



Investing in fixed income

Norges Bank Investment Management





**Our mission is to
safeguard and build
financial wealth for
future generations**

Investing in fixed income

The 25-year history

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Fixed income for the long term

Our fixed-income management originated in the central bank's management of the foreign exchange reserves. Within five years of the first inflow into the fund in May 1996, however, the investment universe, strategy and organisation had been completely transformed.

From the first inflow to the end of 1997, the fund was managed in line with the long-term foreign exchange reserves and mainly invested in European government bonds. Active management of currency and interest rate risk was not considered appropriate for a central bank. This initially led to a preference for index management, and later on for investment strategies based on the relative value of similar securities rather than views on macroeconomic developments.

The period from 2007 to 2010 was challenging for our fixed-income management. We had aimed for independence of strategies and positions but experienced a high correlation of their returns. Most of the losses originated in the external management of mortgage-backed bonds. The lesson was simply that we needed internal expertise in the entire investment universe. Our crisis management also showed the extraordinary value of being patient as we waited for prices to normalise.

Our fixed-income management has encountered dramatic markets over the last two decades. It has been exciting and taxing, with extraordinary market events, dislocation of entire market segments, bursts of market volatility, and exceptional monetary policy. The stories of our Icelandic, Greek and Russian bond investments are well worth reading. They all muted our index orientation by demonstrating the importance of fundamental credit research, the fragility of

market rules in a crisis, and the recurring futility of fixed-income benchmark specifications. Rather than being scarred by these crises, we have learned to adapt, to be prepared for the unexpected, and to adjust our organisation and strategy continuously.

The fixed-income team have played a central role in our management of the fund. The approach has been to build deep specialist knowledge, to keep the portfolio structured and simple, and to exploit market dislocation and segmentation as they occur. We have built a team with outstanding skills who have shown resilience through adverse markets and managed our fixed-income assets with extraordinary professionalism in all aspects and functions. Over the last two decades, they have safeguarded our assets through efficient and diligent execution while also delivering an outsized excess return.

Oslo, 31 August 2021



Yngve Slyngstad
Chief Executive Officer
January 2008 – August 2020
Norges Bank Investment Management



Enhancing our fixed-income exposure

The role of fixed income in the fund is to reduce return fluctuations, meet liquidity needs and reap bond market risk premiums. These objectives stand despite today's low interest rate environment. Interest rates serve as building blocks for valuations of all financial assets, and expected return differences between asset classes do not necessarily change with interest rate levels.

I joined the fund in autumn 2002 as an assistant portfolio manager in the fixed-income enhanced indexing team. Within weeks, I was dealing with the stresses of sitting on the phone to our trading counterparties, borrowing and lending cash balances at the best possible rates, and I have had changing responsibilities and challenges as a portfolio manager at the fund ever since.

The size and composition of the fund's fixed-income investments are largely determined by the benchmark. Until 2009, fixed income was the largest asset class, and our average ownership in the bond markets reached 0.75 percentage point. Since then, the fixed-income portfolio has grown to almost 3 trillion kroner, while our percentage ownership has been stable.

We are lean and efficient when it comes to staffing, but still our size makes us capable of specialising. We have developed functional specialisation with portfolio managers, analysts and traders, and specialisation in different segments of the investment universe. Financial markets are competitive, and individuals need to know a lot about something rather than a little about everything.

The investment strategies we follow have capacity constraints and liquidity challenges when trading in the markets. Neglecting these limitations makes navigating periods of market de-risking

difficult. The overall positioning of the fixed-income portfolio going into the financial crisis made it a challenging period, and we have learned not to overreach when markets are functioning well and risk premiums are low.

We trade with patience and against the flow, not to move the market. The enhancement strategies give us a constant activity level, make strategic shifts less noticeable to other market participants, and ensure a highly skilled organisation across all functions.

The investment strategies we use to optimise risk/reward within fixed income have been successful in increasing the return on the fund. Since inception, the excess return has been close to 86 billion kroner, with more than half of this coming in the last five-year period. We strive continuously to improve and aim for a modest excess return over the benchmark without undermining the stabilising role the asset class plays for the fund.

Oslo, 31 August 2021


Asgeir Haugland
Global Head of Fixed income
Norges Bank Investment Management



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The history

Internal fixed-income management has played a central role in fulfilling Norges Bank's main responsibilities in managing the fund. The key tasks have been to phase capital from the government's petroleum revenue into ownership of fixed-income instruments, to manage the fund's fixed-income exposure cost-efficiently, and to generate an excess return compared to the fund's fixed-income benchmark.

Norges Bank's initial capacity to manage the fund's fixed-income exposure was based on the skills already in Norges Bank from managing the foreign exchange reserves. In the early 2000s, more active management was built up, inspired by the principles known as the Fundamental Law of Active Management. Early in the financial crisis, it became clear that the totality of the portfolio had undesirable attributes, and the period from 2007 to 2010 was the most dramatic and demanding period for fixed-income management in the history of the fund. It ended well, though, and the relative losses in 2007 and 2008 were more than recouped in the following years. Important lessons were learned, and the investment strategy changed towards more controlled top-down management, with a focus on simplicity, which helped the fund through the European sovereign debt crisis. In the most recent five-year period, the investment strategy and approach have become more tailored to the main sectors of the fixed-income portfolio, with increased delegation and autonomy for active risk taking.



Moving out of the reserves (1996–2000)

Our fixed-income management originated in the central bank's management of Norway's foreign exchange reserves. Following the establishment of a separate management organisation within Norges Bank for the fund in 1998, the investment strategy changed. Our index management developed over the next two years into a structure of delegated investment mandates and a specialisation of investment approaches.

After a series of interest rate hikes in 1994, the Federal Reserve kept its target rate between 4.75 and 6.5 percent in the five-year period from 1996 to 2001. Global long-term interest rates trended modestly downwards, culminating when the yield curve in the US inverted and the spread between two- and 30-year US Treasuries turned negative, reaching -0.75 percent in May 2000.

In Europe, the decline in government bond yields was supported by convergence in the run-up to the common currency. Yield curves flattened on the back of healthier fiscal balances and a reduced supply of government bonds. When the euro was introduced in non-physical form at midnight on 1 January 1999, the national currencies of participating countries ceased to exist independently, in that their exchange rates were locked at fixed rates against each other. The euro thus became the successor to the European Currency Unit (ECU). All bonds and other forms of government debt from countries in the euro area were denominated in euros from this date. The notes and coins for the old currencies continued to be used as legal tender until 1 January 2002 when the euro also assumed this role.

In 1997–1998, several Asian economies suffered a sharp contraction in growth and a fall in their currencies. The Asian financial crisis was followed by the devaluation of the rouble and Russia defaulting on its domestic debt in August 1998. Due to a combination of high leverage and exposure to the Asian and Russian financial crises, the hedge fund Long Term Capital Management (LTCM) collapsed in autumn 1998. Another financial crisis was avoided, as the fund was bailed out by several investment banks, organised and supervised by the New York Federal Reserve. LTCM was liquidated and dissolved in early 2000.

Both the introduction of the euro and the Year 2000 problem created operational challenges. In particular, the risk of computer systems crashing at the turn of the millennium required operational preparations and created uncertainty. Liquidity in the market was poor going into the event, and money market rates were significantly affected.

Restructuring the reserves (1993)

When the Government Petroleum Fund was established by law in 1990, Norges Bank already managed Norway's foreign exchange reserves. At the time, Norway adhered to an exchange rate regime that required relatively large funds. From 1991 to 1993, the Ministry of Finance increased its borrowing in foreign currency. The primary motivation was to increase the level of central bank reserves. The debt's currency distribution and maturity profile were optimised in terms of borrowing costs and risk. The proceeds from the loans boosted the central bank's reserves and led to a more structured approach to reserve management.

In autumn 1993, Norges Bank decided to split the reserves into three parts according to their purpose. First, around half of the capital was carved out to "immunise" – or match – the currency and interest rate risk exposure of the Norwegian government's foreign debt. This was done in close co-operation with the Ministry. The goal of this portfolio was to minimise the net borrowing costs. By the end of 1994, the immunisation portfolio fully matched the debt's currency and interest rate risk. The government established a separate krone account for its debt portfolio at Norges Bank. The cost of the debt and the income from the immunisation portfolio were both booked to that account, producing a negligible net result. This asset and liability co-ordination practically eliminated the bottom-line effect of foreign-currency debt and the corresponding reserves for both the government and Norges Bank. With the prospect of government surpluses in the future, the Ministry would not issue much new foreign-currency debt, and most of the debt was paid down by 1998. The immunisation portfolio would nevertheless survive until 2003 when the last investment matured.

The remaining net reserves were divided into a liquidity buffer and a long-term investment portfolio. The liquidity portfolio was supposed to handle flows from foreign exchange interventions and currency swaps used to influence liquidity in the Norwegian banking system. These funds were invested with a short time horizon, and the size was adjusted every month. The long-term investment portfolio had a longer duration and more focus on return enhancements.

From 1992 to 1994, the reserves doubled to around 140 billion kroner. An investment group within Norges Bank's Market Operations Department was responsible for the day-to-day management. The group consisted of seven to eight portfolio managers, and the management of the reserves was divided into currency blocks. The majority of the net reserves, 50 to 60 percent, were allocated to a Deutsche Mark block. Norges Bank's New York office managed a North American portfolio of US and Canadian dollars, which made up between 13 and 23 percent of the reserves. Pounds sterling, Japanese yen and Swedish kronor made up the rest of the portfolio, and these currencies also had dedicated portfolio managers.

Benchmark portfolios were established to anchor the long-term investment strategy for the net reserves and better measure portfolio management performance. At first, these benchmarks were constructed and maintained internally, using a representative basket of government bonds in each currency market. The bonds were spread across the yield curve with an average duration of around three years. In 1996, Norges Bank decided to use an external benchmark provided by the investment bank JP Morgan to make performance measurement more transparent.

Norges Bank had an investment committee chaired by the Deputy Governor with representatives from each policy department. Initially, the committee was actively involved in managing the reserves by setting duration targets and market allocations. Later, the committee took on a more advisory role and focused on the long-term strategy. The portfolio was kept close to the benchmark during this period. Active management, particularly of the currency exposure, was seen by many as not appropriate for a central bank. Most management activity consisted of selecting similar but higher-yielding substitutes for securities in the given benchmark. The investment universe was limited to government and government-guaranteed bonds for the longer-term investments, and bank deposits and repurchase agreements for the liquidity portfolio. The investment style was an enhanced indexing approach.

Preparing for a petroleum fund (1997)

The fund is an accounting tool and a fiscal instrument for managing the government's financial surpluses. If these surpluses were not allocated to the fund, sound economic policy would have resulted in an equivalent accumulation in Norges Bank's foreign exchange reserves. It thus made sense to base the investment design of the fund on that of the reserves, and later for the strategy for the long-term part of the reserves to mimic that of the fund.

The government made its first allocation to the fund of around 2 billion kroner in May 1996. Larger deposits were made at year-end, bringing its value to 46 billion kroner. At the time, it was assumed that allocations in 1997 and 1998 would be somewhat lower.

The initial regulation on the management of the fund in May 1996 put a lot of emphasis on liquidity considerations. 75 percent was allocated to European currencies, in line with Norway's import weights. The interest rate risk was limited by a maximum average duration of five years. Eligible instruments did not present much credit risk, as only government or government-guaranteed bonds, time deposits and repurchase agreements were permitted. However, the guidelines did allow some derivatives, such as bond futures and interest rate swaps. There was no mention of a reference portfolio or benchmark. However, the Ministry hired a consultant to develop a benchmark for the fund. In 1997, Norges Bank implemented relative volatility as a new tool for managing the overall risk between the portfolio and the benchmark for the foreign exchange reserves. Relative volatility partly complemented and replaced some of the static and partial risk limits in the guidelines. Norges Bank recommended this risk concept in its proposals for guidelines for the Government Petroleum Fund in August 1997.

In 1996, the Bank launched a search for external managers. ABN AMRO Asset Management was tasked with managing a portfolio equivalent to 150 million Deutsche Mark in European currencies. Goldman Sachs Asset Management was assigned the equivalent of 100 million US dollars for investment in North America. Apart from earning an excess return, the purpose was to transfer expertise to the Bank and compare it with internal management activities.

Up to the end of 1997, the Market Operations Department managed the fund in line with guidelines similar to those for its management of the foreign exchange reserves. This made the transfer of funds from the foreign exchange reserves to the Government Petroleum Fund relatively straightforward. In the first two years, transfers were made only twice a year. The primary transfer was made at the end of the year based on the government's preliminary accounts. A residual transfer was made at the end of May the following year when the fiscal numbers were finalised.

In the government's long-term programme for 1998–2001 presented in March 1997, the fund's accumulated capital was estimated at a little more than 300 billion kroner in the year 2000 and 400 billion kroner at the end of 2001. This was a doubling of the estimate in the revised national budget from 1996. The indications were that it would not be necessary to draw on the fund's capital until 2020. The fund's extended time horizon permitted a different emphasis on return and risk. In 1997, the Norwegian parliament decided on several strategic changes for the fund, the most important being a 40 percent allocation to equities. There was also a redistribution of the bond portfolio, with increased weight on investments in the US and Asia, and an extension of the number of countries in the benchmark index from 10 to 17.

The bond reference portfolio's average duration was increased in line with the longer investment horizon.

The strategic equity allocation was the most crucial part of Norges Bank's advice to the Ministry in its proposals for guidelines for the Government Petroleum Fund in its letter of 22 August 1997. However, many other aspects of the proposals, such as benchmarks and external managers, relative volatility as an overall risk measure, and choice of instruments, were to a large extent coloured by experience from the management of the foreign exchange reserves. The Governor at the time, Kjell Storvik, was well versed in the discussions around the management of reserves, as he headed the investment committee for several years as Deputy Governor.

In response to further growth in the foreign exchange reserves in 1996–1997 and the prospect of managing the Government Petroleum Fund, the Bank increased its staff and enhanced its expertise. By early 1997, the Bank already had 24 people working full-time on asset management-related activities.

In May 1997, Knut Kjær was hired to head up a project group that would prepare the Bank for implementing the Ministry's new investment strategy. Most importantly, this entailed new investments in equities, but it also included a significant change in the fixed-income strategy. The new fixed-income benchmark contained several new countries based on different market indices and had a longer duration. There was also a significant increase in the allocation to North America at European markets' expense. Key members of the fixed-income team in the Market Operations Department were included in the project group and worked full-time on the project during parts of 1997.

Establishing Norges Bank Investment Management (1998)

In January 1998, Norges Bank Investment Management was established, and the project group members were transferred to this new division of Norges Bank. Norges Bank's New York office, which managed the North American portfolio, also officially joined the new unit. Knut Kjær became the first CEO of the investment arm of the central bank.

In addition to the Government Petroleum Fund, Norges Bank Investment Management was tasked with managing the long-term part of the foreign exchange reserves not earmarked for short-term liquidity requirements, and the Government Petroleum Insurance Fund under a mandate from the Ministry of Petroleum and Energy. The fixed-income portfolios for the long-term portion of the reserves and the fund were managed under basically the same guidelines. However, the overall benchmark for the reserve portfolio had a slightly different regional split and included fewer countries. The reserves and the fund were invested through separate investment entities and accounts. Even though the portfolios' main risk characteristics within each currency market would be similar, the actual construction would differ somewhat, primarily due to legacy positions in the reserve portfolio.

The Government Petroleum Insurance Fund was a smaller portfolio whose purpose was to cover potential insurance claims related to the government's direct petroleum activities. Because the potential liabilities were uncertain and complex to model, this portfolio was managed more conservatively with fewer currencies, a higher emphasis on liquidity, and a shorter duration of around four years.

A petroleum buffer portfolio was set up to warehouse the new inflows before they were

transferred to the fund. The buffer portfolio was built up through Norges Bank's foreign exchange purchases and direct transfers from the government's petroleum activities. The accumulated inflows were then regularly transferred to the fund, typically at month-end. From the beginning, the petroleum buffer portfolio was managed by Norges Bank Investment Management to make sure that the currency composition was aligned with that of the fund.

Operational support and control functions remained with the Market Operations Department when Norges Bank Investment Management was established. During the first half of 1998, the portfolio changes within the fund and the foreign reserves required adjustments to the systems for managing positions, settling transactions and accounting. Since Norges Bank Investment Management still used systems and resources from the Market Operations Department, a joint project between them was established to make the necessary adjustments by the start of June 1998. The main outcome was to split the fund out from the rest of Norges Bank's fixed-income custody accounts into separate accounts. Citibank was the custodian for fixed income at that time, while JP Morgan was hired as the equity custodian.

Another joint project between the units handled the changeover when the euro was introduced on 1 January 1999. The operational resources and systems were handed over to Norges Bank Investment Management during the course of 1999, and the Market Operations Department acquired a new, separate system. The units that supplied operational services were also transferred to Norges Bank Investment Management, as it was then by far the largest user of these services. A total of 38 people were transferred. By the end of 1999, 79 people

worked at Norges Bank Investment Management. Only 25 of these had been recruited from outside Norges Bank, meaning that most employees had been transferred internally.

Up until the autumn of 1999, the Market Operations Department remained responsible for advising the Ministry on the fund's guidelines and strategy. The strategy function was then transferred to a new unit under the Governor's department, along with a special advisory committee to evaluate the management of the fund.

Transition and index management (1998)

The fixed-income team's main task during the first half of 1998 was to manage the portfolio's transition to the new benchmark while simultaneously funding new equity investments, partly by selling bonds and reallocating capital in line with the new fixed-income benchmark. This transition was the first of many such operations to come, driven by changes in the fund's investment strategy.

From the beginning, Norges Bank's objective was to maximise the return on the fund given the constraints in the mandate from the Ministry. Norges Bank's active fixed-income management efforts focused on selecting external managers. Several mandates were announced in the second half of 1998, and after thorough vetting, three managers were allocated capital in April 2000.

Internally, the level of active management was modest. The fixed-income investments consisted of bonds issued by the countries included in the fund's benchmark index or guaranteed by them. Government-guaranteed bonds exposed the fund to slightly more liquidity risk and a higher yield than the benchmark index. In principle, the

mandate permitted investment in other parts of the fixed-income universe, such as corporate bonds, but no such investments were made until 2001. The focus was on building competence before making significant deviations from the benchmark index.

There was still a modest positive excess return in all years from 1997 to 2000, illustrating that Norges Bank could invest inflows in line with the benchmark and consistently add a little value. The development of active management capabilities was seen as essential for sound fund management, as stated in the annual report for 1999: "An organisation that conducts active management will have a broader competence profile than organisations that only manage passively. We assume that such a careful but ambitious approach can contribute to more secure management in general."

When Norges Bank Investment Management was established, the organisation was split into three business units: Fixed Income, Equity, and Tactical Asset Allocation. The last of these was to take positions at an overall level across asset classes, countries and currencies. The first positions were implemented in 1999, with limited overall risk. In 2000, the Tactical Asset Allocation unit allocated capital to two external managers using the fund's fixed-income portfolio as a benchmark. However, these managers had a broader risk mandate than the managers selected by the Fixed Income unit. As the investment strategy developed, there was less focus on positions between asset classes and currencies. The resources allocated to the Tactical Asset Allocation unit were then moved to the Equity business unit. By the end of 2002, the allocation strategies had been discontinued completely.

Delegation and specialisation (2000)

In 2000, internal fixed-income management was more clearly separated into two main areas: enhanced indexing and active management. The activities within each area were further subdivided into different specialist functions.

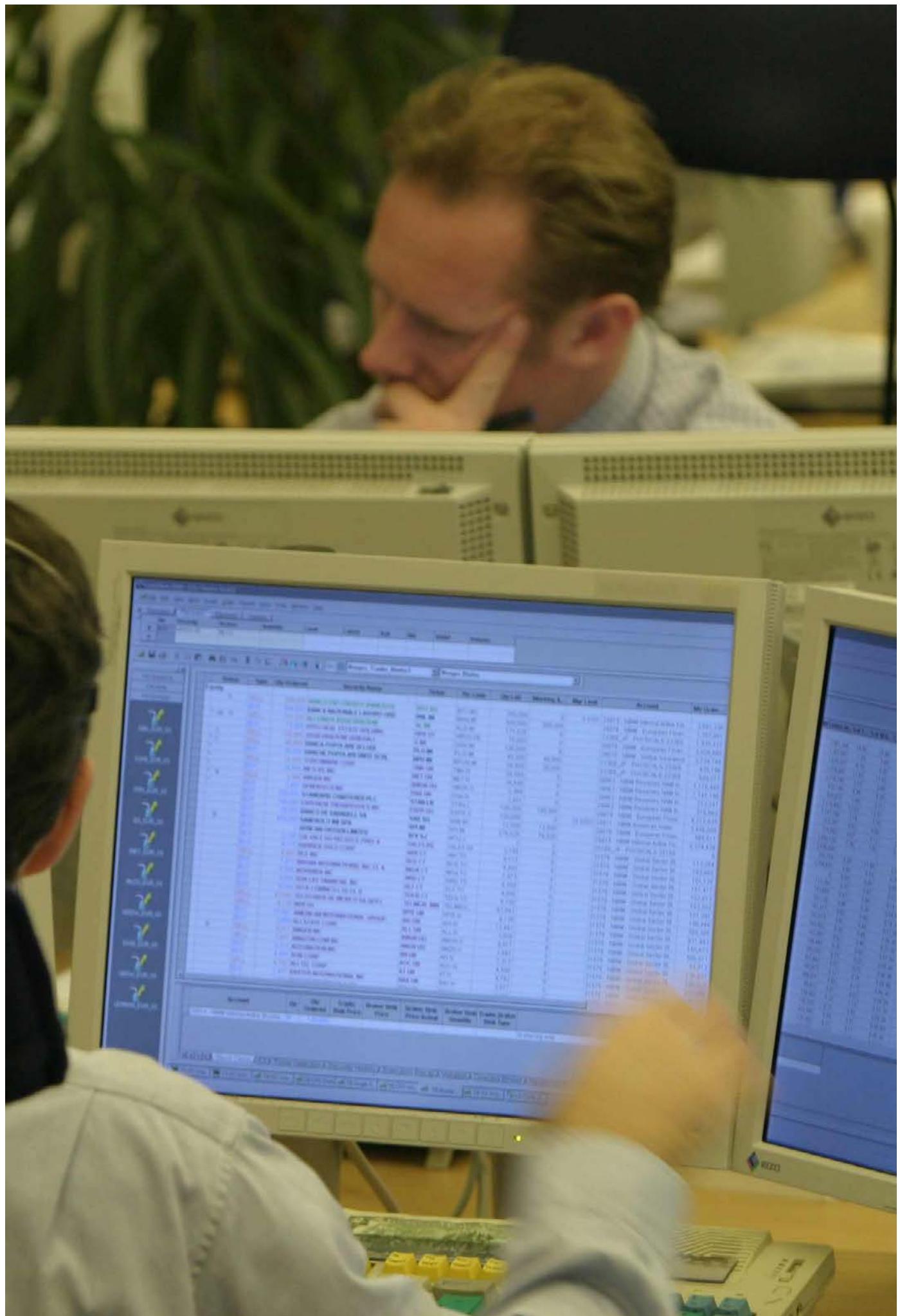
The objective of enhanced indexing, which went under the name of Beta internally, was to replicate the benchmark index exposure in a cost-efficient manner while taking advantage of special pricing situations to create a modest excess return. The area was responsible for phasing all new capital into fixed-income markets, and was also responsible for cash management for the fixed-income part of the fund.

Active management, known internally as Alpha, utilised relative value and macro strategies to create an excess return. The investment strategies were carried out in self-funded long/short portfolios where the portfolio manager had to generate cash by financing the long positions in the repo market. Where possible, the securities sold were borrowed from the enhanced index portfolios, but often the bonds had to be borrowed from other market participants, as they were not owned internally in sufficient size. Interest rate swaps were used to hedge out the interest rate sensitivity of relative value trades and exploit variations in the risk premium embedded in the swap spreads. Macro strategies that took positions on the yield curve or across markets also used derivatives, such as interest rate futures contracts, in their trading.

The idea of separating index management from active management, a trend in international asset management at the time, had several objectives. First, it would allow low-cost management of the index portfolios using

quantitative techniques, balancing relative risk against transaction costs. Second, it ensured focused active management, facilitating the development and utilisation of specialist expertise. Another advantage was the potential to reduce management fees for external managers, which were often linked to assets under management.

Relative value strategies produced an excess return of 200 million kroner in their first year. The average capital invested in fixed income was still below 200 billion kroner at the time, so this translated into an excess return of more than 0.1 percentage point for the overall fixed-income portfolio. The stage was set for confidence in the investment strategy that would dominate relative risk taking together with the enhanced indexing strategy in the years to come.



More active management (2001-2005)

The investment universe covered by the Ministry benchmark was expanded significantly in 2002. The investment philosophy was refined and new systems were put in place for more active management via individual and autonomous investment mandates.

The economic downturn that started in the year 2000 with the burst of the technology bubble was prolonged by the terrorist attack in the US in September 2001 and was still creating headwinds for the global economy in 2002. Global equity prices fell for a third consecutive year in the sharpest downturn since the early 1930s. Interest rates were in decline, making fixed income effective in reducing the overall volatility of the fund. In addition to monetary policymakers lowering their key rates on the back of muted inflation expectations, the drop in yields was explained by a flight to safe assets with a bearish equity market and major bankruptcies at companies such as WorldCom and Enron.

Norges Bank's New York office was evacuated during the attack on the World Trade Center on 11 September 2001. The two leading clearing banks in the US were located near the twin towers. The towers' collapse caused delays in the US settlement systems for a week or so and created some sharp but brief fluctuations in the market. While the office in New York was closed, the fixed-income team in Oslo provided an effective operational backup. The New York team was fully functional again within a month.

The global economy started to do better in 2003, which was a very strong year for equities with a return of 22.8 percent. This carried on into 2004, when the total value of the fund passed 1 trillion kroner for the first time. The strong equity performance continued in 2005. In fixed income, the Federal Reserve started a hiking cycle in the summer of 2004. By the end of 2005, the US monetary authority had delivered a total of 13 policy rate increases of 25 basis points each, raising the discount rate from 1 percent to 4.25 percent. The hiking cycle would end in the middle of 2006 at 5.25 percent. Globalisation and the impact that Asia in general and China in particular had on wage growth hindered a larger upward move in long-term interest rates, making the absolute return on the fixed-income portfolio positive throughout the five-year period, despite the tightening of monetary policy during the last 18 months in the US.

Adopting an investment philosophy (2001)

Norges Bank's early investment strategy and organisation were based on the Fundamental Law of Active Management. This theory's essence is that the expected information ratio can be maximised by spreading active management across many independent positions.

In the Fundamental Law of Active Management, Norges Bank found a sound basis for not allowing individual decisions to affect the overall management outcome. The strategy implied breadth by establishing many independent, active positions. The authority to make investment decisions was delegated down through the organisation to individuals. There was no overall investment stance nor top-down investment decisions taken by an investment committee. Individual portfolio managers were given the resources and opportunities to build up skill and specialist expertise, strengthening the information coefficient, or hit ratio.

In fixed-income management, the Fundamental Law of Active Management concept was adapted by allocating risk budgets to investment units with fundamentally different trading styles and investment philosophies. Within each unit, the risk was further delegated into individual risk mandates, and each portfolio manager tended to diversify their portfolio across many different positions. Correlations between the investment units and across portfolio managers and strategies were monitored regularly.

The survival of investment mandates was dependent on success. Darwinism was practised, and strategies that did not deliver according to expectations were discontinued. New approaches were tried. New specialist mandates were added, sometimes requiring restrictions in the instrument universe to be removed. For successful mandates, scaling obstacles were removed. This was seen as necessary in order not to lower the ambition of an excess return of 25 basis points. While enhanced indexing strategies may be expected to deliver additional excess return in monetary terms when the capital increases, there is no link between capital under management and a self-funded long/short mandate.

Expanding the fixed-income universe (2002)

Following a decision in the Norwegian parliament, substantial changes were made to the fund's fixed-income allocation in 2002. Investments in Asia and Oceania were reduced from 20 percent to 10 percent, while the European and American shares were increased by 5 percent each. The country weights within each region were changed from being based on GDP weights to market capitalisation weights. The greatest impact on the management of the portfolio came from the broadening of the universe to include bonds from issuers other than governments, such as international organisations, corporations and securitised bonds. To reflect this change in the investment strategy, the Salomon Smith Barney index, which included only government bonds, was replaced with the Lehman Global Aggregate index.

The idea behind including non-government bonds in the benchmark index was to make it more representative of the fund's investment universe, to increase the expected return from the fund's fixed-income investments, and to reflect signs that government debt other than in Japan would decline as a share of the overall fixed-income market in the years to come. The implementation of the change took the whole of 2002, and in the case of corporate bonds also the whole of 2003, as corporate bonds have considerably lower liquidity than government bonds. The phasing-in of non-government bonds resulted in total purchases amounting to about 219 billion kroner.

In 2001, fixed-income management had been expanded to include strategies that involved trading non-government bonds with a high credit rating, in preparation for the expansion of the fund's benchmark. In 2002, the organisation was adapted to the strategic allocation of fixed-income investments. Enhanced indexing was

concentrated in three sub-portfolios: one for government and government-related bonds, one for corporate bonds and one for securitised bonds. These sub-portfolios continued to be managed internally, with the exception of securitised bonds in the US, for which Norges Bank lacked internal expertise, experience and systems, as they typically contain optionality elements. The strategic exposure was therefore outsourced to external managers.

When the phasing-in of corporate bonds was completed at the end of 2003, credit investments evolved into the same structure as previously established for the government part of the portfolio. Enhanced index credit was to manage inflows, replicate the fund's benchmark index for credit investments, and enhance returns. Stratified sampling was used to select a subsection of the securities in the benchmark index, which consisted of 900 companies and 4,500 underlying bonds, many of which were difficult to trade. On aggregate, the aim was to have the same characteristics as the benchmark. The employment of a more flexible investment process than the benchmark, such as by avoiding forced buying or selling situations due to rating migrations, and participating in the new issue market, would take care of the return enhancement.



Phasing in corporate bonds (2002)

To account for taking credit risk, corporate bonds generally pay a higher rate of interest than government bonds. This extra yield is referred to as the credit premium. Over the long term, capturing the credit premium will result in better returns, unless credit events where investors do not get their expected cash flow exceed the extra yield obtained.

The Ministry selected the widely used Global Aggregate index as the benchmark for corporate bond investments. The benchmark uses market capitalisation weights. Markets in the Asian time zone were excluded due to limited liquidity and low credit spreads. To allow some flexibility in the event of credit rating downgrades, the fund was permitted to hold some bonds with a rating below investment grade.

When implementation started in 2002, the US corporate bond market was substantially larger and more developed than the corresponding markets in Europe and Asia, where banks were still the largest providers of debt financing to companies. Furthermore, the European market was still adapting after the introduction of the single currency, which was a substantial adjustment for bond issuers and investors. Although the index was constructed on the basis of regional weights that skewed allocation towards Europe, the corporate benchmark was heavily tilted towards US dollars. As a result, most corporate bonds purchased over the next few years were denominated in that currency.

Given the relative importance of the US market, a dedicated credit team was established in the fund's New York office. To facilitate corporate bond investments, the internal settlement team was expanded, and a new team was established to independently monitor the credit quality of

the portfolio and ensure that the holdings and the management complied with the mandate.

2002 was a turbulent year for the global economy, with both equity and credit markets heavily impacted by the Enron and WorldCom bankruptcies as well as the year 2000 dot-com correction. The fund started buying corporate bonds in this uncertain environment, and the performance of the portfolio was volatile during this period. Purchases were made either in the primary market, when companies issue bonds, or in the secondary market.

