.00000040929

Table A9 Corporate Issuers – Variance-Covariance Matrix

	US007903BG12	US594918BM55	US19416QEJ58	XS2592516210	US892331AD13	US771196AU61	US87612EAF34	US962166BR41
US007903BG12	0.00000005931	0.00000276787	0.00000111152	0.00000003213	0.00000001011	0.00000049181	0.00000006779	0.00000008702
US594918BM55	0.00000276787	0.00016204178	0.00005005200	0.00000130107	0.00000042279	0.00002182093	0.00000270656	0.00000346305
US19416QEJ58	0.00000111152	0.00005005200	0.00003975963	0.00000117686	0.00000030884	0.00001785878	0.00000248553	0.00000317932
XS2592516210	0.00000003213	0.00000130107	0.00000117686	0.00000075087	0.00000018942	0.00000130617	0.00000148238	0.00000154970
US892331AD13	0.00000001011	0.00000042279	0.00000030884	0.00000018942	0.00000021692	0.00000030307	0.00000038880	0.00000036516
US771196AU61	0.00000049181	0.00002182093	0.00001785878	0.00000130617	0.00000030307	0.00001929445	0.00000277245	0.00000364790
US87612EAF34	0.00000006779	0.00000270656	0.00000248553	0.00000148238	0.00000038880	0.00000277245	0.00000300965	0.00000324419
US962166BR41	0.00000008702	0.00000346305	0.00000317932	0.00000154970	0.00000036516	0.00000364790	0.00000324419	0.00000392545

Table A10 Issuer Category Optimization – Correlation Matrix

	Corporate	Emerging Market	Developing	Core	Benchmark
Corporate	1.000	0.739	0.758	0.766	0.692
Emerging Market	0.739	1.000	0.601	0.257	0.681
Developing	0.758	0.601	1.000	0.604	0.897
Core	0.766	0.257	0.604	1.000	0.371
Benchmark	0.692	0.681	0.897	0.371	1.000

Table A11 Issuer Category Optimization – Variance-Covariance Matrix

	Corporate	Emerging Market	Developing	Core	Benchmark
Corporate	0.00000487933	0.00000143832	0.00000208696	0.00001009689	0.00000035405
Emerging Market	0.00000143832	0.00000077555	0.00000065947	0.00000134895	0.00000013893
Developing	0.00000208696	0.00000065947	0.00000155325	0.00000448994	0.00000025875
Core	0.00001009689	0.00000134895	0.00000448994	0.00003556979	0.00000051193
Benchmark	0.00000035405	0.00000013893	0.00000025875	0.00000051193	0.00000005362

Figure A2 Total Cash Income by Selected Security (Assuming no Reinvestment)

