NORGES BANK
INVESTMENT MANAGEMENT

# GOVERNMENT PENSION FUND GLOBAL HISTORICAL PERFORMANCE AND RISK REVIEW

10 March 2014

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## Scope

The scope of this document is to analyse the returns of the Government Pension Fund Global (GPFG) and its equity and fixed-income portfolios, with an emphasis on the performance of the active management of the fund. The analysis is performed on the whole history of the fund and multiple sub-periods with an emphasis on the last five years. Real estate is not part of the analysis. The analysis is based on NBIM's framework for calculating and reporting returns for the GPFG. The return time series is based on a time-weighted approach, and the relative return is the arithmetic difference between the return on the actual portfolio and the benchmark for the period.

## Executive summary

- Both absolute and relative returns since 1 January 1998 have been positive for the GPFG. The annualised absolute return was 5.70 per cent at the end of 2013, and the annualised relative return was 0.31 percentage point.
- The absolute and relative returns have been positive for all main periods except for the period around the financial crisis.
- Adjusting the historical returns since 1 January 1998 for realised risk shows that the fund has improved the relationship between risk and return compared to the benchmark. The positive relative return has been achieved with only a small increase in the risk for the GPFG compared to the benchmark.
- Analysis of systematic factor risk exposures is addressed using two returns-based methodologies: the first uses a partial correlation approach, as in Ang et al. (2009), while the second uses a multivariate regression approach. Apart from potential biases introduced by the selection and construction of the factors included, both methods attempt to estimate a value for a constant exposure to a risk factor. This is problematic, as these exposures are time-varying for the GPFG.
- A multivariate regression analysis of the fund's relative returns performed over rolling five-year periods on systematic risk factors has an explanatory power ($R^2$) of 30-50 per cent for the period up to the financial crisis, with none of the credit factors being statistically significant. After 2008, the same regression has an explanatory power of 50-80 per cent, with credit being highly significant. The explanatory power falls back below 50 per cent when data from 2008 exits the rolling window.
- For all sub-periods investigated, both methods estimate a negative and statistically significant exposure to value companies (or a positive exposure to growth companies) in the equity portfolio. Both methods also estimate a negative and statistically significant exposure to low-volatility companies (or a positive exposure to high-volatility companies).
- Gross relative returns are a good measure of net value creation from active management.

# 1 Return and risk measures

## 1.1 The GPFG and asset class returns

The accumulated return for the GPFG, excluding real estate investments, was 143[1] per cent from 1 January 1998 to the end of the fourth quarter of 2013 measured in the *GPFG currency basket*. The equivalent return for the benchmark is 132 per cent. This corresponds to annualised returns of 5.70 and 5.39 per cent for the GPFG and the benchmark respectively. The excess return related to the active management of the fund has been 0.31 percentage point since 1 January 1998. The last five years, from 2009 to 2013, annualised excess returns were 1.16 percentage points.

Within the asset classes, equity[2] and fixed income have had annualised returns of 5.19 and 5.03 per cent respectively. The annualised excess returns have been 0.58 and 0.21 percentage point for equity and fixed income since 1 January 1999 and 1 January 1998 respectively. The annualised excess returns from 2009 to 2013 were 0.69 and 1.83 percentage points in equity and fixed income respectively.

**Table 1 Portfolio returns measured in the fund's currency basket**

| | Portfolio return | | | Active return | | |
|---|---|---|---|---|---|---|
| Portfolio | Since[2] 1.1.1998 | Last ten years | Last five years | Since[2] 1.1.1998 | Last ten years | Jan 2009 - Dec 2013 |
| GPFG | 5.70 % | 6.31 % | 12.04 % | 0.31 % | 0.24 % | 1.16 % |
| Equity | 5.19 % | 7.81 % | 15.64 % | 0.58 % | 0.49 % | 0.69 % |
| Fixed Income | 5.03 % | 4.41 % | 6.01 % | 0.21 % | 0.21 % | 1.83 % |

The GPFG has had an annualised return of 6.70 per cent since 1 January 1998 measured in *US dollars*. The excess return related to the active management of the fund has been 0.32 percentage point since 1 January 1998, and was 1.17 percentage points in the period from 2009 to Q4 2013. Within the asset classes, equity and fixed income have had annualised returns of 5.94 and 6.03 per cent since 1 January 1999 and 1 January 1998 respectively. Both asset classes have had positive annualised excess returns in the period: 0.58 and 0.22 percentage point respectively. The annualised excess returns from 2009 to 2013 were 0.69 and 1.84 percentage points respectively.

**Table 2 Portfolio returns measured in US dollars**

| | Portfolio return | | | Active return | | |
|---|---|---|---|---|---|---|
| Portfolio | Since[2] inception | Last ten years | Last five years | Since[2] inception | Last ten years | Last five years |
| GPFG | 6.70 % | 6.77 % | 12.42 % | 0.32 % | 0.24 % | 1.17 % |
| Equity | 5.94 % | 8.28 % | 16.03 % | 0.58 % | 0.49 % | 0.69 % |
| Fixed Income | 6.03 % | 4.85 % | 6.36 % | 0.22 % | 0.21 % | 1.84 % |

The GPFG has had positive *returns*[3] in 12 out of the 16 *years* since 1 January 1998. Equity and fixed income have had positive returns in 10 out of 15 years and 14 out of 16 years respectively. The GPFG

[1] The performance analysis is based on return data from January 1998 to December 2013 for the GPFG. Fixed-income return data start from January 1998, and equity return data from January 1999. The return figures used in this analysis are expressed in GPFG, equity and fixed-income currency baskets. The return series in this analysis starts in January 1998 and the last observed return period is December 2013. The equity and fixed-income portfolios had asset-class-specific currency baskets up to and including December 2000. As of 2001, both asset classes have used the GPFG currency basket.

[2] The equity returns are based on data from 1 January 1999.

[3] In the GPFG currency basket.

has delivered positive returns in 66 per cent of *months* since 1 January 1998, while the equivalent share for equity and fixed income is 59 and 71 per cent respectively.

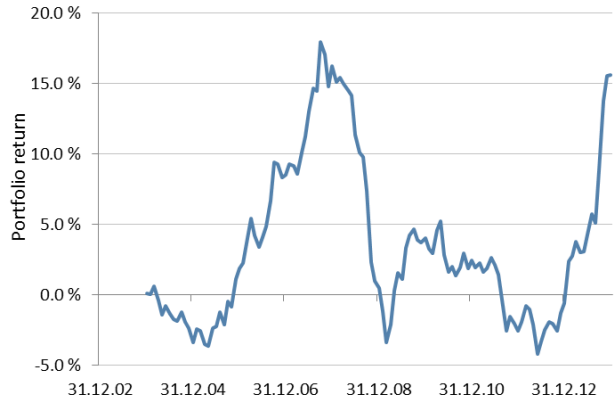
The GPFG has had positive *relative returns* in 13 out of the 16 *years* since 1 January 1998. Equity and fixed income have had positive relative returns in 12 out of 15 years and 13 out of 16 years respectively. The GPFG has delivered positive relative returns in 66 per cent of *months* since 1 January 1998, while the equivalent share for equity and fixed income is 65 and 63 per cent respectively.

*Rolling five-year returns*

Rolling five-year annualised returns on the GPFG have varied between -1.4 and 12.3 per cent. Rolling five-year returns have been positive throughout the period, with the exception of three months in 2009. The rolling returns went up to 9.7 per cent in the period leading up to the financial crisis and were significantly reduced during the financial crisis. The returns rebounded after the crisis, and the rolling five-year return is currently 6.3 percentage points above the GPFG's annualised return since 1 January 1998.

**Figure 1 Rolling five-year annualised portfolio return, GPFG**

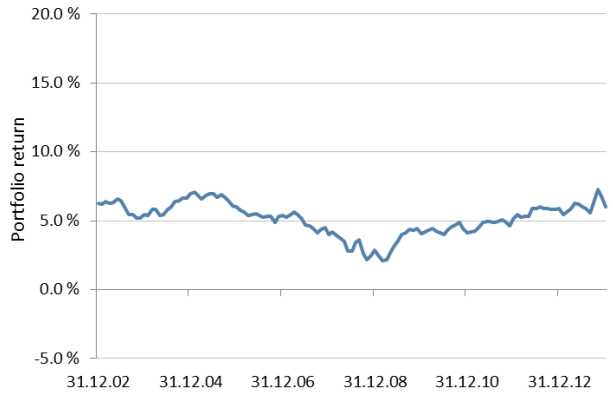
**Figure 2 Rolling five-year annualised portfolio return, equity**




Five-year rolling returns on the equity portfolio were negative in the early 2000s as the markets were falling due to the collapse in the internet and related technology sectors. The rolling returns strengthened in the period up to the financial crisis and were at their highest level in September 2007 with an 18 per cent five-year rolling annualised return. The rolling five-year returns were negative during the financial crisis and in 2011 and 2012. They recovered after the financial crisis and are currently 15.6 per cent, 10.4 percentage points above the equity portfolio return since 1 January 1999.

