GOVERNMENT PENSION FUND GLOBAL HISTORICAL PERFORMANCE MEASUREMENT

4 May 2015

Content

Scope

The scope of this report 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 uses data up to and including of 31st of March 2015. The analysis is performed on the whole history of the fund, the last ten years and the last five years beginning 1st of January 1998, 1st of April 2005 and 1st of April 2010 respectively. The Real estate portfolio of the fund 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 6.04 per cent at the end of first quarter 2015, and the annualised relative return was 0.26 percentage points.

- The realised relative risk for GPFG is a tracking error of 39 basis points the last 5 year. The modest level of active risk is reflected in the risk adjusted return numbers, where the figures for GPFG are in line with the benchmark.

- The absolute risk for the GPFG has been somewhat higher than for 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 constant exposures to risk factors. 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. After 2008, the same regression has an explanatory power of 50-80 per cent. The explanatory power falls back below 50 per cent when data from 2008 exits the rolling window.

- Gross relative return is 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 175[1] per cent from 1 January 1998 to the end of the first quarter of 2015 measured in the *GPFG currency basket*. The equivalent return for the benchmark is 164 per cent. This corresponds to annualised returns of 6.04 and 5.78 per cent for the GPFG and the benchmark respectively. The excess return has been 0.26 percentage points since 1 January 1998. The last five years, annualised excess return was 0.21 percentage points.

Within the asset classes, equity[2] and fixed income have had annualised returns of 5.75 and 5.16 per cent respectively. The annualised excess returns have been 0.51 and 0.15 percentage points for equity and fixed income since 1 January 1999 and 1 January 1998 respectively. The annualised excess returns the last five years were 0.24 and 0.09 percentage points for equity and fixed income respectively.

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

Portfolio	Portfolio return			Active return		
	Since[2] 1.1.1998	Last ten years	Last five years	Since[2] 1.1.1998	Last ten years	Last five years
GPFG	6.04%	6.61%	8.91%	0.26%	0.12%	0.21%
Equity	5.75%	7.89%	11.24%	0.51%	0.36%	0.24%
Fixed Income	5.16%	4.61%	4.82%	0.15%	0.07%	0.09%

The GPFG has had an annualised return of 6.32 per cent since 1 January 1998 measured in *US dollars*. The excess of the fund has been 0.26 percentage point since 1 January 1998, and was 0.21 the last five years. Within the asset classes, equity and fixed income have had annualised returns of 5.75 and 5.44 per cent since 1 January 1999 and 1 January 1998 respectively. Both asset classes have had positive annualised excess returns in the period: 0.51 and 0.15 percentage point respectively. The annualised excess returns last five years were 0.23 and 0.08 percentage points respectively.

Table 2 Portfolio returns measured in US dollars

Portfolio	Portfolio return			Active return		
	Since[2] 1.1.1998	Last ten years	Last five years	Since[2] 1.1.1998	Last ten years	Last five years
GPFG	6.32 %	5.71 %	6.71 %	0.26 %	0.12 %	0.21 %
Equity	5.75 %	6.97 %	8.99 %	0.51 %	0.36 %	0.23 %
Fixed Income	5.44 %	3.73 %	2.70 %	0.15 %	0.07 %	0.08 %

The GPFG had positive *returns*[3] in 14 out of the 18 *years*[4] since 1 January 1998. Equity and fixed income have had positive returns in 12 out of 17 years and 16 out of 18 years respectively. The GPFG

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[1] The performance analysis is based on return data from January 1998 to March 2015 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 March 2015. 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.

[4] The return as of first quarter is used for 2015

has delivered positive returns in 67 per cent of *months* since 1 January 1998, while the equivalent share for equity and fixed income is 61 and 72 per cent respectively.

The GPFG has had positive *relative returns* in 14 out of the 18 *years* since 1 January 1998. Equity and fixed income have had positive relative returns in 13 out of 17 years and 13 out of 18 years respectively. The GPFG has delivered positive relative returns in 65 per cent of the *months* since 1 January 1998, while the equivalent share for equity and fixed income is 64 and 61 per cent respectively.

Rolling five-year returns

Rolling five-year annualised returns of the GPFG have varied between -1.4 and 14.3 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 2.9 percentage points above the GPFG's annualised return since 1 January 1998.

Figure 1 Rolling five-year annualised portfolio return, GPFG

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 pricing of 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 February 2014 with a 19.5 per cent five-year rolling annualised return. The rolling five-year returns were negative during the financial crisis and in 2011 and

Figure 2 Rolling five-year annualised portfolio return, equity

2012. They recovered after the financial crisis and are currently 11.2 per cent, 5.5 percentage points above the equity portfolio return since 1 January 1999.

Five-year rolling returns of 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, falling to 2.1 per cent in February 2009. In the following years, the rolling returns recovered, and are currently at 4.8 per cent, 0.3 percentage points below the annualised return on the fixed-income portfolio since 1 January 1998.

Figure 3 Rolling five-year annualised portfolio return, fixed income

Rolling five-year relative returns

Since 1 January 1998, the GPFG has an accumulated annualised relative return of 0.26 percentage point, with five-year rolling relative returns varying between -0.7 and 1.3 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, to a low in March 2009 with a rolling five-year relative return of -0.7 percentage point, predominantly caused by the fixed-income investments. From March 2010, the rolling relative returns were stable around zero until recovering in 2013, and they are currently 0.21 percentage points, 0.05 percentage points below the relative return on the fund since 1 January 1998.

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 points in July 2012 to 0.99 percentage points in October 2007. The current five-year rolling relative return is 0.24 percentage points, 0.27 percentage points lower than the relative return of 0.51 percentage points since 1 January 1999.

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 points. Through 2008 the rolling returns dropped, and 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 and rose sharply in 2013. They are currently 0.09 percentage points, 0.06 percentage points lower than the relative fixed-income return since 1 January 1998.