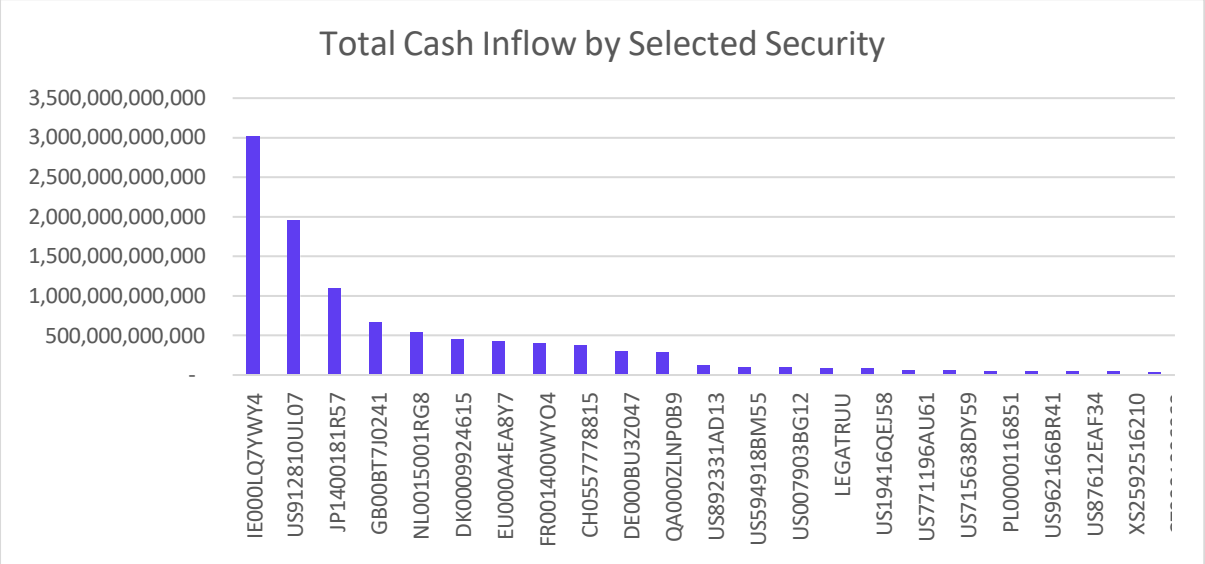

Table A12 Individual Selected Securities Characteristics

ISIN	Issuer	S&P Rating	Type	Currency	Coupon Rate	Frequency	Issue Date	Maturity Date	Tenor (yr)	Last coupon date	Price (clean, ask)	Weight	YTM	Mac. Dur.	Mod. Dur.
GB00BT7J0241	United Kingdom	A	Core	GBP	5.375%	Semi	21-May-25	31-Jan-56	30.6	21-May-25	99.091	3.46%	5.4%	15.0	14.6
US912810UL07	United States Treasury	AAA	Core	USD	5.000%	Semi	2-Jun-25	15-May-45	19.9	2-Jun-25	100.273	13.84%	5.0%	12.8	12.5
EU000A4EA8Y7	European Union	A+	Core	EUR	3.750%	Annual	20-May-25	12-Oct-45	20.3	20-May-25	101.267	3.46%	3.7%	14.3	13.8
FR001400WYO4	Republic of France	A-	Core	EUR	3.600%	Annual	28-Jan-25	25-May-42	16.9	26-May-25	99.615	3.46%	3.6%	13.0	12.5
DE000BU3Z047	Federal Republic of Germany	A+	Core	EUR	2.500%	Annual	10-Apr-25	15-Feb-35	9.7	10-Apr-25	99.938	3.46%	2.5%	8.7	8.5
JP1400181R57	Japan	AA	Core	JPY	3.100%	Semi	29-May-25	20-Mar-65	39.8	29-May-25	100.573	6.92%	3.1%	23.0	22.7
US007903BG12	Advanced Micro Devices Inc	A	Corp.	USD	4.393%	Semi	9-Jun-22	1-Jun-52	27.0	2-Jun-25	81.645	0.50%	5.7%	14.8	14.4
US594918BM55	Microsoft Corp	BBB	Corp.	USD	4.750%	Semi	3-Nov-15	3-Nov-55	30.4	5-May-25	88.750	0.50%	5.5%	15.5	15.0
US19416QEJ58	Colgate-Palmolive Co	BBB-	Corp.	USD	4.000%	Semi	6-Aug-15	15-Aug-45	20.2	18-Feb-25	80.692	0.50%	5.6%	13.1	12.7
XS2592516210	Wolters Kluwer NV	AA-	Corp.	EUR	3.750%	Annual	20-Apr-23	3-Apr-31	5.8	3-Apr-25	103.746	0.50%	3.0%	5.3	5.2
US892331AD13	Toyota Motor Corp	A-	Corp.	USD	3.669%	Semi	20-Jul-18	20-Jul-28	3.1	21-Jan-25	98.219	1.50%	4.3%	2.9	2.9
US771196AU61	Roche Holdings Inc	AA	Corp.	USD	7.000%	Semi	25-Feb-09	1-Mar-39	13.7	3-Mar-25	116.592	0.50%	5.3%	9.3	9.0
US87612EAF34	Target Corp	AAA	Corp.	USD	7.000%	Semi	20-Jul-01	15-Jul-31	6.1	15-Jan-25	111.340	0.50%	4.8%	5.0	4.9
US962166BR41	Weyerhaeuser Co	AAA	Corp.	USD	7.375%	Semi	7-Oct-02	15-Mar-32	6.8	17-Mar-25	111.535	0.50%	5.3%	5.5	5.3
CH0557778815	Confederation of Switzerland	AAA	Dev.	CHF	1.250%	Annual	28-Jun-23	28-Jun-43	18.0	28-Jun-24	115.188	5.04%	0.4%	16.3	16.2
DK0009924615	Kingdom of Denmark	AA	Dev.	DKK	2.250%	Annual	3-Oct-23	15-Nov-33	8.4	15-Nov-25	100.101	5.04%	2.2%	7.7	7.5
NL0015001RG8	Kingdom of the Netherlands	AA	Dev.	EUR	3.250%	Annual	19-Oct-23	15-Jan-44	18.6	15-Jan-25	102.994	5.04%	3.0%	14.2	13.7
IE000LQ7YWY4	Ireland	AA+	Dev.	EUR	2.600%	Annual	18-Jan-24	18-Oct-34	9.3	18-Oct-24	98.522	35.27%	2.8%	8.3	8.1
US715638DY59	Republic of Peru	AA+	EM	PEN/USD	7.300%	Semi	12-Jun-23	12-Aug-33	8.2	12-Feb-25	107.701	0.50%	6.1%	6.3	6.1
CZ0001006969	Czech Republic	AA-	EM	CZK	6.200%	Annual	16-Jun-23	16-Jun-31	6.0	17-Jun-24	113.626	0.50%	3.6%	5.0	4.8
PL0000116851	Republic of Poland	AAA	EM	PLN	5.000%	Annual	12-Apr-24	25-Oct-34	9.4	25-Oct-24	97.737	0.50%	5.3%	7.5	7.1
QA000ZLNP0B9	State of Qatar	A+	EM	QAR	5.250%	Semi	3-Sep-23	3-Sep-28	3.2	3-Mar-25	103.058	3.50%	4.2%	3.0	2.9

