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Master Thesis Preliminary Report

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Preliminary Master Thesis Report

Investments strategies of The Norwegian Government Pension Fund - Global

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Table of Content

Master Thesis Preliminary Report

1. **Abstract**

The thesis aims to provide an evaluation of the Norwegian Government Pension Fund - Global investment portfolio. It will be an analysis of how the Fund's investment strategy is managed and invested today, and where portfolio optimization and asset selection are our primary priority. The main question is whether or not Norges Bank Investment Management would achieve higher excess returns by diversifying their portfolio in more regions than their strategy says today. By that we want to study if Norges Bank and the Ministry of Finance are investing in too few regions, and test if the investment can be optimized by investing in more geographical regions. In this thesis, we will both conduct a quantitative and qualitative analysis of the characteristics of the Fund, and also use different models to test our data with Python as our main tool.

2. Introduction and motivation

The Norwegian Government Pension Fund - Global was created in 1990 by The Norwegian Government as a fiscal policy tool to manage the rapid growing petroleum revenues into long-term investments. The Fund was created with the function to benefit the Norwegian government and inhabitants in the future. Further in this thesis we will refer to the The Norwegian Government Pension Fund - Global as the Fund or the abbreviation GPFG. Today all the Norwegian government's oil and gas revenues are transferred directly into the fund, and invested into three categories which are currently divided as follows; 65,9% in equity-, 31,6% in fixed income -, and 2,5% in unlisted real estate investments.

The purpose of the GPFG is to save for future generations in Norway, and to give the government a tool to stabilize and stimulate the Norwegian economy. The market value for the fund has increased steady over the last decade, making it one of the world's largest funds with a current market value of approximately NOK 8500 billion. The GPFG is managed by Norges Bank Investment Management and Folketrygdfondet, respectively, under mandates laid down by the Ministry of Finance (Norwegian Ministry of Finance, 2017). We will further refer to Norges Bank Investment management as the abbreviation NBIM. All investments in the

Fund are made global, and are invested outside Norway to reduce the risk. Currently the Fund invest in Asia, North America, Europe, Oceania, Latin America, Africa and the Middle East, listed in order of size of their investments. NBIM has the general operational management of the Fund, and this includes both the passive benchmark portfolio and active management.

The Ministry of Finance's investment strategy is to safeguard and build financial wealth for future generations. NBIM are managing the fund actively and assumes that markets are largely efficient. Even though, the efficient market hypothesis states that it is impossible to "beat the market", which in this case is the benchmark portfolio. The reason is that the stock market efficiency causes existing share prices to always reflect relevant information, and therefore the benchmark portfolio hardly deviates from zero. So, in the long run, a performance investor would in theory, not have the possibility to beat the market. We would like to investigate this further in our thesis.

The Fund is a well-diversified portfolio across different asset classes, countries and sectors. The portfolio is based on three different investment strategies; fund allocation, asset strategies and company investment. We will look further into the strategy of fund allocation, since the Fund are only diversified over a few geographical areas. One of the questions that could be raised is if the Fund could be even more optimized when it comes to risk and return if it were allocated over even more geographical areas in the world.

The main research area of this master thesis, in Finance and Economics, are investment and portfolio selection. We will also use theory on asset pricing by looking at the relation between risk and return over time (time-series), and the relation between risk and return across assets (Cross-sectional). The goal of this thesis will be to examine if the performance of the Fund would improve with broader geographical allocation. We will use a mean-variance efficiency test proposed by Basak, Jogannathan, and Sun (2002) to address the performance of the diversification strategies. The test measures the difference between the variance of a benchmark and a mimicking portfolio with identical returns.

Our motivation for conducting this master thesis within the field of theoretical finance takes its origin in the introduction to asset pricing course taught by Sven Klinger as part of the MSc in business, with major in Finance and Economics. This course opened our eyes for mathematical finance, and when searching for a thesis topic it was natural for us to return to an area we knew would be both interesting and challenging. When the opportunity to write under the supervision of Alfonso Irazzobal arose it was an obvious choice for us given his hands-on experience within this topic of interest.

1.1 Problem Definition

Based on the outline of our master thesis above, the main research topic that will form the foundation of our research is:

> *Can the Norwegian Government Pension Fund - Global investment portfolio be optimized if the portfolio, was diversified in more geographical regions, by using strategic asset allocation?*

To execute our study, we have several research questions that will be used. These research questions will together form the basis of our thesis, and will be discussed and investigated to form an answer to our research topic.