Figure 4 Rolling five-year annualised relative return, GPFG
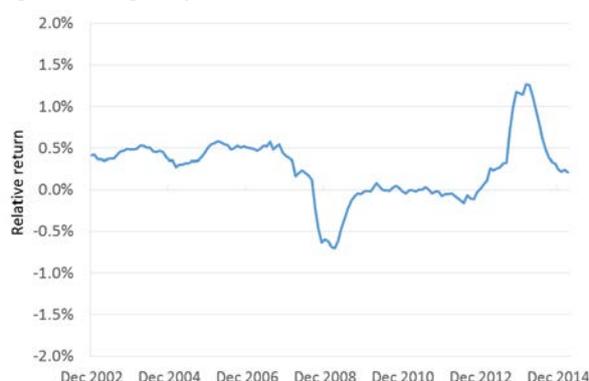
Figure 5 Rolling five-year annualised relative return, equity

Figure 6 Rolling five-year annualised relative, fixed income
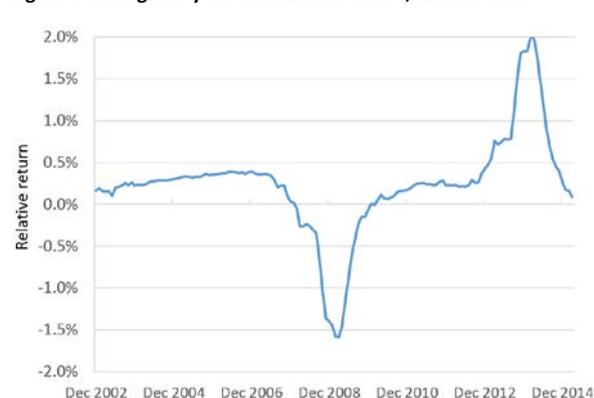
1.2 Relative risk development

One measure of the relative risk of 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[5].

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 and including first quarter 2015[6]. The realised tracking error has been 73 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.

The statistical measures skewness and kurtosis give additional information about distributional characteristics of the return history. Table 3 present these measures for the fund as a whole and for the asset classes.

Figure 7 GPFG tracking error, basis points
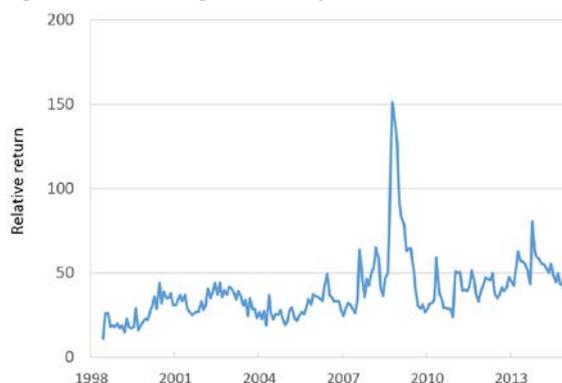
Figure 8 GPFG monthly relative return, basis points
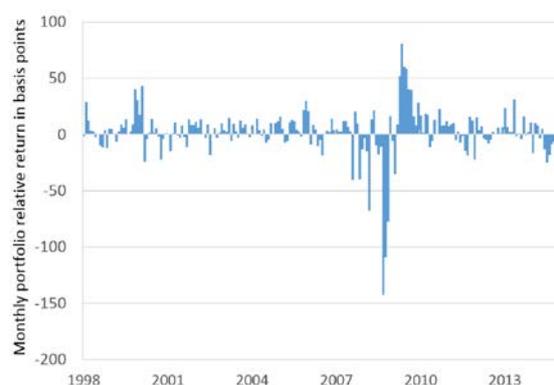
Figure 9 GPFG monthly relative return distribution

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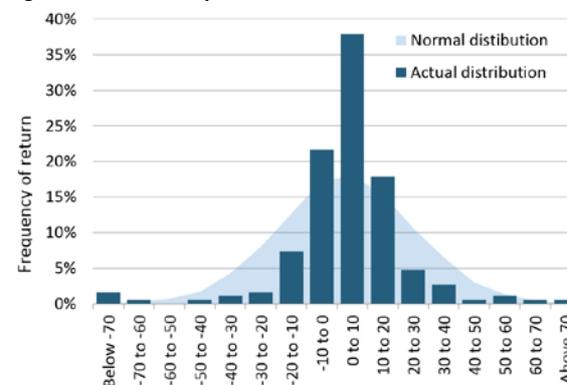
[5] Prior to 2011 the tracking error limit was 150 basis points. Since 2011 the tracking error "limit" has been 100 basis points.

[6] 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.

Table 3 GPFG monthly relative return distribution

	Fund			Equity			Fixed income		
	Since 1.1.1998	Last ten years	Last five years	Since 1.1.1999	Last ten years	Last five years	Since 1.1.1998	Last ten years	Last five years
Mean	0.02%	0.01%	0.02%	0.04%	0.03%	0.02%	0.01%	0.01%	0.01%
St. dev.	0.21%	0.26%	0.11%	0.24%	0.23%	0.13%	0.32%	0.41%	0.14%
Skewness	-2.2	-2.0	-0.1	-0.7	-2.2	-0.8	-0.6	-0.4	-0.1
Excess kurtosis	15.8	10.6	0.3	9.1	13.0	0.9	15.0	8.0	0.0

1.3 Risk-adjusted return

The management of the fund has had an impact on the fund's risk profile. The GPFG has deviated from its benchmark to varying degrees throughout the investment period. Tracking error[7] has been 0.73 percentage points since 1 January 1998 for the GPFG and 0.39 percentage point the last five years.

To analyse whether the trade-off between expected return and risk in the GPFG has improved, the returns have to be adjusted for the impact active management has had 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 4 Annualised standard deviation of returns, portfolio and benchmarks

	Since[8] 1.1.1998	Last ten years	Last five years
GPFG Portfolio standard deviation	7.5%	8.6%	7.1%
GPFG Benchmark standard deviation	7.1%	8.0%	6.9%
GPFG ex post tracking error (in basis points)	73	91	39
Equity Portfolio standard deviation	14.9%	14.9%	11.9%
Equity Benchmark standard deviation	14.5%	14.5%	11.7%
Equity ex post tracking error (in basis points)	82	80	45
Fixed Income Portfolio standard deviation	3.4%	3.5%	2.7%
Fixed Income Benchmark standard deviation	3.2%	3.2%	2.9%
Fixed Income ex post tracking error (in basis points)	110	143	48

Information ratio

The GPFG has had an information ratio[9] of 0.36 since 1 January 1998, and 0.56 the last five years.