Five-year rolling returns on the fixed income portfolio have been positive throughout the history of the fund. In the period prior to, and especially during, the financial crisis, the rolling five-year returns were significantly reduced, reaching 2.1 per cent in February 2009. In the following years, the rolling returns recovered, and they are currently 1.0 percentage points above the annualised return on the fixed-income portfolio since 1 January 1998.

**Figure 1 Rolling five-year annualised portfolio return, fixed income**

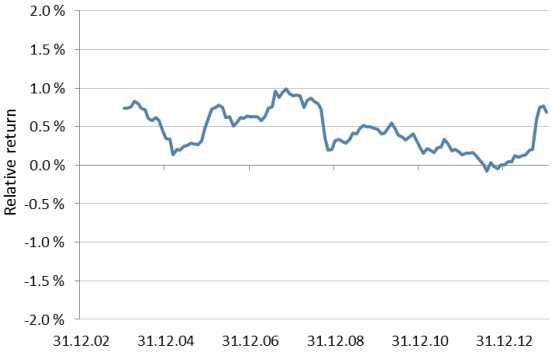


*Rolling five-year relative returns*

Since 1 January 1998, the GPFG has produced an accumulated annualised relative return of 0.31 percentage point, with five-year rolling relative returns varying between -0.7 and 1.18 percentage point in the period. The rolling relative five-year returns have been positive in about two-thirds of the period. The rolling relative returns on the GPFG were positive from 1 January 1998 up to August 2008, ranging between 0.1 and 0.6 percentage points. They dropped significantly during the financial crisis, reaching a low in March 2009 with a rolling five-year relative return of -0.7 percentage point, predominantly driven by fixed-income investments. From March 2010, the rolling relative returns were stable around zero until recovering in 2013, and they are currently 1.16 percentage point, 0.85 percentage points above the relative return on the fund since 1 January 1998.

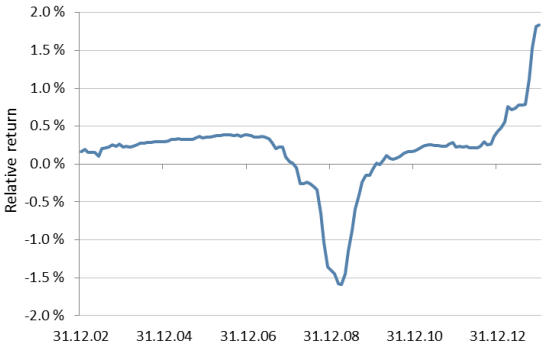
**Figure 4 Rolling five-year annualised relative return, GPFG**

**Figure 5 Rolling five-year annualised relative return, equity**




Five-year rolling relative returns on the equity portfolio have been positive over most of the period since 1 January 1999, ranging from -0.07 percentage point in July 2012 to 0.99 percentage point in October 2007. The current five-year rolling relative return is 0.69 percentage point, 0.11 percentage point higher than the relative return of 0.58 percentage point since 1 January 1999.

**Figure 6 Rolling five-year annualised relative, fixed income**




Five-year rolling relative returns on the fixed-income portfolio have been positive in about four-fifths of the investment period. Prior to the financial crisis, they ranged between 0.1 and 0.4 percentage point. Through 2008 the rolling returns dropped, and they were at their lowest in March 2009 at -1.6 percentage points. Ten months later, the rolling five-year relative returns turned positive, and they gradually increased in the period from 2010 to 2012. In 2013 they have risen sharply, and they are currently 1.83 percentage points, 1.62 percentage points higher than the relative fixed-income return since 1 January 1998.

## 1.2 Relative risk development

One approach used to measure the relative risk in GPFG is the expected tracking error, a measure applying statistical models and parameters to estimate the risk of the portfolio relative to a benchmark. This measure is of particular importance as the GPFG investment mandate states that the relative risk of the portfolio should be aimed at being below a specified tracking error level[4].

In the period prior to January 2008, the expected annualized tracking error of GPFG varied between 11 and 64 basis points. The estimated risk gradually increased through 2008 and reached 151 basis points at the end of October 2008. Nine months later the tracking error was below 60 basis points and has been ranging between 24 and 81 basis points up to December 2013[5]. The realised tracking error has been 75 basis points on an annualized basis since 1 January 1998.

On a monthly basis the Pension Fund experienced the largest relative losses in 2007 and 2008; during the financial crisis. The historical relative return distribution of the GPFG has been more concentrated around zero and been somewhat more negatively skewed compared to a normally distributed return series.

In the period since 2009, the GPFG has been managed with no material leverage, limited usage of derivatives, no shorting of securities and a conservative securities lending programme.

**Figure 7 GPFG tracking error, basis points**

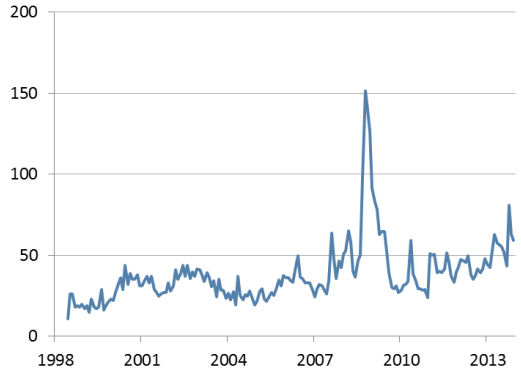



**Figure 8 GPFG monthly relative return, basis points**

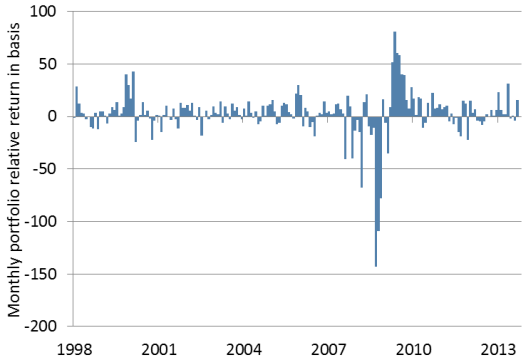
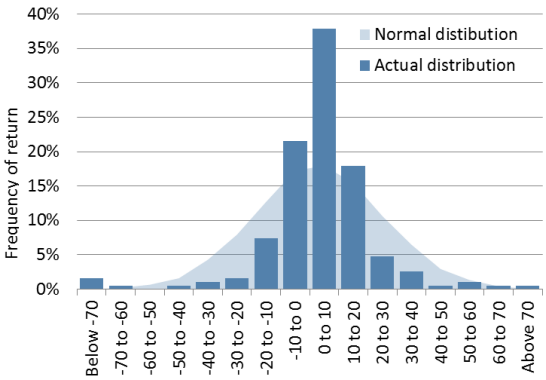



**Figure 9 GPFG monthly relative return distribution**




[4] Prior to 2011 the tracking error limit was 150 basis points. Since 2011 the tracking error "limit" has been 100 basis points.

[5] Prior to 2011 the tracking error was calculated using the latest months of market data when estimating the volatility and correlation of risk factors. From 2011 the last three years of market data has been used when estimating volatility and correlation of risk factors.

## 1.3 Risk-adjusted return

The active management of the fund has had an impact on the fund's risk profile. The GPFG has deviated from its benchmark to a varying degree throughout the investment period. Tracking error[6] has been 0.75 percentage points since 1 January 1998 for the GPFG and was 0.68 percentage point in the period from 2009 to 2013.

To analyse whether the trade-off between expected return and risk in the GPFG has improved with active management, the returns have to be adjusted for the impact of active management on the risk profile of the portfolio. In this section, different risk-adjusted measures will be used to capture the different dimensions of the relative risk.