- *How will a portfolio which is more allocated between geographical regions perform compared with the mimicking portfolio?*
- *How many "regions" must NBIM spread their assets to achieve good geographic diversification?*
- *What will be the maximum portfolio risk reduction and expected return be?*
- *How has a more active management affected the results, compared with the previous passive management? and Is NBMI able to deliver positive risk-adjusted return, profitable, when the efficient market hypothesis says otherwise?*

2. Literature review

This literature review will be on existing literature on diversification, market efficiency, systematic risk factors and active management of such factors. This is the literature we found most relevant for our Master Thesis Preliminary Report.

2.1 Geographical diversification

There exist much literature discussing the challenges and benefits from using diversification as one of your investments strategy for portfolio management, and this is highly relevant for the GPFG. When deciding where to invest there are several different factors that can cause risk or lead to variability in returns on your investment, and there exist many circumstances that may influence your investment. Factors such as uncertainty of income, interest rates, inflation, exchange rates, tax rates, the state of the economy, default risk and liquidity risk. One way to control portfolio risk is using diversification. Diversification is when investments are made in a wide variety of assets so that the exposure to the risk is reduced (Brentani, 2004).One way of diversifying, is to use geographical diversification. That is the practice of diversifying an investment portfolio across countries, or over different geographical regions. This is done to reduce the overall risk of the portfolio, and improve the returns on the portfolio because based on the premise that markets in different parts of the world are most likely not highly correlated with each other. In essence, one wants to safeguard the portfolio investments from political turbulence and potential recessions among many aspects and in such making it even more robust to global fluctuations. However, diversifying your investments cannot eliminate or reduce all risk in your portfolio, because mostly all securities are affected by common (risky) macroeconomics factors. One cannot eliminate all exposure to general economic risk, however it is possible to reduce the exposure to certain factors by using geographical diversification (Bodie, Kane, & Marcus, 2012). In their research, (Morck & Yeung, 1991), (Bodnar, Tang, & Weintrop, 1999), and (Allayannis & Weston, 2001) all found positive value effects from geographical diversification.

2.2 Market efficiency

A highly debated topic is the efficient market hypothesis (EMH) and the academic research on the area is extensive. The EMH is defined to be that security prices

fully reflect all available information by Fama (1991), however Jensen (1978) has a refined version of the hypothesis which states that prices reflect information to the point where the marginal benefit, and hence the profits do not exceed the marginal costs. This definition implies that investors cannot achieve a return over the average without assuming above-average risk (Malkiel, 2003). This hypothesis is relevant for our discussion on passive and active management of the Fund, and it can be interesting to look at why the GPFG has carried out these changes. Even though the EMH states that this will never be profitable, because of cost and that one can never beat the benchmark index with active management.

Using an active strategy that generates excess return is often when basing the investment strategy on exploiting inefficiencies and mispricing in the market. This implies that these three elements are essential; interpretation of the EMH, the existence and identification of possible inefficiencies. Anomalies are evidence of inefficiency argues Lakonishok et al. (1994), and in terms of active management a potential to generate excess return. On the other hand, Fama and French (1993) argues that anomalies and such inefficiencies are sources of risk premium, and claim that these patterns of return may be consistent with an efficient market in which expected returns are consistent with risk. This is in accordance with more recent literature.

2.3 Systematic risk factors

The efficient market hypothesis is an underlying assumption for the well-known capital asset pricing model (CAPM). The main assumption in the CAPM is that the systematic risk of a security depends on the co-variation between the return on the security and the return on the market portfolio, measured by the beta ((Sharpe, 1964), (Lintner, 1965), (Black, 1972)). On the other side, more recent empirical research has shown that the relationship between risk and return is more complex than assumed by the CAPM. Arbitrage pricing theory (APT) was introduced by Stephen A. Ross in 1976 and is a testable alternative to the CAPM. This is a theory that provides a solid theoretical framework for ascertaining whether multiple factors are “priced”, i.e. are associated with a risk premium. Chen, Ross and Roll (1986) used data for individual equities during the period from 1962 to 1972, and concluded that at least three factors are definitely present in the prices.