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 1.92 in February 2014. Currently the five-year information ratio is 0.56.

Table 5 Information ratio

Portfolio	Since 1.1.1998	Last ten years	Last five years
GPFG	0.36	0.13	0.56
Equity	0.62	0.45	0.52
Fixed Income	0.14	0.05	0.18

The equity portfolio information ratio has been 0.62 in the period since 1 January 1999 and 0.52 the last five years. The equivalent for fixed income are 0.14 and 0.18.

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

[8] 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.

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

Sharpe ratios

Since 1 January 1998, the Sharpe ratio for both the GPFG and the benchmark has been 0.53, GPFG having a marginally higher ratio. The last five years the GPFG and the benchmark also had the same Sharpe ratio, 1.25.

The equity Sharpe ratio since 1 January 1999 has been 0.26, 0.03 better than the benchmark. The last five years both the equity portfolio and the benchmark had a sharp ratio of 0.94.

The fixed income Sharpe ratio since 1 January 1998 has been 0.90, 0.01 lower than the benchmark. The last five years the fixed income had a Sharpe ratio of 1.75, 0.14 higher than the benchmark.

Table 6 Sharpe ratio

Portfolio	Since 1.1.1998	Last ten years	Last five years
GPFG	0.53	0.61	1.25
Equity	0.26	0.44	0.94
Fixed Income	0.90	0.92	1.75

Table 7 Sharpe ratio difference (portfolio minus benchmark)

Portfolio	Since[11] 1.1.1998	Last ten years	Last five years
GPFG	0.004	-0.032	-0.003
Equity	0.029	0.012	-0.000
Fixed Income	-0.008	-0.068	0.137

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*[10] seeks to capture these risk characteristics, as it punishes portfolios with excess downside risk. The punishment for downside risk should ideally be a utility function that matches the risk tolerance of the capital owner. In addition to adjusted Sharpe ratio, there are several other measures that try to adjust for the distributional characteristics of the relative returns.

The GPFG's adjusted Sharpe ratio since 1 January 1998 is 0.46, 0.01 below the adjusted Sharpe ratio of the benchmark. The adjusted Sharpe ratio for the equity portfolio since 1 January 1999 is 0.25, while the equivalent for the benchmark is 0.22. The fixed-income portfolio has an adjusted Sharpe ratio of 0.81, compared to the benchmark's 0.88.

Table 8 Adjusted Sharpe ratio

Portfolio	Since[11] 1.1.1998	Last ten years	Last five years
GPFG	0.46	0.51	1.13
Equity	0.25	0.40	0.85
Fixed Income	0.81	0.80	1.39

The GPFG's adjusted Sharpe ratio the last five years was 1.13 same as for the benchmark. The adjusted Sharpe ratio for both the equity portfolio and the benchmark was 0.85 during this period. The fixed-income portfolio has an adjusted Sharpe ratio of 1.39 in the period while the equivalent for the benchmark is 1.36.

Table 9 Adjusted Sharpe ratio difference

Portfolio	Since[11] 1.1.1998	Last ten years	Last five years
GPFG	-0.009	-0.034	-0.004
Equity	0.026	0.008	0.000
Fixed Income	-0.077	-0.174	0.033

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[10] 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.

Simple linear regression

The market beta represents the fund's exposure to the broad market, which in this analysis is represented by the corresponding benchmark index. In this section, the market beta is estimated from a simple linear regression between the fund's monthly relative returns and the monthly returns of the benchmark index. This regression also produces an estimate for the alpha of the investments which is interpreted as the portion of the relative return which is not explained by the systematic and random movements of the market[11].

It should be noted that the estimates for alpha and beta depend on what representation of the market is used in the regression. Using the returns of the equity benchmark index instead of the total fund's benchmark index to estimate alpha and beta for the total fund, will result in significantly different coefficients. Since alpha and beta are estimated based on historical observations, they have a statistical uncertainty which may be represented by confidence intervals. The range of these intervals depends on the confidence level, which is set to 95 per cent in this analysis. Thus, the alphas and betas are within their confidence intervals with 95 per cent certainty based on the chosen model. It is also of importance to evaluate the performance of the chosen model which is often represented by the adjusted R-squared of the regression, which captures how much of the variability in relative returns is actually explained by the model. A low R-squared will give wide confidence intervals for the Alpha and Beta measures. In the analysis of the fund's relative returns the R-squared ranges between 20 and 40 per cent, indicating that the chosen model does not capture the majority of the variations of the fund's relative returns. With this simple linear regression the GPFG has had a beta of 1.06 since inception and an alpha of -0.06 per cent (annualized), where the beta estimate is considered significantly larger than 1, while the alpha is not significantly different from 0. For the equity portfolio versus the equity benchmark the figures are 1.02 and 0.40 per cent with both coefficients being statistically significant. For the fixed income portfolio the corresponding figures are 1.00 and 0.15, where both numbers are considered insignificant. In the report by Ang, Brandt and Denison the beta of 1.06 for the whole fund is explained as a statistical artefact driven by high correlations between the fixed income and equities benchmarks during the crisis period as well as by the high correlation between the fixed income credit factors and the equities benchmark[12].

Table 10 Fund alpha and beta

	Since inception	Last 10 years	Last 5 years
Beta	**1.058 (9.7)**	**1.074 (9.3)**	**1.026 (4.1)**
Alpha (annualized)	-0.063 (-0.4)	-0.323 (-1.4)	-0.015 (-0.1)
Alpha upper bound	0.234	0.124	0.312
Alpha lower bound	-0.360	-0.769	-0.342
R-squared (adj)	31.2	41.8	20.8

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[11] Since the regression is performed on monthly return observations the resulting alpha estimate will need to be annualized. The alpha is annualized arithmetically, i.e. multiplied by 12

[12] The high beta for GPFG and low for the two asset classes is discussed in the Review of the Active Management of the Norwegian Government Pension Fund Global by Andrew Ang, Michael W. Brandt and David F. Denison (2014).