Most companies do not issue bonds every quarter or even every year, so the fund needed to actively consider the secondary market as a source for purchasing bonds. In addition to building up the size of the portfolio, this was needed to provide enough diversification in risk terms and to approximate a maturity profile consistent with the benchmark. So, while the primary market was an important source of corporate bond purchases, the fund was also very active in the secondary market in building a diversified portfolio. To source liquidity and mitigate the market impact of these large purchases, the fund engaged with the many market makers and had them provide exclusive, real-time transparency on their inventories electronically. By mid-2002, the daily number of updates from counterparties had reached 80,000, and offers totalled more than 11 billion US dollars. This inventive approach was key to populating the portfolio during the ramp-up phase from 2002 to the end of 2003.

The phasing-in of corporate bonds resulted in total purchases of about 164 billion kroner. This was more than estimated at the beginning of the transition, as the total size of the fixed-income part of the fund grew rapidly in 2003. The

phasing-in process did, of course, result in extraordinary transaction costs, as debt issued by private companies is less liquid. The extraordinary transaction costs for total purchases of non-government bonds were estimated at 900 million kroner, based on models rather than actual transaction costs. While hard to quantify, the efforts made are believed to have reduced the fund's implementation cost considerably compared to the model cost.

The fund's portfolio of corporate and covered bonds is currently worth around 775 billion kroner, or approximately 30 percent of the overall fixed-income portfolio. The currencies for corporate bonds are the same as in 2002, and the market capitalisation principle is intact. The regional weights have been discontinued, however, making the corporate bond portfolio even more skewed towards North America today than when the segment was originally introduced into the fund.

Developing system support (2003)

The investment strategy for active management with many independent, active positions and efforts to expand this activity were challenging from an operational point of view. In 2002, a new front-office system for fixed income called Denarius from Anvil Software was implemented. Norges Bank became the first customer for this system, which was selected due to the trade capture and position management features that could support trading activity. On the back of being able to tag each individual trade with the necessary attributes via functionality in Denarius, a project was launched in 2003 to develop a Performance, Risk and Attribution Management tool internally.

Before this system was in place, performance and risk were handled using spreadsheet solutions. The increase in active positions made this approach both time-consuming for portfolio managers and hard to quality-assure adequately. The goal was to develop a model that measured the mark-to-market value for each position including funding cost, use it for risk control at individual and group level, and attribute performance.

The Performance, Risk and Attribution Management tool calculated the value at risk of each trade based on the duration of the securities and the estimated volatility. The system assumed that individual trades were fully correlated, summing up the value at risk to get the aggregate risk. The assumptions for volatility were partly based on historical observations. There was also a fundamental aspect to it, however, and a penalty of higher risk for strategies with an asymmetric risk profile. For example, the estimated risk of being short highly rated government bonds was adjusted, especially for longer-term bonds. The positions were marked to market continuously via

connections to real-time data. If a portfolio manager lost half of their risk limit, there would be a risk review with the manager and agreed actions. When losses exceeded the risk limit, the positions would be liquidated or transferred to the group level.

Every transaction was logged in the Performance, Risk and Attribution Management system, where risk and performance were monitored along relevant dimensions, such as individual portfolio manager, investment group and investment strategy. The system was used for all active fixed-income management, and to some extent also enhanced indexing, to monitor specific positions. The existence of the tool was a prerequisite for expanding active management and having the necessary control over this activity.

Expanding the alpha satellites (2004)

Alongside building up enhanced indexing capacity for non-government bonds, the focus in this period was on setting up successful active management mandates. The relative value strategy to exploit systematic price differences between bonds with similar characteristics, and the rate macro strategy, where positions were taken on the basis of future interest rates, needed to be complemented with other strategies to ensure a broad range of active positions in line with the Fundamental Law of Active Management methodology.

One mandate that was established in 2001, and survived to become, in some ways, the main investment strategy in 2009, went under the name of active overlay. The purpose of the mandate was to take positions in extreme situations, either in the form of a defined expected skewed outcome space or a defined extreme profit expectation in relation to expected risk. The positions in the mandate did not have an explicit requirement for defining a horizon or a precise expression of risk in the position. This was because position generation in the portfolio was primarily to take place in periods of turbulence. The overall risk level would still be seen in relation to the total fixed-income portfolio to prevent the mandate from dominating overall relative performance. Such a mandate is not suitable for delegation, as it will by definition be characterised by great variability in risk level and a small number of positions. It was therefore managed by the CIO for fixed income.

With the inclusion of non-government bonds in the fund's benchmark, it became natural to exploit active management in the new sectors. The main initiative was to set up strategies in the corporate bond space. After the completion of the benchmark implementation, establishing

credit alpha mandates became a priority in 2004 and 2005. The main strategy was to capture returns through positions in individual companies – in other words, to generate a positive return by taking idiosyncratic risk. Detailed research and collaboration with the fund's equity portfolio managers were tools used in selecting positions. There was a clear ambition for portfolio managers to specialise, covering fewer sectors and issuers. Mandates were autonomous, and decisions were to be as independent as possible from each other. The credit alpha group, which consisted of up to five portfolio managers, had risk takers with different approaches and focus areas, aligned with the Fundamental Law of Active Management principles. Company-based long/short strategies were complemented with relative value and curve strategies in both corporate bonds and credit default swaps.

In 2005, the big story in investment-grade corporates concerned US car manufacturers. Both Ford and General Motors (GM) had deteriorating financial positions. This led to market speculation that the rating agencies would downgrade these companies to below investment grade. GM was subsequently downgraded, leading to its removal from the index and significant market volatility. Credit alpha had a difficult year, primarily due to its positioning in the US car manufacturers, and investment risk capacity was temporarily reduced.

In other areas, risk capacity and the number of portfolio managers increased. Due to their success, this took place primarily in the relative value strategies. Activity was expanded to covered bonds, and also to position taking in the volatility space in the run-up to the financial crisis. In more macro-oriented strategies, pure quantitative approaches were tried, and activity

was at times skewed more towards foreign exchange markets than rate markets. None of these last strategies were particularly successful, however, and they were subsequently discontinued.

At the end of 2005, the total number of portfolio managers managing alpha mandates was 17, including the CIO himself. The group that selected and had responsibility for external managers had four members, while the beta part of the fixed-income front-office organisation consisted of 11 people. The total number of fixed-income front-office personnel was thus 32. Entering 2006, there was an ambition to increase this number, but neither before nor since has the group of people directly involved in taking portfolio management decisions for the fixed-income part of the fund been that large.

The relative performance was very good throughout the five-year period, with a constant improvement in results measured in monetary terms. As the fund was growing, this was also necessary to reach the target of 25 basis points of excess return. For all the strategies combined, the measured relative risk in fixed income was low, implying a high information ratio. There was a strong view that the high level of specialisation and delegation mitigated risks through diversification. Confidence in the investment strategy and the organisation of the investment process based on the Fundamental Law of Active Management was undisputed, and the most pressing challenge from management's point of view was to increase profitable risk taking in line with the methodology. With the benefit of hindsight, this was a misjudgement. The expanding risk taking in the two years prior to the financial crisis meant that the fixed-income part of the fund faced some daunting challenges when the markets collapsed.

Adding on inflation-linked bonds (2005)

Inflation-linked bonds are securities that are indexed to prices, so that the principal and interest payments rise and fall with the rate of inflation. They are thus designed to help protect investors from inflation. Comparing the yields on these bonds with those on nominal bonds of the same maturities is also a way of observing the average inflation rate expected by the market.

The UK was the first major developed market to introduce inflation-linked bonds. Several other countries followed, including Australia, Canada and Sweden. In January 1997, the US began issuing Treasury Inflation-Protected Securities (TIPS), today the largest component of the global inflation-linked bond market.

Inflation-linked bonds were added to the Ministry's benchmark index in 2005. The reason for including the segment cited in the 2005 national budget was risk reduction. The decision was based on analysis by Norges Bank showing a decrease in expected return, but a more favourable trade-off between return and risk under reasonable conditions. The segment remains in the benchmark index today, despite a few episodes since where the product has not offered the same quality as nominal bonds in terms of reducing the overall volatility of the fund. During both the financial crisis in 2008 and the Covid-19 turbulence in 2020, inflation expectations in the market plummeted, mostly due to dysfunctional markets causing an increase in the liquidity premium for inflation-linked bonds compared to nominal bonds.

The phasing-in of inflation-linked bonds in 2005 was handled by the same enhanced indexing team that invested in government bonds. In line with earlier practice, allocation risk was to be minimal, and so these bonds were managed in a separate portfolio where the capital allocated

was the same as in the benchmark index. Instead of managing the sector globally across currencies, the initial approach was to give the responsibility to the same enhanced index portfolio manager or management team who managed nominal bonds from the same issuer in the same currency. After a different approach during the financial crisis and in the years afterwards, Norges Bank returned to this structure in 2013. Since then, inflation-linked bonds have been managed together with nominal government bonds, but with less stringent restrictions around overall allocation to this particular part of the fixed-income universe.



The financial crisis and its aftermath (2006-2010)

The financial crisis that peaked in late 2008 was a severe test of the resilience of the investment strategy. A housing finance crisis in the US spread into a global banking, funding, liquidity and credit crisis. The fund's fixed-income assets were challenged, with a disappointing relative performance in 2007 and 2008, but recovered strongly in the two following years.

Global economic growth remained high in 2006 and the first half of 2007, although there were signs that the expansion of the past three years was slowing. Equity prices continued to edge higher, while risk premiums in the fixed-income universe became less prominent. This reflected an assessment of being secure in the prevailing macroeconomic climate, with the low volatility leading investors to invest more in riskier, higher-yielding bonds. There was a modest increase in yields, especially in the euro area. Here, the economic expansion was the strongest since 2000, and the European Central Bank (ECB) followed up its policy rate hike in December 2005 with an additional seven hikes of 25 basis points each, raising its main refinancing rate from 2.25 percent to 4 percent.

The global financial crisis started in the second half of 2007. The turbulence was triggered by rising defaults on sub-prime mortgages in the US. Uncertainty about the scope and implications of losses led to a rapid increase in the credit spread between government bonds and bonds with credit risk. Liquidity dried up, not only in securities and instruments with direct exposure to the US securitised market, but generally.

The difficult market environment continued in 2008. Everything but government bonds traded only in low volumes. The Bear Sterns investment bank failure and subsequent sale to JP Morgan Chase supported by guarantees from the US government at the beginning of March marked a temporary low point in liquidity. Risk aversion continued into the summer, and the aftermath of the nationalisation of the US government-sponsored mortgage loan giants Fannie Mae and Freddie Mac was more selling of risky assets at lower prices. This was followed by the dramatic Lehman Brothers bankruptcy and the near-collapse of the giant insurer AIG, leading to a further breakdown in the markets, with even the most liquid ones at near standstill.

2009 started as the year before ended. In January, the Icelandic banking system collapsed, and in February, Ireland announced the nationalisation of some of its banking system. Then, in March, the market turned. Authorities worldwide at this stage had already responded with, or were about to respond with, large support packages to supply the market with liquidity and avoid the collapse of more large financial institutions. The US led the way on the fiscal side, with the new Obama administration signing a huge economic stimulus package in

February. On the monetary side, the scope for further cuts in policy rates was seen as exhausted, and some central banks turned to quantitative easing. The Bank of England announced such purchases early in March, and a few weeks later, the Federal Reserve unveiled plans to buy US government bonds and securities from government-sponsored mortgage enterprises to inject liquidity into capital markets and contribute to stability.

The turn in risk appetite among investors was not necessarily supported by a return to liquidity in the markets. Bid-ask spreads were still abnormally high, leading to substantial costs for investors and unusually high earnings for investment banks, both from their trading desks and from their syndication desks which were helping issuers to place new bonds in the market. Most non-government issuers of bonds had gone through a substantial period of not being able to access the capital market and had a pent-up need to raise term liquidity via bond issuance.

The market recovery continued in 2010. Central banks in the US, the UK, Japan and the euro area bought government debt and other bonds to lower interest rates, stimulate the economy and stabilise the markets. At the same time, uncertainty about government finances in some European countries caused substantial price fluctuations in fixed-income markets. Yields rose on government debt from countries such as Greece, Ireland, Spain, Portugal and Italy, driven by uncertainty about their ability to pay their debts. Yields climbed most in Greece and Ireland, with ten-year Greek government bond yields rising from 5.8 percent to about 12.5 percent at the end of the year, while Irish yields climbed to about 9 percent from 4.8 percent. Both countries concluded that they were unable to refinance themselves in capital markets and accepted EU and IMF support packages.

The emerging crisis

- the US mortgage market (2007)

There was strong growth in the issuance of mortgages to borrowers with low credit scores – sub-prime mortgages – in the US in 2005 and 2006. This increase can probably be explained by general changes in the US credit market which began a few years earlier. In mid-2004, the Federal Reserve began to raise interest rates in well-advertised increments of 25 basis points. This led to lower spreads between short-term and long-term interest rates. It was therefore less attractive for banks to issue ordinary mortgages. Traditionally, banks held a portfolio of mortgages funded through short-term borrowing, and banks' net revenue derived from an interest margin which reflected partly the spread between short- and long-term interest rates, and partly a credit/liquidity spread. Smaller differences between short- and long-term interest rates, and between government bonds and bonds with credit risk, reduced their revenue. Growth in the sub-prime market segment was one avenue to compensate for this.

The issuance of securities and associated structuring were also profitable for banks in themselves due to the commission income. In addition, banks took on exposure by investing directly in the highest-rated tranches of collateralised debt obligations (CDOs). This type of risk exposure can best be viewed as a way of issuing options. The options are "way out of the money" – there is little likelihood of them being exercised. Hence, the credit rating was typically at the highest level: AAA. The return on the options is positive, with a linear function of time, as long as the market remains within normal parameters. The issuer of the options will then derive income from the option premiums. However, if we move outside these parameters on the negative side, with higher defaults and

greater correlation, losses can increase exponentially. The return profile thus has a high probability of a relatively modest positive outcome, and a low probability of a very negative outcome.

This risk profile is important to bear in mind when attempting to understand how developments in house prices in the US, which started to fall from mid-2006, with increased losses on sub-prime mortgages, gradually created great uncertainty for the banking sector. In the first half of 2007, the high-quality segment where banks were large investors was unaffected. The losses were covered by bonds with lower priority. In July, this started to change. The value of the AAA segment began to be affected, and the price sensitivity of the options banks had written became clear.

In August, the spread between the unsecured rate at which major global banks lent to one another – the London Interbank Offered Rate (LIBOR) – and the federal funds rate widened quite sharply. This reflected an increased need for liquidity in the banking sector. The volume of outstanding asset-backed commercial paper (ABCP) had decreased substantially, as investors in the market for ABCP were uncertain about the value of the underlying collateral and pulled out of their investments. This removed a source of liquidity in the market for banks, forcing them to look for funding elsewhere to cover their liquidity needs. At the same time, they were reluctant to lend to one another, owing to uncertainty about the counterparty's exposure to the situation in the mortgage market. As a result, there was a "flight to quality", where virtually all high-risk assets fell in price relative to lower-risk assets, with high correlations between the various market segments.

The Federal Reserve reacted to the situation with rate cuts, but this could not prevent the underlying situation in the sub-prime segment of the housing market from continuing to deteriorate. It became difficult for borrowers to refinance, which meant that the expected negative value of aggregate defaults increased. UK bank Northern Rock became one of the first banks to get into trouble, due to its reliance on short-term funding. It received a liquidity support facility from the Bank of England in September. Later in the year, several other financial institutions had to announce substantial write-downs. It was clear that there was a capital crisis on top of a liquidity crisis. Paper and instruments with direct exposure to the sub-prime market were hit hardest, but liquidity also dried up in the other bond markets.

A housing finance crisis

- the external mandates

Fixed-income management underperformed significantly against its benchmark in 2007. Overall, the return on the fixed-income portfolio was 1.29 percentage points lower than the index used by the Ministry. A sizeable part of this was attributable to external specialist mandates for US securitised debt.

The Ministry benchmark had exposure only to the agency part of the US mortgage-backed security (MBS) segment of the fixed-income universe. A common strategy for the externally managed MBS mandates was also to invest in US securitised debt in the non-agency MBS category. These were mortgage bonds not guaranteed by the government-sponsored mortgage corporations Fannie Mae and Freddie Mac, mostly with the highest possible credit rating. Despite this, non-agency MBS as a group heavily underperformed the agency MBS market and contributed significantly to the fund's underperformance.

This came on top of some of the external managers using leverage in their management. The mandates awarded to external managers did not restrict their capacity to lever their investments, but were based on trust in their own risk management and reporting, including on-site reviews at least annually. For the worst-performing mandate, Norges Bank had to reluctantly agree to inject more capital, as the manager could no longer refinance the portfolio managed on behalf of Norges Bank. The alternative would be for the manager to liquidate the positions and then most likely end up with a negative cash position that the fund would have to cover.

One important conclusion Norges Bank drew from this was that the fund should not invest in

specific market segments without establishing an adequate internal organisation that can assess the risk taking by external managers based on deep market knowledge, and quickly step in if necessary. During 2007, there was an intense focus on getting internal fixed-income management ready to manage US securitised bonds. This included implementing a completely new portfolio management system, the Aladdin platform from BlackRock, to handle the specifics of the US MBS market.

In 2008, the process of terminating external mandates and bringing the assets into internal management started. A total of 13 external mandates were terminated during the year, taking the number of surviving external mandates down to nine at year-end. The process of reducing external fixed-income management would continue over the next couple of years until all fixed-income assets had been transferred into internal management.

A funding crisis

- the short-term bond funds

In 2000, State Street was appointed as a securities lending agent for fixed income. The agent had access to any bonds that were left unutilised in custody. These bonds could then be lent in overnight transactions against cash collateral. This cash collateral was invested via reverse repos and, to a lesser extent, unsecured deposits in banks on a term basis. The strategy was thus to earn a spread on maturity transformation in the money markets, a strategy that was, and is, quite common in the fixed-income industry.

In 2002, Dresdner Bank was chosen as a second agent lender. At the same time, the reinvestment universe for cash collateral was expanded. First, the reverse repo collateral sets were expanded to include lower-rated collateral that would earn higher spreads. The lower-rated collateral was compensated for by increasing the required haircut, meaning that the initial value of the asset received needed to be higher relative to the cash in the repo trade. Second, the unsecured investment universe was expanded from bank deposits to commercial paper, corporate bonds, asset-backed paper and structured investment vehicles (SIVs). Although some of these were riskier assets, the strategy included a structure which would include them all in a single AAA-rated fund. Both agents set up such funds, known as the short-term bond funds, to increase the yield received on the reinvestment of the cash collateral. With this, the strategy of maturity transformation was extended to also capture a credit spread in individual assets, within a diversified portfolio that received a AAA rating.

Internally, fixed income did not have the systems or capacity to rate and price all the underlying instruments. Credit quality was assured via a

requirement that the agents had to receive a top rating from at least one of the rating agencies, Moody's or Standard & Poor's. The agents paid for this service. The individual investments held in the short-term bond funds were thus exempted from rating requirements. For pricing, the short-term bond funds were not marked to market, as they were held off the fund's balance sheet with the assumption that all assets were held to maturity.

With two agents, it was possible to evaluate the performance of each of them relative to the other. They became benchmarks for each other. One of them had access to all bonds with final maturity in odd years, while the other had access to those maturing in even years. Apart from this, the mandates were identical. The agents were able to get a significant amount of assets out on loan, and through a combination of reinvestments in reverse repos and their respective short-term bond funds, they were able to achieve spreads consistently between 15 and 20 basis points, generating cumulative revenue of over 1 billion kroner up to and including 2006.

The beginning of the financial crisis in 2007 affected the liquidity and valuation of the assets the short-term bond funds were investing in. This was first seen as a buying opportunity, with both agents increasing the size of investments in the funds. By the autumn, markets had deteriorated, and it was clear that some of the assets were trading below par. It was then decided to value and mark-to-market all holdings in the short-term bond funds. Loss provisions began in September, and the write-down at year-end was more than 3 billion kroner compared to the purchase price.

From the start of 2008, assets in the short-term bond funds were frozen, allowing investments to

mature. As uncertainty about the value of securities related to the US market for MBSs continued to grow, many of the underlying assets dropped sharply in value. Further mark-to-market losses were taken, and the cumulative write-down of the short-term bond funds peaked at 8.7 billion kroner at the end of the year. In 2009, markets sharply improved, and more than two-thirds of the unrealised losses could be reversed. The recovery continued in 2010, and another 1 billion kroner was recognised as revenue.

The short-term bond funds were wound down over the period from 2008 to 2011, primarily through maturities. Some assets were sold, and there were a couple of defaults. In the end, the total loss on the assets in the funds was less than the gains accumulated over the years. The first agency mandate was terminated in 2010, and the second in 2011. Some remaining assets were then transferred into internal fixed-income management.

A liquidity crisis

- Japanese inflation-linked bonds

The lack of liquidity also hit the pricing of fixed-income assets in segments with no obvious connection to the situation in the US mortgage market. One victim of what happened on the other side of the Pacific Ocean was the market for Japanese inflation-linked bonds (ILBs). The market stopped functioning in autumn 2008, with pricing of inflation expectations reaching extreme deflationary levels.

Japan came quite late as an issuer to the ILB segment of the bond market. A ten-year ILB issuance programme was introduced in 2004. The structure chosen did not have a principal floor at par. This made it possible for an ILB bond to mature ten years after it was issued and pay out less than its face value. This lack of deflation protection would eventually prove to be detrimental for the product. The Ministry of Finance in Japan stopped issuing the bonds in late 2008 and bought back a large portion of the bonds issued until then, before relaunching the product in 2013. This time the issuer chose a structure with a deflation floor. As a minimum, the investor will then be returned the principal at maturity.

The perception among several portfolio managers in Norges Bank in 2006 and 2007 was that the market pricing of future inflation in Japan at around 0.5 percentage point annually was below the likely outcome. By purchasing real rate bonds, and selling nominal bonds of the same maturity, so-called breakeven positions were established. At the end of 2007, the accumulated holding of Japanese ILBs in the fund had a local-currency market value of 565 trillion yen, equivalent to 27.5 billion kroner.

The Japanese fixed-income market is predominantly held by domestic investors. ILBs were an exception in 2008. Many reasons were

cited for this. First, the dominant life and pension asset managers had no natural need to hedge inflation, as liabilities are not linked to it. Second, many asset managers did not have the operational capacity to handle indexed bonds. Third, the lack of a floor in the product was problematic from an accounting perspective. Fourth, and perhaps most important, the likelihood of inflation after many years without inflation was perceived as very low domestically.

The result was that an estimated 70–80 percent of the issued ILBs were held by foreigners. Many of these were probably levered. To finance a position, the investor then needed to raise yen using the ILB as collateral in a repo trade. This would not normally be a problem. However, autumn 2008 was not normal. After Lehman Brothers went under in September, liquidity providers in the yen repo market stopped accepting ILBs as collateral. For an investor relying on financing the position, there were then few options other than selling the investment. For Japanese ILBs, there was no-one willing to take the other side of that trade towards the end of 2008.

The result was a collapse in price. Bonds that were expected to fluctuate by a couple of percent lost around 25 percent of their value. Real yields, which move inversely with price, spiked to above 5 percentage points in December 2008. Nominal yields were also declining, further adding to losses in a breakeven trade construction. The market pricing of future inflation in Japan, according to the market for ILBs, was negative by more than 3.5 percentage points annually on average for the next ten years. This drop in inflation expectations in the ILB market did not imply that market participants expected that level of deflation in the future; it reflected a market imbalance. It was a dash for cash. No matter how cheap an asset is, if you

need to sell it to monetise your investment, you do that, and accept your loss.

The fund had no need to use its ILBs for financing and was not a forced seller. On the other hand, no portfolio manager had a delegated mandate to take advantage of the situation either. The nominal holdings of Japanese ILBs in the fund were hence mostly unchanged in 2008. With the decrease in prices, market value measured in local currency declined. Measured in kroner, the story was quite different. From July to December 2008, the exchange rate between yen and kroner shot up from around 4.75 to nearly 8. This inflated the value of the fund's Japanese ILBs to more than 40 billion kroner at the end of 2008. It also inflated the mark-to-market losses in the breakeven position to around 7 billion kroner for the full year.

Compared to the recovery in asset prices that took place in other parts of the fixed-income universe, Japanese ILBs lagged behind. Due to this, no changes to the position were made, and the fund had the same amount of yen-denominated real rate bonds at the end of 2009. Prices continued to recover in 2010, helped by continuous buybacks by the Japanese Ministry of Finance and the Bank of Japan as part of their quantitative easing programme. A milestone in price recovery for the product was reached just before year-end, when real yields declined to the levels seen in the first half of 2008 before the market breakdown. Recovery continued in 2011, and during the spring that year, breakeven levels again turned positive. One year later, in April 2012, breakeven levels reached 0.5 percentage point again, the level where most of the original position for the fund was initiated. For the remainder of the year, breakeven levels fluctuated between 0.5 and 0.8 percentage point.

A small part of our Japanese ILBs were sold in 2010. As prices continued to recover, larger sales of the product were made in 2011 and 2012. While internal changes make it challenging to track performance exactly, most, if not all, of the losses incurred in 2008 were recouped. At the end of 2012, the market value of our Japanese ILBs was down to 4.5 billion kroner, close to the benchmark index.

In the midst of the Covid-19 outbreak in March 2020, participants in the Japanese ILB market were served a reminder of the lack of structural demand. Liquidity vanished from the market, with buyers requiring significant price cuts to take yen ILBs onto their balance sheets. This resulted in breakeven levels moving into negative territory despite the new structure with a deflation floor in the product. Not only is there then a free option on inflation averaging above zero, but also a higher return from holding the ILB instead of the nominal bond in a deflationary scenario. This arbitrage opportunity, which can be explained with worse liquidity in the real rate bond, lasted for nearly a year until February 2021.

A credit crisis

- regulatory capital

The financial crisis was a reckoning for markets and societies that were laden with too much debt and risk. In the period leading up to the crisis, liquidity was plentiful, volatility was low, and as a result, leverage became a tool that was used in the pursuit of higher returns. Measures of risk such as the VIX and CDX indices were at cyclical lows. At the same time, rating agencies assigned high credit ratings to banks, financial companies and structured products. Within the corporate universe, banks and financial institutions with high ratings became preferable to the idiosyncratic risk that existed at the time within non-financial companies. Large leveraged buyouts (LBOs) were abundant in 2006, with deals such as Georgia-Pacific, Albertson's, Freescale Semiconductor and TXU. Investment-grade bond investors wanted to avoid holding bonds in a company bought out in this way, since that company's bond prices would typically decrease due to a more levered balance sheet. The financial institution sector provided an area that was mostly immune from that type of risk due to regulatory constraints and an existing business model built on leverage.

The fund's corporate bond positioning also grasped onto these themes and was overexposed to financials heading into the crisis. The overweight excluding covered bonds totalled around 60 billion kroner, was largely in European banks, and was built up primarily in 2006. Especially problematic was the exposure to banks' regulatory capital. A bank's capital essentially consists of tier 1 capital, which provides loss absorption on a going-concern basis, and tier 2 capital, which is gone-concern capital. In other words, tier 2 instruments must absorb losses before depositors and senior unsecured bonds, but are not loss-absorbing as long as the bank does not fail.

As banks are required to maintain specific minimum levels of capital, they are very active in the bond market, issuing both tier 1 and tier 2 bonds. In normal times, tier 1 bonds – which by regulation need to be structured as perpetual bonds – were redeemed by the issuer at first call date. As capital markets came to a halt, banks were no longer able to issue such debt on acceptable terms, and they stopped exercising their call options. This repriced the market for subordinated debt on top of the price correction stemming from the market turmoil and enormous uncertainty around bank losses in the financial crisis. Even bonds from the largest and most solid international banks tumbled, with the market value typically decreasing between 50 and 75 percent.

In addition to an overweight, some strategies attempted to capture arbitrage by pairing up bonds and credit default swaps (CDSs) of the same entity in a so-called CDS basis trade. The CDS basis is the difference between the spread over a government bond that an investor receives when owning a corporate bond, and the CDS of the same bond. As both reflect market perception of the credit risk, the spread is normally quite similar. Sometimes, however, they can differ substantially, due to market segmentation, and this can be taken advantage of by investors that have liquidity-provision capacity by entering CDS basis positions. While such strategies are not risk-free, as the basis can be volatile and the payout from CDS contracts in a credit event is decided via procedures that could deviate from the effect the credit event has on bonds, the risk-adjusted return for the fund from being active in such a strategy was seen as attractive. During the financial crisis, CDS basis positions were a source of large, but temporary, mark-to-market losses for the fund.

Covered bonds are a special type of debt issued by financial institutions. These bonds are linked to a specific pool of assets, normally high-quality residential mortgages, or loans to the public sector. The issuing bank is also responsible for this debt through its own capital. This market has a long history in several European countries, and the assessment by investors has been that it is a segment with very low credit risk, supported by no such bonds having ever been restructured. The fund built up large positions in this segment up until 2007. These investments were made largely on a levered basis, or as an alternative to holding government bonds. As in other segments of the fixed-income market, the liquidity of these securities decreased considerably in 2008 and caused significant, but temporary, mark-to-market losses.

Altogether, losses on investments in bonds related to the banking sector accounted for almost a third of the fixed-income portfolio's underperformance in 2008. In the following year, the authorities introduced a number of measures to improve funding options for banks, and their willingness and ability to support banks through recapitalisation eased some concerns about systemic collapse. Further support packages, such as the ECB's covered bond purchase programme, helped further. Price differentials between issuers still remained substantially larger than two years earlier, though, suggesting a different attentiveness among investors. The fund mostly kept its substantial investments in covered bonds, while other holdings in capital instruments issued by banks were reduced. The fund recovered more than 80 percent of the losses incurred from these positions during the financial crisis.

The collapse of an investment bank

- Lehman Brothers (2008)

Lehman Brothers was a prominent investment bank, and the collapse in September 2008 is often seen as the peak of the financial crisis. The market reaction was severe, both in terms of losses on risky assets and in the way market liquidity dried up. Norges Bank had trading relationships with several Lehman Brothers entities. The majority of the exposure, however, was with Lehman Brothers International Europe (LBIE). Exposure was spread across several products, both internally and through external managers.

When buying a corporate bond, an investor is in principle compensated for credit risk by getting a higher yield than on a comparable government bond. When entering into a trade with a bank counterparty, there is no compensation for the counterparty risk. Therefore, the goal is to minimise the risk of losses from the counterparty not fulfilling its trading obligations in a default situation. Due to this, all fixed-income transactions executed by Norges Bank are done on a delivery-versus-payment basis. This means that the fund does not risk paying for bonds it does not receive, or delivering bonds without receiving cash. However, if the counterparty defaults on its obligations to deliver what was agreed in a trade, the market exposure will still end up being different to what was intended.

LBIE had a high rating of A+ at the time of default, which meant that the Bank could trade with it across most transaction types. Within fixed income, the trading relationship included buying and selling of bonds, repurchase agreements (repos) and interest rate swaps. In addition to internal activity, external managers and the securities lending agents also had trading activity with LBIE.

All repo and derivatives transactions were covered by market-standard legal agreements which

regulated what actions Norges Bank could take in the event of counterparty default. The outstanding derivatives transactions were marked to market daily. When the value of the transactions was positive, Norges Bank required the counterparty to put up collateral in the form of cash or government securities. For the most part, these collateral agreements were asymmetric due to the status Norges Bank has as a central bank. This meant that the counterparty had to collateralise any mark-to-market exposure it had, while the opposite action was not required. In addition to this, a haircut provided additional protection in repo transactions, meaning that the trades with LBIE were over-collateralised. Repo transactions were also marked to market daily with margin requirements.