**Table 3 Annualised standard deviation of returns, portfolio and benchmarks**

| | Since[7] 1.1.1998 | Jan 2009 - Dec 2013 |
|---|---|---|
| GPFG Portfolio standard deviation | 7.7 % | 9.0 % |
| GPFG Benchmark standard deviation | 7.2 % | 8.6 % |
| GPFG ex post tracking error (in basis points ) | 75 | 68 |
| Equity Portfolio standard deviation | 15.3 % | 15.0 % |
| Equity Benchmark standard deviation | 15.0 % | 14.8 % |
| Equity ex post tracking error (in basis points ) | 84 | 41 |
| Fixed Income Portfolio standard deviation | 3.5 % | 3.4 % |
| Fixed Income Benchmark standard deviation | 3.3 % | 3.0 % |
| Fixed Income ex post tracking error (in basis points ) | 113 | 136 |

### Information ratio

The GPFG has had an information ratio[8] of 0.42 since 1 January 1998, and 1.70 from 2009 to 2013.

The rolling five-year information ratio has fluctuated over time and was above 1 in most of the period prior to the financial crisis. During the financial crisis, the information ratio dropped to -0.68 in March 2009 before recovering to the current level of 1.70.

**Table 4 Information ratio**

| Portfolio | Since[7] 1.1.1998 | Last five years |
|---|---|---|
| GPFG | 0.42 | 1.70 |
| Equity | 0.69 | 1.68 |
| Fixed Income | 0.19 | 1.35 |

The equity portfolio information ratio has been 0.69 in the period since 1 January 1999 and was 1.68 in the period from 2009 to 2013. The equivalent figures for fixed income are 0.19 and 1.35.

### Sharpe ratios

Since 1 January 1998, the GPFG's Sharpe ratio has been 0.46, while the benchmark has had a Sharpe ratio of 0.44. Hence, the GPFG has had a higher positive Sharpe ratio than the benchmark. From 2009 to 2013, the GPFG and the benchmark had Sharpe ratios of 1.33 and 1.26 respectively. Hence, the GPFG had a higher positive Sharpe ratio than the benchmark in this period.

**Table 5 Sharpe ratio**

| Portfolio | Since[7] 1.1.1998 | Last five years |
|---|---|---|
| GPFG | 0.46 | 1.33 |
| Equity | 0.21 | 1.04 |
| Fixed Income | 0.81 | 1.74 |

[6] Ex post tracking error, calculated based on monthly observations of actual excess returns in the relevant period.

[7] Note that the tracking error limit is measured against *ex ante* tracking error. *Ex post* tracking error is calculated using actual excess returns, while ex ante tracking error applies current positions and estimated future volatility and correlations when estimating risk.

[8] Portfolio relative return divided by the standard deviation of the relative return.

Within the asset classes, the Sharpe ratios since 1 January 1999 and 1 January 1998 have been a positive 0.21 and 0.81 for equity and fixed income respectively. The equivalent figures for the benchmarks are 0.17 and 0.80.

**Table 6 Sharpe ratio difference (portfolio minus benchmark)**

| Portfolio | Since[10] 1.1.1998 | Last five years |
|---|---|---|
| GPFG | 0.01 | 0.07 |
| Equity | 0.03 | 0.03 |
| Fixed Income | 0.01 | 0.39 |

From 2009 to Q4 2013, the Sharpe ratios were a positive 1.04 and 1.74 for equity and fixed income respectively. The equivalent figures for the benchmarks are 1.01 and 1.35.

The Sharpe ratio is an appropriate risk-adjusted performance measure for comparing returns with other portfolios or benchmarks when the returns are normally distributed. However, as the Sharpe ratio only captures the average risk of a portfolio, it does not account for any asymmetric risk profile (skewness in returns). The *adjusted Sharpe ratio*[9] seeks to capture these risk characteristics, as it punishes portfolios with excess downside risk.

The GPFG's adjusted Sharpe ratio since 1 January 1998 is 0.42, at the same level as the benchmark. The adjusted Sharpe ratio for the equity portfolio since 1 January 1999 is 0.20, while the equivalent for the benchmark is 0.17. The fixed-income portfolio has an adjusted Sharpe ratio of 0.81, compared to the benchmark's 0.85.

**Table 7 Adjusted Sharpe ratio**

| Portfolio | Since[10] 1.1.1998 | Last five years |
|---|---|---|
| GPFG | 0.42 | 1.58 |
| Equity | 0.20 | 1.12 |
| Fixed Income | 0.81 | 2.31 |

The GPFG's adjusted Sharpe ratio in the period from 2009 to 2013 is 1.58, while the equivalent for the benchmark is 1.47. The adjusted Sharpe ratio for the equity portfolio is 1.12 during this period, compared to 1.09 for the benchmark. The fixed-income portfolio has an adjusted Sharpe ratio of 2.31 in the period from 2009 to 2013, while the equivalent for the benchmark is 1.49.

**Table 8 Adjusted Sharpe ratio difference**

| Portfolio | Since[10] 1.1.1998 | Last five years |
|---|---|---|
| GPFG | 0.00 | 0.11 |
| Equity | 0.03 | 0.04 |
| Fixed Income | -0.04 | 0.82 |

[9] Alexandra Wiesinger (2010): *Risk-Adjusted Performance Measurement – State of the Art Adjusted Sharpe Ratio*, bachelor's thesis, University of St. Gallen School of Business Administration.

[10] The equity performance indicators are calculated based on data from 1 January 1999.

## 1.4 Risk-adjusted returns in sub-periods

The variations in fund returns and the risk characteristics have fluctuated throughout the investment period. In this section, the analysis is broken down into multiple periods to gain insight into the performance characteristics of the fund under different market environments. It also gives information on how sensitive the risk-adjusted return measures are to the period analysed.

In addition to the periods presented in previous sections, the following sub-periods are assessed:

- Pre financial crisis (January 1998 - April 2007)
- Financial crisis and main recovery (May 2007 - December 2009)
- Post financial crisis (January 2010 - December 2013)

The fund return has been positive over the period as a whole and in all sub-periods except during the financial crisis period. The analysis shows that the portfolio returns and the level of volatility change significantly over time. When looking at the period since 1 January 1998, the GPFG annualised standard deviation is 7.7 per cent, but varying between 5.2 and 13.0 per cent in the various sub-periods. For the relative return, the ex post tracking error has been 0.75 percentage point since 1 January 1998, varying between 0.37 and 1.65 percentage points in the sub-periods.

The different performance indicators give different results when looking at the various sub-periods. In the pre and post financial crisis periods, all performance measures show a positive contribution from the active management of the fund. During the financial crisis, the benchmark performed better than the fund. The key return and performance indicators used throughout this analysis are shown in the table below.

**Table 9 Returns, risk and risk-adjusted performance indicators, GPFG**

| | Since 1.1.1998 | Jan 1998-Apr 2007 | May 2007-Dec 2009 | Jan 2010-Dec 2013 | Last five years |
|---|---|---|---|---|---|
| Portfolio return (annualized) | 5.70 % | 6.34 % | -1.01 % | 8.88 % | 12.04 % |
| Portfolio standard deviation | 7.67 % | 5.21 % | 12.99 % | 7.82 % | 9.01 % |
| Benchmark standard deviation | 7.22 % | 5.10 % | 11.68 % | 7.63 % | 8.60 % |
| Excess return | 0.31 % | 0.49 % | -0.52 % | 0.51 % | 1.16 % |
| Ex. Post Tracking Error (in basis points ) | 75 | 37 | 165 | 37 | 68 |
| Information ratio | 0.42 | 1.31 | -0.32 | 1.37 | 1.70 |
| Portfolio Sharpe ratio | 0.46 | 0.58 | -0.19 | 1.13 | 1.33 |
| Portfolio Sharpe ratio vs. Benchmark | 0.01 | 0.08 | -0.02 | 0.04 | 0.07 |
| Portfolio Adjusted Sharpe ratio | 0.42 | 0.57 | -0.19 | 1.25 | 1.58 |
| Portfolio Adjusted Sharpe ratio vs. Benchm | 0.00 | 0.08 | -0.02 | 0.05 | 0.11 |

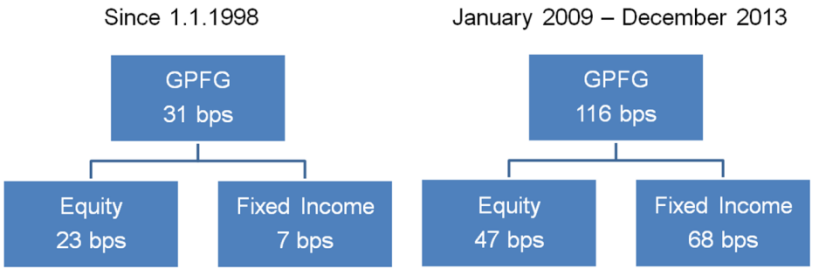
## 1.5 Excess return contribution from asset classes and strategies

The GPFG has returned 31 basis points in excess of the benchmark since 1 January 1998, and 116 basis points from 2009 to 2013. This section presents the asset class contributions to the GPFG's excess return and the return contributions from the different strategies to the equity and fixed-income asset class returns.