Table 11 Equity Asset class alpha and beta

	Since inception	Last 10 years	Last 5 years
Beta	**1.023 (6.2)**	**1.029 (6.9)**	**1.021 (5.0)**
Alpha (annualized)	**0.396 (2.1)**	0.161 (0.7)	0.006 (0)
Alpha upper bound	0.768	0.591	0.361
Alpha lower bound	0.025	-0.269	-0.349
R-squared (adj)	16.3	27.9	28.7

Table 12 Fixed Income asset class alpha and beta

|	Since inception	Last 10 years	Last 5 years
Beta	1.000 (0)	1.001 (0)	**0.927 (-3.8)**
Alpha (annualized)	0.149 (0.5)	0.074 (0.2)	0.419 (2.0)
Alpha upper bound	0.722	1.043	0.845
Alpha lower bound	-0.423	-0.894	-0.007
R-squared (adj)	-0.5	-0.8	18.4

Figure 10 Fund rolling 5 year beta
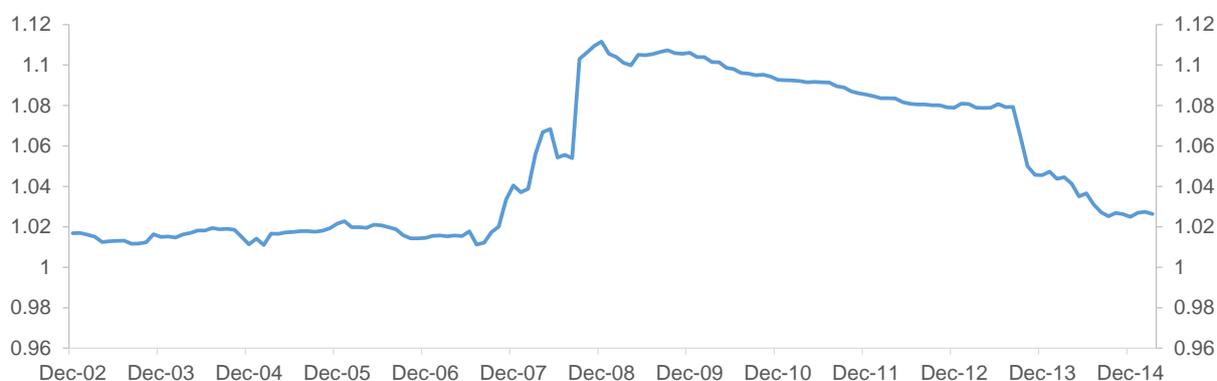
Figure 11 Equity asset class rolling 5 year beta
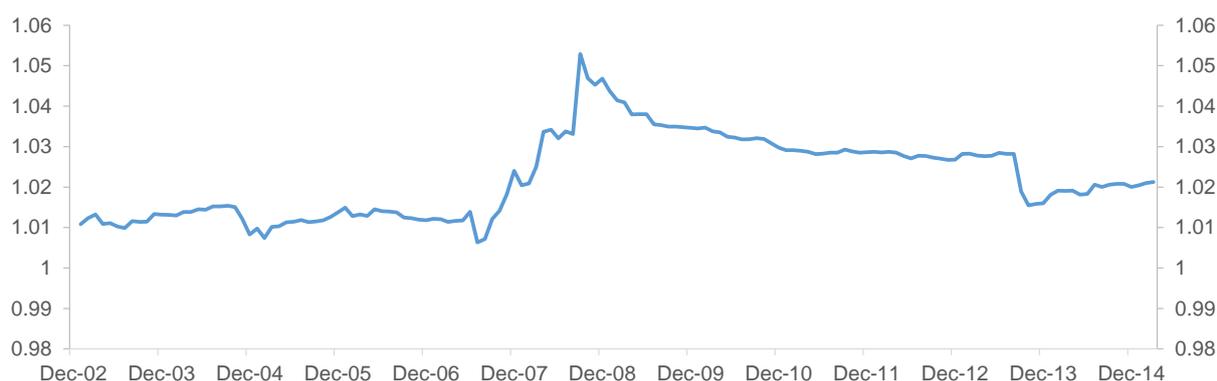
2 Analysis of systematic risk factor exposures

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 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 13 Variance attribution

	Total Fund			Equity			Fixed Income		
	Since inception	Last 10 years	Last 5 years	Since inception	Last 10 years	Last 5 years	Since inception	Last 10 years	Last 5 years
Benchmark	99.2%	98.7%	99.7%	99.7%	99.6%	99.7%	98.1%	97.0%	99.7%
Active	0.8%	1.3%	0.3%	0.3%	0.4%	0.3%	1.9%	3.0%	0.3%

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 12 Variance attribution of active returns