On Sunday, 14 September, a day before the default, a credit event task force with members from risk management, legal, trading and settlement was set up. This task force prepared the operational procedures that the anticipated default of Lehman Brothers would trigger. The plan was to serve notice of default to LBIE when the markets opened on Monday, effectively terminating the outstanding repo and derivatives transactions. The critical task was to get an overview of all these outstanding transactions and create a buy-and-sell list of securities and swap contracts to replace the terminated positions. This task was further complicated by the fact that our external managers traded under the same repo and swap agreements.

The internal trading desk had 45 outstanding repo transactions with LBIE, while the external managers had an additional 43 open trades. In a repo trade, the parties simultaneously agree on prices for the sale and repurchase of a security at two different dates in the future. Where Norges Bank had borrowed securities against cash, in a reverse repo transaction, the transaction's first leg

– the purchase – would typically be settled. However, the default notice would cancel the sale in the far leg. This meant that the Bank would suddenly own a security it had only borrowed. This position would then need to be sold in the market to eliminate this unintended market exposure.

The Bank declared a default under the Global Master Repurchase Agreement (GMRA) with LBIE as of 16 September. The trading desk's challenge was to replace the cancelled positions at a cost that would be lower than the initial prices adjusted for any mark-to-market changes. Any over-collateralisation would create a price buffer in our favour. When all replacement trades were completed, the Bank ended up with surplus cash for the internal positions, which exceeded the negative cash value of the external managers' transactions. As both internal and external trades were made under the same GMRA, this meant that the Bank owed LBIE or its administrator a net cash amount.

The bulk of the outstanding derivatives contracts were with external managers. While the Bank internally only had 15 open derivatives transactions, the external managers had 1,071. The Bank sent a default notice to LBIE under the International Swaps and Derivatives Association (ISDA) Master Agreement as of 15 September, and all open transactions were closed out. Most of the derivatives positions were interest rate swap contracts used as hedges. The bulk of these transactions were replaced in the market within a few days to maintain the same interest rate exposure. As with the repo trades, the Bank ended up owing LBIE a significant amount under the ISDA Master Agreement when the trading operation was completed.

As one would expect, it is easier to agree on paying an administrator than to get money back from a bankrupt estate. With the net result being

that Norges Bank owed LBIE a substantial amount of money, the fund was in a good position. Still, Norges Bank had to serve the necessary notices under the respective agreements detailing which transactions had been cancelled and the valuations of these. LBIE did not have its books and records in order, and largely depended on the Bank to identify the contracts and the balance. In the end, the administrators of the LBIE estate presented a claim that confirmed the amount the Bank had calculated.

Under the ISDA Master Agreement, the Bank was also able to set off claims we had against LBIE under any other agreement, such as certain failed equity trades and the cost of replacing LBIE as an over-the-counter derivatives administrator. Additional set-off claims were considered, to see if we could further reduce the final pay-out. With advice from outside legal counsel, the Bank concluded that the possibility of asserting additional claims would not have a good chance of success, and the agreed amount was paid to the LBIE administrator.

The Lehman Brothers default was a valuable experience for Norges Bank in dealing with counterparty risk, and was used to improve the counterparty risk guidelines. Different scenarios could have played out, but the main reason for the smooth outcome was the robust legal agreements and the collateral procedures that were in place. The asymmetric collateral agreements served us well at the time. A stricter regulatory regime has since required our trading counterparties to price in those arrangements' cost of capital, and it has not been possible for Norges Bank to maintain such asymmetric agreements. On the other hand, the introduction of central clearing of interest rate swaps and some other derivatives instruments has reduced counterparty risk and the impact the failure of a global, systemically important bank would have in the future.

Navigating the crisis

- reducing exposure (2008)

It was not only in the externally managed portfolio that results were poor. Losses on internal fixed-income mandates were also considerably larger than anticipated. The uncorrelated position taking underpinning the Fundamental Law of Active Management methodology was undermined. The relative value investment strategy suffered particularly. The increase in credit and liquidity premiums dominated underlying supply and demand structures in the various markets. Correlations between positions increased strongly, as they typically had exposure to one or both macro factors. Failing to foresee the magnitude of price divergence that would take place, many strategies scaled up investment risk as instruments started to deviate significantly from the expected equilibrium price. Individual portfolio managers were stopped out, but positions were transferred to the group level, and mostly retained.

Entering 2008, the task for fixed-income management was twofold. One was index management, and the other was to reduce the investment risk and complexity. The first quarter of 2008 was dominated by gaining control over what the external managers had purchased on behalf of Norges Bank and preparing for bringing the assets under internal management. Reducing the gross balance sheet remained a goal throughout 2008. The pace for winding down positions was a function of liquidity and price movements.

The setup with long/short strategies financed via the repo market was discontinued. It was replaced with assets being organised in silos that each represented part of the investment universe. There was one silo for government and government-related debt, one for corporate

debt, one for securitised debt and one for emerging market debt. The last one consisted primarily of sovereign debt issued by emerging market countries but denominated in developed market currencies. The clear separation of index management (beta) and active management (alpha) was thus abandoned. The new silos were responsible for all risk taking within their segment. The Performance, Risk and Attribution Management system was discontinued, and positions that used to be measured as a unit were dissolved when necessary to focus on the primary objectives.

Another major change was that a centralised trading desk was established for fixed income, inspired by the setup on the equity side. The fixed-income trading desk was staffed entirely with former portfolio managers, many of them quite experienced. Part of the responsibility for simplifying and exiting positions could then be given directly to this trading desk. To facilitate this, transition portfolios were created where fixed-income traders executed when liquidity was available without involvement of portfolio managers, making it possible to act in an agile manner.

While the market made it difficult, some measures were successfully implemented. Going into 2008, the net position in government bonds was a negative 61 billion kroner, primarily due to positioning in relative value strategies. During 2008, all short positions, with a very few exceptions, were bought back in the market. At the end of the year, the fund owned government bonds worth 435 billion kroner. As all the inflows into the fund, and also cash flows from coupons and redemptions, were being allocated to equity purchases, these adjustments had to be made without the assistance normally received from being able to invest new capital and reinvest cash flows in parts of the portfolio that reduce

relative investment risk. Within corporate bond investments, there was a move up the capital structure, and more of the holdings became insured via the credit default swap market. The number of external mandates was reduced, and a great number of derivatives contracts terminated.

The efforts made during 2008 could not prevent a highly unsuccessful year in terms of relative return. The fund had extensive legacy holdings of bonds that had no liquidity in the marketplace and where prices declined sharply due to fear and uncertainty. The fixed-income part of the fund underperformed the Ministry benchmark by 6.6 percentage points in 2008.

The asset class rebalancing – selling bonds (2009)

Debate about the fund's equity share was high on the agenda in 2006 and 2007. The Ministry of Finance eventually concluded that it should be increased from 40 percent to 60 percent. The decision was announced in the annual white paper on the fund and given parliamentary approval in late spring 2007.

The plan agreed between the Ministry and the Bank for implementing these changes was to use inflows into the fund to purchase equities and freeze the overall size of the fixed-income portfolio. The implementation period started in the second half of 2007. From the beginning of 2008, the tempo was increased by reallocating cash flows from coupons and redemptions in the fixed-income portfolio to purchases of equities. With this change, around 10 billion kroner was divested from fixed income every month.

With oil prices rising and peaking in summer 2008, this was a period of large inflows into the fund, with a record-high 384 billion kroner of fresh capital during the course of 2008.

However, the steep fall in equity prices made the rebalancing approach chosen insufficient to reach the goal. The share of fixed income had decreased only from 52.5 percent at the beginning of the year to 50.5 percent at its end. A bold decision was made for the first half of 2009: the fund should actively sell down fixed income to reach the reduced strategic weight of 40 percent, regardless of market conditions. In retrospect, this was probably the single best investment decision taken during the first 25 years of managing the fund.

The poor liquidity in the market made the disposal of bonds to rebalance the fund to the new strategic benchmark weight unusually expensive and challenging. However, when equity markets turned around towards the end of the first quarter, the selling volumes could be reduced, as the process received a tailwind from rising equity prices. On 30 June, the goal was reached. The new share of fixed income in the fund was 40 percent, and it would remain there until 2017 as far as the strategic benchmark is concerned. In practice, however, it would be lower than that, as investments in real estate, for which Norges Bank was then still preparing, have had the majority of their funding from fixed income since the first investment was made in London with the Regent Street transaction in January 2011.

Recovering from the crisis

- normalisation (2009)

Entering 2009, there were two priority tasks. One was still index management. The major challenge here was the aggressive rebalancing out of fixed income to reach the 60 percent equity share in illiquid market conditions with the unalterable target of achieving this by the end of the second quarter. The other priority was to monitor positions that were too large and/or too illiquid for an enhanced indexing approach. While the fund was prepared to hold these positions to maturity, progressive reductions depending on market movements to simplify the overall exposure and reduce risk were part of the ambition.

To focus on these tasks, assets were reorganised into two groups. One concentrated on replicating the benchmark index, and the other monitored legacy positions and advised senior management. For this, a framework was created where a likely path and a normalised price for the legacy assets were defined, and trigger points identified to guide the work done by the designated management team. With this reorganisation, a few remaining specialist self-funded long/short mandates that had been part of the silo structure the year before were discontinued.

Prices for the assets that had caused the relative losses in the preceding years recovered more strongly than anyone dared hope going into the year. This was the main reason for a record excess return of 7.36 percentage points for the fund's fixed-income portfolio in 2009. The largest gain came from the assets labelled large and illiquid that were managed internally, at close to 40 billion kroner. The parts of the portfolio that were more dynamically managed and handled the rebalancing process performed more modestly in comparison, but still did very well

with an excess return of close to 9 billion kroner. The quantitative easing purchases made by central banks as part of their monetary policy on a large scale in 2009 created an avenue both to sell assets and to take attractive positions in the market with very limited investment risk. For example, the portfolio of UK government bonds had an excess return over its benchmark of 125 basis points that year, primarily by following a comfortable strategy of selling temporarily expensive bonds that the Bank of England wanted in its monetary policy operations, and instead holding cheaper bonds also issued by the UK government.

How could it be that, despite the risk reduction initiatives in 2008, the fixed-income portfolio had a larger positive relative return in 2009 than its negative relative return the year before? First, generally only government bonds were sold in the first half of 2009 to accommodate purchases of equities for the rebalancing of the fund. The decision to sell government bonds instead of weighted amounts of all fixed-income securities was based both on a view that the risk premium in the non-government sectors was very attractive, and on concerns around transaction costs. Second, the significant stress in financial markets led to many securities being downgraded to sub-investment grade by the rating agencies in 2009. In turn, this meant that the downgraded securities were excluded from the Ministry benchmark. Management took the view that the underlying financial value of many of the downgraded and excluded bonds was higher than the prices that could be fetched in the market at the time of exclusion. On a name-by-name basis, many downgraded bonds were therefore retained in the portfolio.

The outcome of these approaches to the benchmark dynamic was a fixed-income portfolio that, on average, harvested more risk

premiums relative to its benchmark even though no new investments were made in distressed fixed-income securities. As these premiums declined rapidly during 2009, this contributed to the excess return. The so-called "fallen angel" bonds that migrated from investment grade to sub-investment grade did particularly well, and many of these bonds would later return to the Ministry benchmark when they regained their investment-grade rating.

A key lesson from the financial crisis was the high correlation of relative returns in certain market environments. This acknowledgement still influences the investment strategy followed by the fund for fixed-income investments, which also aims to do well in stressed environments when the hedging properties that fixed income has for the fund are vital.

Resetting the investment strategy (2010)

With the V-shaped recovery in prices for most legacy assets, there was no longer a need for specifically monitoring these. At the end of 2009, the two fixed-income groups were reintegrated. The combined management team was still small, though. While part of the reason was many former portfolio managers working on the trading desk, it was also caused by high turnover. A group of around a dozen portfolio managers managed the entire fixed-income part of the fund in 2010. Portfolio construction was to be simple with limited use of derivatives and no leverage. More emphasis was put on overall exposure, and the individual mandates had less freedom. There was an increased ambition around fundamental analysis of individual issuers, and building up skills in this area would be a priority in the years to come.

Greece lost its investment-grade rating from Standard & Poor's in April, and then from Moody's in June. In line with the index methodology, this

triggered the removal of Greece from the fund's benchmark at the end of June 2010. As the ECB was actively purchasing Greek government debt in its Securities Markets Programme (SMP) at the time, the fund was able to exit a significant part of its Greek holdings around the exclusion from the benchmark. However, some Greek government debt was kept. As the benchmark no longer had any holdings, this became a relative long position for the fund. In the portfolio construction, this was viewed together with holdings of government debt from other countries in southern Europe. The overall positioning was cautious, and with contagion from Greece to other countries, the total exposure to euro-denominated government bonds was a positive contributor to the relative return in 2010.

Overall, the return on the fund's fixed-income investments was 1.53 percentage points higher than the benchmark return in 2010. In addition to euro-denominated government debt, the excess return was particularly helped by investments in US mortgage securities and European corporate bonds. These were positions that were taken prior to the financial crisis and caused losses in 2007 and 2008.

The financial crisis had highlighted weaknesses in the fixed-income management of the fund. The four-year period from 2007 to 2010 was dramatic and demanding. It ended well, though, with the relative losses incurred in 2007 and 2008 recouped in 2009 and 2010. Important lessons were learned, and significant changes were made to the investment strategy. Norges Bank went to internal management only, long positions only, longer-term holdings only, and only issuers and instruments that it could fully analyse. The last of these changes implied accepting relative risk by not buying part of the universe that was in the Ministry benchmark.



The euro crisis and the recovery (2011–2015)

The fixed-income portfolio was simplified after the financial crisis, which helped its management as a new crisis arrived, this time in the euro area. The investment strategy was broadened to include more currencies, and there was a focus on fundamental analysis of bond issuers.

The sovereign debt crisis in the euro area entered a new phase in 2011. Despite an agreement in February to set up what was called a permanent bailout fund, the European Stability Mechanism (ESM), Portugal became the third euro country after Greece and Ireland to receive financial support from the EU and the IMF during the spring.

Calls to restructure Greek government debt to achieve some sharing of the burden between taxpayers and the private sector, until then a taboo, were growing, led by Germany. This caused considerable volatility in stock and bond markets in the autumn. In September, the IMF warned of serious consequences if European authorities failed to prevent contagion of the debt crisis, while the OECD voiced concerns in November about the euro's survival. In Greece and Italy, austerity measures to reduce debt following the crisis led elected politicians to be replaced by technocratic governments.

In February 2012, Greece received its second bailout from what was now known as the Troika: the IMF, the EU countries part of the euro area, and the ECB. The deal included a huge write-down for what were dubbed private Greek bondholders. By far the largest sovereign debt restructuring that has ever taken place was completed in March. On the back of this, contagion in the euro area bond market

increased. When summer arrived, both Italy and Spain were facing refinancing costs for selling new debt that put them on an unsustainable path. Spain, despite decent government finances to begin with, fell victim to choosing to help its banking sector. Bankia, Spain's fourth-largest bank, received a government bailout in May, with the country making a formal request in June for loans from euro area funds to shore up more of its banking sector.

With other policymakers unable to act fast enough in this evolving situation, then ECB president Mario Draghi made his famous "whatever it takes" speech at a conference in London in July 2012. He claimed the euro was irreversible and promised to do whatever was necessary to save it, within the ECB's mandate. The speech was followed up by the ECB at the subsequent governing council meetings, and in September the modalities for an open-ended programme to buy government bonds from euro-area countries under certain conditions were revealed. This new programme, Outright Monetary Transactions (OMT), replaced the Securities Markets Programme, and was the missing liquidity backstop for sovereign debt in the monetary union.

The OMT programme has never been used, but the mere existence of the programme eased concerns over possible sovereign defaults.

Ten-year Spanish government bond yields fell to 5.3 percent at the end of 2012 from a euro-era record of 7.6 percent prior to Draghi's speech. Similar-maturity Italian bond yields fell to 4.5 percent at the end of the year from 7.1 percent at the beginning of 2012. There would be more challenges ahead, but the peak of the crisis had been passed.

2013 was tumultuous for fixed-income markets and is remembered as the year of the "taper tantrum". Then Federal Reserve chief Ben Bernanke triggered this market volatility when he unveiled plans to wind down the Fed's quantitative easing programme during an appearance before the US Congress in May 2013. This led to a sharp surge in US Treasury yields as investors responded to the prospect of less support from the US monetary authorities. While equity markets experienced only a temporary decline, the impact was longer-lasting for emerging market debt. In retrospect, investors' appetite for this segment of the fixed-income universe had been inflated by expansive monetary policies in developed markets, and the taper tantrum exposed this, with the outcome being capital outflows from emerging markets.

In 2014, voters throughout Europe supported EU and Eurosceptic parties in unprecedented numbers in elections for the European Parliament. UKIP was topping polls in Britain, the National Front triumphed in France, and the coalition of the Radical Left (Syriza) won most support in Greece. While the Russian economy and financial markets were hit hardest by the sanction regime on the back of the conflict in Ukraine, it also compounded economic uncertainty in Europe. The ECB took its deposit rate into negative territory in June, the first time a major central bank had charged depositors for holding cash. Towards the end of the year, it became clear that further monetary easing was

necessary. Prior to the ECB announcing an 1,100 billion euro quantitative easing programme in late January 2015, the Swiss central bank sent shockwaves through the foreign exchange markets by abandoning its three-year-old floor against the euro, causing a nearly 30 percent appreciation of the Swiss franc.

At the same time, parliamentary elections were held in Greece, with Syriza leader Alexis Tsipras becoming prime minister. He promised to renegotiate the bailout terms to his austerity-weary electorate but found little support outside his own country. The situation reached its climax in early summer. On the back of Tsipras launching a national referendum on the bailout terms, the ECB refused to increase the flow of emergency liquidity assistance to Greek banks, leaving the country with little option other than to implement drastic capital controls. Greece defaulted on a repayment to the IMF, and the possibility of a "Grexit" from the euro area seemed increasingly likely, with the populace overwhelmingly voting against accepting the Troika's most recent bailout terms. At the last minute, the Greek authorities backtracked, however, and accepted a deal that left intact most of the demands made by Greece's creditors.

The portfolio simplification (2011)

The strategy plan for the fund for 2011–2013 stated: "The fixed-income area has been through considerable changes and will continue to simplify the instrument universe and benchmark composition. The transition to a simpler portfolio with fewer bond holdings will be carried out in an efficient manner. There is limited scope for a large number of uncorrelated investments in the fixed-income area, and we will focus on managing the risk from individual but correlated positions. Individual mandates will be supplemented with a decision structure for larger positions, and key risk aspects such as term, credit and liquidity will be managed for the combined portfolio."

During spring 2011, the few remaining strategic, distressed positions established in connection with the financial crisis were reintegrated with the rest of the portfolio. Later in the year, at the end of August, what remained of the reinvestments of proceeds from external securities lending, the short-term bond funds, was transitioned back into internal management. At the end of the year, only one external mandate was still live, with a manager assisting the fund with consolidating positions from other external managers during the financial crisis. These were all milestones in dealing with the legacy, and Norges Bank could now move on and focus on how best to manage the fund in the future.

The benchmark index chosen by the Ministry is from a leading index supplier and ensures transparency and verifiability. It is designed to serve as a yardstick for Norges Bank's implementation of the management mandate but has limitations when it comes to being tailored to the fund's specific characteristics. Norges Bank had a need for a tool that allowed a higher degree of customisation. This was

dubbed the operational reference portfolio. It was established in April 2011 and created a new starting point for fixed-income management.

The operational reference portfolio's objective was to address weaknesses and unnecessary complexity in the fund's benchmark index, better reflect the fund's investment universe, introduce an alternative to market capitalisation weighting, and adapt to structural changes and time-varying risk premiums. The number of securities in the reference portfolio was more than halved from about 11,000 to 5,000. While the largest reduction came from filtering away the smallest constituents of the Ministry benchmark, some entire sectors were also excluded, such as mortgage- and other asset-backed securities in the US.

Market indices typically weight securities on the basis of their market value. For fixed income, this principle means that borrowers issuing large volumes of bonds get a higher weight in the benchmark index. An alternative weighting method for public debt, used from the fund's inception until 2002, is to base each country's share on its economic output. In the operational reference portfolio, this weighting principle was chosen for the euro-area countries. The change from market capitalisation to GDP weights reduced investments in the euro-area countries with the highest government debt levels.

The expanded credit research capacity (2011)

Until 2010, corporate bonds had been managed without dedicated credit research analysts. Any fundamental analysis conducted was done by portfolio managers. In 2011, a credit research function started to be built up. The task was primarily to carry out fundamental bottom-up analysis of individual bonds and bond issuers. The research was to be independent from the portfolio managers to maintain objectivity. In addition to recruitment, development of a common research framework that could be used across different issuers and sectors to assess credit risk was a priority in the initial phase. Business models and capital structure were cornerstones of this work. For covered bonds, which were still a large overweight for the fund because the portfolio managers responsible viewed them as an attractive asset class, there was a focus on analysis of cover pools with applicable stress tests.

The output from credit research would serve as a stepping stone in helping portfolio managers to move away from benchmark replication. The investment strategy was to permit significant idiosyncratic risk at the individual bond, company and sector levels. While credit research often focuses on tail risk events to identify weaknesses that might eventually lead to a bond default, there was also an emphasis on identifying cases where the market risk premium was excessive in relation to the perceived credit risk. While this used to be mostly a relative consideration within a particular sector, the new approach allowed both over- and underweights of sectors or even the entire corporate bond market. A small team of portfolio managers carried out a holistic assessment of the pricing of risk premiums in the fixed-income universe and connected this with the fundamental analysis.

While the primary objective of the credit research initiative was fundamental analysis of issuers of corporate debt, debt issued by government and government-related entities was also covered. Particularly in Europe, sovereign debt sustainability and explicit and implicit guarantee mechanisms set up between governments and non-government issuers of bonds were analysed. At times, this required the involvement of legal resources, making the investment due diligence process more thorough. Norges Bank went from having trust and confidence in the opinions expressed by third parties, in particular the rating agencies, to insourcing this activity and forming its own opinion.

At the end of 2011, there were five people working on credit analysis. Ambitious plans were made for 2012. Fundamental analysis was to be carried out on the 150 largest bond issuers, including a dialogue with the top 50. Due diligence was to be performed for all syndicated initial offerings. Collateral was to be analysed for the 100 largest holdings backed by assets. To achieve all this, the number of analysts would be doubled. Four new hires were duly added to the team in 2012 and another the following year.

In 2013, the investment strategy evolved, and a separate credit team was re-established to manage the asset class separately, marking a move away from a consolidated fixed-income structure. Overall portfolio risk was still managed on a top-down basis, but with individual portfolios structured around specific industry and currency benchmarks so that the fund could benefit from specialisation. With this, active risk taking based on bottom-up company research increased. The independent structure for credit research was de-emphasised in favour of a more team-oriented workflow. Those working on analysing government and

government-related debt were integrated with the portfolio managers who focused on this part of the universe and were given portfolio management roles.

The strategy developed further in 2014 with the introduction of mandates at industry sector level replacing the previous segmentation by currency. As large multinational companies typically issue bonds across multiple currencies, the rationale was to align the mandate structure accordingly and to allow for more specialisation and the ability to take positions in an issuer across currencies. This new model gave clear responsibility for specific companies to individual portfolio managers and analysts. It was also a significant step towards aligning corporate bond portfolio management with the sector strategies team within equity management. With analysts and portfolio managers specialising in a comparable subset of companies, it was expected that internal knowledge would be leveraged, leading to better investment decisions across the fund. While a few of the credit analysts have transitioned into portfolio manager roles, the majority have been faithful to their original assignment, and the credit analyst role is still a cornerstone of corporate bond management.

The fixed-income benchmark reset (2012)

Ten years after the last overhaul of the benchmark index for fixed income with the introduction of non-government bonds, the Ministry of Finance decided on a major new change in 2012. The regional weightings of 60 percent Europe, 35 percent North America and 5 percent Asia and Oceania were discontinued in favour of a 70 percent weight for government debt with a GDP weighting principle, and a 30 percent weight for corporate debt. For the government part, the currency universe was expanded with the inclusion of all emerging market currencies that were part of the Global Aggregate index. The government-related sector was removed, except for bonds issued by multilateral institutions. For corporate debt, the market capitalisation principle was retained, as was the narrower universe of seven currencies. The securitised segment was removed apart from covered bonds, which were kept on as part of the corporate bond weight.

The changes to the fund's benchmark aimed to clarify the role of fixed-income investments in the overall portfolio. While the return is low, they improve the ratio between expected risk and return, as their market value does not fluctuate in line with the return on the equity portfolio. In addition, large volumes can be traded quite easily. The characteristics of the segments removed were less suited to accomplishing these objectives. At the same time, the Ministry highlighted its wish for fixed-income portfolio management to harvest risk premiums other than the term premium, such as credit and liquidity premiums. The main argument was that the long horizon for the fund's investments means that the fund should be well positioned to absorb fluctuations in market value stemming not only from equity risk premiums but also from those embedded in the fixed-income market.

The Ministry's reasoning for changing to a GDP weighting principle for government bonds was that the size of the nation's economy as measured by GDP may be a better measure of its ability to service its debt. However, the Ministry also stressed that flow indicators such as budget balance and current account balance are important in measuring a country's fiscal strength. Due to this, the Ministry added a requirement to Norges Bank's mandate that the management of government bonds must be designed to take account of differences in fiscal strength. This requirement, intended to highlight that one purpose of the fund's investments in government bonds is to reduce fluctuations in the fund's total return over time, has since led Norges Bank to systematically underweight bonds from more fiscally vulnerable countries in the euro area, using up part of the investment risk tolerance in the management mandate.

Government bonds from emerging markets were included because they were expected to improve the trade-off between risk and return in the long term. While short-term returns are often correlated with equity markets, more emphasis was put on spreading investments across more bond markets and so reducing the impact on the fund's returns of a crisis in an individual country or group of countries. It was also regarded as a natural further development of the fund's investment strategy, as the new currencies were already included in the fund's equity benchmark.

The entry into emerging markets (2012)

On the back of these changes to the Ministry benchmark, the year was dominated by transition activity within fixed income. The largest challenge for Norges Bank was to build up exposure in new currencies. From only 0.3 percent of the fixed-income portfolio going into the year, emerging market local-currency bonds were up at 10 percent at year-end. Norges Bank approved nine additional currencies from emerging markets for fixed-income investments in 2012, and there were investments in as many as 19 emerging market currencies at the end of the year. This was a broader subset of countries than in the Ministry benchmark, where many of the markets Norges Bank started to invest in were not included due to various shortcomings in relation to the inclusion criteria for the index.

Before allocating to emerging market debt, much practical work had to be done. Emerging market local-currency debt is a very heterogeneous market sector, where most countries pursue their own idiosyncratic market practices. Internal trading, portfolio management and transaction settlement systems had to be amended to accommodate emerging market debt with different tax regimes, day count conventions and settlement cycles. The legal department had to review tax legislation and bilateral tax treaties in a host of new countries, to make sure Norges Bank's potential tax liabilities would be consistent with prevailing rules and regulations. New counterparties to trade with had to be onboarded, as regulations in many countries stated that only locally incorporated counterparties were permitted. New custody agreements had to be signed, and investment quotas had to be acquired from some countries, such as China and India. In parallel, there was an ongoing endeavour to stay informed about the macro and political fundamentals of each

country, always in the context of the surrounding global economy.

During 2012, Norges Bank invested around 150 billion kroner in emerging market debt. To put this in perspective, the market capitalisation of the leading emerging market local-currency bond index, the Government Bond Index - Emerging markets (GBI-EM) from US investment bank JP Morgan, was around 5,300 billion kroner at the end of 2012. The fund was thus a sizable buyer in this space during that year, acquiring nearly 3 percent of the outstanding amount represented in the index.

Unlike some other investors, who on occasion might want to create self-fulfilling price dynamics by pushing through large transactions in a short period of time, Norges Bank's trading philosophy has always been to have as small a market impact as possible. The purchases therefore took place gradually with a focus on not pushing prices higher than they might have been without the fund being active in the market. Nevertheless, the year was strong for returns on emerging market debt, with the quantitative easing still taking place across the largest developed bond markets causing a decline in global bond yields. The result was that the more gradual implementation than for the Ministry benchmark led to a relative loss in fixed-income management. This was a main reason why fixed income underperformed the Ministry benchmark by 0.29 percentage point that year.

The restructuring of Greek bonds (2012)

Joining the euro area seemed to be the answer to many of Greece's challenges. Adopting the common currency of the EU would bring financial stability in the form of lower interest rate payments and the stability that the euro could offer. In addition, the strong institutions underpinning the currency were likely to benefit the Greek institutional setup. In the short run, it looked like the strategy had paid off. Greece saw high growth rates, and investment soared as government yields came down close to German levels.

The global financial crisis brought this rosy economic development to an abrupt halt and showed the real state of Greek government finances. In autumn 2009, the opposition socialist party Pasok was voted into government and, on taking office, adjusted the deficit forecast for the year from 3.7 percent to 12.5 percent of GDP. The final figure ended up above 15 percent. International rating agencies reacted by downgrading Greek bonds, and in June 2010, Moody's followed Standard & Poor's in assigning a sub-investment-grade rating to Greek government debt. This disqualified it from the Global Aggregate index used by the Ministry and most other major fixed-income indices, putting further pressure on Greek debt in financial markets.

Several measures were taken by the European authorities to calm financial markets and reduce the market pressure on Greece. First, bilateral loans from EU countries at affordable rates were granted. Second, the euro-area countries set up a new institution, the European Financial Stability Facility (EFSF), which would lend to the country. Third, the ECB set up the Securities Markets Programme (SMP), which purchased Greek debt to control the rise in yields. When responding to the complete removal of all Greek government debt from the Ministry benchmark, the SMP was helpful for the fund in exiting nearly half of its nominal bond holdings, which were

reduced from 1,400 million euros to 860 million euros during June 2010.

The restructuring of Greek government debt came on the back of worse-than-expected performance by the Greek economy and a gradual shift in approach from European policymakers. Growth had continued to underperform projections, with the primary balance failing to reach the original targets in the adjustment programme. This created an additional funding need that the euro-area countries refused to bridge without involvement from holders of Greek government debt.

An agreement formally reached between the Greek authorities and the Institute of International Finance (IIF), a global association of the financial industry, was announced in February 2012. It included a so-called voluntary Private Sector Involvement (PSI). By retroactively inserting collective action clauses (CACs) into Greek bonds governed by local law, and control over a qualified majority of bondholders via binding commitments from IIF members and domestic bondholders, the Troika knew they would manage to restructure the debt stock. Eventually, 85.8 percent of bondholders agreed to participate in the restructuring. Bonds were exchanged for a mix of new long-term Greek government bonds representing 31.5 percent of the face value of the outstanding Greek bonds, EFSF notes with a face value of 15 percent of outstanding Greek bonds, and a set of GDP-linked securities that would pay an additional coupon if Greek GDP exceeded projections. The CACs made sure that all bondholders had to abide by the vote of a qualified majority.

Some, however, had already escaped. The European authorities protected institutions such as the ECB, the European Investment Bank and

the national euro-area central banks from losses on their Greek debt. This was engineered by allowing them to exchange their bonds for other securities issued by Greece that were not subsequently part of the PSI. Hence, bonds that were supposedly of equal rank – so-called pari passu – received different treatment based on who held them.