### Asset class contributions to GPFG return

The equity and fixed-income contributions to the GPFG's excess return since 1 January 1999 and 1 January 1998 are 23 and 7 basis points respectively. In the period from 2009 to 2013, equity and fixed income contributed 47 and 68 basis points respectively to the GPFG's excess return.

**Figure 10 Asset class contribution to GPFG excess return**[11]




The excess returns in the asset classes are mainly a result of the active management of the portfolios and the related strategies. The contribution from the various strategies will be presented in the next section. In addition to these strategies, the GPFG has earned positive returns through its securities lending programmes. Securities lending amounts to 4 and 8 basis points of the equity contribution to the GPFG's excess return from 1 January 1998 and the period from 2009 to 2013 respectively. In the fixed-income portfolio, securities lending has contributed 1 basis point in the period since 1 January 1998 and was marginally positive in the period from 2009 to 2013.

### Strategy contributions to equity excess return

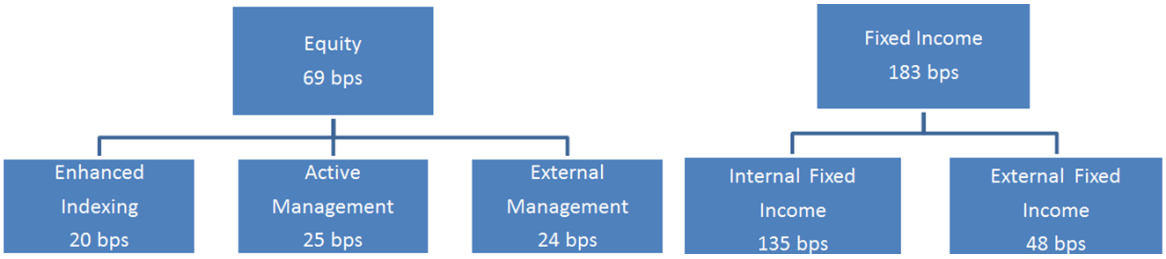
The equity portfolio has produced an annualised excess return over its benchmark of 58 basis points since 1 January 1999, and 69 basis points from 2009 to Q4 2013. The excess return originates from three main investment strategies: enhanced indexing (internal), active management (internal) and external management.

Through the *enhanced indexing* portfolio, the GPFG aims to enhance performance through a flexible approach in emulating the composition of the benchmark portfolio. The enhanced indexing strategy has contributed 12 basis points of the equity excess return since 1 January 1999, and 20 basis points from 2009 to Q4 2013. Revenues from security lending within equity asset class are mainly incorporated into this strategy.

[11] The equity returns are calculated based on data from 1 January 1999.

**Figure 11 Contribution to asset class returns since 1 January 1999 and 1 January 1998, equity and fixed income**[12]

**Figure 12 Contribution to asset class returns, January 2009 – December 2013**




Since 1 January 1999, the active management strategy within equities has contributed 19 basis points of the equity asset class excess return of 58 basis points. From 2009 to 2013, it contributed 25 basis points to the equity excess return.

The external management strategy has contributed 26 basis points of the equity excess return since 1 January 1998, and 24 basis points in the period from 2009 to 2013.

#### *1.5.1.1 Fixed income*

The fixed-income portfolio has produced an annualised excess return over its benchmark of 21 basis points since 1 January 1998, and 183 basis points during the period from 2009 to 2013. Securities lending of fixed income securities are included in the excess return for the fixed income portfolio.

The internal fixed-income portfolio has contributed 33 basis points of the fixed-income excess return since 1 January 1998, and 135 basis points from 2009 to 2013.

The contribution to the asset class excess return from the external fixed income strategy is a negative 12 basis points since 1 January 1998, and a positive 48 basis points from 2009 to 2013.

During the financial crisis, a significant portion of the externally managed mandates were transferred to the internal fixed income portfolio for termination. Hence, during this period the excess returns from both the internal fixed income and external fixed income strategies were impacted by the approach used when transitioning the external mandates into the internal fixed income portfolio.

[12] The contribution figures from the various strategies are not calculated in line with the GIPS standard.

# 2 Analysis of systematic risk factor exposures

In this part, we analyse how much of the variability of the return of the fund can be explained by active positions, and how the relative returns co-move with systematic risk factors. The analysis is performed on the return for both the total fund and the equity and fixed-income portfolios. The first sections (variance contribution, risk factor correlations) follow the methodology used in Ang et al. (2009). In the final section, we present the results based on an analysis that uses global, tradable systematic risk factors in a multivariate regression setting.

## 2.1 Variability of total returns attributed to active returns

As expected, given the tight tracking error limits in the GPFG mandate, Table 10 shows that the variation in the monthly total portfolio returns is mostly driven by the choice of benchmark. For equities and fixed income, the variance attributed to active returns is expressed as a percentage of the asset-specific portfolios.

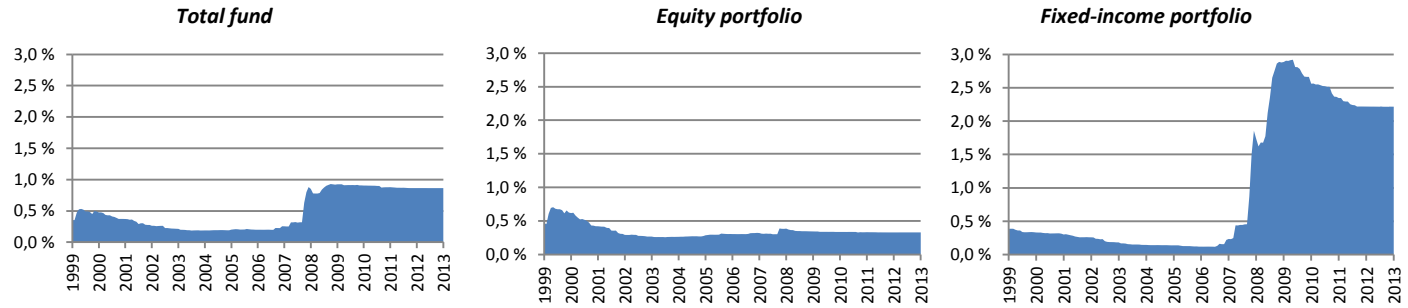
**Table 10 Variance attribution**

| | *Total Fund* | | | *Equity* | | | *Fixed Income* | | |
|---|---|---|---|---|---|---|---|---|---|
| | Since inception | Inception – Apr 2007 | Jan 2009 – Dec 2013 | Since inception | Inception – Apr 2007 | Jan 2009 – Dec 2013 | Since inception | Inception – Apr 2007 | Jan 2009 – Dec 2013 |
| *Benchmark* | 99.1% | 99.8% | 99.2% | 99.7% | 99.7% | 99.9% | 97.8% | 99.9% | 97.3% |
| *Active* | 0.9% | 0.2% | 0.8% | 0.3% | 0.3% | 0.1% | 2.2% | 0.1% | 2.7% |

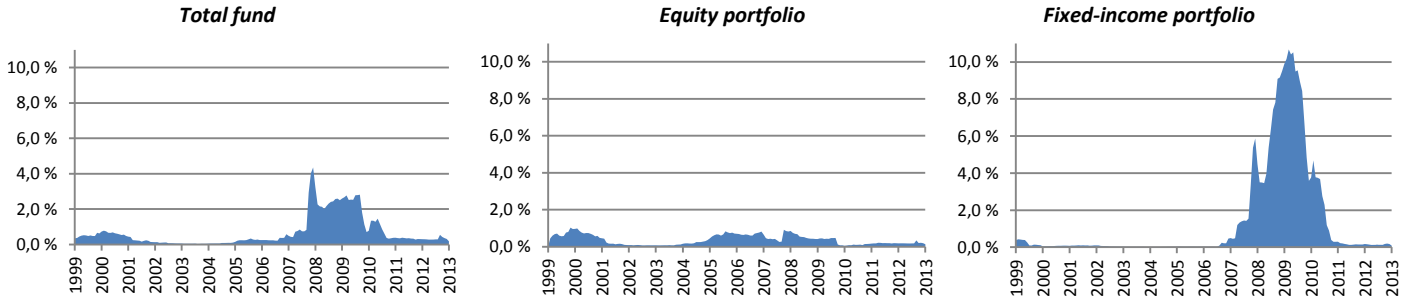
The results from such analyses are sensitive to the time period chosen. In Figure 12, we demonstrate that the variance contribution from active returns is time-varying and highest in periods of increased market volatility; for fixed income, the rolling-time-window chart shows that the period from 2007 to 2010 is responsible for the increase in the attributed active return visible in the since-inception/expanding-time-window chart.