Expanding time window

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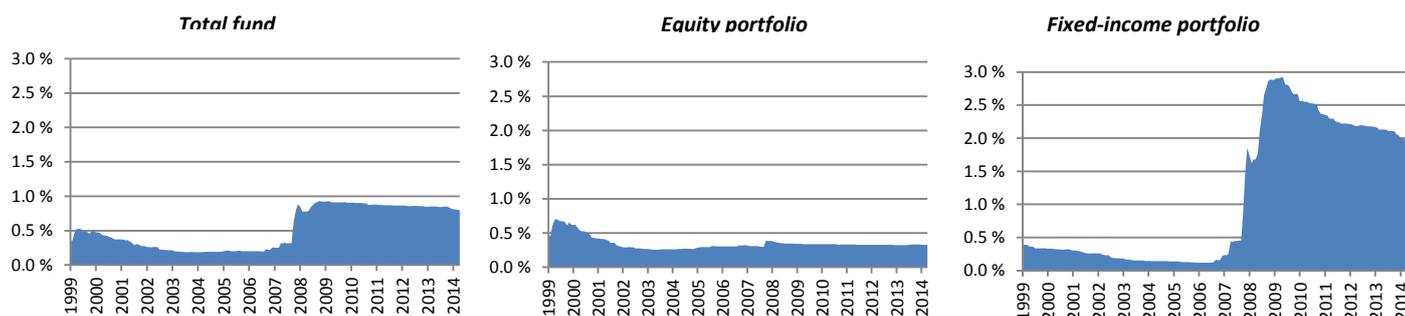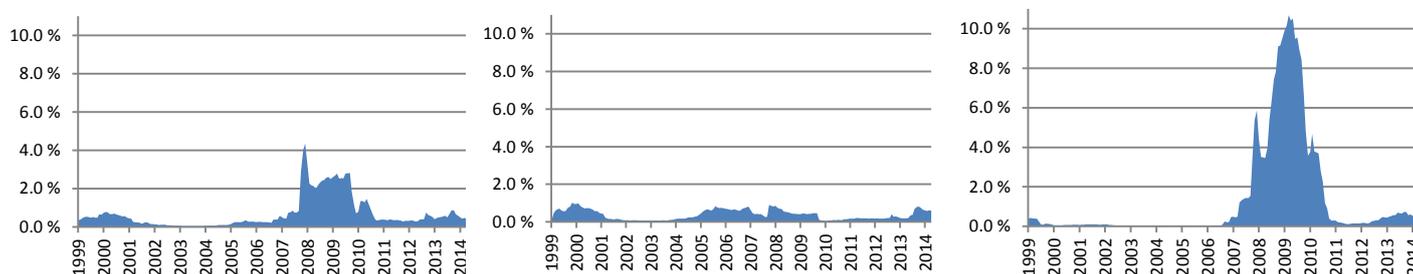
2.2 Active returns' co-movement with systematic risk factors

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

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[13] Source: Bloomberg.

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

- *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.

Table 14 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 14 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	0.45	-0.08	0.26	-0.19
Momentum	0.13	-0.28	-0.30	-0.33	-0.13	-0.22	-0.37	-0.02	
Small/Large	-0.05	0.23	0.29	0.26	0.22	0.13	0.04		
Value/Growth	0.03	0.01	-0.03	0.06	0.06	0.09			
Illiquidity	0.21	0.05	0.32	0.15	0.44				
FX Carry	-0.16	0.47	0.44	0.30					
Cr. High Yield	-0.69	0.47	0.58						
Credit Baa	-0.47	0.56							
Credit Aa	-0.52								

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.

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[15] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/ftp/F-F_Momentum_Factor.zip. Note that this series has been changed retroactively, so that the series in this report is not identical to the series used in NBIM (2014).

[16] Spliced series: Merrill Lynch Equity Volatility Arbitrage Index up to October 2012, CBOE S&P 500 VARB-X from November 2012 until December 2013 and JP Morgan Volemont US Short-Only Strategy thereafter.

Table 15 Correlations and partial correlations of active returns with systematic factor returns (p-values in parentheses). Statistically significant (at 5% level) partial correlation coefficients in bold type

GPFG	Since inception		Last 10 years		Last 5 years	
	Corr	Partial corr	Corr	Partial corr	Corr	Partial corr
Term	-0.22 (.00)	0.06 (.41)	-0.25 (.01)	**0.24 (.01)**	-0.61 (.00)	-0.15 (.39)
Credit Aa	0.53 (.00)	**0.32** (.00)	0.59 (.00)	**0.42 (.00)**	0.49 (.00)	-0.03 (.87)
Credit Baa	0.52 (.00)	-0.07 (.30)	0.57 (.00)	-0.03 (.71)	0.40 (.01)	-0.07 (.63)
Cr. High Yield	0.41 (.00)	0.12 (.09)	0.53 (.00)	**0.31 (.00)**	0.64 (.00)	0.02 (.79)
FX Carry	0.44 (.00)	0.05 (.51)	0.51 (.00)	0.06 (.50)	0.38 (.01)	0.08 (.57)
Illiquidity	0.32 (.00)	0.11 (.10)	0.40 (.00)	0.08 (.38)	-0.23 (.13)	0.13 (.46)
Value/Growth	-0.18 (.01)	**-0.26** (.00)	-0.13 (.15)	**-0.22 (.02)**	-0.25 (.10)	-0.05 (.77)
Small/Large	0.41 (.00)	**0.29** (.00)	0.52 (.00)	**0.19 (.04)**	0.67 (.00)	**0.44 (.00)**
Momentum	-0.14 (.04)	-0.01 (.91)	-0.34 (.00)	-0.09 (.34)	-0.07 (.66)	-0.04 (.80)
Volatility	0.62 (.00)	**0.34** (.00)	0.66 (.00)	0.14 (.12)	0.42 (.00)	-0.01 (.99)

Equity portfolio	Since inception		Last 10 years		Last 5 years	
	Corr	Partial corr	Corr	Partial corr	Corr	Partial corr
Value/Growth	-0.38 (.00)	**-0.38** (.00)	-0.31 (.00)	**-0.25 (.01)**	-0.31 (.04)	-0.11 (.51)
Small/Large	0.40 (.00)	**0.40** (.00)	0.52 (.00)	**0.39 (.00)**	0.67 (.00)	**0.58 (.00)**
Momentum	0.12 (.09)	0.05 (.52)	-0.10 (.27)	-0.05 (.61)	-0.05 (.75)	-0.14 (.37)
Volatility	0.37 (.00)	**0.29** (.00)	0.45 (.00)	**0.25 (.00)**	0.50 (.00)	**0.43 (.00)**

Fixed-income portfolio	Since inception		Last 10 years		Last 5 years	
	Corr	Partial corr	Corr	Partial corr	Corr	Partial corr
Term	-0.19 (.01)	**0.16** (.00)	-0.22 (.02)	**0.38 (.00)**	-0.29 (.06)	-0.16 (.24)
Credit Aa	0.48 (.00)	**0.27** (.00)	0.52 (.00)	**0.38 (.00)**	0.14 (.37)	-0.14 (.25)
Credit Baa	0.48 (.00)	**-0.01** (.01)	0.54 (.00)	0.06 (.12)	0.09 (.58)	-0.20 (.12)
Cr. High Yield	0.39 (.00)	**0.20** (.00)	0.54 (.00)	**0.46 (.00)**	0.36 (.01)	0.10 (.66)
FX Carry	0.38 (.00)	0.01 (.41)	0.44 (.00)	0.01 (.80)	0.17 (.25)	0.14 (.37)
Illiquidity	0.27 (.00)	0.00 (.35)	0.37 (.00)	-0.01 (.72)	-0.02 (.89)	0.29 (.06)
Volatility	0.58 (.00)	**0.33** (.00)	0.61 (.00)	0.12 (.19)	0.14 (.39)	-0.11 (.52)