References

Adam, T., & Smith, J. (2022). *Fixed income analysis* (4th ed.). Wiley.

Bank for International Settlements (BIS). (2023). *Basel framework: Credit risk – Standardised approach*. https://www.bis.org/basel_framework/chapter/CRE/32.htm

Bloomberg. (2023). *Global aggregate index* [PDF]. https://assets.bbhub.io/professional/sites/27/Global-Aggregate-Index.pdf

Bloomberg. (2023). *Global inflation-linked index (Series-L)* [PDF]. https://assets.bbhub.io/professional/sites/27/Global-Inflation-Linked-Index-Series-L.pdf

Bloomberg. (2024). *Bloomberg fiscal strength weighted index methodology* [PDF]. https://assets.bbhub.io/professional/sites/27/Bloomberg-Fiscal-Strength-Weighted-Index-Methodology_May-2024.pdf

Bloomberg LP. (2024). *Bloomberg Market Concepts (BMC)* [Online course]. https://www.bloomberg.com/professional/product/bloomberg-market-concepts/

Bogle, J. C. (2007). *The little book of common sense investing: The only way to guarantee your fair share of stock market returns* (Rev. ed.). Wiley.

CFA Institute. (2010). Elements of an investment policy statement for institutional investors [Position paper; PDF]. CFA Institute Research and Policy Center. https://rpc.cfainstitute.org/sites/default/files/-/media/documents/article/position-paper/investment-policy-statement-institutional-investors.pdf

Fabozzi, F. J. (2013). *Bond markets, analysis and strategies* (8th ed.). Pearson.

Goldman Sachs. (2025). *Tariff-induced recession risk* [PDF]. https://www.goldmansachs.com/pdfs/insights/goldman-sachs-research/tariff-induced-recession-risk/tariff-induced-recession-risk.pdf

Han, N. B., Naing, S., Ghoshal, D., Whalley, E., & Wesshasartar, N. (2025). China-backed militia secures control of new rare earth mines in Myanmar. *Reuters*. https://www.reuters.com/world/china/china-backed-militia-secures-control-new-rare-earth-mines-myanmar-2025-06-12/

International Monetary Fund (IMF). (2023). *General government debt (% of GDP)*. https://www.imf.org/external/datamapper/GG_DEBT_GDP@GDD/CAN/FRA/DEU/ITA/JPN/GBR/USA

International Monetary Fund (IMF). (n.d.). *IMF data portal* [Online database]. https://data.imf.org/

Joshi, M., & Patterson, R. (2013). *Introduction to mathematical portfolio theory*. Oxford University Press.