**Figure 13 Variance attribution of active returns**

***Expanding time window***




***24-month rolling time window***




## 2.2 Active returns' co-movement with systematic risk factors

Several quantitative methods can be used to assess the degree to which active returns of a portfolio co-move with systematic risk factors. In this section, we update the correlation analysis in Ang et al. (2009). All correlation figures are between active returns and systematic risk factor returns, calculated on a stand-alone basis. The partial correlations can be regarded as marginal correlations between the fund active returns and factor returns on each factor after taking into account and subtracting the effects from the other factors.

The factors evaluated in this analysis are:

- *Term:* Difference in returns on the total return Barclays US Treasury 20+ year index and the total return Barclays US Treasury Bill 1-3 month index
- *Credit Aa:* Difference in returns on the total return Barclays US Corporate Aa Long Maturity index and the total return Barclays US Aggregate Long Government Treasury index
- *Credit Baa:* Difference in returns on the total return Barclays US Corporate Baa Long Maturity index and the total return Barclays US Corporate Aa Long Maturity index
- *Credit High Yield:* Difference in returns on the total return Barclays US Corporate High Yield Caa index and the total return Barclays US Corporate Baa Long Maturity Baa index

- *FX Carry*[13]*:* Difference in returns between currency returns on the top three G10 currencies with the highest short-term yields and the bottom three G10 currencies with the lowest short-term yields
- *Illiquidity*[14]*:* The negative of changes in the on-the-run/off-the-run spread on 10-year US Treasury bonds
- *Value/Growth:* Difference in returns between global "value" stocks and global "growth" stocks computed using MSCI world indices
- *Small/Large:* Difference in returns between global small-cap stocks and global large-cap stocks computed using MSCI all-country indices
- *Momentum*[15]*:* Difference in returns between US stocks with past high returns and US stocks with past low returns
- *Volatility*[16]*:* Returns on a variance swap between implied and realised volatility on the S&P500 in excess of LIBOR

All returns are translated to NOK. The US-centric nature of this factor selection is a potential weakness, as is the choice of including non-tradable/hard-to-replicate factors such as the liquidity and volatility factors. Finally, the original AGS study does not indicate whether the fixed-income credit factors are duration-matched; in our study we assume they are not, and take the data series directly from Barclays Capital without adjustments, which means that the credit factors will have term effects embedded.

Figures 13 and 14 illustrate the different return dynamics for two bond indices with the same credit quality, but different maturities. We see that, even for the same credit quality, the maturity (and thus the exposure to yield curve movement) of the constituents will determine almost all the return variability of the index, as the credit spread component moves almost in sync. To circumvent this issue, one might attempt to construct indices using only bonds with perfectly matched maturities for different credit qualities. The resulting benchmark portfolios would, however, contain fewer bonds and would yield more unstable estimates due to their higher issuer-specific risk. On average, higher-credit-grade bond indices will have constituents with longer maturities.

The duration-matching issue serves as a good illustration of a typical problem in a study like this: the factor portfolios constructed to mimic a certain factor return might not capture perfectly the risk signal they are intended to represent.

[13] Source: Bloomberg.

[14] Off-the-run curve obtained from http://www.federalreserve.gov/pubs/feds/2006/200628/200628abs.html.

[15] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/ftp/F-F_Momentum_Factor.zip.

[16] Spliced series: Merrill Lynch Equity Volatility Arbitrage Index up to October 2012, the CBOE S&P 500 VARB-X thereafter.

**Figure 14 Option-adjusted spread (in basis points) for two bond indices with different maturity buckets**

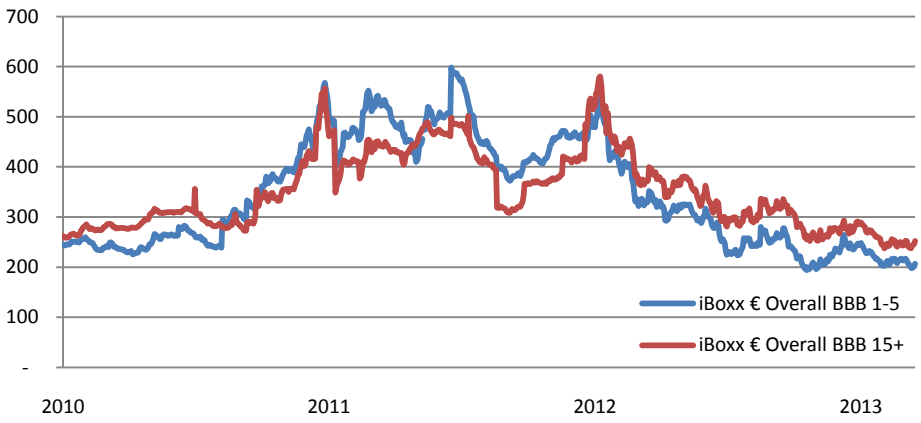
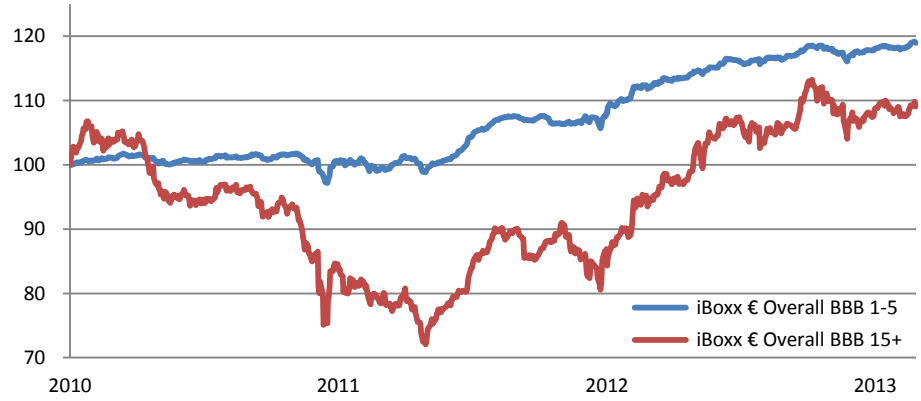



**Figure 15 Cumulative returns for the same two bond indices**




Another risk factor that could have been included in the analysis is foreign exchange. The base currency in which active and factor portfolio returns are expressed will introduce differences in correlations due to fluctuations in exchange rates relative to the base currency. In active returns relative to a benchmark and in long-short portfolios, as the factors in this analysis are designed, currency effects will be marginal, but they could be relevant during periods of high exchange rate volatility and correlation of exchange rates to the factors. Care should be taken in the design of the factor portfolios and the application of the appropriate currency conversion methodology, as long-only and long-short portfolios will be affected differently by currency returns.

Table 11 shows the co-movement between the factors from the fund's inception. The high degree of correlation between the factors justifies the use of partial correlations to interpret systematic risk factor exposures. These co-movements between factors can also vary over time.

**Table 11 Correlation matrix between monthly factor returns**

| | *Term* | *Credit Aa* | *Credit Baa* | *Credit High Yield* | *FX Carry* | *Illiquidity* | *Value/Growth* | *Small/Large* | *Momentum* |
|---|---|---|---|---|---|---|---|---|---|
| *Volatility* | -0.18 | 0.42 | 0.70 | 0.39 | 0.49 | 0.46 | -0.07 | 0.27 | -0.19 |
| *Momentum* | 0.12 | -0.28 | -0.30 | -0.33 | -0.11 | -0.21 | -0.37 | -0.04 | |
| *Small/Large* | -0.07 | 0.24 | 0.31 | 0.27 | 0.24 | 0.13 | 0.04 | | |
| *Value/Growth* | 0.05 | 0.00 | -0.04 | 0.05 | 0.05 | 0.09 | | | |
| *Illiquidity* | -0.21 | -0.05 | -0.33 | -0.15 | -0.45 | | | | |
| *FX Carry* | -0.11 | 0.45 | 0.43 | 0.28 | | | | | |
| *Cr. High Yield* | -0.68 | 0.46 | 0.57 | | | | | | |
| *Credit Baa* | -0.45 | 0.55 | | | | | | | |
| *Credit Aa* | -0.51 | | | | | | | | |

The results on correlations and partial correlations for the GPFG and its equity and fixed-income portfolios are provided below. The analysis does not take particular account of timing decisions on the benchmark, such as the increase in the equity allocation from 40 to 60 per cent. New active decisions on allocation to systematic risk factors (value, size) are not yet reflected in these factor exposures due to the short time they have been in place and the time-series nature of this calculation.