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 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 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 30th percentile by book-to-market (value stocks) minus the return on the stocks in the bottom 30th percentile (growth stocks) in the FTSE World Developed universe, equally weighted portfolios.
- *Small/Large:* Return on the stocks in the bottom 30th percentile by market capitalisation (small-cap stocks) minus the return on the stocks in the top 30th percentile (large-caps) in the FTSE World Developed universe, equally weighted portfolios.
- *Low Volatility:* Return on the stocks in the bottom 30th percentile by past 250-day volatility (low-volatility stocks) minus the return on the stocks in the top 30th 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 16 shows the results of the regression analysis. New in this report is that we include a row showing arithmetically annualized intercept / alpha, that should be regarded as a crude approximation of annualized active return not explained by the factors in the model. It is important to point out that as the explained variation (R^2) of the regressions are relatively low, one should be careful in making statistical inferences based on these results. To highlight the inherent uncertainty of these results, we include 95 per cent confidence bands around the estimated intercepts (intercept upper and lower bounds). As the confidence interval includes zero for the full period for GPFG, a statistical test would

fail to reject the hypothesis that the intercept is zero. However, this result should not be interpreted to mean that the intercept is zero at a 95 per cent confidence level.

For the period since inception up to the first quarter of 2015, for the total GPFG (excluding real estate), the factor regression explains 36 per cent of the variability in active returns. The Volatility, Credit Aa and Credit Baa factors are significant in this regression. Looking only at the last five years, Volatility and Emerging markets are significant in explaining the total GPFG variability, although Growth and Small Cap are also significant in explaining the equity portfolio. The full multifactor regression explains 43 per cent of the variability of active returns over this period.

Table 16 Multifactor regression coefficients (t-values in parentheses). Significant[17] (non-zero at 5% confidence) coefficients in bold type. Annualized intercept and intercept estimate bounds at a 95% confidence level are given at the bottom of the tables. R-squared is not adjusted for the number of factors in the model.

GPFG	Since inception	Last 10 years	Last 5 years
Term	0.00 (-0.5)	0.01 (0.4)	-0.02 (-1.5)
Credit Aa	**0.05 (3.3)**	**0.10 (4.4)**	-0.03 (-1.2)
Credit Baa	**0.05 (3.9)**	**0.06 (3.2)**	0.01 (0.2)
Credit Caa	-0.01 (-1.3)	0.00 (-0.2)	0.00 (0.4)
Emerging	0.00 (0.8)	0.01 (1.0)	**-0.01 (-2.1)**
Value/Growth	-0.01 (-1.0)	0.01 (0.6)	-0.02 (-1.7)
Small/Large	0.01 (1.3)	-0.02 (-1.0)	0.03 (1.6)
Low Volatility	**-0.02 (-4.2)**	**-0.03 (-3.7)**	**-0.02 (-3.3)**
% variability explained (R^2)	36%	56%	43%
Annualized intercept (alpha)	0.2736% (1.8)	0.0558% (0.3)	0.2062% (1.2)
Intercept - Lower bound	-0.0271%	-0.351%	-0.1329%
Intercept – Upper bound	0.5743%	0.4626%	0.5453%

Equity portfolio	Since inception	Last 10 years	Last 5 years
Emerging	0.01 (1.6)	0.01 (0.9)	**-0.02 (-3.4)**
Value/Growth	**-0.04 (-4.3)**	-0.03 (-1.9)	**-0.02 (-2.4)**
Small/Large	0.02 (1.5)	0.00 (0.1)	**0.05 (2.6)**
Low Volatility	**-0.03 (-6.8)**	**-0.05 (-6.6)**	**-0.02 (-4.5)**
% variability explained (R^2)	27%	44%	52%
Annualized intercept (alpha)	**0.5691% (3.2)**	0.3581% (1.8)	0.1218% (0.8)
Intercept - Lower bound	0.2165%	-0.0284%	-0.1797%
Intercept – Upper bound	0.9218%	0.7446%	0.4232%

Fixed-income portfolio	Since inception	Last 10 years	Last 5 years
Term	-0.02 (-1.2)	-0.01 (-0.4)	**-0.04 (-2.27)**
Credit Aa	**0.08 (3.8)**	**0.19 (5.2)**	0.00 (-0.02)
Credit Baa	**0.12 (5.8)**	**0.15 (4.7)**	-0.02 (-0.63)
Credit Caa	-0.01 (-1.4)	0.00 (-0.1)	0.00 (0.07)
% variability explained (R^2)	25%	42%	11%

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[17] The significance of the coefficients and intercepts depends, in addition to the actual co-dependence between returns, on the length of the time period considered in the analysis, since the larger the sample size, the higher the statistical convergence of the estimates to their real values.

Annualized intercept (alpha)	0.2498% (1.1)	-0.0956% (-0.3)	0.2918% (1.24)
Intercept - Lower bound	-0.2188%	-0.8085%	-0.1808%
Intercept – Upper bound	0.7185%	0.6173%	0.7643%

In Table 17, we compare the results for the multivariate regression for the total GPFG as reported in NBIM (2014) vs. this report. The factors measured as significant are in line, however – the intercept is statistically significant for the period from inception to December 2013.