The bonds in this exchange made up just over half of Greece's overall debt burden, and the required haircut was large. In nominal terms, bondholders took a haircut of 53.5 percent, while at net present value, losses were 70–75 percent relative to par. Credit default swap contracts on Greek sovereign debt ended up paying out 78.5 percent. In order to provide a certain level of debt relief for an issuer, unequal treatment will increase the loss for those that are discriminated against. Given our principled stance against unequal treatment of creditors and retroactive changes to contracts, Norges Bank decided to vote against the restructuring. Due to the CACs, all bonds governed by Greek law would still be restructured. The fund's nominal holdings prior to the PSI were 6 billion kroner, although their market value had already sharply diminished to 1.3 billion kroner. Following the PSI, the market value of the new Greek government bonds, GDP-linked securities and EFSF bills was 1.6 billion kroner.

Some of the Greek government debt was governed by foreign law. Here, the Greek government was not able to change the contract clauses retroactively, and bondholders choosing not to participate in the restructuring ended up being paid in full. The fund had two such holdings, which were both held to maturity: a dollar-denominated bond with a face value of 24 million US dollars, and a yen-denominated bond with a face value of 2 billion yen.

In December 2012, Greece received capital from its European partners to conduct a buyback operation for the debt that was issued in the PSI exchange. This was a purely voluntary exercise where investors could choose not to participate. The portfolio management team viewed the level of Greek debt to be too high to ensure long-term debt sustainability without further outside support. With the volatile political situation in Greece and the uncertain reaction from European partners, the assessment was that a further restructuring, with or without Greece exiting the euro area, was likely. The price offered in the debt buyback therefore appeared fair, and all the fund's euro-denominated Greek holdings were tendered.

In the period following 2012 and until 2017, the fund was not active in the Greek bond market, and so it did not see any mark-to-market losses as spreads spiked again in 2015 when Greece was on the brink of leaving the euro area. Since mid-2017, however, as the economic and political situation in Greece has looked increasingly stable, and debt servicing appears sustainable given the long maturities of outstanding debt, the fund has at times held small off-benchmark positions in Greek government bonds.

In absolute terms, holdings of Greek government bonds generated heavy losses in both 2010 and 2011 as yields increased, of an estimated 2 billion kroner in each year. In 2012, there was a positive return, because the market value of the holdings received in the PSI exchange was higher than that of the bonds that were cancelled.

As the fund's position in Greek debt was, and is, part of a holistic portfolio construction, it is hard to assess the relative performance impact. A generally cautious stance on euro-area

government debt helped the fund outperform the Ministry benchmark in both 2010 and 2011, including the losses on Greek debt. In a hypothetical alternative scenario where everything else was equal apart from the fund not holding any Greek debt, the result would have been even better, but it is likely this would have led to increased holdings in other vulnerable issuers of euro-denominated government debt which also suffered large mark-to-market losses during these years.

The positioning of the euro portfolio

Both in the build-up to the Greek debt restructuring and in its aftermath, there was widespread anxiety in financial markets around the survival of the euro. Some of the same sequence of events that played out on the back of turbulence in the US mortgage market in the run-up to the financial crisis was visible. The difference between the rate banks quoted each other for unsecured euro-denominated loans and the deposit rate at the ECB – the Euribor-OIS spread – increased considerably, with fear and uncertainty around losses in the banking system triggering large declines in European bank stocks.

It was a challenging but exciting period for managing euro-denominated fixed-income investments. Risk premiums reflected the uncertainty around the monetary union and the ultimately political decisions that had to be made. Investment risks were high, but so were the rewards of choosing to invest in debt instruments from the so-called peripheral euro-area economies rather than safer alternatives such as German government debt.

Portfolio construction was centred around a number of key themes. One was a cautious stance on government debt from the most stressed euro-area economies. This was balanced with a constructive view on the secured part of banks' capital structure, meaning covered bonds. Riskier parts of banks' capital structure were seen as unattractive, as the regulatory environment was expected to move towards bail-in of creditors, with greater protection for bank depositors at the expense of bondholders.

The result was an overall portfolio construction that had an underweight in government debt from countries such as Italy and Spain, and in unsecured and subordinated debt from financial institutions, and an overweight in covered bonds. Due to the main themes in the market being the survival of the euro and the link between sovereigns and their domestic banking sector, markets tended instead to evaluate credit risk and hence price bonds based on issuers' country of origin. While there was merit to such an approach in scenarios where the euro did not survive as the EU's common currency, Norges Bank took the view that there were nuances to this and positioned the fund accordingly.

An unpopular segment of the euro debt market was the Spanish version of covered bonds, called cédulas. These are bonds that were issued in large quantities by Spanish banks during the boom years in real estate prior to the financial crisis. Being secured against either a pool of mortgage assets or public-sector securities meant a higher recovery rate if the issuing bank failed. This was not always fully reflected in the price of cédulas, which tended to move in tandem with other Spanish bonds without this extra layer of protection for bondholders. This made it possible to construct a portfolio with near-neutral carry properties, but with lower expected losses in scenarios where policymakers chose a path other than further developing the EU's monetary union.

The defining role of the ECB

ECB struggled to clarify its role in the sovereign debt crisis under the leadership of Jean-Claude Trichet. While it intervened directly in the government bond market through the Securities Markets Programme, the inflation outlook in 2011 did not warrant monetary easing. Instead, the policy rate was raised by 25 basis points both in April and in July. On 1 November, Mario Draghi took over as president of the ECB. Two days later, the bank cut its policy rate by 25 basis points, and it did so again at the following meeting in December, reversing the hikes from earlier in the year. The central bank also offered unlimited three-year loans to banks if they had adequate collateral. A new, more active approach to combating the crisis by the euro-area monetary authority was being formed.

The turning point in market stress in the bond market came in autumn 2012 when the ECB laid out the modalities for its Outright Monetary Transactions programme. This replaced the Securities Markets Programme, which was limited in size and so not designed to be an effective liquidity backstop for government debt in the euro area. While the Outright Monetary Transactions programme can only purchase debt with no more than three years to final maturity, and is conditional on the member state asking for financial support and agreeing on certain economic measures, it is unlimited in size. This makes it effective in safeguarding an appropriate monetary policy transmission and the "singleness" of monetary policy. While being part of the euro area is ultimately a political decision, the design of the new programme protected the euro from the financial market sitting in the driver's seat and pricing the redenomination risk of euro-denominated assets to an extent that made it self-fulfilling.

Not all the challenges were resolved, however. The Cypriot economy had been under pressure since the financial crisis, with the financial industry having an inordinate weight of more than 700 percent of GDP. After the financial crisis, non-performing loans increased dramatically. Moreover, Cypriot banks suffered sizeable losses following the Greek debt restructuring. In February 2013, the two largest banks had prospective capital needs of nearly 8 billion euros. For the sovereign, this represented 44 percent of the economy, and the sustainability of its debt would be endangered if a bail-out with taxpayers' money was engineered.

With Cyprus not being able to find a solution with the EU and the IMF, the ECB was forced to act as the situation for the banking sector became critical. Under the threat of liquidity support for its banks being withdrawn, Cyprus agreed to a deal. Traditional ways of sharing the burden with private-sector bank creditors were limited, given that the funding structure of the banks was primarily based on attracting deposits by offering high rates. Therefore, Cyprus had to close the country's second-largest bank Laiki, with a bail-in of deposits exceeding the 100,000 euros guaranteed by the EU-wide guarantee scheme. It also put a 47.5 percent levy on large deposits in the island's largest bank, Bank of Cyprus. The ECB and the euro-area politicians had demonstrated that bank deposits can be bailed in when deemed appropriate.

The performance of the euro portfolio

Despite Cyprus, overall developments in the euro area were encouraging. The first country in the monetary union that had struggled under the weight of its banking sector, Ireland, was successfully able to return to the bond market and conclude its stability programme in 2013. It would soon be followed by Portugal, which completed the terms of its bail-out agreement in May 2014. Spread compression led by periphery government debt was the market trend.

While this was a welcome development for the fund with its large regional overweight in European investments on the equity side, in isolation it caused a relative loss for Norges Bank's fixed-income management. The fiscal sustainability adjustments in response to the requirement introduced into the Ministry's mandate in 2012 were made at the height of the stress in the euro-area bond market. Underweighting countries with a more challenging debt sustainability outlook caused an aggregated loss of 5 billion kroner in the period from 2012 to 2015. This mandate requirement has since been reconfirmed by the Ministry and is still applied. With further yield compression, it has continued to be a drag on performance, with another 3 billion kroner in underperformance from 2016 to 2020.

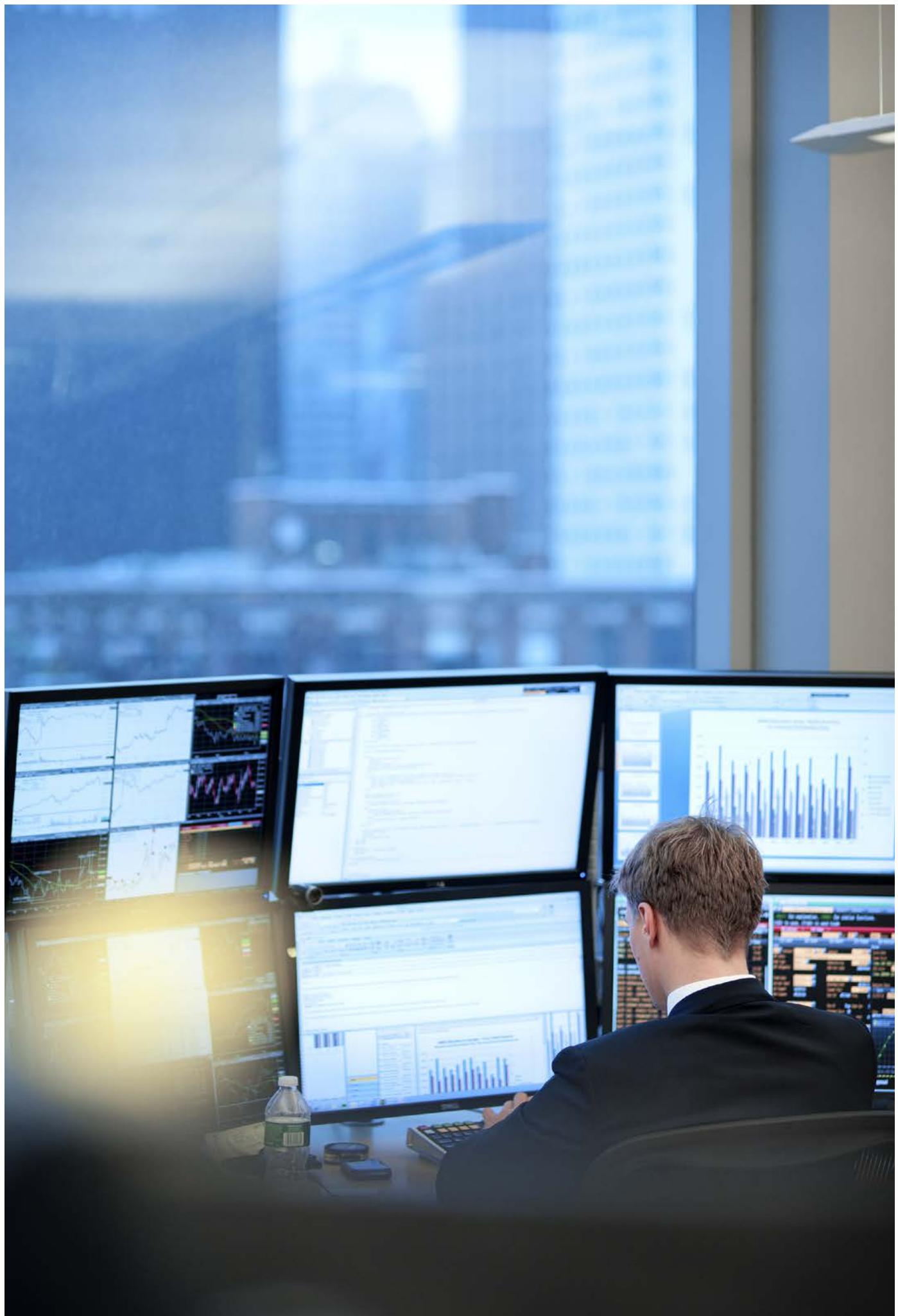
The adjustment works well as a position that reduces the overall absolute volatility of the fund, however, as country spreads in the euro area have been, and still are, correlated with performance in the equity market. In addition to reducing mark-to-market fluctuations, it can also be viewed as paying an insurance premium against a break-up of the euro area. This is a tail risk event which, if it ever happens, is likely to be a major shock for the financial markets, and even more so in an even more developed and integrated monetary union without any proper mechanism for an orderly exit.

Fund adjustments such as that for fiscal sustainability are not suited to delegation down to portfolio managers, because they are compulsory, and they are therefore taken at a fund level. While the team managing euro-denominated fixed-income exposure was cautious, losses on government bonds and the unsecured part of financial institutions' liability structure were offset by other positions when the spread compression started from the summer of 2012 and into 2013. Large gains on holdings of covered bonds and active management around relative value opportunities were two main contributors. The new issue premium – the discount an issuer has to offer investors when launching new bonds to attract

sufficient demand – increases with market turbulence. Opportunities in this area were plentiful during the period, also helped by many new issuers, such as the EU's own multilateral bond issuance vehicles in the form of the European Financial Stability Facility and, subsequently, the European Stability Mechanism.

After 2013, positioning in euro-denominated assets gradually became more constructive on the strength of these favourable developments. Prior to the ECB launching its large quantitative easing programme in January 2015, the management team took the view that yield compression within the part of the euro-area bond market that the ECB would target with its programme would be the main outcome for the euro-area fixed-income market. As this played out, results in this part of the fund would be strong in both 2015 and the years that followed. While the turbulence around Greece's near-exit from the euro area in summer 2015 was notable, this was treated mostly as an idiosyncratic event for Greece, with less severe contagion to other countries. While never actually used, the Outright Monetary Transactions programme probably prevented the financial markets from seeing Grexit as something that could break up the whole euro area.

All in all, the negative impact on returns from the fiscal sustainability position and the positive impact from the delegated management of euro-denominated assets cancelled each other out from 2011 to 2015. The consolidated approach to managing the portfolio in 2011 and 2012 makes measurement of performance by currency a questionable way to measure results, but nevertheless shows an accumulated return for euro-area fixed income of 2.6 billion kroner. From 2013, corporate bonds were segregated from other sectors, and non-corporate bonds were managed by currency. The relative return for this part of the universe in the three years from 2013 to 2015 was 2.5 billion kroner.



Monetary policy driving the markets (2016-2020)

Financial assets increased in value during this period, supported by central banks, culminating in unprecedented monetary policy actions to handle the pandemic crisis in the first half of 2020. Our management became more tailored to the different segments in fixed income, with investment teams and a regional presence in Asia. The benchmark was adjusted in 2019 and led to a reduction in our investments in emerging market debt.

2016 was a year with some notable political events and some significant market volatility. The year started with a downturn in financial markets, with uncertainty about developments in China. Commodity prices declined, and the disinflationary impact from this along with weakness in equity and corporate bond markets triggered further monetary stimulus. The ECB lowered its key interest rate further, and the size and scope of its asset purchase programme were increased. In Japan, the central bank lowered its policy rate into negative territory to counteract an appreciating yen. As winter passed, markets stabilised, reassured by accommodative monetary policy, better growth numbers in China, and communiqués from G20 meetings where members committed to refrain from competitive devaluations. The market was quickly able to shrug off the outcome of the UK referendum on EU membership, while the election of Donald Trump as the 45th US president had a more lasting impact on financial markets. The prospect of more expansionary fiscal policy and higher inflation created expectations of rate increases from the Federal Reserve. The first one came in December, and ten-year US Treasury yields ended the year more

than 1 percent higher than their intra-year low at the start of July.

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Supported by strong and stable markets, further rate hikes from the Federal Reserve followed in 2017. The Federal Open Market Committee raised its policy rate three times to 1.5 percent, which was in line with market expectations. It also began to reduce its balance sheet after a long period of quantitative easing, and it signalled further rate hikes in the coming years. Towards the end of the year, it was joined by other major central banks in some cautious monetary tightening. The Bank of England hiked its policy rate for the first time since the financial crisis, while the ECB scaled back the size of its quantitative easing programme.

The next year was more turbulent. The trade conflict between the US and China led to greater uncertainty about future economic growth, and it escalated towards the end of the year. In Europe, the UK's future relationship with the EU could not be settled, as the British parliament rejected the deal negotiated by Theresa May's government. Elsewhere in Europe, Italy was in focus. A surprise coalition was formed between

the two largest parties in the general election, and the new Italian government challenged the budget rules in the euro area. For the first time since the euro crisis, there was a significant increase in the risk premium for Italian government bonds.

Despite these political developments, monetary policy continued to be tightened carefully. In the US, the strong labour market allowed four rate hikes of 25 basis points each. The Bank of England raised its policy rate once, while the ECB ended its quantitative easing programme in December. Ten-year US Treasury yields reacted to the increase in the policy rate and climbed through to November. They then fell again amid market turmoil to levels little higher than at the beginning of the year, making a flatter US yield curve the main market development for the full year.

The decline in interest rates was to continue in 2019. Weighed down by uncertainty around world trade in particular, global growth was relatively weak. The Federal Reserve changed its plans to continue raising its policy rate in the first quarter of 2019. Ten-year US Treasury yields started to drop and went from 2.75 to 1.45 percent during the six-month period from March to August. In the second half of the year, the rate hikes from 2018 were reversed, and the Federal Reserve also cut short its balance sheet runoff programme. In Europe, which is more dependent on global trade, growth was hit harder. The ECB lowered its policy rate further into negative territory and reintroduced its quantitative easing programme, engineering another round of yield compression in the euro area.

The coronavirus pandemic plunged the global economy into a severe crisis in 2020. In the first part of the year, the pandemic and measures to contain the virus triggered a sharp decline in

economic activity. Over the summer, lower infection rates and a gradual relaxation of restrictions in many countries led to higher activity, but then infections surged again in most places, with the authorities in many countries introducing stringent new measures. The end of the year brought fresh optimism, fuelled by effective vaccines and the start of mass immunisation. Over the year, the repeated lockdowns nevertheless resulted in a dramatic downturn in the global economy.

Unprecedented policy support, from both fiscal and monetary authorities, helped stabilise financial markets and supported the real economy during the year. Risk premiums did a complete U-turn as the year progressed. In a rapid widening of credit spreads in the first quarter, the premium for investment-grade corporate bonds denominated in US dollars jumped from 1 percent to above 3.5 percent. By the end of 2020, this had reversed, and the premium was back down to around 1 percent.

Policy action was taken much more quickly and on a much greater scale than in previous economic crises. Central banks worldwide cut interest rates and made huge support purchases in financial markets, mainly of fixed-income securities. Central bank balance sheets in the US, the euro area, the UK and Japan grew by around 5 trillion dollars in just three months, whereas they took several years to expand that far after the financial crisis in 2008. Fiscal support was especially high in the US. In the EU, national fiscal stimulus packages were supplemented with a joint borrowing programme to support the economies hit hardest by the crisis, with a recovery fund of 750 billion euros. This was seen by many as a step towards closer economic integration in the union coming out of the crisis.

Specialised investment teams (2016)

The fund's fixed-income portfolio is broadly invested across geographies, currencies, sectors and types of issuers. Specialisation has always been regarded as key for achieving good investment results at Norges Bank. In addition to the functional specialisation into portfolio management, trading and credit analysis developed in the wake of the financial crisis, more segmental specialisation into specific parts of the investment universe has taken place in recent years. Competition in the investment world is fierce, and it is easy to overreach. For most investment strategies, it is much more important to know a lot about something than a little about everything.

Over time, a more team-oriented way of organising portfolio management has been introduced. The investment teams are headed by a lead portfolio manager with overall responsibility for portfolio positioning, supported by team members responsible for certain segments or investment strategies within the investment mandate. Additionally, one or more traders who execute orders in the relevant markets will be part of the team. The incentive structure is uniform and based on the portfolio performance achieved by the entire team, to encourage everyone to put forward investment ideas and challenge investment theses they do not agree with.

The investment team model was first implemented for the management of government, government-related and covered bonds denominated in euros. That was not by chance. The euro debt market is more fragmented than, for instance, the US dollar market, as the currency is used by 19 countries that all have their own history and their own specific ways of accessing capital markets. This tends to create relative value opportunities that

can be taken advantage of. The positive relative return from the fund's fixed-income management has to a large extent been driven by relative value investment strategies as opposed to more macro-oriented strategies. To put portfolio managers in the best position to take advantage of these opportunities, close collaboration with the trading desk is essential, and it was on the back of this understanding that the euro investment team was formed. Over the next couple of years, the same structure would be implemented for all regions and segments of fixed income except corporate bonds.

Portfolio management by committee, where decisions are done by voting, was forbidden in the early days of fixed-income management in Norges Bank and is still avoided. The lead portfolio manager is the ultimate decision maker and takes the final decision when there is disagreement. Team members with less responsibility must nevertheless be comfortable voicing their opinions and challenging views and market outlooks, to avoid groupthink. Making sure that investment ideas brought by less experienced portfolio managers are implemented and tracked is the most important part of encouraging and developing talent. A lot of emphasis is therefore put on decomposition of investment results.

While there are similarities with the self-funded relative value alpha satellite in the 2000s, there are also important differences. Portfolios are set up based on investment strategies instead of portfolio managers. Overall risk is managed with a team investment mandate that measures the aggregated exposure of all the portfolios in the mandate. There is no shorting of bonds that need to be covered via the market, just internal borrowing. There is little room for leverage, and use of derivatives is modest and restricted to exchange-traded or centrally cleared instruments only.

Expanding in New York and Singapore (2016)

The changes to the investment strategy for corporate bonds, with idiosyncratic risk-taking based on bottom-up company research, initially focused on large-cap companies in Europe. This was natural, as they were also emphasised by the internal equity security selection strategies where the deepest company knowledge in the Bank is situated. Working together with portfolio managers on the equity side, corporate debt managers could more easily make use of the fund's strong access to company management by participating in company meetings.

Companies are not used to facing both their equity and their fixed-income investors at the same time, with the message they convey potentially having a different impact on a shareholder focusing on the upside and a bondholder worried about the company servicing its debt. Having the fixed-income perspective present at the meetings was also a welcome synergy for equity portfolio managers.

Favourable experience led to the expansion of this approach to the full universe of corporate bonds in 2016. To accomplish this, a regional team was set up in Norges Bank's New York office. While there was specialisation according to function, close collaboration was aimed at between credit analysts, portfolio managers and traders. To capture more tactical opportunities, both in relative value and in new issuance, corporate bond traders were given increased autonomy. Activity level was confined by portfolio management via investment mandates, to ensure the aggregated positioning stayed as intended.

While the fixed-income trading desk had been present in Asia for many years, first via a resource at the Shanghai office and later by establishing a desk in Singapore, Asian and Oceanian fixed-income portfolio management

was based in non-Asian time zones. This led to opportunities not being captured and complicated co-operation between portfolio management and trade execution. In 2016, a portfolio management presence was established in Singapore, and a regional management team was formed. The original team of two people has since been expanded, with up to five fixed-income portfolio managers working out of the Asian time zone.

Changes to the Ministry benchmark (2019)

In view of the decision in 2017 to increase the fund's equity share to 70 percent, the Ministry initiated a review of the fixed-income investment framework and benchmark composition. This was completed with the white paper released in April 2019.

The main conclusion was that the increase in the equity share did not in itself necessitate any significant change in the risk level of the fixed-income benchmark, reaffirming the main goals for fixed income: reduce the volatility of total returns, meet the liquidity needs of the fund, and reap bond market risk premiums. However, the Ministry proposed, and gained parliamentary approval for, omitting bonds issued by governments and companies domiciled in emerging markets from its benchmark. In reaching this conclusion, the Ministry stressed the challenge of rating migrations and the subsequent turnover impact on an index with an investment-grade threshold.

While the Ministry stopped short of taking bonds issued by emerging markets out of the investment universe, a limit was introduced of 5 percent of the total fixed-income portfolio. Prior to the change, the fund had around 10 percent of its investments in such issuers, meaning that at least half of those investments had to be sold

during a transition period agreed between the Ministry and Norges Bank.

Getting out of market exposure in fixed income tends to be more challenging for the trading desk than getting into the same exposure. When building up a portfolio, there will be multiple opportunities to purchase bonds when they are first issued in the primary market. This avenue of execution is not available when reversing an investment. While there is some assistance from coupons being paid and bonds being redeemed at maturity, this is limited by the long duration of the index. On top of coupon payments having declined with the low level of interest rates, many issuers have prolonged their funding mix by issuing a higher share of long-dated maturities. The Ministry benchmark automatically adjusts for this, effectively letting the choice of bond issuers decide the duration of the fixed-income benchmark. A further increase in duration comes from all bonds with less than a year to final maturity being excluded from the index.

Since 2017, portfolio managers working on emerging market debt had been collaborating closely with equity colleagues focusing on emerging markets, based on the same ideas driving the changes to corporate bond management. It was expected that internal knowledge could be leveraged and would lead to better investment decisions across the fund. With the new benchmark from the Ministry and the quota for debt from issuers in emerging markets, there began a phase dominated by transition. Co-operation with the trading desk to steer the fund through the change became a priority, and the organisation was adapted to this, with a structure similar to the regional government investment teams in developed markets.

The 5 percent cap and the expanded reporting requirement for bonds from emerging market

issuers led to adjustments to the investment strategy. Risk premiums for bonds issued by emerging market issuers in foreign currency, known as hard-currency debt, used to be assessed against other investment opportunities within the mandate responsible for the currency in question. With a limit for issuers from markets classified as emerging regardless of currency denomination, priority was given to assessing local-currency bonds versus hard-currency bonds. Since the end of 2020, non-corporate hard-currency debt has hence been managed by the team that used to be responsible for local-currency emerging market debt only. When the limit is used for local-currency investments, currency risk is actively managed, implying that it will often be hedged using the foreign-exchange forward market. The active position then becomes an interest rate position instead of a combined currency-and-interest-rate position. With such an approach, the tracking error versus the Ministry benchmark is heavily reduced, as currency risk tends to be the more volatile component when investing in local-currency emerging market debt.

Benchmark turnover (2020)

The fixed-income market began to discount the expected economic consequences of the coronavirus pandemic in late February and early March 2020, pricing in monetary easing and higher risk premiums as investors moved out of risky assets and into safer assets. There followed a few weeks of dysfunctional markets. Even US Treasuries, the bedrock of the global financial system, became illiquid and difficult to trade. All asset prices were plummeting at the same time. Supported by action from central banks, fixed-income markets quickly found their footing again, though, with core rates adjusting to the monetary policy stance, and US ten-year yields stabilising well below 1 percent.

The year became one of the busiest for turnover in the fixed-income portfolio in the history of the fund. Several factors contributed to this. Withdrawals from the fund were used to finance the Norwegian government's fiscal response to Covid-19. The process of selling assets to raise cash adds to turnover. The fund is used to frequently being funded or defunded by the Ministry, but the outflows in 2020 were significantly larger than ever before. Turnover was also impacted by the market reaction to the pandemic. The sharp slide in equity prices reduced the equity share of the fund's benchmark to below the threshold for an asset class rebalancing at the end of March. This also led the fund to sell fixed-income assets.

Normally, these would be the dominant drivers of turnover. In 2020, however, they explained less than half. Changes within the fixed-income benchmark were the largest driver. A cocktail of aggressive central bank interventions, accelerating bond issuance activity and an inconsistent benchmark methodology revealed shortcomings in the Ministry benchmark framework which led to unnecessary changes in

the government bond benchmark and subsequently high transaction volumes in the portfolio.

Since 2012, the government bond part of the benchmark has been based on the size of a country's GDP. The GDP weights are updated once a year by the index provider. In the period between the annual reset of GDP weights, country weights are allowed to drift, as there would be substantial transaction costs if the benchmark was continuously rebalanced back to GDP weights.

While market changes, such as moves in exchange rates, are reflected in both the benchmark and the portfolio, the market value of the benchmark also changes with underlying bond composition. Here the portfolio must trade in the market to follow the benchmark. Normally, volumes are small. However, in 2020 it became large due to the methodology applied by the benchmark provider to central bank purchases. The market value of the benchmark is adjusted down by the Federal Reserve's purchases, while bonds bought by other central banks are not reflected in the benchmark. In March and April 2020, the Federal Reserve bought more than a trillion dollars' worth of US Treasuries, reducing the benchmark's market value by more than 10 percent. Consequently, the US part of the fixed-income portfolio was heavily defunded in spring 2020 and re-invested in other markets. This was reversed towards the end of the year when the annual GDP reset arrived. The fund then carried out its largest fixed-income rebalancing in its history, with more than 100 billion kroner traded in the foreign exchange market.

Norges Bank proposed some adjustments to the mandate to reduce transactions related to benchmark movements. The changes were approved with effect from December 2020, with

the country weights in the government bond benchmark drifting with the benchmark return in each market. With the link to changes in the benchmark universe removed, turnover in the benchmark will decrease, enabling more cost-effective management.

Opportunities in volatile markets (2020)

In 2019, yield spreads between corporate issuers and government issuers narrowed towards historically low levels. Credit risk was viewed as unattractive by the portfolio management team, which went underweight credit risk. When the turbulence hit the market in late February 2020, the credit premium exploded, with US investment-grade corporates going from yielding 1 percent more than US Treasuries to as much as 3.7 percent more a month later. The underweight in credit risk was largely traded out of during March 2020, locking in an excess performance of more than 10 billion kroner in the first quarter of 2020.

Management of non-corporate bonds was also very successful in 2020. Market dislocations were plentiful, providing great potential for investors oriented towards relative value opportunities. Governments had to increase their issuance of bonds to support the economy via fiscal policy, and offering issuers liquidity by purchasing new bonds in syndication processes was an attractive investment strategy, especially in the euro area.

In the US, the market for municipal bonds was going through a rough patch, as it was sold from the retail investor base that dominates the market. Acting countercyclically, the fund invested a significant amount of capital in this off-benchmark part of the investment universe at attractive levels. As the market calmed down, liquidity returned and dislocations started to

correct, the investment in municipal bonds was sold with a significant positive return impact.