Kim, C. (2025). South Korea Q1 GDP unexpectedly contracts, reinforcing rate cut chances. *Reuters*. https://www.reuters.com/world/asia-pacific/south-korea-q1-gdp-unexpectedly-contracts-02-qq-exports-cool-2025-04-23/

London Stock Exchange Group (LSEG). (2024). *Industry Classification Benchmark (Equity) ground rules* (Version 4.9) [PDF]. https://www.lseg.com/content/dam/ftse-russell/en_us/documents/ground-rules/icb-ground-rules.pdf

Markowitz, H. (1952). Portfolio selection. *The Journal of Finance, 7*(1), 77–91. https://www.jstor.org/stable/2975974

Martellini, L., Priaulet, P., & Priaulet, S. (2003). *Fixed income securities: Valuation, risk management and portfolio strategies*. Wiley.

Mendez Ramos, F. (2020). *Sudden influxes of resource wealth to the economy: Avoiding "Dutch disease"* (Research and Policy Briefs, No. 31). World Bank.

Moody's Analytics. (2025). *ORBIS database*. Available through ISEG Library database.

Moscatelli, M., Parlapiano, F., Narizzano, S., & Viggiano, G. (2020). Corporate default forecasting with machine learning. *Expert Systems with Applications, 161*, 113567. https://doi.org/10.1016/j.eswa.2020.113567

Norges Bank. (2025). *Inflation*. https://www.norges-bank.no/en/topics/Monetary-policy/inflation/#:~:text=Norges%20Bank%27s%20operational%20target%20is%20annual%20inflation%20of%202%20percent

Norges Bank Investment Management (NBIM). (2022). *Strategy 2025: Our strategy for the Government Pension Fund Global* [PDF]. https://www.nbim.no/contentassets/5381a580dd9643e8bbe3ed971ff53d09/gpfg-strategy-25.pdf

Norges Bank Investment Management (NBIM). (2025). *About the fund*. https://www.nbim.no/en/about-us/about-the-fund/

Norges Bank Investment Management (NBIM). (2025). *Responsible investment*. https://www.nbim.no/en/responsible-investment/

Norwegian Ministry of Finance. (2020). *Government Pension Fund Act – as of 1 January 2020* [PDF]. https://www.regjeringen.no/contentassets/9d68c55c272c41e99f0bf45d24397d8c/government-pension-fund-act-01.01.2020.pdf

Norwegian Ministry of Finance. (2023). *The Norwegian fiscal policy framework*. https://www.regjeringen.no/en/topics/the-economy/economic-policy/economic-policy/id418083/

Norwegian Ministry of Finance. (2024). *Management mandate for the Government Pension Fund Global – as of 30 June 2024* [PDF]. https://www.regjeringen.no/contentassets/9d68c55c272c41e99f0bf45d24397d8c/2024.06.30_gpfg_management_mandate.pdf

Refinitiv. (2025). *Eikon* [Online database]. https://www.refinitiv.com/en/products/eikon-trading-software

S&P Global Ratings. (2025). *Default, transition, and recovery: 2024 annual global corporate default and rating transition study*. https://www.spglobal.com/ratings/en/research/articles/250327-default-transition-and-recovery-2024-annual-global-corporate-default-and-rating-transition-study-13452126

Trappenberg, T. P. (2020). *Fundamentals of machine learning* (1st ed.). Oxford University Press.

World Bank. (2024). *Worldwide governance indicators (WGI)* [Online database]. https://databank.worldbank.org/source/worldwide-governance-indicators

World Bank. (n.d.). *Data360* [Online]. https://data360.worldbank.org/en/search

Ye, L. (2023). Credit rating of Chinese companies based on XGBoost model. In W. C. Gartner (Ed.), *New perspectives and paradigms in applied economics and business* (pp. 99–110). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-23844-4_8

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Tim Švrček, June 2025