Table 17 Multifactor regression for GPFG since inception as of December 2013 and as of March 2015

GPFG	*Inception to Dec 2013*	*Inception to Mar 2015*
Term	0.00 (-0.4)	0.00 (-0.5)
Credit Aa	**0.05 (3.3)**	**0.05 (3.3)**
Credit Baa	**0.05 (3.9)**	**0.05 (3.9)**
Credit Caa	-0.01 (-1.4)	-0.01 (-1.3)
Emerging	0.00 (0.8)	0.00 (0.8)
Value/Growth	-0.01 (-1.0)	-0.01 (-1.0)
Small/Large	0.01 (1.2)	0.01 (1.3)
Low Volatility	**-0.02 (-4.1)**	**-0.02 (-4.2)**
% variability explained (R^2)	37%	36%
Annualized intercept (alpha)	**0.3271% (2.0)**	0.2736% (1.8)
Intercept - Lower bound	0.0078%	-0.0271%
Intercept – Upper bound	0.6463%	0.5743%

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 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 13, 14 and 15, 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 13 Five-year rolling betas vs variability explained (R²), GPFG**
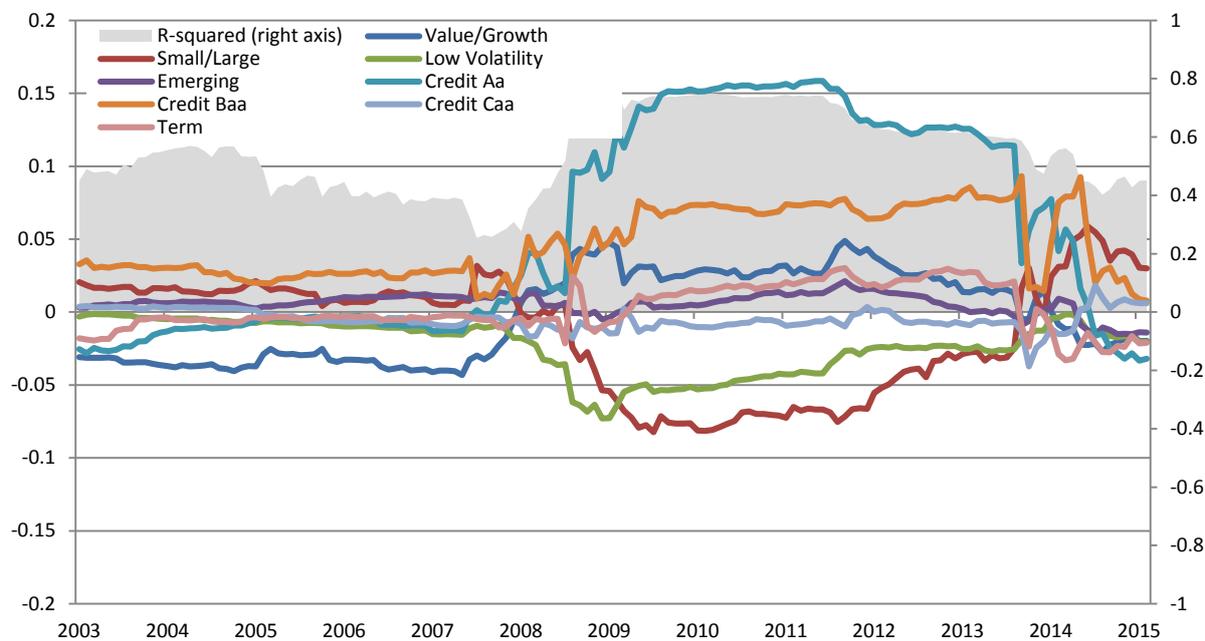
Figure 14 Five-year rolling betas vs variability explained (R²), equity portfolio
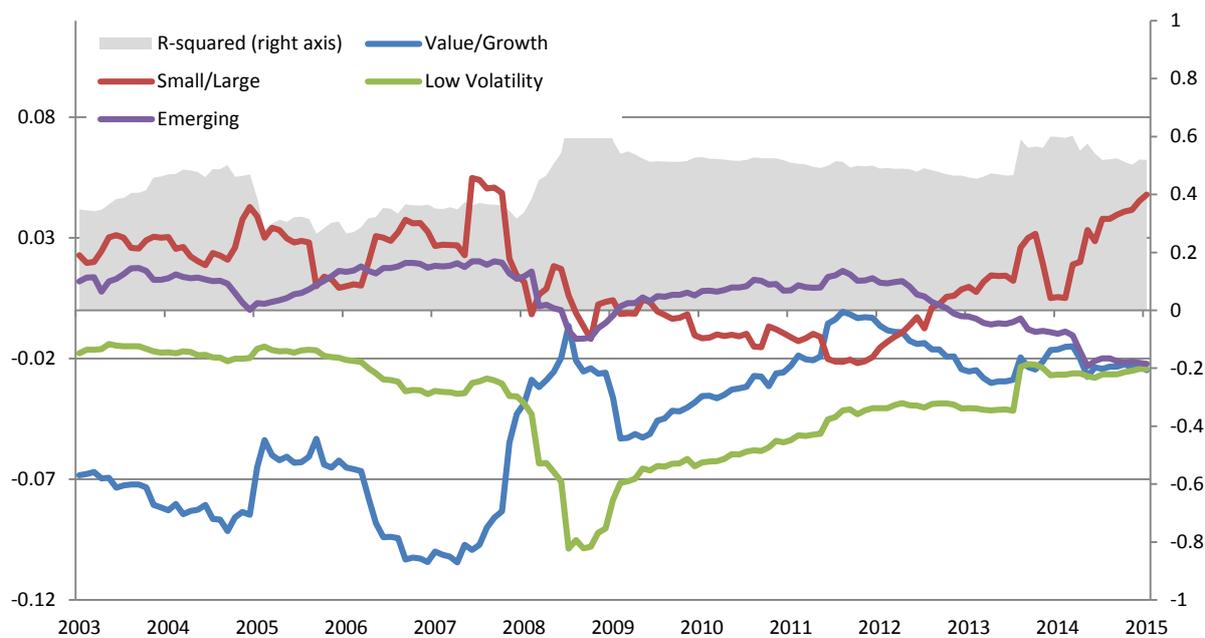
Figure 15 Five-year rolling betas vs variability explained (R²), fixed-income portfolio
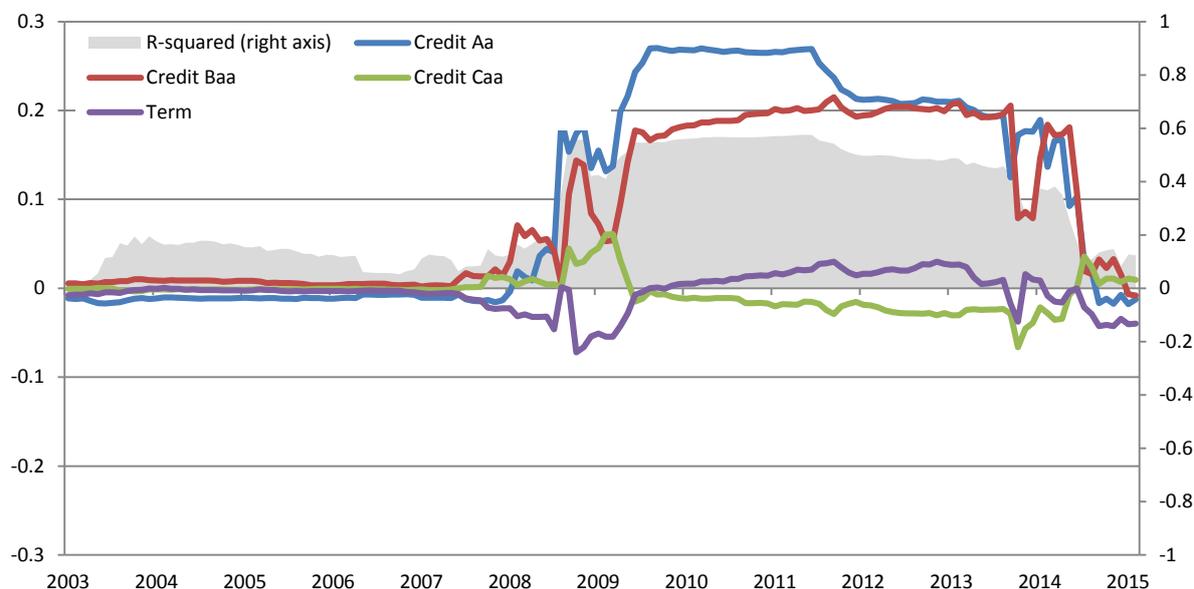
The same weaknesses described in the previous section on partial correlations also apply to this analysis based on linear regressions. This portfolio-return-based model implicitly assumes that the factor sensitivity measures are constant during the period of analysis. Moreover, they measure linear relations only, as is also the case in partial correlations modelling. 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[18] and GIPS[19]. 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. The broad MoF benchmark indices for equity and fixed income are used as the underlying indices.
- **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