**Table 12 Correlations and partial correlations of active returns with systematic factor returns (p-values in parentheses). Significant partial correlation coefficients in bold type**

| *GPFG* | *Since inception* | | *Inception – Apr 2007* | | *Jan 2009 – Dec 2013* | |
|---|---|---|---|---|---|---|
| | Corr | Partial corr | Corr | Partial corr | Corr | Partial corr |
| *Term* | -0.21 (.00) | 0.07 (.37) | -0.07 (.51) | -0.07 (.36) | -0.32 (.01) | **0.37** (.00) |
| *Credit Aa* | 0.53 (.00) | **0.32** (.00) | 0.16 (.09) | 0.11 (.39) | 0.58 (.00) | **0.50** (.00) |
| *Credit Baa* | 0.52 (.00) | -0.08 (.23) | 0.26 (.01) | 0.09 (.49) | 0.41 (.00) | 0.16 (.22) |
| *Cr. High Yield* | 0.41 (.00) | 0.13 (.08) | 0.16 (.08) | -0.02 (.86) | 0.55 (.00) | **0.37** (.00) |
| *FX Carry* | 0.45 (.00) | 0.05 (.51) | 0.02 (.82) | -0.13 (.14) | 0.28 (.03) | 0.00 (.96) |
| *Illiquidity* | 0.33 (.00) | 0.11 (.12) | 0.16 (.10) | **0.35** (.00) | -0.05 (.72) | -0.09 (.45) |
| *Value/Growth* | -0.19 (.00) | **-0.27** (.00) | -0.43 (.00) | **-0.50** (.00) | 0.26 (.05) | 0.04 (.81) |
| *Small/Large* | 0.42 (.00) | **0.30** (.00) | 0.46 (.00) | **0.52** (.00) | 0.51 (.00) | **0.26** (.05) |
| *Momentum* | -0.14 (.05) | -0.01 (.89) | 0.25 (.01) | **0.22** (.01) | -0.45 (.00) | 0.10 (.44) |
| *Volatility* | 0.63 (.00) | **0.35** (.00) | 0.23 (.01) | 0.15 (.09) | 0.39 (.00) | -0.17 (.20) |

| *Equity portfolio* | *Since inception* | | *Inception – Apr 2007* | | *Jan 2009 – Dec 2013* | |
|---|---|---|---|---|---|---|
| | Corr | Partial corr | Corr | Partial corr | Corr | Partial corr |
| *Value/Growth* | -0.39 (.00) | **-0.40** (.00) | -0.45 (.00) | **-0.45** (.00) | -0.10 (.46) | **-0.26** (.05) |
| *Small/Large* | 0.41 (.00) | **0.40** (.00) | 0.37 (.00) | **0.43** (.00) | 0.63 (.00) | **0.46** (.00) |
| *Momentum* | 0.12 (.11) | 0.05 (.50) | 0.30 (.00) | 0.15 (.13) | -0.30 (.02) | -0.18 (.17) |
| *Volatility* | 0.37 (.00) | **0.29** (.00) | 0.23 (.02) | **0.24** (.01) | 0.51 (.00) | **0.38** (.00) |

| *Fixed-income portfolio* | *Since inception* | | *Inception – Apr 2007* | | *Jan 2009 – Dec 2013* | |
|---|---|---|---|---|---|---|
| | Corr | Partial corr | Corr | Partial corr | Corr | Partial corr |
| *Term* | -0.18 (.02) | **0.17** (.00) | -0.04 (.67) | -0.01 (.86) | -0.14 (.39) | **0.51** (.00) |
| *Credit Aa* | 0.48 (.00) | **0.28** (.00) | 0.10 (.27) | 0.13 (.16) | 0.44 (.00) | **0.48** (.00) |
| *Credit Baa* | 0.48 (.00) | **-0.02** (.01) | 0.06 (.50) | 0.05 (.66) | 0.28 (.03) | 0.20 (.25) |
| *Cr. High Yield* | 0.39 (.00) | **0.21** (.00) | 0.00 (.98) | -0.07 (.43) | 0.37 (.00) | **0.48** (.00) |
| *FX Carry* | 0.39 (.00) | 0.01 (.38) | -0.10 (.30) | -0.16 (.09) | 0.18 (.15) | -0.02 (.51) |
| *Illiquidity* | 0.28 (.00) | 0.00 (.37) | 0.03 (.78) | 0.06 (.52) | -0.01 (.86) | -0.08 (.64) |
| *Volatility* | 0.59 (.00) | **0.34** (.00) | 0.05 (.62) | -0.02 (.82) | 0.23 (.08) | -0.20 (.14) |

The results presented above are in line with those presented in Ang et al. (2009), although not identical, as the report alone does not contain enough technical details to recreate the analysis exactly. As in Ang et al. (2009), the main factor tilts identified are, in simple terms, a positive tilt to small companies, volatile companies and credit Aa, and a negative tilt to credit Baa and value companies (positive tilt to growth stocks). These results are generally also in line with the results observed from other methodological approaches.

Nevertheless, the numbers should be regarded with caution, knowing the model uncertainty inherent in every statistical analysis. Partial correlations in particular measure only the average linear dependence between the factors and active returns over the whole period of the study, so different co-movement with the factors could be observed in active returns during different market periods. Correlations might change dynamically over time, and they tend to increase during recessions and periods of high factor volatility. In addition, partial correlations depend on the full set of factors specified to attribute the variability of returns. If, for instance, more factors were added to the set, some marginal correlations would decrease whenever some of the marginal effect from a factor was shared with the other newly added factors.

## 2.3 Multivariate factor regressions

In addition to (partial) correlation analyses, NBIM monitors factor exposures in the GPFG from other perspectives and uses several internal and third-party models. In this section, we will present the results from a time-series multifactor regression of active portfolio returns on returns from investable, global factor portfolios, as a complementary, direct method. The equity factor portfolios used in this section are constructed as long-short portfolios from a global universe of stocks. In this way, specific asset returns will be diversified, and the performance of the portfolio will presumably proxy a global systematic risk factor. The returns are all considered in US dollars, as a large part of the portfolio is traded in this currency. Using NOK as a base currency would introduce exchange rate volatility which might make the interpretation of the results more difficult.

The factors considered in this analysis are as follows:

Equity portfolio:

- *Emerging:* Return on MSCI World Emerging minus return on MSCI World Developed.
- *Value/Growth:* Return on the stocks in the top 30$^{th}$ percentile by book-to-market (value stocks) minus the return on the stocks in the bottom 30$^{th}$ percentile (growth stocks) in the FTSE World Developed universe, equally weighted portfolios.
- *Small/Large:* Return on the stocks in the bottom 30$^{th}$ percentile by market capitalisation (small-cap stocks) minus the return on the stocks in the top 30$^{th}$ percentile (large-caps) in the FTSE World Developed universe, equally weighted portfolios.
- *Low Volatility:* Return on the stocks in the bottom 30$^{th}$ percentile by past 250-day volatility (low-volatility stocks) minus the return on the stocks in the top 30$^{th}$ percentile (high-volatility stocks) in the FTSE World Developed universe, equally weighted portfolios.

Fixed-income portfolio:

- *Term:* Return on US ten-year Treasury futures index minus return on US two-year Treasury futures index.

- *Credit Aa:* Return on Aa-rated bonds minus the return on Treasury bonds (global aggregates).
- *Credit Baa:* Return on Baa-rated bonds minus the return on Aa-rated bonds (global aggregates).
- *Credit Caa:* Return on Caa-rated bonds minus the return on Baa-rated bonds (global aggregates).