There is extensive academic literature about which factors are associated with a persistent risk premium. Fama and French (1993) introduced two systematic risk factors in addition to the market factors in their so-called “three-factor-model”. Their research was based on U.S. stocks during the period from 1963-1990, and they found out that a size factor (small versus large capitalization) and a value factor (value versus growth stocks), are additional determinants of stock returns. A further expansion of the model was made by Mark. M Charhart (1997) by adding a fourth factor capturing the one year momentum anomaly. Another researcher, Cochrane (2011) argues that there exist dozens of priced factors that describe the cross-sectional variation in expected returns. He further argues that characterizing risk premium variation has replaced efficiency as the central organizing question of asset pricing research.

2.4 Active management and excess return

There are several studies that are investigating the benefit of active management. In financial literature, market efficiency is highly discussed, where it describes investors who “chased” alphas by uncovering inefficiency priced asset in order to achieve excess return. The theories provide the framework for organizing asset-pricing research. However, more recent literature explains many of these inefficiencies as priced systematic risk factors and how investors need to understand these factors in order to outperform the benchmark.

There are two main ways to implements active management and in that way, deviate from the benchmark portfolio, which are market timing and stock selection. These are based on the assumption that priced systematic risk factors are determinants of stock returns.

2.4.1 Market timing

Market timing is the decision to change the proportion of the benchmark itself. This can be done in two ways; first one is to shift some of the investment from the benchmark into a riskless asset and the second alternative is to borrow and buy more of the benchmark.

There are sever empirical research on active management and performance, where the researchers do not support the hypothesis that mutual fund managers are able to beat the market. Henriksson and Merton (1981) was one of these, and they meant that managers are not able to follow an investment strategy that successfully times the return on the market portfolio. Their research emphasizes that the ability to earn superior returns are based on superior forecasting ability would be a violation of the efficient market hypothesis, and would have significant implications for the theory of finance. Becker, Ferson Myers and Schill (1999) did a more recent study based on more than 400 mutual funds in the time period from 1976 to 1994, where they distinguish timing based on publicly available information from timing based on finer information. They found that the average timing performance of mutual funds is insignificant and sometimes even negative.

2.4.2 Stock selection

Stock selection is when the manager chooses to hold securities in different proportions than the capital weights. By using benchmark based on the characteristics held by 125 portfolios in mutual funds in the period from 1975 to 1994, Daniel et al. (1997) applied new measures of portfolio performance. Based on the benchmarks, “characteristic selectivity” and “characteristic timing” measures are developed to detect whether portfolio managers successfully time their portfolio weightings on these characteristics. Another part of the study, also examined whether portfolio managers can select stocks that outperform the average stock having the same characteristics. The research shows that mutual funds, particularly aggressive-growth funds, exhibit some selectivity ability, but that funds exhibit no characteristic timing ability.

3. Theory

The debate of how to optimally invest the GPFG is an ongoing process that constantly changes, and is highly relevant for our study. The main research topic that will form the basis of our thesis is as mentioned above:

> *Can the Norwegian Government Pension Fund - Global investment portfolio be optimized if the portfolio was diversified in more geographical regions, by using strategic asset allocation?*

In the area of strategic asset allocation, we will start by reviewing some of the more basic theoretical underlying concepts and assumptions. This will be the foundation of our analysis.

3.1 Short-term portfolio choice and asset allocation

In portfolio management, the common practice is a top-down approach when it comes to asset allocation. The first step is to decide on the weights of the country allocation. Further, step two involves the choice of stocks and their weights in the countries under consideration. This is a well-known method to diversify portfolios, since financial markets in different parts of the world are often not highly correlated with one another. For example, if the developed markets are declining because of recession in the economy, it can be more valuable to allocate part of this portfolio to emerging economies with higher growth rates such as China, Brazil and India. Green and Hollifield (1992) argued that if stocks or indexes are highly correlated and exhibit a high diversity of betas, then we can form portfolios with essentially zero factor risk. However, such a portfolio will take a large negative position in one stock and an even larger positive position in another stock, or index.

Markowitz (1952) mean-variance analysis is built on the theory that investors should pick assets if they care only about the mean-variance, or equivalently the mean and standard deviation - of portfolio returns over a single period. For simplicity, he used three assets: stocks, bonds and a short-term money market fund. As you can see in the figure below, the vertical axis shows expected return, and the horizontal axis shows risk as a measured by standard deviation.