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[18] Published on www.nbim.no.

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

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.

3.1 Net value creation from active management 1998-2014

Below is an indication of added value from active management of the GPFG for the years 1998-2014. With the adjustments detailed in the above analysis, estimated net value creation from active management for the period 1998-2014 has been in line with the calculated gross excess return. Also for the recent period 2010-2014 the value creation has been in line with gross excess return.

Figure 16 Estimated value creation 1998-2014. Figures in basis points, annualised
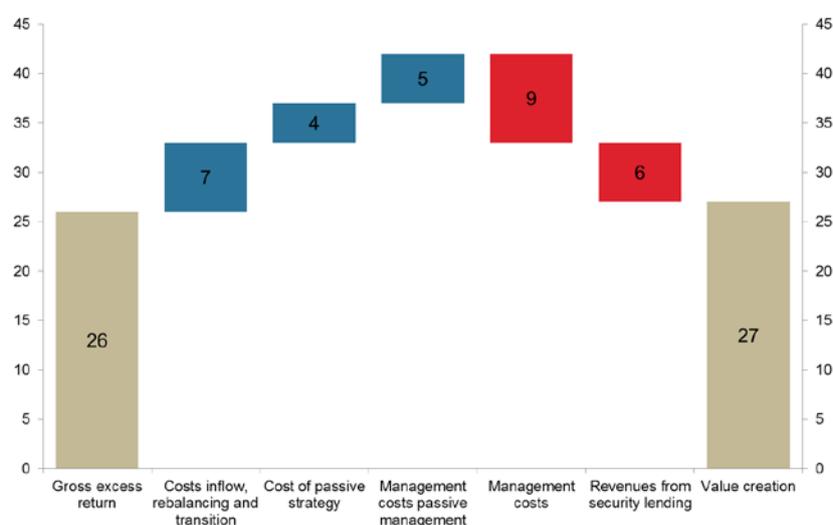
Figure 17 Estimated value creation last 5 years by end of 2014. Figures in basis points, annualised
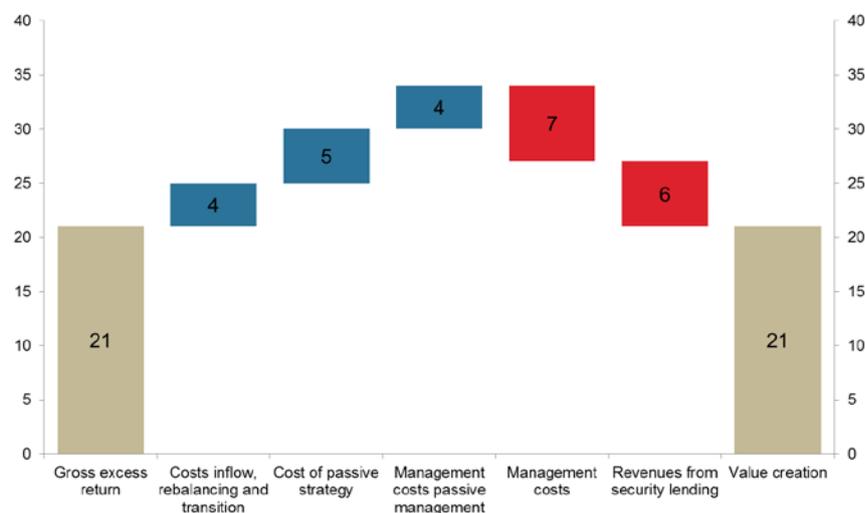
4 References

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