Table 13 shows that, over the full period, for the total GPFG, the factor regression explains 37 per cent of the variability in active returns. Volatility, Credit Aa and Credit Baa are significant in this regression. Looking only at the last five years, Credit Aa is significant in explaining the total GPFG, although Growth and Volatility are also significant in explaining the equity portfolio. The full multifactor regression explains 45 per cent of the active returns over this period.

**Table 13 Multifactor regression coefficients (t-statistics in parentheses). Significant coefficients in bold type**

| *GPFG* | *Since inception* | *Inception – Apr 2007* | *Jan 2009 – Dec 2013* |
|---|---|---|---|
| *Term* | 0.00 (-0.4) | -0.01 (-0.9) | 0.00 (-0.1) |
| *Credit Aa* | **0.05** (3.3) | -0.01 (-0.9) | **0.07** (2.5) |
| *Credit Baa* | **0.05** (3.9) | -0.02 (-0.9) | 0.02 (0.6) |
| *Credit Caa* | -0.01 (-1.4) | **0.00** (2.0) | -0.02 (-1.6) |
| *Emerging* | 0.00 (0.8) | **-0.01** (2.6) | 0.00 (-0.1) |
| *Value/Growth* | -0.01 (-1.0) | **-0.03** (-5.7) | 0.01 (0.5) |
| *Small/Large* | 0.01 (1.2) | **0.02** (2.5) | 0.01 (0.4) |
| *Low Volatility* | **-0.02** (-4.1) | **-0.01** (-3.0) | -0.01 (-1.5) |
| *% variability explained ($R^2$)* | 37% | 38% | 49% |

| *Equity portfolio* | *Since inception* | *Inception – Apr 2007* | *Jan 2009 – Dec 2013* |
|---|---|---|---|
| *Emerging* | 0.01 (1.7) | **0.02** (2.6) | -0.01 (-1.8) |
| *Value/Growth* | **-0.04** (-4.3) | **-0.07** (-5.8) | **-0.02** (-2.6) |
| *Small/Large* | 0.02 (1.3) | 0.02 (1.2) | 0.02 (1.8) |
| *Low Volatility* | **-0.03** (-6.7) | **-0.02** (-3.5) | **-0.02** (-5.7) |
| *% variability explained ($R^2$)* | 29% | 34% | 57% |

| *Fixed-income portfolio* | *Since inception* | *Inception – Apr 2007* | *Jan 2009 – Dec 2013* |
|---|---|---|---|
| *Term* | -0.02 (-1.0) | -0.01 (-1.2) | 0.02 (0.5) |
| *Credit Aa* | **0.09** (3.8) | -0.01 (-1.4) | **0.18** (3.4) |
| *Credit Baa* | **0.12** (5.8) | 0.00 (0.5) | 0.08 (1.4) |
| *Credit Caa* | -0.01 (-1.5) | 0.00 (-0.3) | -0.04 (-1.4) |
| *% variability explained ($R^2$)* | 26% | 3% | 28% |

Apart from the global systematic risk factors considered here, active management might involve decisions on changing allocations to regions, industries, countries or even asset classes (market timing) over time. These types of active investment decisions may carry some implicit exposure to the style risk factors considered here. This dynamic positioning combined with the time-varying nature of risk premiums themselves (see e.g. NBIM 2011), will give rise to systematic exposures that vary over time. In Figures 15, 16 and 17, this is illustrated by showing rolling five-year exposures (active return betas) for the total fund, the equity portfolio and the fixed-income portfolio. The credit exposure that becomes apparent in August 2008 seems to be responsible for a large rise in what a regression model will show as explained variability.