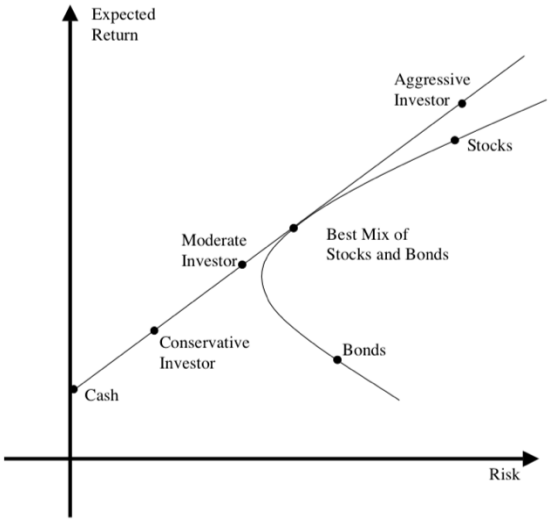

Figure 1. Mean-standard deviation diagram. Markowitz (1952)

As you can see, stocks have high standard deviation, and therefore high expected return, while bonds are low. The curved line shows the set of means and standard deviations that can be achieved by combining stocks and bonds in a risky portfolio. A risk averse investor would choose a point on the straight line, which is the mean-variance efficient frontier.

To make a short-term portfolio choice, NBIM must choose the weights on the risky assets. In a simple case with two assets, where one asset is riskless with simple return Rf_{t+1} from time t to time t+1, and the other asset is risky with R_{t+1} from time t to time t+1, with conditional mean $E_t R_{t+1}$ and conditional variance σ_t^2. The risk-free interest rate is realized at t+1, and known one period in advance at time t. The conditional mean and variance are the mean and variance conditional on the investor's information at time t; thus, they are written with t. The investor puts a share α_t of her portfolio into the risky asset. Then the portfolio return is

$$\begin{aligned} R_{p,t+1} &= \alpha_t R_{t+1} + (1-\alpha_t) R_{f,t+1} \\ &= R_{f,t+1} + \alpha_t (R_{t+1} - R_{f,t+1}) \end{aligned}$$

With the mean portfolio return

$$E_t R_{p,t+1} = R_{f,t+1} + \alpha_t (R_{t+1} - R_{f,t+1})$$

and the variance is

$$\sigma_{pt}^2 = \alpha_t^2 \sigma_t^2$$

The preferred investment for the NBIM is a high mean and a low variance of portfolio returns. We assume that these trade-offs are linear, which means that she maximizes a linear combination of mean and variance, with a positive weight on mean and a negative weight on variance:

$$\underset{\alpha_t}{Max}\ (E_t R_{p,t+1} - \frac{k}{2}\sigma_{pt}^2)$$

Then, substituting in the mean and variance of portfolio returns, and subtracting Rf_{t+1}, which can be written

$$\underset{\alpha_t}{Max}\ \alpha_t(E_t R_{p,t+1} - R_{f,t+1}) - \frac{k}{2}\alpha_t^2\sigma_t^2)$$

And the solution to this maximization problem is

$$\alpha_t = \frac{E_t R_{p,t+1} - R_{f,t+1}}{k\sigma_t^2}$$

This formula tells us that the portfolio share in the risky asset should equal the expected excess return, also called risk premium, divided by conditional variance times the coefficient k that represents aversion to variance. However, for a NBIM there will be many risky asset, and the definition of the portfolio return is the same, except the denotation of vectors and matrices. Thus, R_{t+1} is now a vector of risky returns with N elements. The mean vector is $E_t R_{t+1}$ and a variance-covariance matrix Σ_t. Also, α_t is now a vector of allocation to the risky assets. So, the maximization problem now becomes:

$$\max_{\alpha_t} \alpha'_t\,(E_t R_{p,t+1} - R_{f,t+1}\iota) - \frac{k}{2}\alpha'_t\Sigma_t\alpha_t$$

Here ι is a vector of ones, and $(E_t R_{p,t+1} - R_{f,t+1}\,\iota)$ is the vector of excess returns on the N risky assets over the riskless interest rate. The variance of the portfolio return is $\alpha'_t\Sigma_t\alpha_t$. The solution to this maximization problem is

$$\alpha_t = \frac{1}{k}\Sigma_t^{-1}(E_t R_{p,t+1} - R_{f,t+1}\iota)$$

The single excess return is replaced by a vector of excess returns, and the reciprocal of variance is replaced by Σ_t^{-1}, the inverse of the variance-covariance matrix of returns. The scalar term 1/k is the investor's preference. Thus, investors differ only in the overall scale of their risky asset portfolio, not in the composition of the portfolio. Tobin (1958) and his mutual fund theorem says that conservative

investors with a high k hold more of the riskless asset and less of all risky assets, but they do not change the relative proportions of their risky assets, which are determined by the vector $\Sigma_t^{-1}(E_t R_{p,t+1} - R_{f,t+1}\,\iota)$.