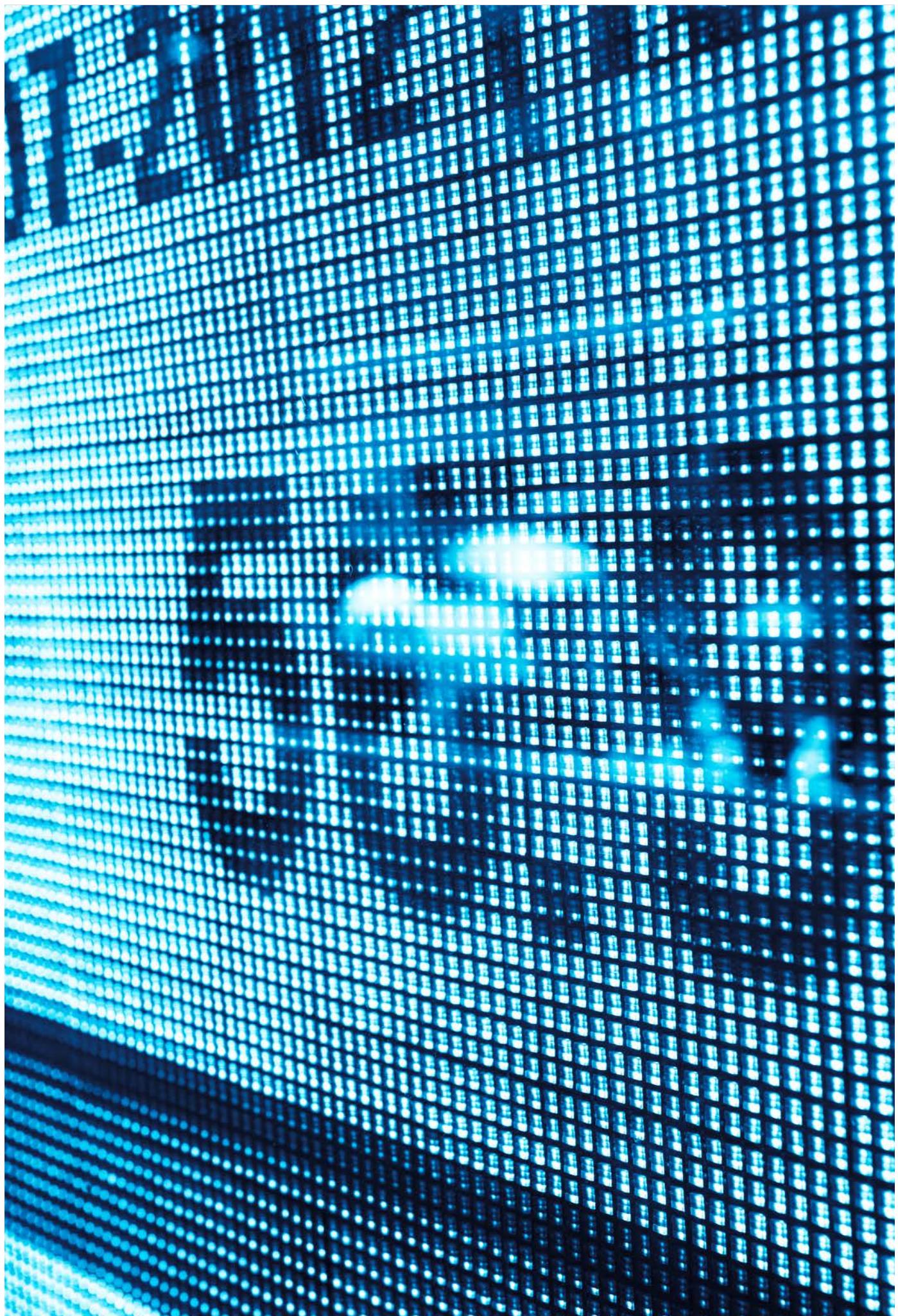
The management of emerging market debt issued in local currency also did well in 2020. The knee-jerk reaction to the pandemic was a harsh sell-off in emerging market bonds and currencies. This was considered as an opportunity based on an assessment that emerging market monetary policy would prioritise assisting the domestic economy via monetary easing, rather than protecting exchange rate stability by hiking interest rates. As the year progressed, this positive view of interest rate risk was rewarded as yield levels came down to below the levels at the start of the year.

The results in 2020 were second only to 2009 with regard to relative return measured in monetary terms, at more than 20 billion kroner. While 2009 was mostly about recovering mark-to-market losses from legacy assets, we came into the turbulence in 2020 in a better position and captured the opportunities that come with market volatility. For the full five-year period from 2016 to 2020, the relative performance for internal fixed-income management was 45 billion kroner. This makes it the most successful period for fixed-income management in the history of the fund.



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The portfolio management

Overall, the relative return from internal fixed-income management strategies has been 85.9 billion kroner since the start of the fund. A variety of strategies have been used for the different segments of the fixed-income portfolio in different time periods, but these strategies have overlapped in focus and objective. So while management has at times been dominated by one or more of these strategies, there will often also be elements of the other strategies impacting on the relative return.

One common denominator with these strategies is that they have focused primarily on improving the fund's relative return and had a short- to medium-term investment horizon. Norges Bank has also pursued strategies in the fixed-income asset class that are geared more towards absolute return with a longer-term investment horizon. One important example is the establishment of the operational reference portfolio, with significant adjustments to fixed-income investments from 2011. Such strategies are categorised as allocation strategies, however, and are not discussed as part of this management review.



The enhanced index strategies

One core management task is to efficiently create and maintain the financial market exposure defined by the benchmark in the management mandate. Instead of replicating a benchmark that will always have some weaknesses, the strategy aims to deliver a small and consistent excess return.

For large funds, expected risks and returns are determined largely by the overall choice of investment strategy by the capital owner. Particularly important for the fund, which operates in a narrow set of asset classes compared to its peers, is the choice of allocation between equities and fixed income. A recommendation is made by the Ministry after seeking advice from Norges Bank and others, and parliamentary approval is obtained. The strategy is then crystallised into a benchmark portfolio of equities and bonds. Here, many choices around other dimensions of the investment strategy must also be taken. Of particular importance for fixed income is the currency composition. Other choices centre around exposure to the term, credit and liquidity premiums. Different preferences can be expressed via changes in the duration and sector weights of the fixed-income index.

Index management

One point of departure for Norges Bank's investment management is investing all new capital in line with the benchmark portfolio. This kind of investment management is often known as index management. Another name is beta management. The latter name reflects how the aim of management is to achieve the exposure to systematic market risk determined by the client as its long-term strategy, known in financial theory as beta. Excess returns beyond those resulting from diversified exposure to the market are known as alpha. In fixed-income management, alpha and beta management were kept separate from 2000. They were seen as two different types of management with different requirements in terms of expertise and focus. Beta management needs high-quality, up-to-date and forward-looking data, and reliable IT systems.

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When new recruits were hired for this part of fixed-income management, the emphasis was on the intersection between finance and technology. The ability to make good investment judgements was second to obtaining the necessary skillset in creating, implementing and using portfolio management tools. This resulted in a data- and technology-oriented group of people who developed their own software and maintained their own data warehouses to solve the various tasks they were given.

Enhanced indexing

Index management is often referred to as passive management. However, there are constant changes to which the portfolio managers must adjust over and above changes in investment strategy. New bonds join the index, while others leave. Weights of currencies and countries change, and coupons are paid and need to be reinvested. In the beta management setup at Norges Bank, such changes and other openings were used in active strategies to try to achieve a slightly higher return than would result from pure index management. The strategy was labelled enhanced indexing. When picking securities, we attempted to reproduce the risk characteristics of the benchmark portfolio as efficiently as possible, but also to choose an overweight of bonds which had a slightly better risk-adjusted return profile than the benchmark.

To measure the investment risk versus the benchmark, tracking error was the key statistic. The tracking error of a portfolio is the divergence of performance in the portfolio relative to the benchmark. Low tracking error means a portfolio closely follows its benchmark, while high tracking error indicates the opposite. The goal for enhanced indexing was not to minimise tracking error, but rather to minimise relative investment risk from macro-oriented factors.

Currency risk is one such factor. To minimise return differences from fluctuations in exchange rates, portfolios were organised by currency. At every month-end, the capital allocation to each of these portfolios was aligned with the currency mix in the Ministry benchmark. Together with prohibiting currency positions within the single-currency portfolios, this assured that the currency exposure mimicked the benchmark, and portfolio managers could concentrate on tasks other than taking a view on the future path of foreign exchange rates.

Duration deviation is another macro factor that was generally minimised in the enhanced indexing approach. More specifically, a three-factor model for interest rate risk in a system delivered by the company MSCI called Barra Cosmos was used to control this macro factor. It captured changes in the level of the yield curve via a shift factor, the slope of the yield curve via a twist factor, and changes in the curvature of the yield curve via a butterfly factor. The factors were derived mathematically in a rigorous way and were calculated from the history of the term structure for each market. Barra Cosmos was also the system used for forward-looking measurement of tracking error. Typically, this would be kept below 10 basis points, indicating that the return on the portfolio would be very close to the benchmark return in normal markets.

Chart 1 Enhanced index strategies, including security lending. Annual contribution, by sector, 1998–2007. Arithmetic difference in basis points.

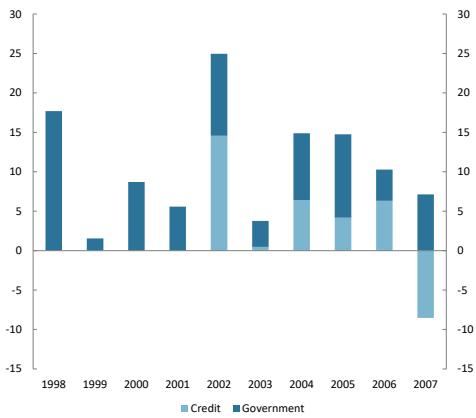


Chart 2 Enhanced index strategies, including security lending. Cumulative contribution, by sector, 1998–2007. Geometric difference in basis points.

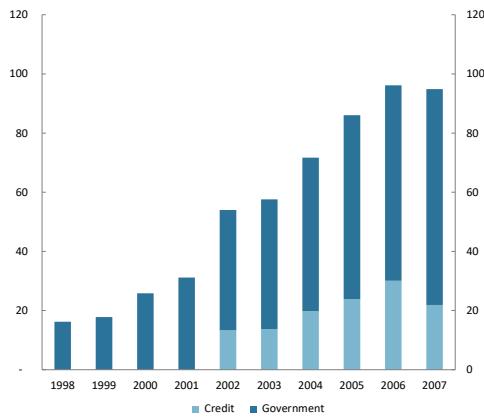


Chart 3 Enhanced index strategies, including security lending. Annual contribution, by sector, 1998–2007. Million kroner.

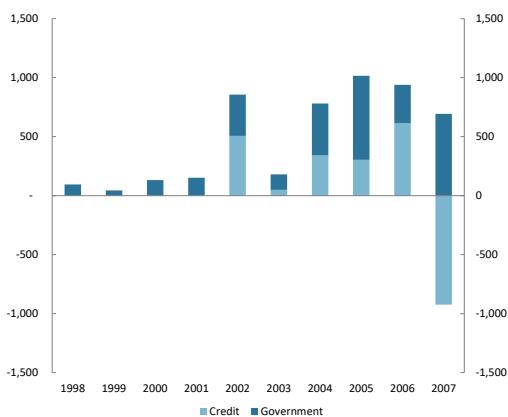
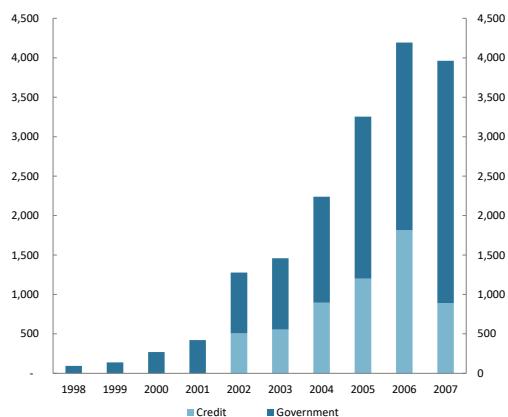


Chart 4 Enhanced index strategies, including security lending. Cumulative contribution, by sector, 1998–2007. Million kroner.



Specialised indexing

The portfolio structure within each currency was further decomposed into sectors. When non-government bonds were added to the benchmark in 2002, corporate bonds received their own index portfolio, as did securitised bonds. The allocations to these segments aimed, in the same way as with currencies, at being identical to the benchmark, neutralising the sector risk. The management of US securitised debt required systems and competence Norges Bank did not have and was outsourced to external managers. Changes to capital allocation to US mortgage-backed securities was matched by amending funding to external managers in the same way as would have been done if the segment had been managed internally in Norges Bank.

To manage the enlarged universe, a separate unit for enhanced indexing of corporate bonds was established. A small part of the government-related segment and some of the securitised bond segment were also managed from this new unit. Covered bonds and most government-related bonds were managed by the enhanced index government unit. This group was also responsible for inflation-linked bonds when this segment was added to the benchmark in 2005, and for cash management for the fixed-income part of the fund. This last task included some activity linked to taking advantage of bonds held in the portfolio that had special value as collateral, which meant lending them in the repo market and re-investing the cash proceeds at the general collateral money market rate.

While the split between alpha and beta management in its pre-financial crisis form had been discontinued by then, the addition of emerging market local-currency bonds to the Ministry benchmark in 2012 led to the creation of a new unit for managing this part of the

universe. While the freedom to deviate from the benchmark was larger than for the original enhanced indexing approach, clear similarities were still to be found with the primary focus of efficiently implementing the benchmark exposure and generating a modest relative return.

Management of legacy positions

With the shift in focus from the beginning of 2008, from building up active management towards simplifying the investments and taking down the leverage, the clear distinction between alpha and beta disappeared. As cost-efficient implementation of the desired market exposure decided by the capital owner has always been our number one priority, it was natural that the core of the new approach was built on the existing expertise in beta management.

Assets were reorganised into segments that each represented part of the investment universe. The three main silos were government and government-related debt, corporate debt and securitised debt. Investments made in alpha satellites were integrated into the enhanced indexing portfolios, completely changing their risk profile against the benchmark index. A few of the cornerstones of enhanced indexing were retained, however, such as neutralising the currency risk.

Going into 2009, the totality of the portfolio was simpler, but there were new challenges. One was to raise capital for equity purchases to increase the equity share of the fund, and the other was that a large share of the fixed-income portfolio was both illiquid and valued by the market at prices not reflective of its fundamental value. To best manage these two aspects, the assets that could be matched with the Ministry benchmark were segregated from the rest and managed with an enhanced

indexing strategy. The rest of the assets had specialised management that aimed at maximising their value.

As the value of the distressed assets recovered sharply, they were mostly merged with the other assets towards the end of the year. With this, the risk profile of the enhanced indexing portfolios changed again, acquiring significant macro-type risk.

Combined indexing

From 2010 to 2012, position taking resembling an enhanced indexing strategy was blended with a holistic management approach with high tolerance for macro-oriented risk taking. Since this period, the largest allocation differences between the Ministry benchmark and the actual portfolio have been segregated and reported as allocation positions. The remaining position taking has never returned to the enhanced indexing strategy prior to the financial crisis, but has had greater excess return ambitions and so included tactical macro positions and some structural tilts that would not belong in a more conservative enhanced indexing approach. This way of managing the portfolio has been labelled an asset management strategy.

While corporate bonds were again managed separately from other sectors from 2013, the investment strategy was the same. From autumn 2014, part of the corporate bond portfolio was managed with more emphasis on company-specific positions. This investment strategy was labelled security selection. Since March 2016, all corporate bonds have been managed with such an approach.

The excess return for asset management has been consistently positive for Europe. This is the part of the portfolio with the largest use of resources, with five to seven portfolio managers

and three traders. Position taking has been dominated by relative value positions, with a more fragmented market than in other regions forming the basis for a large opportunity set.

The largest portfolio by capital is US dollars, which has been managed together with the Canadian dollar portfolio by up to four portfolio managers and two traders. Position taking is more macro-oriented than for Europe. The Asia-Pacific part of the portfolio is dominated by the yen, and low volatility and generally few opportunities have resulted in fewer resources being required, with one portfolio manager handling it prior to local management being established in Singapore in 2016, and two afterwards. On top of the regional mandates sits a cross-regional overlay mandate. This has contributed positively in recent years, dominated by cross-market swap spread and inflation break-even positions.

Chart 5 Asset positioning and security selection. Annual contribution, 2013–2020. Arithmetic difference in basis points.

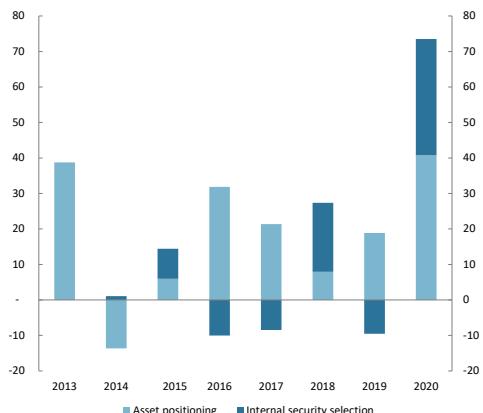


Chart 6 Asset positioning and security selection. Cumulative contribution, 2013–2020. Geometric difference in basis points.

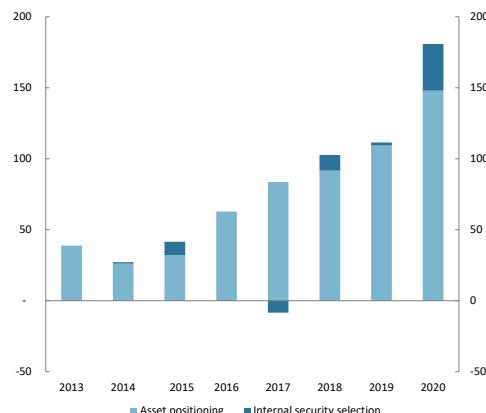


Chart 7 Asset positioning and security selection. Annual contribution, 2013–2020. Million kroner.

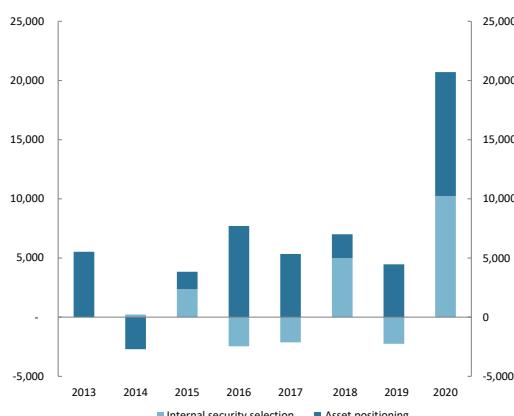


Chart 8 Asset positioning and security selection. Cumulative contribution, 2013–2020. Million kroner.

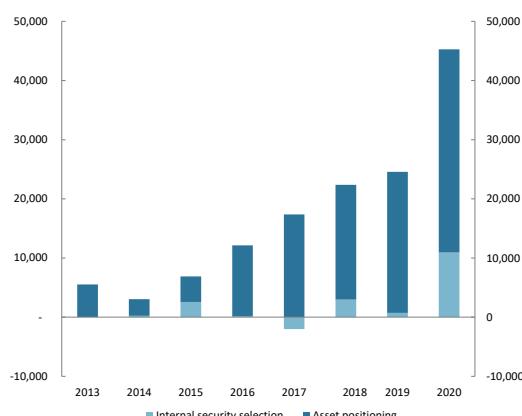


Chart 9 Asset positioning, developed markets. Annual contribution, by region, 2013–2020. Arithmetic difference in basis points.

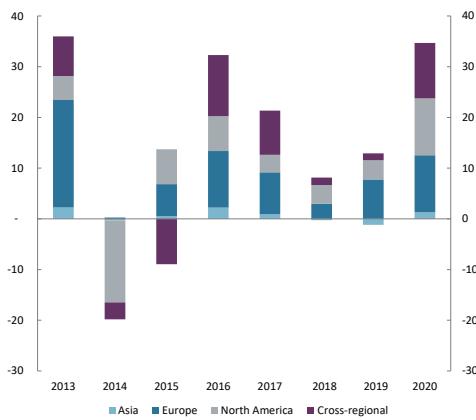


Chart 10 Asset positioning, developed markets. Cumulative contribution, by region, 2013–2020. Geometric difference in basis points.

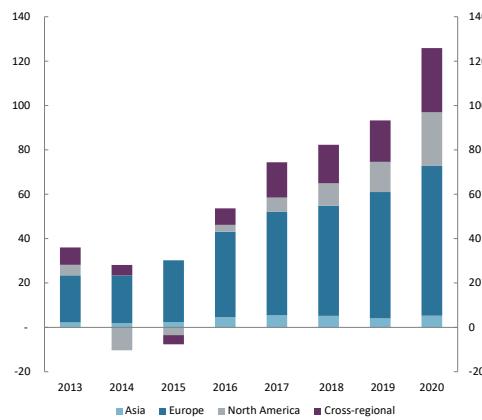


Chart 11 Asset positioning, developed markets. Annual contribution, by region. 2013–2020. Million kroner.

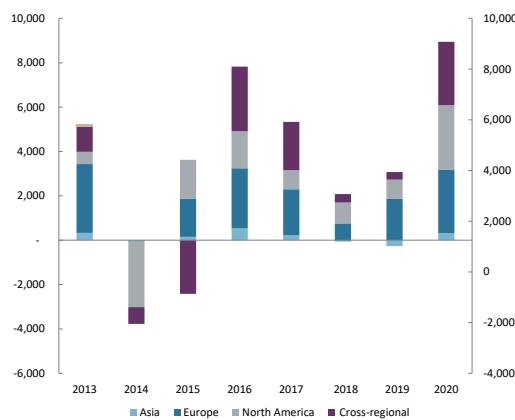
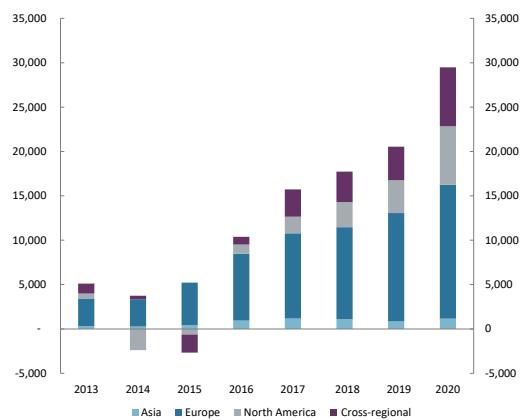


Chart 12 Asset positioning, developed markets. Cumulative contribution, by region. 2013–2020. Million kroner.





The relative value strategies

The majority of the active positioning in the early days of fixed-income management had a relative value focus. Relative value strategies seek to select specific investments based on an analysis of the relative yields of different investments in the investment universe with similar risk characteristics.

The ability to exploit relative value opportunities for a long-only investor is limited to selecting the cheapest securities to buy and avoiding relatively expensive ones. To increase the opportunity set, trading strategies were established that were independent of the funded portfolio and used the repo and derivative markets to finance the positions and to hedge unintended interest rate and/or credit risk.

A separate relative value group was formally established in 2000. Its focus was on exploiting variation in the liquidity premium and price discrepancies between issuers and instruments with similar risks. All positions were financed through the repo markets. When buying a bond, the portfolio manager would lend that bond through a repurchase transaction. The cash received as collateral for the loan was used to finance the purchase of the bond. When selling a bond, the portfolio manager would first see if they could source it internally. If not, it would be borrowed in the market through a resale transaction. These financing transactions were of a short-term nature and renewed regularly, typically between weekly and monthly. The cost of financing was monitored and subtracted from the performance of the trade.

Liquidity strategies

One classic relative value strategy is trading "on-the-run" versus "off-the-run" bonds. On-the-runs are recently issued government bonds that serve as benchmark bonds for a specific maturity segment, while off-the-run bonds are older and have lost their benchmark status. On-the-runs are traded more frequently, and this superior liquidity often results in a lower yield for such bonds than more seasoned issues. With time, on-the-run bonds lose their status as the benchmark and the higher liquidity in the market. The enhanced indexing strategy would often avoid buying these relatively expensive bonds, while the relative value group would sometimes sell these bonds short and buy older and cheaper bonds from the same issuer. In both cases, close attention needed to be paid to how the bonds traded in the repo market. Since they are often sold short in the market, on-the-run bonds can be expensive to borrow in the repo market. On the other hand, this repo value is beneficial to the bond owners, who lend them out for a margin. When on-the-run bonds traded without much of a yield premium, a relative value portfolio manager would often go long, as the risk was positively skewed at the cost of a small insurance premium.

In relative value management, the on-the-run versus off-the-run position could involve a whole segment of the yield curve. A common strategy in the US Treasury market was to sell recently issued 10-year and 30-year bonds to buy old bonds with around 20 years remaining to maturity. The seasoned bonds in the 20-year segment often traded at a yield premium to the 10- and 30-year benchmark bonds, creating a hump in the yield curve. Through a so-called "butterfly" trade, managers could buy the cheap 20-year "belly" and sell the 10- and 30-year "wings" without being directly exposed to changes in the overall yield level, and have limited exposure to curve steepness.

Swap strategies

From the beginning, the relative value group used interest rate swaps (IRSs) in its investment strategies to hedge out unintended interest rate risks and to exploit variations in the spread between IRS rates and high-quality bond yields. Receiving a fixed rate in an IRS contract is equivalent to buying a bond, financing it short-term, and paying a floating rate in the repo market. In a bond asset swap trade, the investor buys the bond and pays fixed in the IRS. The fixed rate's maturity matches the bond's maturity, eliminating any interest rate risk in the package or asset swap trade. The performance of this position is driven by the level and change in the spread between the yield on the bond and the fixed rate of the IRS on one side, and the difference between the repo market's financing rate for the bond and the floating rate of the IRS contract on the other side.

Liquidity in the IRS market is often similar to, or higher than, that for government bonds in the respective currencies. There is no principal credit risk in an IRS agreement. The fixings for the floating leg are based on deposit rates quoted by a panel of creditworthy banks, typically with AA or better ratings. If a bank is downgraded, it will be removed from the panel. However, if the whole banking system is perceived as weak, most banks will have to bid up deposit rates, and rate fixing for the floating rate will increase, causing swap spreads to widen across the maturity spectrum. In theory, the term structure of swap spreads is determined by expectations of future differences between government repo rates and interbank deposit rates, variations in supply and demand, and risk premiums.

At the end of 2006, more than 40 percent of the value at risk in the relative value investment strategy stemmed from swap spread positions across different countries and maturities. While

the trades in US dollars and pounds sterling were primarily short government bonds with maturities of less than five years, the positions in euros and yen were long government bonds seven years and out. In the second half of 2007, swap spreads started to widen as the liquidity squeeze in the banking system caused the interest rates at which major global banks lent to one another to increase relative to government repo rates. Since the widening of swap spreads was mainly driven by tighter liquidity conditions and higher interbank rates, the effect was much more significant in the shorter maturities. In this environment, the gains from long swap spread positions in euros and yen were not able to offset the losses in short spread positions in dollars and sterling.

Spread strategies

The relative value strategy would also buy government-related bonds and covered bonds. Despite such bonds being of very high credit quality and rarely, if ever, having suffered any credit event, they were characterised as spread products, as they usually traded with a positive yield spread to government bonds. The size of the spread would vary across currencies and over time due to changes in supply and demand and perceived liquidity risk. The yield curve for these bonds was usually steeper than the IRS curve. Thus, the relative value strategy would typically buy government-related bonds and covered bonds against IRSs in longer maturities. These positions were often initiated at a positive spread, and the bonds would – in a stable market – gain from a lower swap spread over time as they “rolled down” the spread curve.

The yield on covered bonds widened sharply relative to IRSs during the financial crisis and caused a significant mark-to-market loss in the portfolio. However, none of the issuers missed any payments. The positive carry on these positions was substantial, because the bonds yielded more than the fixed swap rate and profited from the high interbank rate settings on the floating side. Covered bond spreads recovered strongly in 2009, especially after the ECB started its first bond-buying programme targeting covered bonds in July that year.

The fund was one of the largest investors in the primary market for covered bonds and was often asked for pricing guidance on new issuance. Norges Bank also participated actively in discussions around the transparency and legal structure of covered bonds. In 2009, Norges Bank was a founding member of the Covered Bond Investor Council and provided its first chair.

Correlation challenges

The relative value group had six to seven portfolio managers between the Oslo and New York offices. Its activities were spread across currencies and strategies. Close attention was paid to the correlations of performance across portfolio managers and strategies. Besides monitoring correlations based on historical data, there was an attempt to classify positions as to whether they would gain or lose from a tail risk event.

There was little correlation between strategies across the currency markets during the first seven years. The contribution to the relative return in basis points was steady, as the growth in absolute risk and performance was proportional to the increase in capital in the fixed-income part of the fund. In 2006, the ex-post correlations were low, and the diversification gain across the portfolio managers was still relatively large. However, this picture changed sharply in the second half of 2007. Most of the portfolio managers lost money that year, and losses from short swap spread positions in UK gilts and US Treasuries with maturities below five years were much larger than expected.

The drawdown in 2007 was within the relative value group's risk limit, but it wiped out more than two years' worth of return in basis points, and nearly four years' worth of return in monetary value. Correlations across portfolio managers and strategies increased sharply, and only individual mandates with positions that embedded an insurance premium succeeded and survived. Only one portfolio manager produced a significant positive performance. Despite efforts to penalise riskier trades, the balance between short- and long-volatility strategies was, in hindsight, skewed towards positions that underperformed in a market

environment exposed to systemic risks. In August 2007, some portfolio managers reached their risk review levels, and positions were reduced significantly. Later in the autumn, these portfolio managers were stopped out, and the majority of the positions were absorbed and managed at the group level.

As the market turned outright dysfunctional in autumn 2008, there seemed to be no boundaries on how far fundamental pricing relationships could fall apart. The critical notion behind relative value strategies – that the market would sooner or later correct itself – seemed to be broken. In 2009, the market started to function again, and relative value positions performed strongly. However, it would probably have taken longer or more losses before the market normalised were it not for the interventions and bank bailouts from the authorities. There were no credit events in any relative value positions, but the large swap spread positions in dollars and pounds suffered significant negative carry from the high interbank rate settings during the financial crisis.

By nature, relative value investment strategies that seek to capture a risk premium by providing liquidity are characterised by an insurance-like return profile: long streams of steady returns, occasionally interrupted with steep losses. Long-term investors such as the fund have the risk capacity to absorb large drawdowns, as long as the strategy can harvest a premium over the long term. Norges Bank would continue to deploy relative value strategies throughout its fixed-income management, but without leverage and with limited use of derivatives.

Chart 13 Relative value strategies. Annual contribution, 2000–2007. Arithmetic difference in basis points.

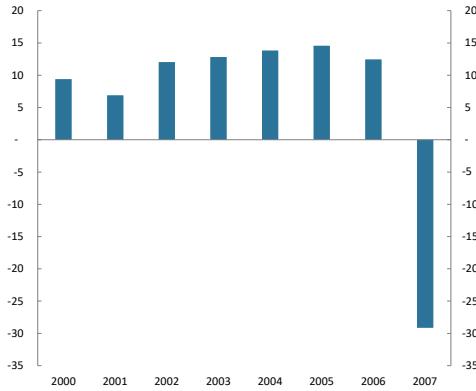
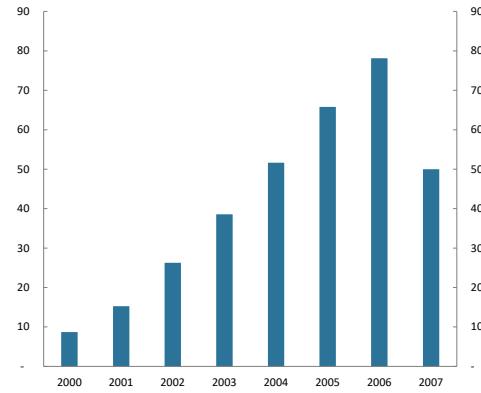


Chart 14 Relative value strategies. Cumulative contribution, 2000–2007. Geometric difference in basis points.



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Chart 15 Relative value strategies. Annual contribution, 2000–2007. Million kroner.

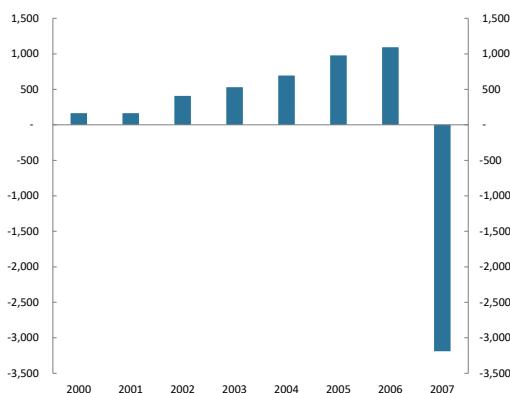
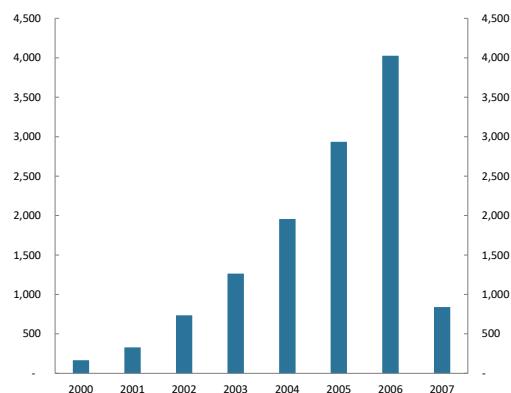


Chart 16 Relative value strategies. Cumulative contribution, 2000–2007. Million kroner.