**Figure 16 Five-year rolling betas vs variability explained ($R^2$), GPFG**

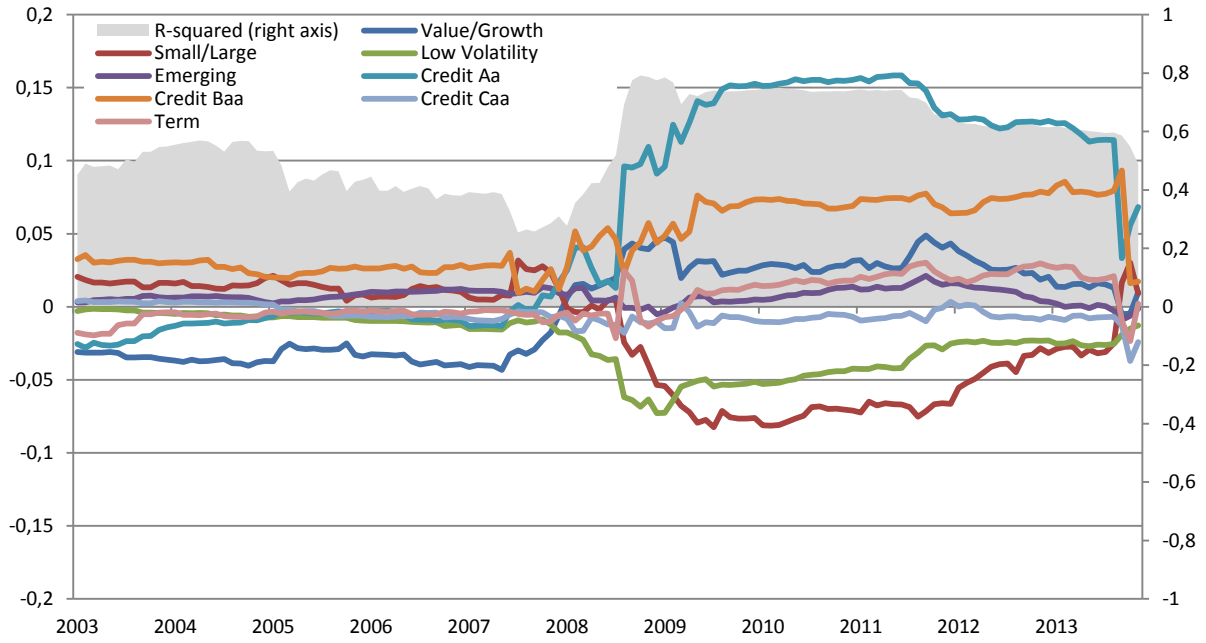



**Figure 17 Five-year rolling betas vs variability explained ($R^2$), equity portfolio**

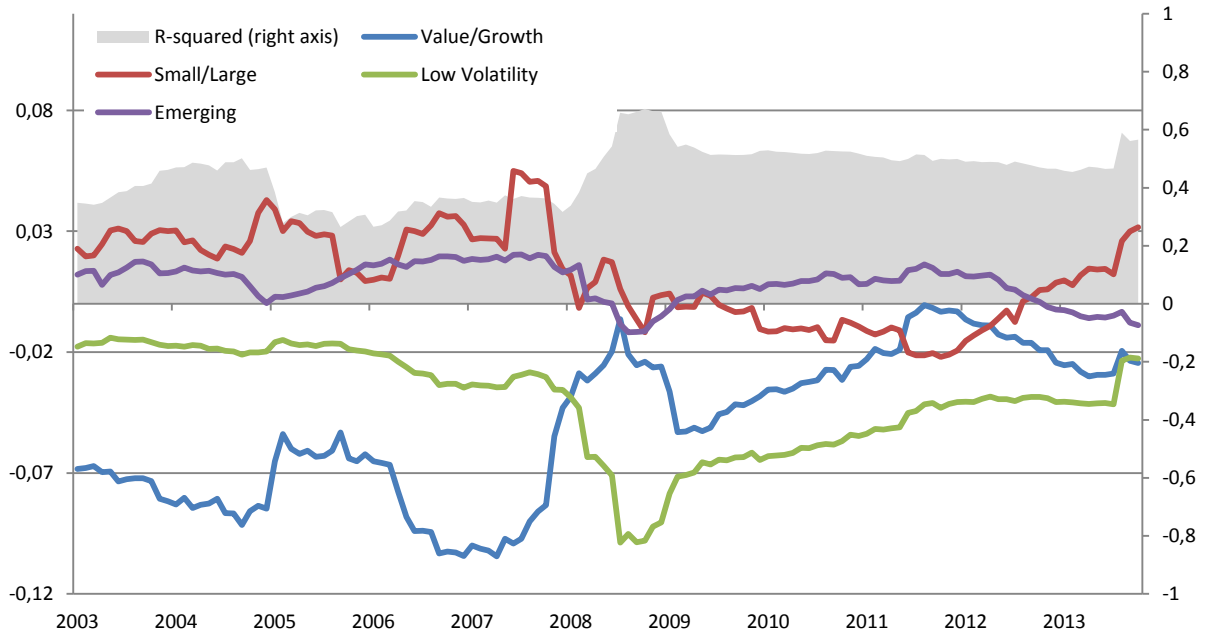
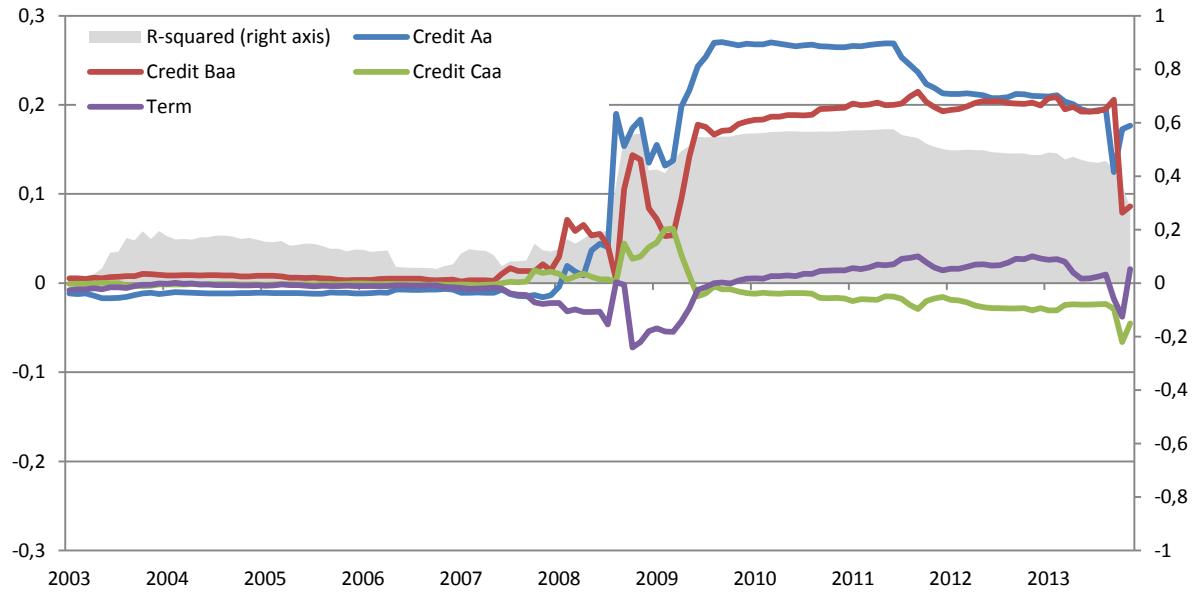


**Figure 18 Five-year rolling betas vs variability explained ($R^2$), fixed-income portfolio**




The same weaknesses described in the previous section on partial correlations also apply to this analysis based on linear regressions. This portfolio-return-based model implicitly assumes that the factor sensitivity measures are constant during the period of analysis. Moreover, they measure linear relations only, as is also the case in partial correlations. Apart from noise introduced during the practical factor portfolio construction, correlations between the theoretical market risk factors may also bias the estimated factor sensitivities, since the model assumes that these are independent from each other, which is not the case empirically.

# 3 Gross excess return vs net value creation

Net value creation is defined as the difference between the fund's actual results with active management and the results that could theoretically have been achieved with passive index management. Passive index management would aim at replicating an index that follows set rules. Making actual investments identical to such an index will result in a variety of costs. The key elements in the analysis are:

- **Gross excess return:** NBIM's actual return calculated according to the principles laid down in the NBIM Policy for Performance Measurement[17] and GIPS[18]. This is the gross excess return for the equity and fixed-income portfolios versus the aggregated benchmark index for equities and bonds. Real estate is not part of the measurement of value-added. The performance of the equity benchmark is adjusted for the GPFG's tax position. Revenues from security lending are included the gross return for the fund and the respective asset classes.
- **Inflows, rebalancing and benchmark index transition costs:** These costs are estimated costs related to phasing new capital into the fund, costs related to set rules for rebalancing of the asset allocation in the benchmark, and transition costs related to rule changes for the benchmark. During the last five years, the Ministry of Finance has decided new rule sets for both the equity benchmark index and the bond benchmark index, with associated transition phases from the old to the new benchmarks. The costs related to inflows, rebalancing and index transition costs are estimated based on market-standard assumptions about trading costs, not actual realised costs, and are therefore uncertain in nature.
- **Cost of passive strategy:** Changes in the equity and bond indices, such as company inclusions and periodic index re-weightings trigger transactions in the portfolio and subsequent costs. These costs are estimated based on models and not on realised costs, and are therefore uncertain in nature.
- **Management costs:** Management costs will be incurred for both active and passive management strategies, but will be higher for active management. The management costs here incorporate all GPFG management costs, including external managers' performance-related fees.
- **Management cost of a passive strategy:** Estimated management costs for a passive management strategy based on actual GPFG management costs for each year, where costs related to both internal and external active management strategies are subtracted.
- **Revenues from securities lending:** Unlike a theoretical index, a passive index portfolio will be able to generate income from securities lending. It is open to question to what extent securities lending revenues would be compatible with a passive investment mandate. This income is neither risk-free nor cost-free. In this analysis, actual revenues from securities lending are used, consistent with the financial reporting for the GPFG.

[17] Published on www.nbim.no.

[18] Global Investment Performance Standard. Annual GIPS reports are published on www.nbim.no.

## 3.1 Net value creation from active management 1998-2013

Below is an indication of added value from active management of the GPFG for the years 1998-2013. With the adjustments detailed in the above analysis, estimated net value creation from active management for the period 1998-2013 has been in line with the calculated gross excess return. Also for the recent period 2009-2013 the value creation has been in line gross excess return.

**Figure 19 Estimated value creation 1998-2013. Figures in basis points, annualised**

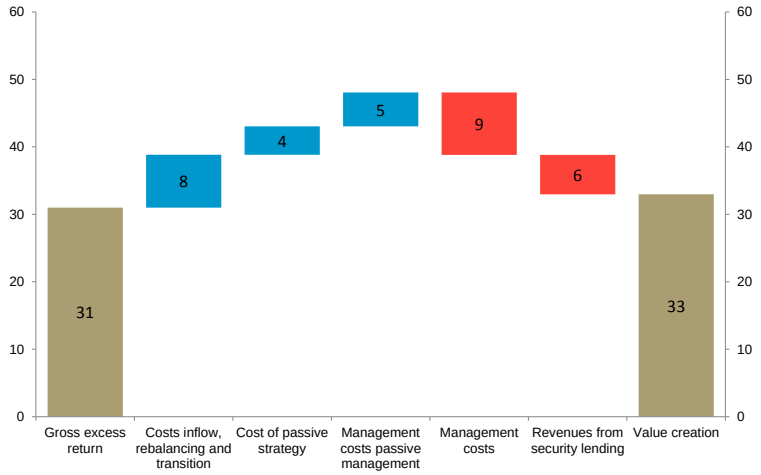
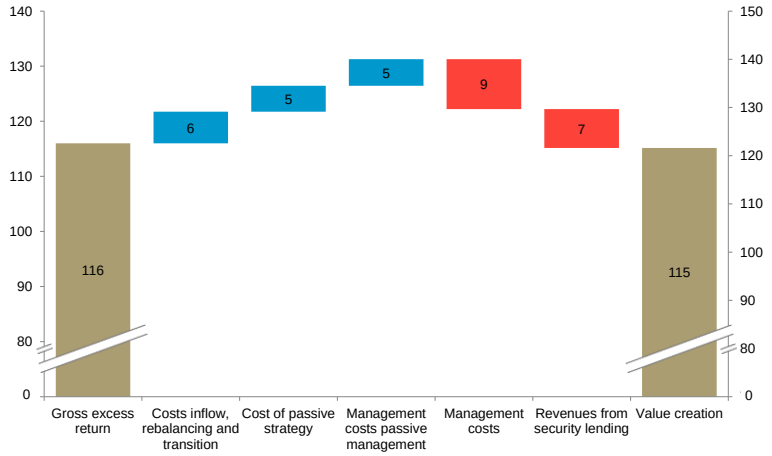



**Figure 20 Estimated value creation last 5 years. Figures in basis points, annualised**




# 4 References


Ang et al. (2009): *Evaluation of Active Management of the Norwegian Government Pension Fund – Global*.

NBIM (2011): "On risk premium variation", NBIM Discussion Note 1-2011.