3.2 Geographically diversification

Several theories suggest that geographic diversity will enhance efficiency, spread idiosyncratic risk, and reduce agency costs, with positive ramifications on corporate valuations. Specifically, geographic diversity could enhance market valuations through economies of scale (Chandler, 1977; Gartner, Scharfstein, & Stein, 1994; Houston, James, & Marcus, 1997; Berger, Demsetz, & Strahan, 1999), and by reducing exposure to idiosyncratic local shocks. The literature suggests that firms invest abroad to exploit firm-specific assets, the markets for which are imperfect so that the assets cannot be sold for their internal value (Caves, 1971; Hymer, 1976). By internalizing the market imperfections, NBIM is able to extract above market returns on its specific assets which, in efficient financial markets, are capitalized into a higher value of the fund. The specific source of these gains from growing geographically comes from expanding firm-specific assets and potential economies of scale for the use of these assets.

3.3 Hypothesis

The hypothesis reflects the main question we would like to answer: Will the GPFG benefit from increasing their geographical diversification?

H0: Can the Norwegian Government Pension Fund - Global investment portfolio be optimized if the portfolio was diversified in more geographical regions, by using strategic asset allocation?

If NBIM can optimize the portfolio by diversifying over a broader geographical allocation, then the null hypothesis will be rejected.

H1: The portfolio can be optimized by diversifying in more geographical regions
H2: The portfolio cannot be optimized by diversifying in more geographical regions

4. Data

In this thesis, we will use multiple data sources to conduct our research. Firstly, we will use the public data from NBIM and the Ministry of Finance, such as their quarterly and annual reports and their investment strategy reports. This is data we can easily find online that has a lot of information about our research question. In addition, we will use data from our supervisor for our tests that we shall run in Python. We will need data on the GPFG such as the price index, dividend yield and exchange rates. Data on returns, variance, mean and data on the different regions they invest in will also be needed. As well as data on stocks, bonds and real estate.

5. Methodology

In this section, we will describe the methodology we will apply in order to test whether or not using strategic asset allocation, where they invest in even more geographical regions will diversify the portfolio even more. Our research method will be to use a quantitative research method to investigate the research topic we have chosen. We want to analyse the historical data on the overall portfolio and the benchmark portfolio, depending on the data we receive from our supervisor. After agreement with our supervisor we will use Python as our programming device for our quantitative analysis.

We will use mean-variance efficiency test proposed by Basak, Jogannathan, and Sun (2002) to address the performance of the diversification strategies. The test measures the difference between the variance of a benchmark and a mimicking portfolio with identical returns. We will use this model as a basis for our analysis on order to be able to compare our results with the results from NBIM. However, we will also solve a dynamic asset allocation problem where we look at five regions which NBIM are investing in today, and compare it with K regions to try to optimize the portfolio. NBIM reports that they uses Fama and French (2015) five-factor model, along with Capital Asset Pricing Model (CAPM) by Treynor (1962); Sharpe (1964); Lintner (1965a,b); Mossin (1966) and Carhart (1997) four-factor model when evaluation the equity investments. Hence, we will also look into these models, to get an accurate perception of the expected return and standard deviation.

6. Organization of the rest of the thesis

Further our first priority will be to start collection the relevant data for our research. We will need to collect and organize a huge amount of data and sources to investigate our topic. Find the data that is most suited for our analysis using Python, and also find the literature that will support our findings. Furthermore, we need to determine if we want to use informants as a source for information in our research. If so, they need to be contacted and informed. Hopefully the data will be collected within a few months and we can start our analysis, and further investigation. Simultaneously, we will start working with our theoretical framework and finding sources that can build up our thesis results. Our implementation part is still the same, but changes can and will most likely happen.

	Deadline
Preliminary thesis	1. june.2017
Preliminary thesis report	15. january.2018
Literature review	30. January.2018
Theory	30. February.2018
Methodology	30.March.2018
Data	30.April.2018
Results and analysis	30.June.2018
Conclusion	15.July.2018
Additional elements	1.August.2018
Master thesis	25. August.2018

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