0.68741



9 073.50



1494.13

60.50

12 903.3

The macro and overlay strategies

The investment strategies based on macro factors take more of a top-down view. The strategies try to anticipate moves in broad market drivers such as interest rates and currencies.

The analysis is geared more towards broad economic cycles and policies than detailed evaluation of specific securities, and requires a thorough understanding of what is already priced into the markets.

As with relative value, a global value group operating independently of the funded portfolios was established in 2000. The following year, an active overlay investment strategy went live. Taking views on macro factors such as duration and currencies did not have the same tradition from the management of the foreign exchange reserves, and the portfolio managers involved in macro and overlay strategies were mostly recruited externally. It diversified the approach for fixed-income management and aligned well with the investment philosophy of spreading active management across many independent positions.

Global value strategies

The global value team based its investment strategies on macro factors and broadened the scope of active management within fixed income. Considerable analysis went into understanding the reaction function of G10 central banks. The outcome of this analysis was a set of interest rate expectations compared to what was priced into the markets as per the interest rate term structure. The focus was on identifying pricing along the global yield curves that was not aligned with the expected central bank actions. Often, the positions were based on views across markets, as it was considered easier to identify relative mispricings between yield curves.

The active positions were spread across the G10 currency markets. The main strategies were outright short or long duration and positions on the yield curve in individual markets, and spread trades across currencies. The group was to a limited extent involved in currency trading, often through options. The investment horizon for the individual trading positions in global value was usually relatively short, typically three to four weeks. As with the relative value strategies, trades were executed independently of the underlying fixed-income portfolio. Positions to reflect the market views were mostly taken through derivatives, such as futures on short-term interest rates or government bonds. The use of liquid instruments was in line with the philosophy of putting on many positions and executing stop-loss rules when necessary.

In the early years, there was a separate effort to implement systematic strategies with the support of an external finance professor. Various quantitative signals were tested historically, and a subset were applied in a model portfolio that guided the position taking. The strategy suffered from a negative performance skew and an

inclination to override the quantitative signals, and was discontinued in 2002.

The global value group put a lot of emphasis on disciplined position management. Each position had profit targets and stop-loss limits. The stop-loss limit was a function of the expected profit and estimated risk of the trade, which produced a cone-shaped probability distribution over time. Every position had its performance chart with volatility bands around an expected profit trend line. When the line of the accumulated performance crossed any of the bands, closer scrutiny was warranted. This helped the portfolio manager to cut losing positions and let winners run.

The position hit ratio and profitability profile were closely monitored across portfolio managers and strategies. As the hit ratio in macro strategies is, at best, expected to be slightly above 50 percent, portfolio managers were encouraged to increase the number of positions. Most of the added value from the macro trading in the global value group came out of strategies that played on the differences in short-term interest rates between some of the smaller currency markets.

The team was Oslo-based, and the number of portfolio managers in the team varied between two and six. In 2004, two of the team's core members moved to Norges Bank's office in London to sit closer to the information flow in global markets.

Global macro strategies

In 2005, the team was given new leadership and changed its name to Global Macro. The experience of the new team was more tilted towards outright rates and currency trading. The goal was to fundamentally diversify the position types, reduce the number of positions, and extend the investment horizon. There was also

an emphasis on increasing risk to contribute to an ever-larger fixed-income portfolio. Positions were classified into types of strategy and different time horizons: short, medium and long. The risk and performance in the first year were driven by foreign exchange and outright interest rate positions, and to some extent on position taking within volatility.

In 2005, the group hired a portfolio manager specialising in high-frequency foreign exchange trading. Another team member had more of a quantitative background and was tasked with building a rule-based, or systematic, approach. In 2007, the systematic effort was strengthened and organised in a separate risk unit called Global Factors. This was a new attempt at a quantitative approach that sought exposure to various risk factors in a systematic and structured way. The initial focus was to extend the trend-following and mean-reversion models employed in the foreign exchange market to fixed income, equities and commodities. The Global Factors group was part of a new macro umbrella, including Global Macro and emerging market debt, headed by the CIO for fixed income.

Active overlay strategies

An active overlay portfolio was managed by the CIO for fixed income with support from senior portfolio managers. The focus was on extreme market situations with expectations of extraordinary or positively skewed profitability. Positions in the active overlay portfolio would often be different versions or escalations of strategies in the separate teams. There were no explicit risk limits on positions or diversification requirements, but the risk in active overlay was not supposed to have a material impact on overall fixed-income performance. The risk in the active overlay portfolio would vary over time and be based on a limited number of positions.

Some of the strategies that added significant value were outright short positions in seven-year Japanese government bonds in 2003, yield-curve-flattening trades in the US, and swap spread positions long German government bonds versus IRSs in 2004–2005. The yield curve position in the US was a broader version of the relative value off-the-run strategies in the 20-year sector of the US government bond curve. The active overlay group would try to capture the same yield premium as the relative value group but implemented the strategy with less fine-tuning in the hedging of interest rate risk. It would also put on interest rate and currency positions that were more concentrated and would require a longer holding period than typical for macro trades in other investment mandates.

The concept of a fixed-income overlay portfolio would persist through time and was still an active risk management tool at the end of 2020. With more specialised mandates, the scope for overlay positions has expanded beyond high-conviction positions to include opportunities that cross the boundaries of the segments the other mandates operate in.

In 2005, a new hard-currency emerging market mandate was established as part of the active overlay mandate. The positions were divided into an active strategy and a beta exposure based on the JP Morgan EMBI Global Index. The active mandate would include positions in local currencies. The eligible country list was quite limited and included Poland, Hungary, Mexico, South Africa and South Korea. After phasing out the long/short mandate during the financial crisis and a period of preparation, Norges Bank returned to local-currency markets in 2011 and then on a much larger scale in 2012 when the segment was included in the benchmark.

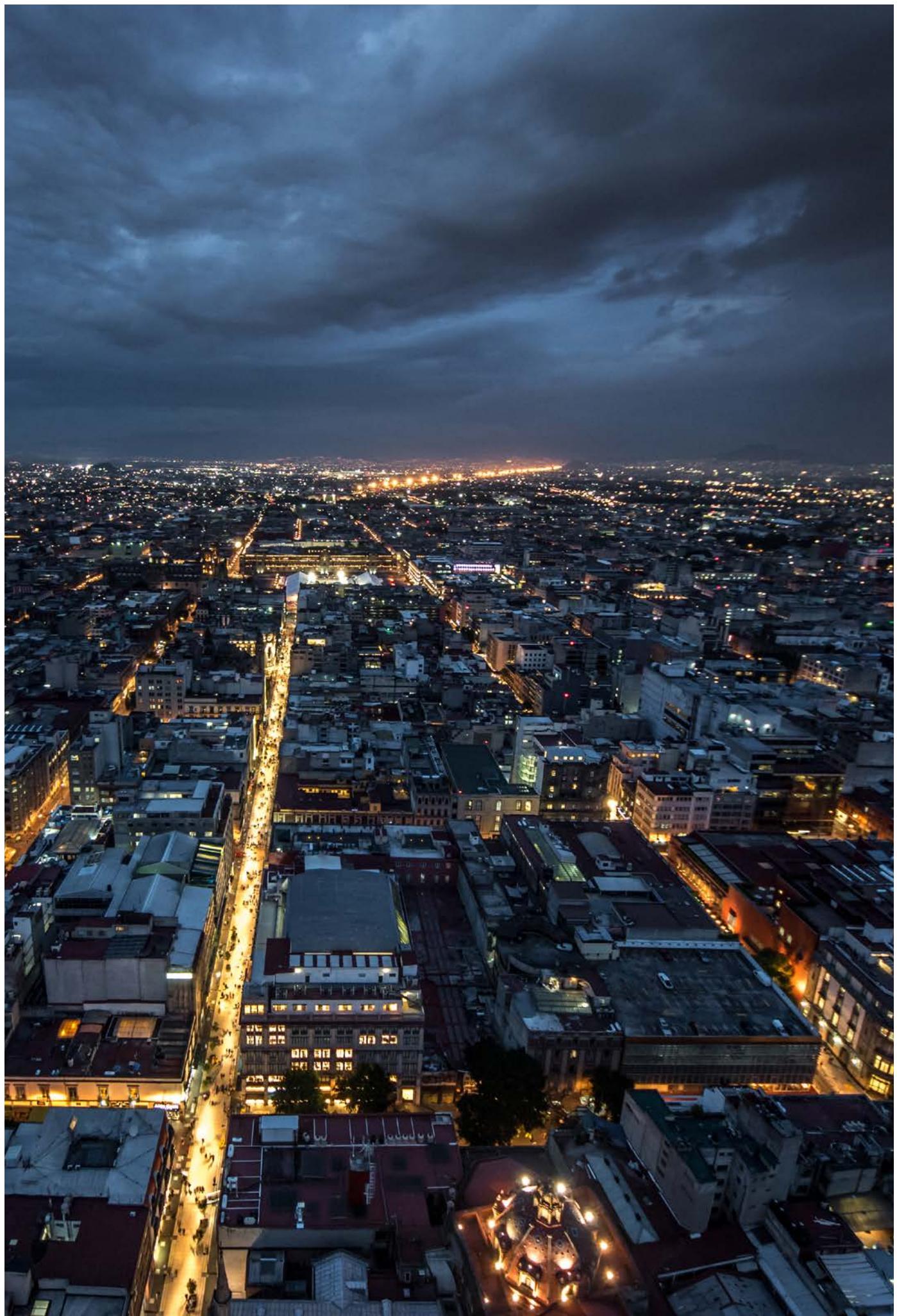


Chart 17 Macro and overlay strategies. Annual contribution, 2000–2007. Arithmetic difference in basis points.

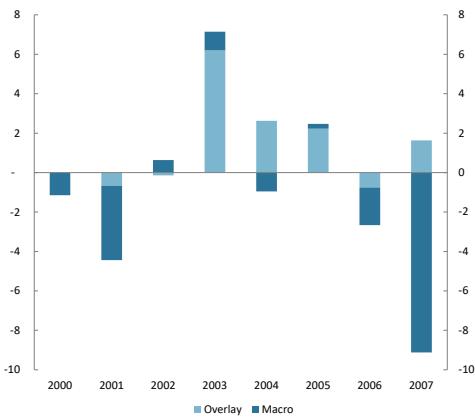


Chart 18 Macro and overlay strategies. Cumulative contribution, 2000–2007. Geometric difference in basis points.

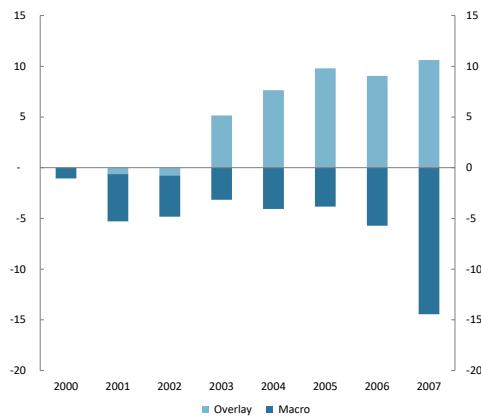


Chart 19 Macro and overlay strategies. Annual contribution, 2000–2007. Million kroner.

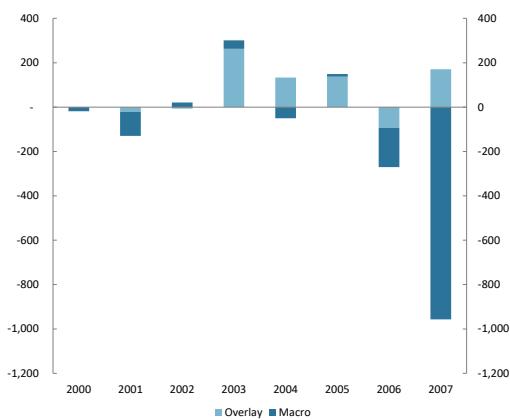
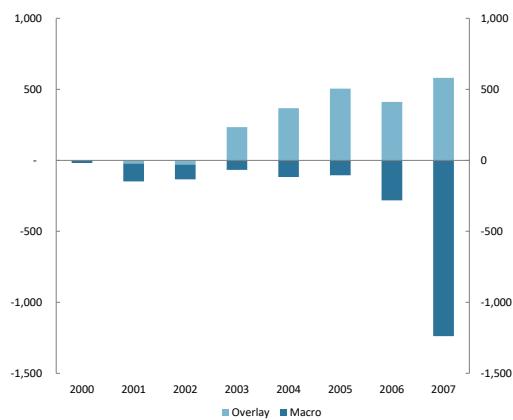
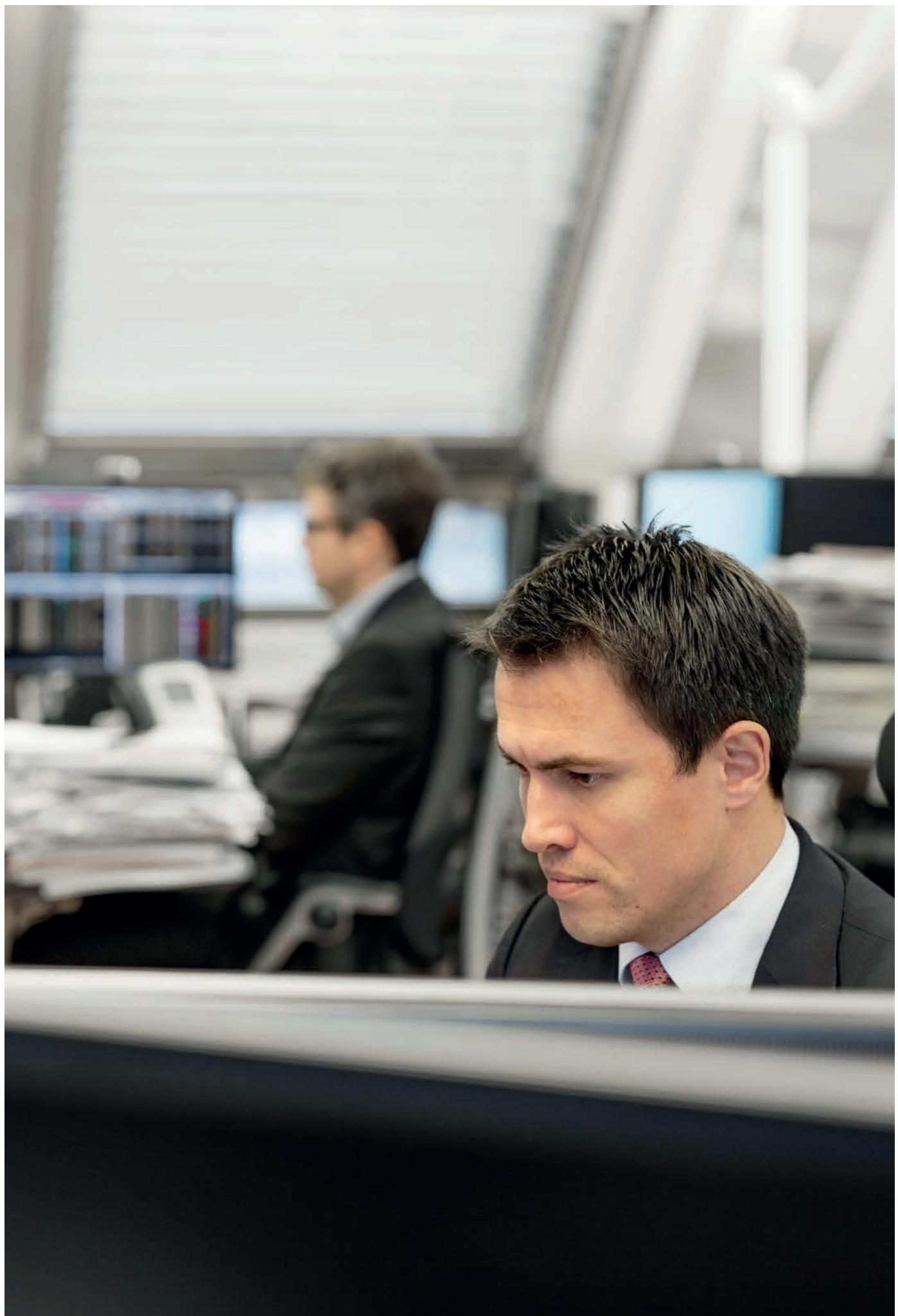


Chart 20 Macro and overlay strategies. Cumulative contribution, 2000–2007. Million kroner.





The credit strategies

In 2002, the fixed-income benchmark was expanded to include non-government bonds. The change aimed to align the benchmark with the investment universe and to achieve higher expected long-term returns.

To account for a higher chance of the borrower not repaying the money lent, corporate bonds pay a higher rate of interest than government bonds. Over the long term, this extra risk for the lender should be compensated for in the form of higher returns. The portfolio of corporate bonds has grown to around 775 billion kroner, or close to 30 percent of the aggregated fixed-income portfolio.

Benchmark expansion

The Ministry selected the widely used Lehman Global Aggregate as the benchmark for fixed-income investments in 2002 to cover all the new sectors. The overall allocation to credit was a function of the size of the corporate bond market relative to other segments, based on market capitalisation. The benchmark did not include corporate bond markets in the Asia-Pacific region due to limited liquidity and low credit spreads.

The initial corporate bond index included close to 5,000 individual bonds issued by more than 900 companies with a median investment-grade rating from the major rating agencies. To allow some flexibility in the event of downgrades, the fund was permitted to hold bonds rated below investment grade up to a maximum of 5 percent of the total fixed-income portfolio. At the end of 2001, the fund's fixed-income investments were

valued at 363 billion kroner, and it was estimated that the size of the corporate bond portfolio would be around 100 billion kroner.

At the time, the US corporate bond market was substantially larger and more developed than corresponding markets in Europe and Asia, where banks were still the largest providers of debt financing to companies. Furthermore, the European market was still developing following the introduction of the single currency, which was a substantial adjustment for bond issuers and investors. Although the Ministry's index used regional weightings which took the European share higher compared to North America, the benchmark was heavily tilted towards the US dollar market. As a result, the bulk of the corporate bonds purchased over the next few years were in this market.

Given the relative importance of the US market, a dedicated credit team was established in the fund's New York office. In addition to the internal team, a few specialised mandates were issued to external managers. To facilitate corporate bond investments, the internal settlement team was expanded, and a new team was created to monitor the credit quality of the internal portfolios independently and ensure that they were managed in accordance with the mandate.

Ramping up the corporate bond portfolio

The first credit investments were made in mid-2001, and the complete benchmark framework with a phase-in plan was finalised early in 2002. This was a turbulent time for the global economy with both equity and credit markets impacted by the Enron and WorldCom bankruptcies as well as the 2000 dot-com correction. The fund started to buy corporate bonds in this uncertain environment, and the resulting performance of the portfolio was volatile during this period.

Purchases were made both at the time companies issued bonds into the market, known as the primary market, and in the secondary market. As most companies do not issue bonds every quarter or even every year, the fund needed to actively consider the secondary market as a cost-efficient source of portfolio holdings. Also, the team needed the secondary market to provide enough diversification and to approximate a maturity profile consistent with the benchmark.

To source liquidity and mitigate the market impact of such a large volume of purchases, the team innovatively engaged with the many market makers for corporate bonds and had them provide exclusive, real-time transparency on their inventories electronically. By mid-2002, the daily number of updates from our trading counterparties had reached 80,000, and the offers summed up to more than 11 billion dollars. This approach was key to populating the portfolio during the ramp-up phase.

The fund's corporate bond portfolio had grown to 130 billion kroner at the end of 2003 when the implementation was concluded. This was more than expected when the phase-in started, as the fixed-income part of the fund grew faster than predicted. While hard to quantify, the

implementation cost due to bid-ask spreads in the market was probably significantly lower than in the models used for estimating it, due to the intense focus from the team on building the corporate bond portfolio cost-efficiently.

Developing alpha and beta strategies

Following the phase-in period, the management of the corporate bond portfolio was separated into a beta team following an enhanced indexing strategy, and an alpha team with more active management. This split of strategies and responsibilities was geared towards increased potential performance through specialisation. The enhanced credit indexing unit managed inflows and replicated the risk characteristics of the benchmark, which provided the fund with the desired exposure to the corporate bond asset class. In addition, the strategy allowed for relative return enhancement by selecting bonds with better risk-adjusted return characteristics.

Meanwhile, the credit alpha group's main strategy was to capture returns through positions in individual companies by taking primarily idiosyncratic risk. The group's mandates were set up as long/short, so without capital and a benchmark. This was believed to simplify the risk taking and allow portfolio managers to focus on active management of a smaller set of opportunities. The credit alpha group also utilised relative value and curve strategies in both bonds and credit default swaps (CDSs) as complements to the company-based long/short strategy.

By the end of 2005, there were nine portfolio managers working on corporate bonds: four in index management and five on the active credit team. While the results for the enhanced indexing strategy were good, performance in the long/short mandate was more muted.

The Icelandic banks

The privatisation of Iceland's state-owned, conservative banks around 2000 led to excessive borrowing, growth, risk taking and leverage. When the global financial crisis struck in 2008, the Icelandic banking sector collapsed. It was too big for the government to rescue, so liabilities were not transferred from the banks to the sovereign, as was the case in several other European countries. Still, the damage done to the Icelandic economy and society was devastating.

Some portfolio managers in the credit alpha group had concerns in the years leading up to the crisis and positioned the fund accordingly. As early as 2005, during a period of very compressed spreads and low volatility, protection was bought against a default at the Icelandic bank Kaupthing using CDSs, and its bonds were shorted. Kaupthing's acquisition strategies and risky loans to holding companies, and a general scepticism about Iceland's highly interconnected financial system, were the starting point for the short. Additionally, the bank had a sizeable debt load that was due to mature within a few years, and it would need liquidity and capital from the markets to extend them. This could become challenging and was viewed as a possible catalyst for Kaupthing's credit spreads to underperform.

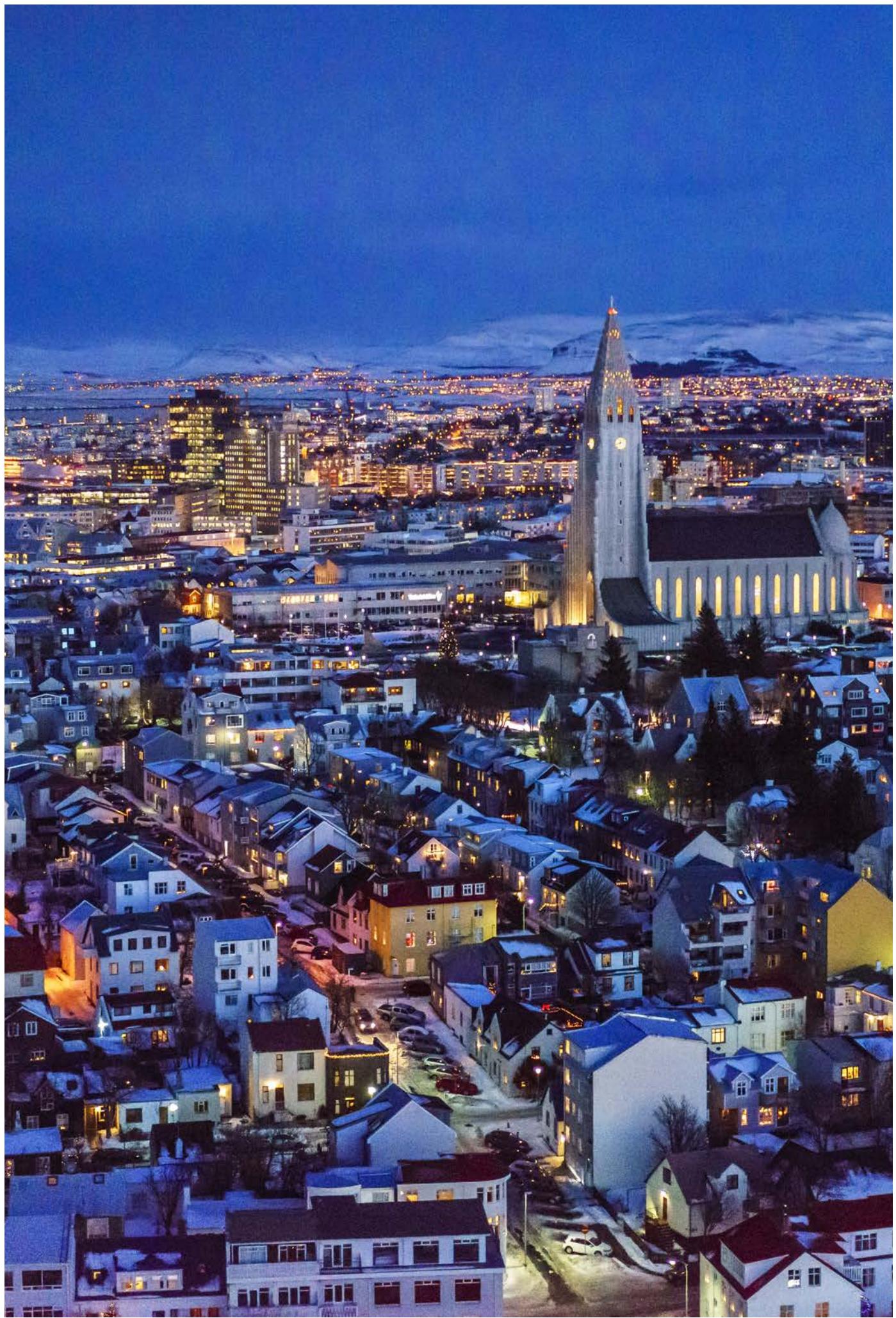
As part of the investigation into the Icelandic banks, thousands of stock exchange announcements detailing transactions of the listed companies and their major shareholders over many years were analysed. These found that many transactions took place between related parties and were almost always paid for in new shares. This increased the total equity in the system, but not the underlying values. Companies raising equity accepted shares in other listed Icelandic entities as payment instead

of cash. As a result of these activities, the banks could lend even more money for purchases of foreign assets. These would need to be paid for in cash, hence the need to finance the banks in foreign bond markets.

While details such as the size and the characteristics of the fund's positions were unknown outside Norges Bank, the scepticism expressed by the portfolio managers about the sustainability of the strategy chosen by the Icelandic banks became public knowledge. This attracted attention not only from the banks themselves, but also from Icelandic policymakers, with some taking the view that investor worry was destabilising the Icelandic banking system. The excessive growth in the banks' balance sheets was allowed to continue, and ended up at an extreme level of ten times the country's GDP before the global financial crisis struck.

In late 2005, spreads on Icelandic banks widened enough to effectively shut them out of the bond market. This volatility was dubbed the Geyser Crisis by the financial media. To survive, the banks devised a way to raise capital outside the bond markets. Billions were raised by offering market-beating interest rates to retail clients for online savings accounts, most notably in the UK and the Netherlands. Additionally, municipalities and pension funds were enticed by the overly generous AAA ratings the banks enjoyed from the rating agencies. These funding practices only delayed their collapse, however, as the global financial crisis proved insurmountable.

During the spring of 2006, the portfolio managers decided that the imminent threat to the banks' survival was no longer there, and the market agreed. Spreads tightened, and the bond market re-opened for the banks. Instead of unwinding the CDS positions, the portfolio



managers decided to reduce the short by buying back the bond shorts and purchasing newly issued bonds from the banks. By doing so, the position changed to a so-called basis position, where the fund owned both the bonds and the insurance on the bonds.

At its peak, the fund's short exposure to the Icelandic banks was around 4 billion kroner, which was huge for the portfolio managers and sizable for fixed-income management as a whole. At the time of the banks' bankruptcy in 2008, the net profit was about 500 million kroner, excluding prior years' trading profits and any underweight against the benchmark.

Our experience with the Icelandic banks confirmed the profit potential of engaging in fundamental credit research. The contrarian view taken of the Icelandic banks when spreads were tight turned out to be profitable relative to the risk of the positions.

The financial crisis

The global financial crisis was a reckoning for a market that was laden with too much debt and risk. In the period leading up to the crisis, liquidity was plentiful and volatility was low, and so leverage became a tool that was used in the pursuit of higher returns. Measures of risk such as the VIX and CDX indices were at cyclical lows. At the same time, rating agencies assigned high credit ratings to banks, financial companies and structured products.

Within the corporate universe, banks and financial institutions with high ratings became preferable to the idiosyncratic risk that existed at the time within non-financial companies. Large leveraged buyouts were abundant in 2006 with deals such as Georgia-Pacific, Albertson's, Freescale Semiconductor and TXU. Investment-grade bond investors wanted to avoid holding bonds in companies that were targets for such buyouts, since the more leveraged balance sheets that ensued made the companies' debt riskier, and its bond prices would typically decrease. The financial institutions sector provided an area that was immune from that type of risk due to regulatory constraints and an existing business model built on leverage.

The fund's corporate bond positioning grasped onto this theme as well and was overexposed to financials and in particular their subordinated debt heading into the crisis, with systemic risk to the financial corporate bond sector instead of idiosyncratic risk as a way to enhance returns. In addition, some strategies attempted to capture riskless arbitrage by pairing up bonds and CDSs of the same entity in a manner that would generate small, but leverageable, returns. In a very pure, academic sense, these packages of bonds and CDSs would offset each other in a default scenario, but investors were subject to the mark-to-market on each leg of the package.

In hindsight, this was a source of large but temporary losses for many investors, including the fund.

The early signs of the financial crisis started to appear in mid-2007 with concerns around the US housing market. In August, BNP Paribas suspended three funds with substantial exposure to the sub-prime mortgage market. Within a period of just over a month, the differential between the three-month LIBOR and the US Fed Funds rate moved from below 15 basis points to above 100 basis points, illustrating the substantial systemic stress. The spread on the corporate bond benchmark more than doubled from 74 basis points in June 2007 to well above 150 basis points at year-end. The performance of fixed-income strategies that were based on superior carry, i.e. yielding more than their benchmark, suffered whether this was justified by the fundamentals or not. The corporate bond portfolio's exposure to subordinated financial bonds in Europe and exposure to US investment banks were material areas of underperformance.

However, 2007 was just a presage to 2008. Losses mounted in 2008 in the corporate bond portfolio, with the credit premium in the corporate part of the Global Aggregate index increasing from 170 basis points to a peak of 515 basis points in early December. The year was characterised by headline risk and illiquidity, especially following the bankruptcy of Lehman Brothers in September. Several explanations for this were plausible, one being that the leverage in the financial system was broad and excessive.

The systematic repricing of risk was an area that many industry participants, including the fund, were exposed to. Risks that were thought to be independent of each other became highly correlated. The portfolio's exposure to European

bank bonds and to the bond-CDS differential was particularly challenging for the fund.

With the rise of systemic risk causing a global unwinding of leverage and risk positions, credit alpha was merged into the enhanced indexing team, and the focus shifted from generating outperformance to risk management and pricing transparency. As noted above, many asset classes and trades became highly correlated during the crisis, and this development led to a rethink of the complexity of the corporate bond strategies. The extensive use of CDSs on individual companies and the structure of having multiple long/short books were thought of as a hurdle in terms of managing aggregate risk. As a result, the portfolio structure was simplified, with assets being consolidated into a main corporate bond portfolio in 2008. In 2009, assets were organised in a more liquid part that followed an enhanced indexing strategy, and a legacy portfolio with large and illiquid positions.

Management recognised that many of the active positions within the legacy portfolio were undervalued, and as a result the fund kept a substantial amount of risk during the peak of the market volatility. It took a while for the co-ordinated policy efforts by governments and central banks in late 2008 to turn around the downward path in confidence and markets, but the S&P500 gained 67 percent from March to the end of December 2009. The performance of the corporate bond portfolio in 2009 was very positive, with large parts of the losses from the year before recouped.

The strategy reset

The tumultuous time of the financial crisis was exited with lessons learned and a greater appreciation for risk management. The corporate bond area delivered on its assignment of consolidating outsized active exposures and a holistic approach of managing overall fixed-income portfolio risk. From there on, portfolio construction was to remain non-complex with very limited use of derivatives and leverage, maintaining some of the principles from the crisis era.

From 2010 to 2012, the different segments of the fixed-income portfolio were managed on a combined basis by a team looking at risk-adjusted return from a holistic point of view. Their task was to decide the overall fixed-income portfolio risk characteristics and exposure to individual sectors. Under this framework, the exposure to the different segments of corporate bonds was considered in relation to government and covered bond holdings, resulting in large sector deviations. Another team then took over and was responsible for implementing the strategy in the cheapest manner possible with an approach that was essentially pure index replication with little enhancement. An example of this type of top-down positioning was the Spanish covered bonds held against government bonds and unsecured credit bonds. A key assumption derived from the crisis was the low recovery rates on unsecured credit, which resulted in a strategic decision to overweight covered bonds backed by a pool of assets. The offsetting position was an underweight in unsecured financial credit both in the US and Europe.

The strategy for corporate bonds evolved incrementally from benchmark replication to taking fundamental views on companies and sectors. In 2011, the credit area began to build up a dedicated team of research analysts to support

the bottom-up selection of issuer and sector overweights and underweights. The research staff, who were independent from the portfolio managers, developed a common research framework to assess company credit risk.

From 2013, the strategy evolved further, and a credit team was established to once again manage the asset class separately, marking a move away from the consolidated fixed-income structure. The individual portfolios were structured with specific industry benchmarks by currency so that the fund could benefit from specialisation. Exposure to bottom-up company positioning increased, and positioning across large sector groups, such as financials versus industrials, was limited. The credit analysts continued to support the bottom-up positioning, but the independent structure was de-emphasised in favour of a more team-oriented workflow.

Developing credit research

In October 2014, it was decided to take the collaboration between portfolio managers working with credit and equities another step forward by moving three credit portfolio managers and four credit research analysts to the equity part of the organisation to establish a credit team working closely together with specialist equity portfolio managers. The new team would cover just under 150 large-cap companies that were also significant components of the equity benchmark.

Another substantial change was the introduction of mandates at the sector level, which replaced the former segmentation by currency. As large multinational companies typically issue bonds across multiple currencies, the rationale was to align the mandate structure accordingly and to allow for more specialisation and the ability to take positions across currencies in one issuer. This new model gave clear responsibility for

Chart 21 Credit strategies. Annual contribution, 2001–2007 and 2013–2020. Arithmetic difference in basis points.

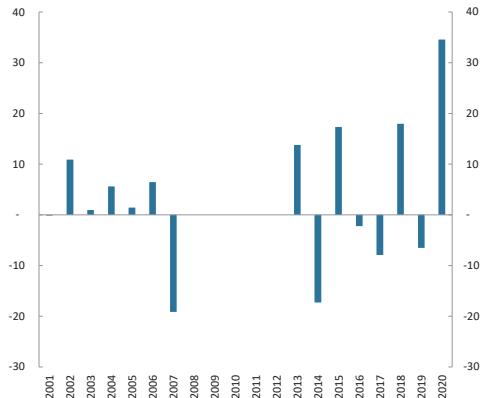


Chart 22 Credit strategies. Cumulative contribution, 2001–2007 and 2013–2020. Geometric difference in basis points.

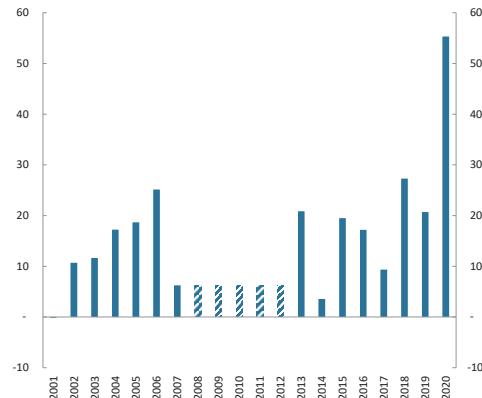


Chart 23 Credit strategies. Annual contribution, 2001–2007 and 2013–2020. Million kroner.

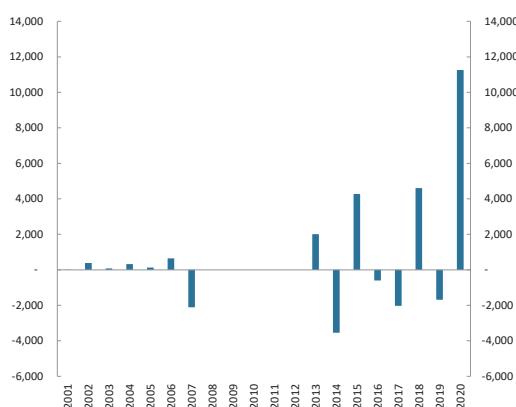
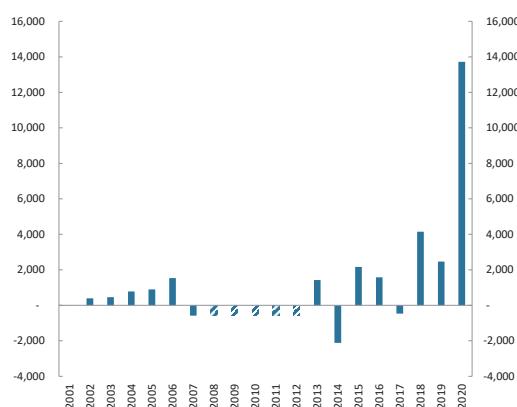


Chart 24 Credit strategies. Cumulative contribution, 2001–2007 and 2013–2020. Million kroner.



specific companies to individual portfolio managers and analysts. This was also a significant step towards aligning those working on the debt capital part of a company's balance sheet with those working on its equity capital. With analysts and portfolio managers working alongside their equity colleagues, it was expected that internal knowledge could be leveraged and that this would lead to better investment decisions across the fund.

In early 2016, all management of corporate bonds was consolidated in the group that was organisationally part of the equity area. In previous years, the fund had learned that building investment strategies based on company expertise and analysis led to more disciplined risk-taking and positioning. These strategies took advantage of the fund's long-term horizon, and also the strong access to company management teams. It was for these reasons that the fund's active strategies based on company risk in both bonds and stocks were combined within a common business unit.

Corporate bond mandates were issued with industry and regional specialisation in mind, and the credit team collaborated with their counterparts in equities. Within credit, there was also a distinct division of labour between portfolio managers, research analysts and credit traders. This structure allowed for a different prism of specialisation, this time by function type. Since the fund began investing in credit in 2001, the corporate bond market had evolved and matured, and specialisation was rewarded as opportunity sets became more competitive.

Another area of progress in credit was increased focus on new issuance of bonds and other relative value opportunities. Instead of trying to generate performance with fundamental analysis, these strategies focus on shorter-horizon

opportunities within bonds issued by the same or similar companies in different parts of the credit curve. Holdings were separated in dedicated portfolios and position taking was managed by the credit trading team. Investment risk was managed within the overall corporate bond portfolio, however, which provided comprehensive risk management and appropriate performance targeting.

Today, corporate bond assets are managed with the philosophies of deep company and industry analysis, robust risk management, innovative trading solutions and a collaborative yet specialised investment team. The team produces independent research and shares information with the equity portfolio managers. The structure of independent mandates with top-down oversight provides a strong yet flexible framework that can respond to changing market conditions.

The approach to the management of corporate debt has evolved considerably since our first corporate bond was purchased some 20 years ago. Today's setup is based on two decades of experience and is intended to be prepared for shifting market conditions. The strategies have outperformed significantly during the last five-year period to December 2020, with global financial markets going through Brexit, low-volatility regimes, stock market highs and a global pandemic.



The emerging market strategies

In 2012, after being evaluated on two earlier occasions, local-currency government debt from emerging markets was added to the benchmark. The benchmark construction was challenging, however, and this decision was reversed in 2019.

The build-up of expertise in Norges Bank in the management of emerging market debt (EMD) goes back to 2005, when a portfolio manager was hired in the New York office as part of the overlay and macro strategies. The focus was on dollar-denominated debt issued by emerging market issuers. While investing in local-currency debt adds more aspects to the investment decision and has many operational challenges, the fundamental research is still quite similar, and many investors operate simultaneously in both local- and foreign-currency debt.

The universe extension

Local-currency EMD is a relatively new asset class that has developed at a rapid pace. This reflects higher economic growth, stronger government finances and increased trade as part of a general globalisation trend in many emerging markets. Today, more than 90 percent of the total sovereign debt stock from emerging markets is denominated in local currency, up from little more than 50 percent back in 2000.

Lending in local currency to government issuers in emerging markets has been a recurring topic of discussion between Norges Bank and the Ministry. The first assessment was in 2002 as part of a broad evaluation of emerging market investments. Analyses of historical returns indicated that it would probably be advantageous for the fund's long-term return to include local-currency EMD in its investment strategy. However, returns in EMD markets had historically been more volatile than in developed markets, and more correlated with equity markets,

particularly during turbulent periods. In addition, there were operational challenges. This led Norges Bank to advise against adding further currencies.

The theme was revisited in 2008. The financial crisis led to a reluctance to invest in EMD, but when the markets calmed down, the idea of making a strategic allocation to the segment was brought up again. The four largest currencies, the so-called G4 consisting of US dollars, euros, pounds sterling and Japanese yen, dominated the fund's fixed-income holdings, with a share of more than 95 percent in 2010. Broadening the fixed-income portfolio to include additional currencies would reduce this concentration among the largest global issuers of government bonds.

The benchmark expansion

In 2012, the fund's benchmark was amended to include EMD. As a result, the currency basket of the fund's fixed-income benchmark was enlarged by ten new currencies. The weight each of them was assigned was based on GDP, in line with the new methodology for the government part of the Ministry benchmark introduced the same year. As the stock of government debt is generally lower in emerging markets, and to a larger extent financed via foreign currencies, basing allocation on GDP resulted in a higher share than an alternative weighting principle such as market capitalisation. China, India, Brazil and Russia, the four largest emerging market economies, did not qualify for the index at the time, however, making a GDP weighting approach viable.

There are several local-currency emerging market bond indices available from various index providers. These indices have different eligibility criteria. The Global Aggregate index requires an investment-grade credit rating. Quite a few emerging markets tend to migrate between investment grade and sub-investment grade, and this causes substantial transition activity in the benchmark that is costly to replicate in the actual portfolio. The changes in the currency composition of the benchmark stemming from downward rating migration happen with short lead times and significant implications for the relative-risk position of the fund. For example, South Africa, a large emerging market, was downgraded to below investment grade on 24 November 2017. Only six days later, at the November month-end, it was removed from the Global Aggregate.

Credit ratings are the result of available quantitative as well as qualitative data and a debt sustainability model created by the rating agency. They are nonetheless ultimately a result

of someone's subjective opinion of the credit quality of an issuer. Outsourced credit analyses from rating agencies should therefore be used as an additional source of information only.

The eligibility of local-currency debt markets for the Global Aggregate index is also dependent on a sufficient ability for investors to invest in the market. To qualify, the currency must be freely tradable and convertible and not exposed to exchange controls. There must be an established and developed forward market or non-deliverable forward market for the local currency so that foreign market participants can hedge their exposures into core currencies. Other aspects of the local bond market, such as market size, settlement and clearing, tax regimes and secondary market liquidity, are also considered when assessing potential inclusion.

The outsourcing of which countries and hence which currencies should be part of the benchmark to the index provider, and indirectly to the rating agencies, has proved to be problematic. Trading in and out of emerging government bond markets at scale results in both high transaction costs and potential market impact. This comes on top of the emerging markets included in the Global Aggregate not being representative of the investment universe available to the fund, which also has access to the bond markets in many countries that do not meet the investability criteria for the index.

To mitigate the troublesome methodology and concentration risk in the Ministry benchmark, the fund's strategic allocation to EMD has deviated substantially from this exposure. Selling bonds when an issuer is downgraded below investment grade is usually not a good investment decision, as there are many market participants forced to do so, creating overall selling pressure in the market. While the fund

has retained holdings in several countries that have made the journey from investment grade to sub-investment grade, the strategic allocation has still been unstable. Sizable benchmark changes have necessitated adjustments of holdings to keep tracking error at an acceptable level.

Preparing for emerging markets

The onboarding of a new market requires co-operation between multiple departments. The portfolio management team would draft the business case, the trading team would bring in new counterparties, the transaction management team would ensure trade settlement and corporate actions were followed up, the risk team would look at exposure in a fund allocation context and at the contribution to tracking error, the legal team would review tax legislation and bilateral tax treaties, and the tax team would make sure potential tax liabilities were discovered.

Taxation needed to be assessed in several countries, with withholding taxes being used by the Philippines, Chile and Colombia. In the last of these, there was also capital gains tax. In Brazil, the largest economy in Latin America, a tax on foreign exchange transactions was introduced in 2010 and had to be considered when making investments in its currency.

Other countries controlled capital flows more directly than with taxes. Taiwan operated a quota system dependent on the size of equity investments, while China and India had investment quotas that had to be acquired.

Since the fund's first fixed-income investment, China has taken many steps to internationalise its domestic, or onshore, bond market. In 2012, however, it was still a rather closed market. The fund instead entered the offshore Chinese bond market that was established in Hong Kong. This market was a pilot project for the internationalisation of the onshore yuan and was small and illiquid. Moreover, investment opportunities were limited in practice to the new securities auctioned once or twice a year by the Chinese finance ministry.

China has since opened up its onshore bond markets through various new schemes. Thanks to its status as a sovereign wealth fund, the fund gained access to the China Interbank Bond Market (CIBM) by the end of 2015. Today, the local-currency Chinese bond market is considered fully liberalised, and the major bond index providers have included it in their flagship fixed-income indices.

India has been one of the countries with restricted access to its domestic bond market. Worried about the impact of large and potentially unstable capital flows on both the level and the volatility of the rupee, the country controlled foreign bond holdings for many years through a quota regime. The quota for foreign investors was 5 billion dollars in early 2012, very small for a market worth 790 billion dollars that year. Whenever a small portion of the quota opened up following the exit of another investor, this would be auctioned off at prices as high as 1.2 percent.

The quota regime has undergone several changes since 2012, including the construction of a separate quota for sovereign wealth funds. Especially during 2018, access to the Indian government bond market became more liberalised. While the market is still not part of the most widely used fixed-income indices, inclusion is an objective for the country and is likely to happen.

Entering emerging markets

During 2012, nearly 150 billion kroner was phased into EMD. This represented around 10 percent of the fixed-income portfolio, and it took ownership in some markets from zero to over 5 percent of total local-currency government bonds outstanding.

The pace of implementation in 2012 was more gradual than the benchmark. This caused relative losses, as sentiment in EMD was strong, probably due to quantitative easing policies in developed markets. The positive sentiment changed abruptly in 2013, however, when the Federal Reserve announced that it would soon start to reduce its purchases of US Treasuries. This put in motion the so-called taper tantrum, where both bonds and currencies from emerging markets sold off aggressively.

Our entry into the EMD asset class did attract the attention of local policymakers. In dialogue with these, the fund has done its best to contribute to more efficient financial markets in these countries by promoting best practices. The establishment of a well-functioning domestic debt market and the effective management of interest rate policy are important contributors to a country's ongoing economic development and stability, as it makes it less dependent on the dollar.

The Russia crisis

The GDP weighting regime chosen by the Ministry was soon to be challenged. In late 2013, it was announced by the index provider that Russia would be included in the Global Aggregate index from 1 April 2014. On the back of this, the fund started to purchase rouble-denominated government debt, aiming to buy approximately half of the allocation before, and the other half after, benchmark inclusion. Just before the inclusion date, in March 2014, Russia annexed the Crimean peninsula, causing the rouble to depreciate and local rates to sell off significantly. The index provider did not change or revise the decision to add Russian local-currency bonds to the index, and Russia was included as planned.

Including Russia at its full GDP weight under the methodology used for the benchmark would have entailed an allocation of close to 40 percent of the total size of the local Russian government bond market. After an emergency meeting, the Ministry decided to include the Russian market at a quarter of this weight. This left the fund with a substantial overallocation to Russian government debt. As a result of Russia's annexation and occupation of parts of Ukraine, international economic sanctions were introduced against the former later in 2014. Following this, Norges Bank ceased trading in the market, apart from exchanging received cash flows in roubles back to dollars.

The sanction regime gradually weakened the economic outlook for Russia. Bonds sold off as yields increased, and the rouble struggled with a depreciation trend throughout 2014. This caused poor performance for the substantial rouble-denominated fixed-income investments that had already been made by the fund. The introduction of an investability factor of 0.25 removed most of the originally planned rouble exposure in the

benchmark, and the decision proposed by Norges Bank served the fund well, as the benchmark return was significantly improved. The fixed-income relative return suffered as a consequence, however, as the portfolio ended up with a very large loss relative to the investability-adjusted benchmark.

The foreign exchange investment strategies

Market functioning in EMD is inferior to other parts of the universe, and this presents opportunities for active investors. It requires a constant focus on news, data and market developments, all of which inform an understanding of price formation in the markets. The EMD portfolio has been actively managed by two different groups of portfolio managers, each specialising in one of the two main drivers of returns: currency risk and interest rate risk. However, there has always been a close relationship between the two groups, partly because the fundamental research would be around the same themes. In addition, unlike in developed markets, returns from currency and interest rates tend to correlate in emerging markets. To gain an in-depth understanding of the most recent economic and political developments, regular meetings with local policymakers and observers has been part of our approach.

The group focusing on foreign exchange was based in Europe until 2018, with portfolio managers at Norges Bank's offices in London and Oslo. This was natural given that London had long been the most important centre for foreign exchange trading. The investment mandates were global, however, and this led to extensive co-operation with local trading resources in Singapore and New York. In Asian emerging markets, foreign exchange and bond trading needed to be co-ordinated, as there are market restrictions in place for holding local currency. In 2018, two of the team members moved to Singapore to strengthen our presence in Asia.

The investment strategy has avoided an overallocation to high-interest-rate currencies. While the "carry factor" has historically given investors a good risk-adjusted return and was an

element in the strategic allocation to EMD, it is also a strategy that entails periods of large drawdowns. Instead, value models cross-checked with fundamental research were used to identify attractive investment positions with mean-reverting properties. The investment strategy has strived for a number of uncorrelated positions with different investment rationales and has also tried to avoid being too correlated with market momentum. Drawdowns in times of stress have mostly been avoided.

In addition to having a diversified set of positions, being patient and waiting for opportunities has been part of the philosophy. The strategy has aimed for low turnover, with a realisation that Norges Bank has no advantage in high-frequency trading.

The foreign exchange investment strategy was implemented both through outright foreign exchange positions and by allocating capital differently to the benchmark. The latter would entail exposure to both currency and interest rate risk. The strategy has smoothed out the pace of benchmark changes and has hence worked well in assisting with implementing these changes. As most emerging market currencies naturally trade against US dollars or euros, exposure to developed market currencies has been part of the opportunity set. In 2017, the capacity to hold positions in developed market currencies was removed, but it was reintroduced to the mandate in 2019.

The interest rate investment strategies

Our investment management focusing on interest rates has paid significant attention to duration and curvature positioning. The team has also, in close co-operation with the trading desk, had responsibility for implementing all the changes made to the country allocations in the market. The EMD rate group in its setup is hence very similar to a developed market enhanced indexing mandate, with limited scope to take currency risk.

While it might be expected that common factors such as global interest rates and commodity prices would drive EMD returns, it is a heterogenous asset class often highly influenced by local factors. A global investor looking at a wide range of emerging markets has a comparative advantage over a local investor looking at just one or a few markets in taking country duration positions. Our experience is that it is easier to succeed by being overweight duration in one country, offset by being underweight in another, than by simply being long or short duration. Duration positions between countries have been the largest performance contributor to the EMD rate mandate.

Curve positions are the second-largest performance contributor. Countries' yield curves develop at a different pace and exhibit differing shapes through shifting market conditions, allowing active investors to add value by positioning across different maturities. Several markets had local regulations that would force yield curves to be shaped in a way that did not reflect their macro fundamentals. One recent example is the introduction of the IFRS 17 accounting standard in South Korea in 2019. This required insurance companies to increase duration on the asset side of their balance sheets, as liabilities were moved from book

value to market value with a resulting appreciation in value. The market outcome was for the yield curve to invert temporarily between 10 and 30 years, as demand for the very long end of the curve was not met with the necessary bond supply. In this situation, the fund could both help market functioning by selling some of its longest-dated Korean bonds, and create an excess return over a passive management approach as the situation gradually normalised and the yield curve returned to a more natural shape.

A third way to enhance returns has been arbitrage opportunities stemming from market inefficiencies, as not all market participants can be active in all market segments. In some cases, Norges Bank has had an advantage in being able to access both the onshore and the offshore markets. One such example has been the Indian onshore bond market where foreign investors had limited access because of the foreign portfolio investment quota system and wanted to have more exposure to the rapidly developing Indian market. This created a sizable dislocation of around 2 percent at times between one-year implied yields in the offshore non-deliverable foreign exchange forward market compared to onshore government bond rates. As the Indian authorities have liberalised access to the bond market, this dislocation has ceased to exist.

Fourth, a thorough understanding of market behaviour can further complement fundamental research and have a significant impact on returns. The optimal security selection is based on several factors, with relative value and liquidity being the most important ones to assess. Several local-currency emerging market government bond curves consist of more than 100 securities, where the spread between more liquid on-the-run bonds compared to less liquid off-the-run bonds can be in the range of 0 to 70

basis points. In addition, it is important to pay attention to various bond auction calendars and buyback announcements, since much of the market liquidity may be associated with such events.

Over almost a decade, the EMD portfolio management and trading teams have built expertise and understanding of the complex and volatile nature of local-currency EMD as an asset class. This manifested itself in around 6.7 billion kroner in excess return for the period from 2013 to 2020. In addition to this, three external mandates for EMD that were awarded in 2015 and terminated in 2017 gained around 500 million kroner during their lifetime. This further indicates that, despite high transaction costs, it is possible to manage a large EMD portfolio and deliver excess performance, as the opportunity set is substantial.

The benchmark contraction

Capital allocation to local-currency EMD peaked in 2015. That year, the fiscal deficit in Brazil threatened to spin out of control, with the country losing its investment-grade credit rating and the market coming under severe pressure. Fearing a fiscal crisis, the fund's investments in Brazilian debt were reduced from 30 billion kroner to around 20 billion kroner.

The allocation underwent further reductions in late 2017, when it was decided to divest around 70 billion kroner from the asset class. With a stronger dollar trend and US Treasury yields on the rise with some degree of complacency on the part of policymakers in some emerging markets, the fund found it prudent to reduce its investments. At the same time, it was decided to skew the country allocation more towards higher-yielding emerging markets.

In 2019, the Ministry decided to remove all bonds from issuers domiciled in emerging markets from its benchmark. The operational challenges stemming from benchmark turnover were a consideration. The phase-out of EMD from the benchmark index started in the second half of 2019.

The benchmark value of bonds issued by governments and companies from emerging economies was around 230 billion kroner in summer 2019, with an average ownership share of around 3 percent in the local-currency EMD markets included in the index. The selling has been patient, making for a calm exit dependent on market conditions. EMD has not been removed from the fund's investment universe, however, and is permitted to account for up to 5 percent of the total bond portfolio.

Chart 25 Emerging market strategies. Annual contribution, 2011–2020. Arithmetic difference in basis points.

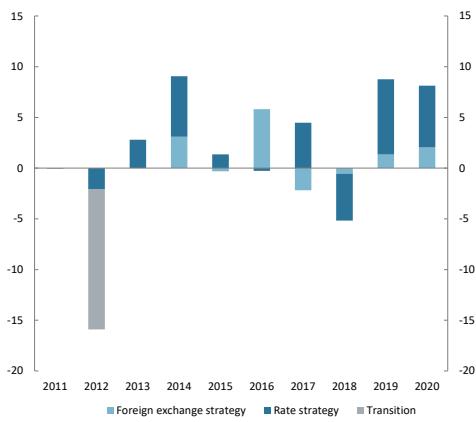
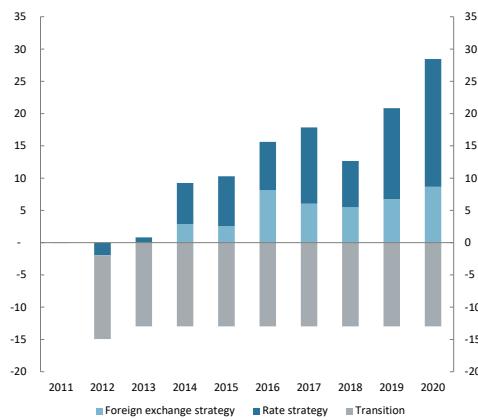


Chart 26 Emerging market strategies. Cumulative contribution, 2011–2020. Geometric difference in basis points.



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Chart 27 Emerging market strategies. Annual contribution, 2011–2020. Million kroner.

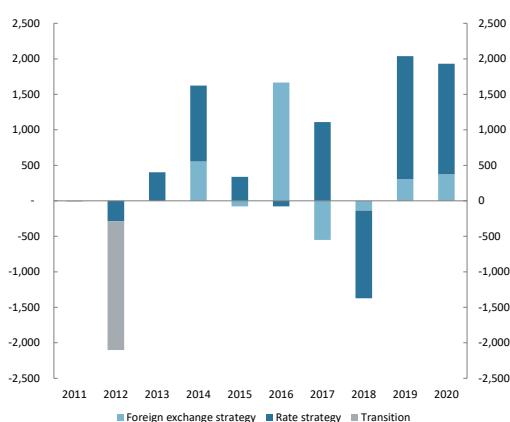
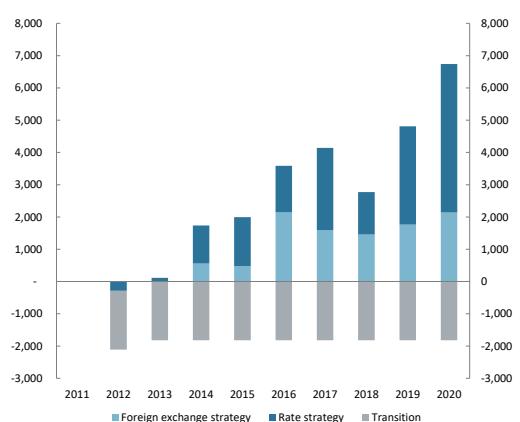
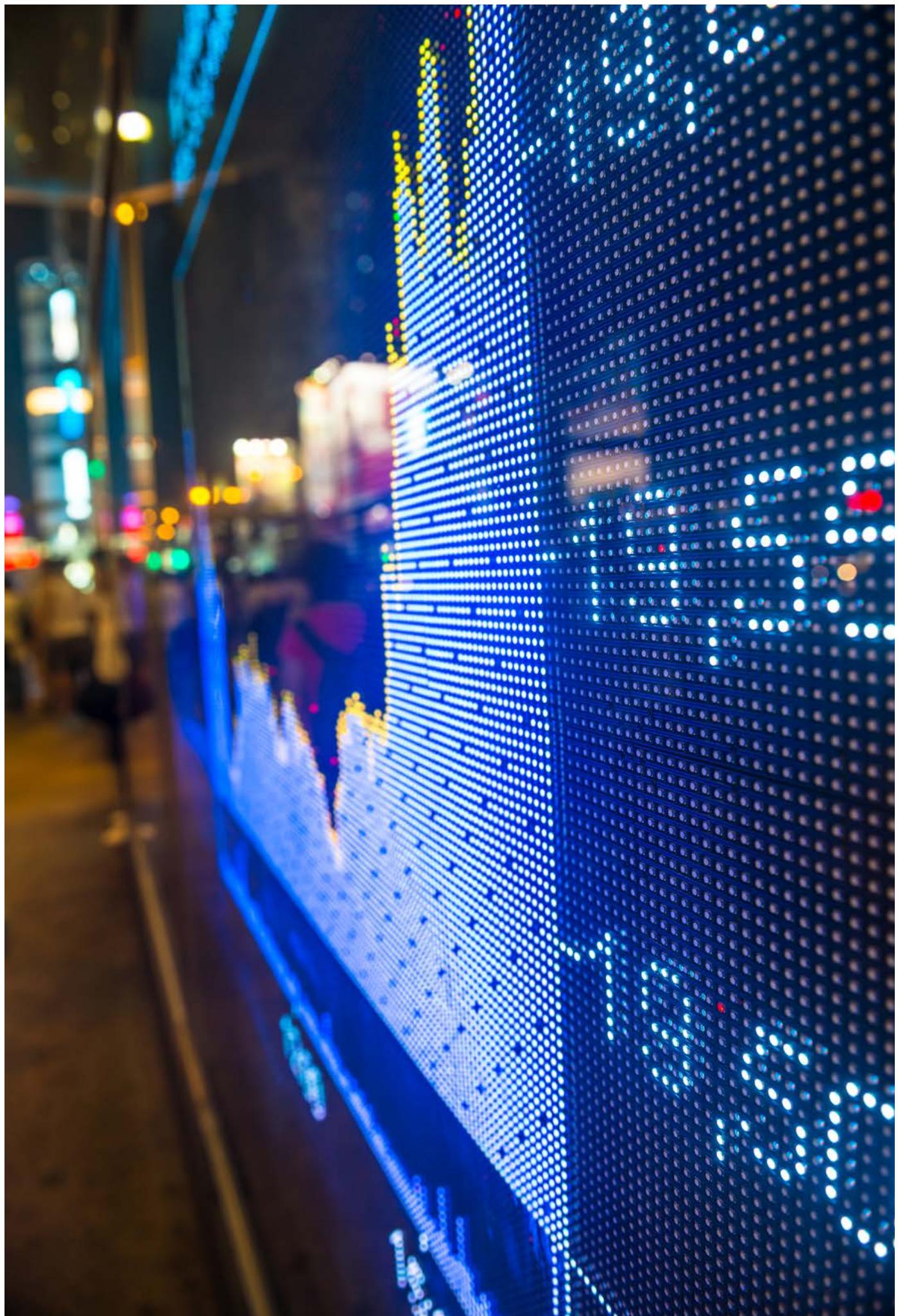


Chart 28 Emerging market strategies. Cumulative contribution, 2011–2020. Million kroner.





The investment returns

As the portfolio is managed with limited deviation from the benchmark, the portfolio returns will largely reflect the benchmark returns. The exceptions are the 6.60 percentage point loss in 2008 and the related 7.36 percentage point gain in 2009.

The enhanced indexing strategy and the relative value strategy delivered steady excess returns in percentage terms and increased excess return in monetary terms from the fund's inception through to 2006. In 2007, the relative value strategy suffered, and the increased size and scope of the risk taking meant that the drawdown in basis points translated into a loss of nearly four years of accumulated monetary returns for relative value.

Decomposition of the relative return between investment strategies for the years from 2008 to 2012 has limited value, as assets were reorganised dynamically in response to the fluid market situation, and our management was characterised by a focus on the totality of the portfolio. From 2013, the most dominant macro tilts were more clearly segregated, and a hybrid model was formed. This combined elements of our management before the financial crisis with knowledge gained from the crisis, and was named asset positioning. Management of corporate bonds gradually took a different path, inspired by and complemented with insight from the more active part of our equity portfolio management.

The transaction costs

As there will always be a bid-ask spread in the market, any portfolio tracking a benchmark will incur transaction costs to implement the desired exposure. These are not accounted for in the benchmark returns, as they are difficult to estimate for index providers and will depend on the investor's size and execution capabilities.

The cost is in general lower for fixed-income investments compared to equities. In the larger and more developed markets, huge volumes can be traded when market functioning is normal with little market impact both in foreign exchange and government bonds. When exposure is changed in non-government bonds, and in less traded currencies, transaction costs and the marginal impact each trade has increase.

It is hence during periods of market turbulence or extraordinary benchmark changes in less liquid parts of the fixed-income investment universe that costs related to tracking the benchmark have been significant. There have been several of these during the lifetime of the fund. The phase-in of non-government bonds during 2002 and 2003, the sale of fixed income to reach a 60 percent equity share in 2009, and the changes in benchmark composition first in 2012 and then in 2019 involving emerging market debt, were all changes that caused a significant performance drag from transaction costs.

The securities lending revenue

Unlike the theoretical benchmark, the actual portfolio can generate income from engaging in securities lending. The revenue is in general lower for fixed income compared to equities. Pure securities lending only works when an asset has some intrinsic value as collateral in a repo transaction. As there are fewer such opportunities in fixed income, the lending revenue is smaller.

There are different methods that can be used to lend the portfolio. Principal lending would be to insource the activity, operating our own lending desk and managing collateral, risk and operations. Another way is agency lending, where we select one or more agents to take care of lending the portfolio, splitting the revenue with the agent. A third way could be to put a portfolio up for auction, where a selected agent takes care of the operational duties, but the decision-making process remains with the principal.

From the start of the fund, there has been agency lending via the custodian. This has brought some very modest income on the fixed-income side. In the early 2000s, two specialist mandates were awarded to securities-lending agents. While the agents originally could only earn income from lending bonds in demand from investors having short positions and maturity transformation in the money markets, this was soon expanded to a strategy of capturing risk premiums in the reinvestments via short-term bond funds.

The investments were off balance sheet and enhanced the income from securities lending. It became clear during 2007 that the funds needed to be marked to market, and they were subsequently assessed on a quarterly basis. The write-downs during 2007 and 2008 were

substantial at 3,088 and 5,640 million kroner, respectively. Through redemptions, some sales and market recovery, the accumulated provision was reversed during the next three years. As there were just a few defaults in the short-term bond funds, they ended up having a small positive return effect for the fund over their full lifetime.

In addition to agent lending, there has been lending activity internally. Internal repo trading was very active between 2000 and 2007 when the investment strategies in fixed income allowed short positions that were financed via the repo market. In addition to this activity, some lending of bonds in demand from investors having short positions has always taken place when such opportunities have presented themselves.

As with other strategies that aim to create value for the fund, earning revenue from securities lending depends on the skill and systems of the manager. Sound knowledge of counterparties and the market, good technological solutions and a solid legal framework are necessary building blocks. After a few years with very limited revenue when the specialist agent lending was discontinued, regulatory requirements in the banking sector created some opportunities in fixed-income securities lending in the years from 2016 to 2018. This has since faded, and earning potential is nearly absent in the market at the end of 2020. The mantra sometimes found in reports from Norges Bank, that securities lending revenue might be able to offset the performance drag from transaction costs, is hence a more optimistic assumption today than has historically been the case.

The relative return in 2008

The management of the fixed-income part of the fund had a negative excess return of 6.6 percentage points in 2008. The losses can be attributed to five main market segments where the risk taking was excessive going into the crisis.

The financial crisis began with a drop in the prices of securities backed by US sub-prime mortgages. The fund was overexposed through external fixed-income mandates that were levered up and/or involved in the non-agency MBS part of the market. This exposure contributed significantly to the under-performance of the portfolio, accounting for around 40 percent of the total.

As uncertainty about the value of securities related to the US MBS market grew, the crisis spread to the related money market. The fund had lent securities and reinvested the cash received for these loans in various money market instruments with a higher rate of interest. Many of the assets purchased were difficult to value during 2008, and significant write-downs were made in line with accounting principles. Losses associated with these investments accounted for around 10 percent of the portfolio's overall underperformance.

As banks' losses on loans and investments soared, they had to take loans back onto their own balance sheets that had previously been funded on a short-term basis in the money market. As the extent of banks' actual obligations became clear, the market's valuation of credit risk in respect of bank funding changed dramatically, and bonds issued by financial institutions became hard to sell. At the beginning of 2008, the portfolio had large positions in various parts of banks' capital structure. The portfolio was particularly exposed to banks' regulatory capital and covered bonds.

Losses on investments in bonds issued by banks accounted for almost a third of the losses.

At the beginning of 2008, the portfolio had large positions in swap spread investment strategies. A swap spread is the difference between the fixed component of a swap and the yield on a sovereign debt security with the same maturity. These positions were part of relative value strategies that failed to foresee the magnitude of the price divergence that took place. Such strategies accounted for around 10 percent of the overall underperformance.

As the financial crisis spread, the market began to discount a sharp economic downturn and a growing probability of deflation in several countries. The portfolio had an overweight in inflation-linked bonds, especially in Japan. The liquidity in this market segment collapsed in 2008, with pricing of inflation expectations reaching extreme deflationary levels. Losses on positions in inflation-linked bonds accounted for around 10 percent of the total.

The relative return in 2009

Prices for the assets that had caused the losses in 2007 and 2008 recovered strongly in 2009. This was the main reason for a record excess return of 7.36 percentage points for the fund's fixed-income portfolio. The legacy positions that were isolated in a segregated structure internally in Norges Bank with the aim of maximising their value made the largest gain, of close to 40 billion kroner, while the more dynamic management using an enhanced indexing approach produced an excess return of nearly 9 billion kroner. Attributed to market segments, the excess performance largely breaks down in a similar way to the losses the year before.

The US introduced a number of measures to support the market in late 2008 and early 2009. The aim was to boost demand for securitised debt, stimulate refinancing and home purchases, and limit foreclosures. Prices for the fund's holdings of US securitised debt increased, with around half the losses from the years before being recouped. US securitised debt accounted for about a quarter of the excess return in 2009.

As uncertainty in the money market fell, more than 80 percent of the loss of value associated with reinvestments of proceeds from bond lending in 2007 and 2008 was reversed. The size of the short-term bond funds was also greatly reduced through maturation and some sales. Money market investments accounted for 10 percent of the excess return in 2009.

Authorities' willingness and ability to support banks through recapitalisation and funding options eased concerns of systemic collapse. Investments in bonds issued by banks accounted for nearly a third of the fixed-income portfolio's excess return in 2009.

Liquidity continued to be difficult, and market inflation expectations were still substantially lower than analysts' estimates at the end of 2009. Inflation-linked bonds accounted for about 5 percent of the fixed-income portfolio's excess return in 2009.

As uncertainty faded and market functioning improved, banks started to lend to each other, and swap spreads corrected. The reorganisation of assets towards the end of 2008 segregated interest rate swap contracts from sovereign securities, making it challenging to measure the effect precisely, but a significant share of the loss from the swap spread investment strategies was recouped. New relative value opportunities were also plentiful, as the initial implementation approach central banks took to their quantitative easing programmes had a significant impact on the pricing of individual bonds. As the monetary authorities enhanced their approach, such distortions were typically reversed.

In the first half of 2009, a sizable amount of government bonds was sold to reach the new strategic equity weight of 60 percent. These bonds underperformed other segments of the fixed-income market later in the year, and this contributed to the excess return. In addition, many securities were downgraded below the rating threshold for the benchmark and were subsequently excluded. This further increased the relative exposure to fixed-income risk premiums.

The relative return from internal fixed-income management (1998–2020)

In the management of financial assets, it is possible to construct portfolios that in most years will outperform the benchmark by adding investment risk. Superior carry can be obtained in fixed income by loading on risk premiums embedded in the fixed-income investment universe, such as credit and liquidity risk. This leads to a probability distribution with a majority of positive observations, but with negative fat tails, as with insurance.

This understanding is used as an argument for capital owners to create mandates expressing the tolerance level for investment risk in the form of benchmarks, and have asset managers passively follow these. While there is merit to such an approach, it generally shifts choices that must be made from the asset manager to the index provider and the capital owner. Off-the-shelf indices are not adapted to the special needs of individual capital bases, and tailor-made solutions often become complex and have unintended side-effects.

While the fund and its fixed-income management are by and large based on an indexing approach, the belief at Norges Bank has always been that some active management is necessary to ensure the best possible quality in the performance of all aspects of the management task. This includes advising on the fund's investment strategy and contributing to well-functioning markets.

The results from deviating from the benchmark have exceeded expectations for internal management focused on excess return generation for the fixed-income portfolio. The cumulative monetary return has been 85.9 billion kroner above the benchmark. A purely passive approach with securities lending by the

custodian would have underperformed the benchmark due to transaction costs.

These results have been achieved with modest extra resources compared to passive management, and moderate investment risk for the fund. The standard deviation of the relative return for the full period is 15 billion kroner, with an average return of 3.7 billion kroner. This gives an information ratio of 0.25. Focusing on the latest ten-year period, the information ratio is 0.84 when using the monetary return, and as high as 0.97 if the percentage return is used as the basis for the calculation.



Chart 29 Internal fixed-income strategies. Annual contribution. Arithmetic difference in basis points.

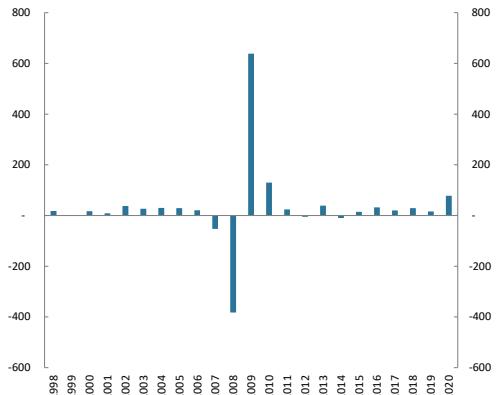


Chart 30 Internal fixed-income strategies. Cumulative contribution. Geometric difference in basis points.

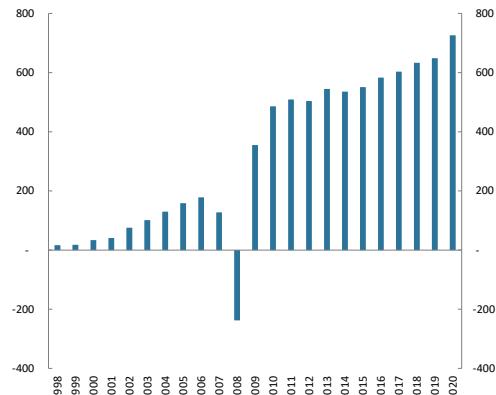


Chart 31 Internal fixed-income strategies. Annual contribution. Million kroner.

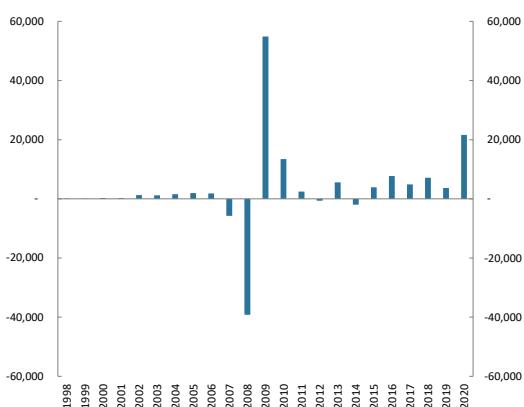
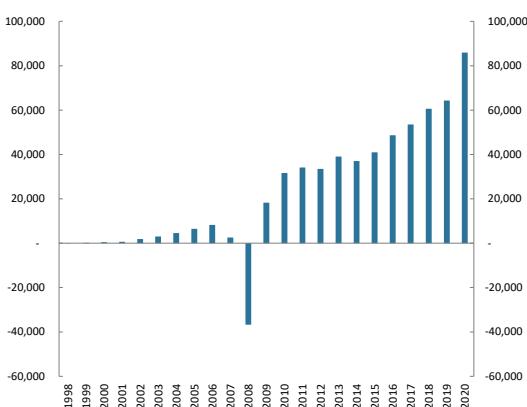


Chart 32 Internal fixed-income strategies. Cumulative contribution. Million kroner.



The relative return from the fixed-income asset class (1998–2020)

The results from the management of the fixed-income asset class are also impacted by external fixed-income mandates and allocation strategies. The latter has affected both the total capital allocated to the fixed-income portfolio and the composition of the portfolio. Many allocation positions have reflected a long-term strategy of optimising the risk-adjusted return for the fund, and not the fixed-income part of the portfolio on a stand-alone basis. Others, such as the emphasis on fiscal strength, have incorporated the Ministry's mandate requirements.

External managers already managed assets on behalf of the central bank prior to the fund being established. This activity expanded considerably in 2002 as the strategic exposure to mortgage-backed securities in the US was outsourced. External managers performed poorly going into

and during the financial crisis, and external management of fixed income was phased out on the back of this experience. The assets that were taken into internal management were largely retained, and these boosted the results for internal fixed-income management in the following years.

In the years from the fund's inception until 2006, the relative return in fixed income was dominated by positive results from enhanced indexing and relative value strategies. As the crisis in the US mortgage market spread to global financial markets, the excessive risk taking going into the crisis was exposed and led to unforeseen deviations in relative returns in 2008 and 2009. Since then, the total relative return for fixed-income management has often been dominated by allocation strategies anchored at levels above those directly involved in the daily management of the fixed-income portfolio.

Relative return for fixed income asset class, per year

Year	Relative return (bps)	Strategy/market colour
1998	+21	Activity dominated by transition into new benchmark and raising capital to purchase equities
1999	+1	Gains in fixed-income management offset by losses in tactical asset allocation
2000	+7	Alpha management in self-funded portfolios segregated from beta management with positive results from both
2001	+8	Excess return from the relative value and enhanced indexing strategies
2002	+49	Half of the outperformance from enhanced indexing while a quarter each from relative value and external mandates
2003	+48	Very strong year for external mandates, which contributed close to half of the result
2004	+37	Results dominated by contributions from enhanced indexing and relative value strategies
2005	+36	Breakdown of results by strategy similar to the year before
2006	+25	Another year of continuation, with relative value, enhanced indexing and external mandates performing strongly
2007	-129	Financial crisis causing losses in most mandates with particularly poor performance by externally managed assets
2008	-660	Positioning in US securitised debt and corporate debt caused around 70 percent of the mark-to-market losses
2009	+736	Legacy positions that were held onto through the financial crisis recovered sharply in price
2010	+153	Continued recovery in assets that suffered during the financial crisis, and cautious positioning in euro area market
2011	+52	Gains from underweight in unsecured bonds from financial institutions and overweight in Japanese inflation-linked bonds
2012	-29	Relative loss from a more patient implementation of emerging market exposure than the Ministry benchmark
2013	+25	Less sensitivity to taper tantrum via short duration and an overweight in covered bonds were positive return drivers
2014	-70	Short duration and overweight in Russia as an investability factor introduced into the Ministry benchmark caused losses
2015	-24	Negative result dominated by overweight in emerging markets, most notably in Brazil
2016	+16	Gains from emerging market overweight and management of non-corporate bonds
2017	+39	As the year before, an overweight in emerging market was the single largest source of excess return
2018	-1	Gains in management of corporate bonds offset by losses from an allocation overweight in emerging markets
2019	+11	Largest gains came from portfolio management of emerging markets and euro-denominated debt
2020	+76	Bought back underweight in credit risk during height of Covid-19 market turbulence, and relative value strategies

Chart 33 Total fixed-income asset class. Annual contribution. Arithmetic difference in basis points.

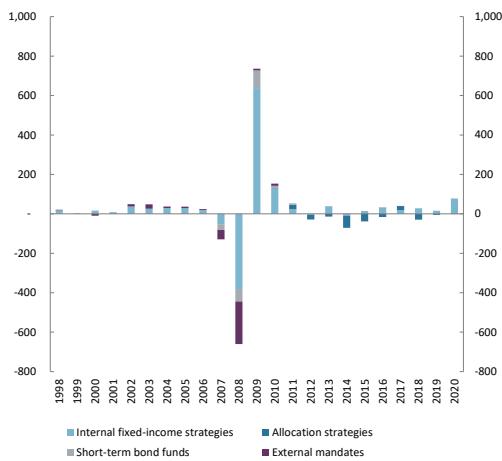


Chart 34 Total fixed-income asset class. Cumulative contribution. Geometric difference in basis points.

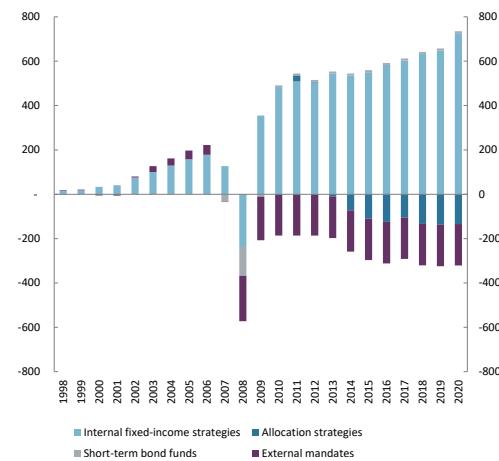


Chart 35 Total fixed-income asset class. Annual contribution. Million kroner.

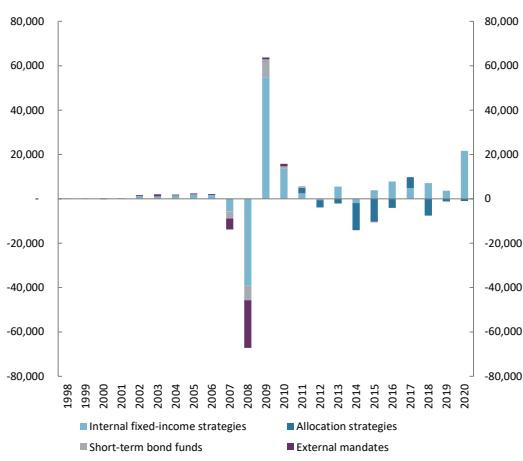
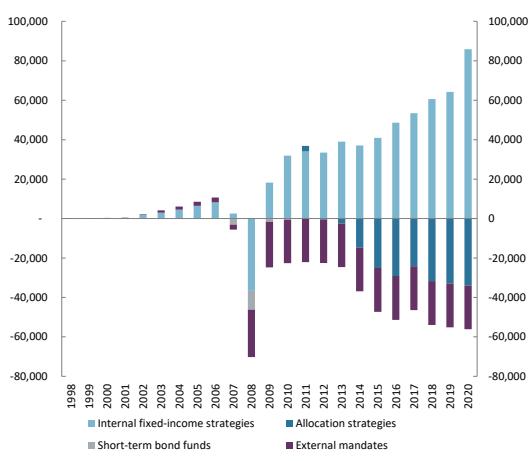


Chart 36 Total fixed-income asset class. Cumulative contribution. Million kroner.





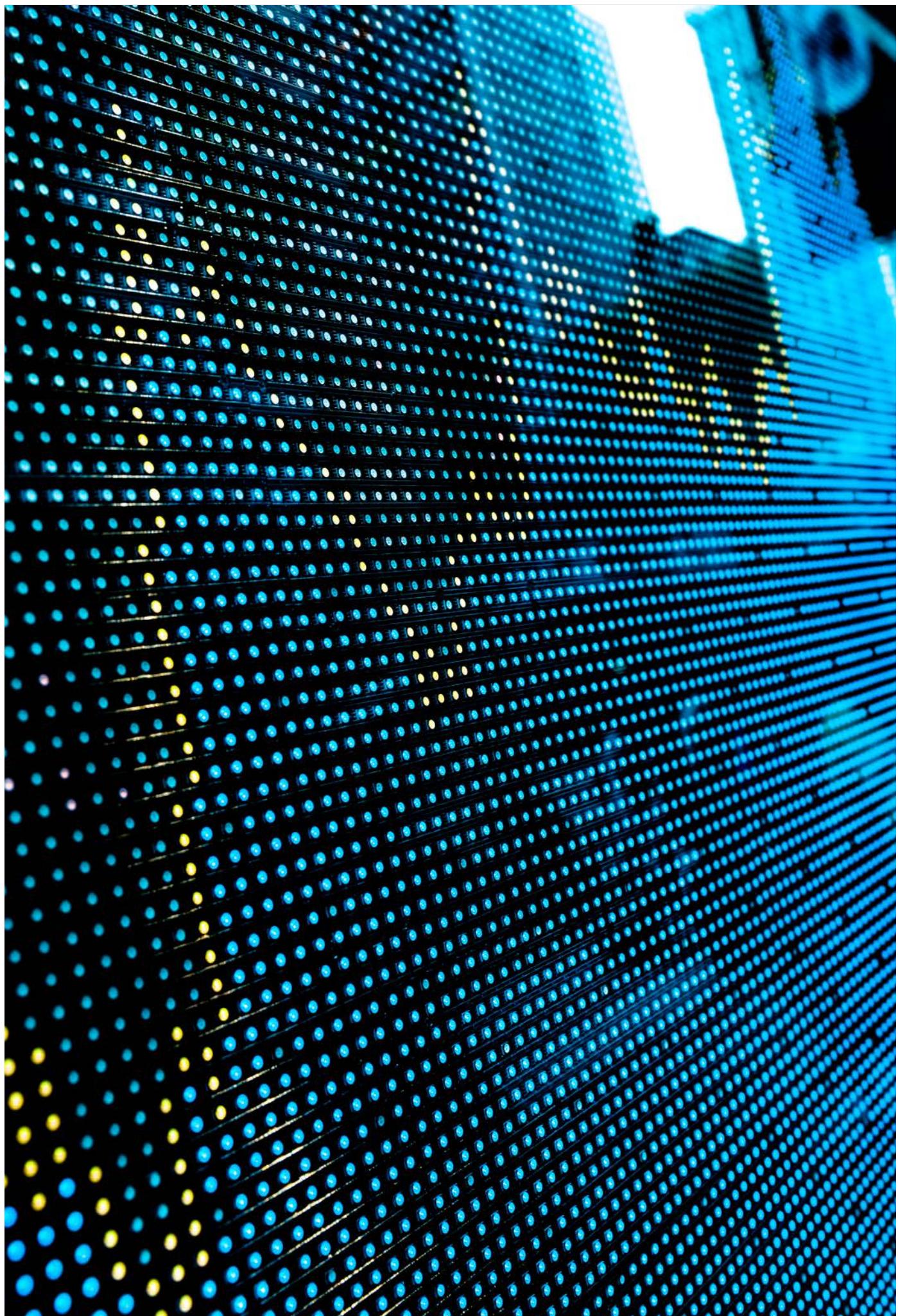
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Trading in size

In 2008, Norges Bank decided to restructure the fixed-income organisation and establish a separate trading desk. The main motivation for separating trading from portfolio management was a desire to specialise. With the new division of labour, portfolio managers could focus on the long-term portfolio construction and traders on the short-term timing and the sourcing of liquidity in the market. From a compliance perspective, the separation of trading also ensured that all transactions were monitored by at least two people.

The trading desk

When the trading desk was established, traders were given autonomy from the outset over how a trade should be executed in the market. The portfolio managers have a long-term view of markets and how to construct their desired portfolio exposure. Traders will know the current market environment and how best to source liquidity and time the execution of a trade in the market. The concept of an execution desk for fixed income was well established in other buy-side firms. The standard setup would be for a portfolio manager to instruct the trader how and when to execute a trade in the market. Our unique characteristics as a sovereign wealth fund with one owner and a long time horizon, together with developments in the market structure after the global financial crisis, made it very clear that our fixed-income trading desk would not follow this classic concept of an execution desk. Therefore, a better way was to define it as a trading desk whose goal was to obtain best execution over time, minimising transaction and market impact costs across the aggregate of all orders.

At first, we considered creating a trading desk that would mimic the banks' market-making model. The first challenge here would be to establish an internal price fair for both the

portfolio manager and the trader. Even though prices in most fixed-income markets can be observed on a screen, there is little transparency regarding market depth – how much volume can be traded at specific prices, and how much volume there is above and below the current market price. Most observed screen prices are not firm – the banks are not actually obliged to trade at the prices they quote. It can quickly become a challenge to set a fair internal price for a specific trade size. Another obstacle to replicate a traditional market-maker desk is that these are run with profit in mind and therefore include compensation for the risk involved when quoting a price. A trading desk in Norges Bank should not explicitly be a profit centre as it would potentially create an internal conflict of interest. An internal trading desk's purpose should be to provide a service to the fund and its portfolio managers that ensures cost-efficient implementation of investment decisions to minimise the market impact.

The separation of the investment decision and its implementation in the market took place gradually from March 2008. By the fourth quarter of 2008, all orders were instructed by a portfolio manager and executed by a trader in the market. A good dialogue between the portfolio manager and trader every time an order is sent to the trading desk has always supported a secure and transparent process. Portfolio managers will typically specify the intention behind the order in terms of immediacy and price targets. These inputs give the traders the prerequisites for assessing how to execute the trade.

Measuring trader execution performance has always been an ambition but a very complex matter. The lack of a consolidated tape – a central register that reports all bond trades with price, volume and timestamp – makes it impossible to reasonably measure traders'

shortfall (implementation cost). Consequently, the focus has been on driving trader performance measurement towards hard performance numbers, as described later.

Setting up an efficient trading desk involves establishing trading guidelines and procedures to define the workflow of orders from the portfolio managers through to execution on the trading desk. One of the first tasks for the trading desk would be to find an order management system (OMS) to handle our portfolio managers' orders in a structured way, where all steps from initial order to final trade execution would be captured and recorded. In previous years, the fund had invested time in finding a better portfolio management system, and an early decision was made to use BlackRock's system called Aladdin. The system also had an OMS module, and this was implemented in May 2008 as the first real OMS used on the trading desk. The desk used Aladdin until it was replaced with Linedata's system Longview in February 2016. Several systems have been built internally to manage interest rate risk and orders to support the trading process.

The trading team

The people who moved to the trading desk in 2008 were all former fixed-income portfolio managers in the fund. The desk was fully operational from inception with very experienced traders, many of them with backgrounds in market-making outside the fund. We have recruited traders both externally and internally over the years. Where there has been an immediate need for senior traders, we have hired people externally with trading experience, mainly from the sell side. Experienced trading colleagues then trained internal hires from other departments.

First, we established a trading team in New York and Oslo with three traders at each location. In Asia, we had assistance from our Shanghai office, where we had an equity trader with previous experience from fixed-income trading on the sell side. The team in New York quickly grew to four traders and has varied between three and six traders over the years. In Oslo, the team grew to four members shortly after

inception and then to seven from 2014 to 2018. This included one to three traders based in our London office from 2015 to 2018. From 2013, we hired externally to build a dedicated fixed-income trading desk in Singapore to cover our growing activity in Asia. The team there grew to three full-time fixed-income traders in 2015 and has since consisted of two or three traders.

Since inception, proximity to our trading counterparties both in terms of geography and time zone has put our traders in the best position to communicate and gain market intelligence from local market players. Trading presence in the various regions has also made it easier to recruit local trading expertise. This is of utmost importance in a people business based on relationships and mutual trust. The fund's ability to retain and hire very senior personnel and utilise their skills through specialisation has taken the fund through challenging times with no major market disruptions.

Chart 37 Number fixed-income and foreign-currency traders by region, 2008–2020.

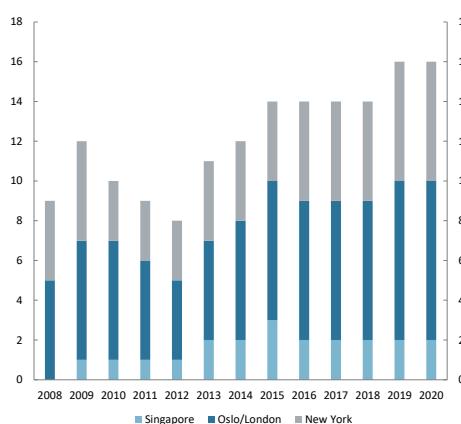
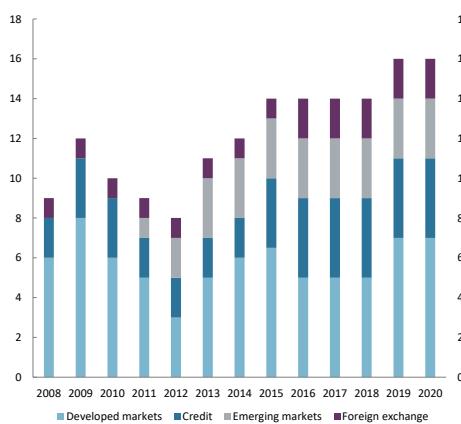
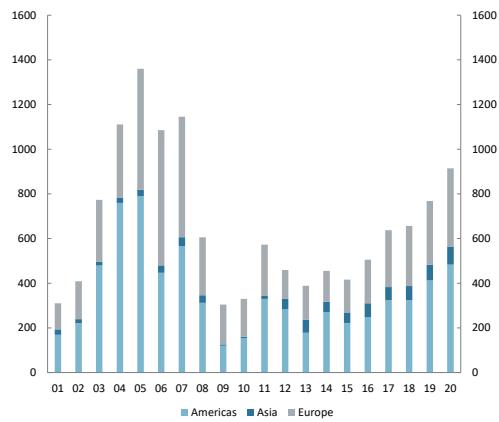


Chart 38 Number of traders by specialisation, 2008–2020.



Providing feedback to the portfolio manager on the execution helps build internal trust and knowledge to support future investments. The communication between the portfolio manager and the trader in Oslo was initially by telephone as the trading desk was located on a different floor. However, permanent chatrooms were soon established to supplement verbal communication, as written communication in chatrooms is an effective way of sharing information between areas. In New York, where a smaller organisation allowed for closer collaboration, it was quickly discovered that there were benefits from having traders sit next to the portfolio managers. The possibility of instantly sharing specific market information was paramount in making good investment decisions, not least because they can be implemented in many different ways in a large bond universe. In Oslo, portfolio managers moved to sit back-to-back with traders in 2013.

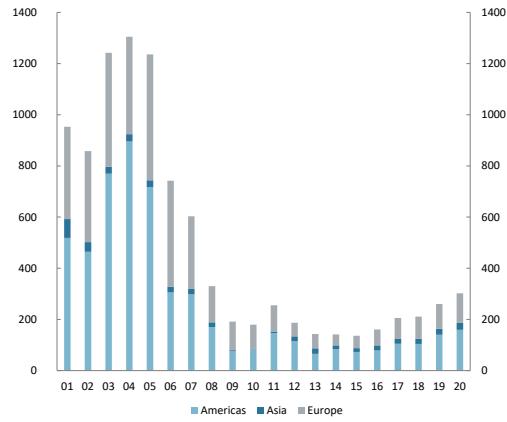
Chart 39 Total trading volume per year, all bonds by region. Million US dollars.



The trading activity

The trading desk was established amid the financial crisis, so one might have expected high trading volumes. On the contrary, trading volumes were much lower in 2009 and 2010, and we have to go right back to 2001 to see similarly low volumes in absolute terms. The fund was much smaller then, so trading volumes had never been lower in relative terms than they were in 2009 and 2010. There were two main factors behind this. The first was the extensive overhaul of fixed-income management in 2008, going from being a very active leveraged investor to managing the overall portfolio exposure in 2009 and 2010. The second was the dramatic fall in market liquidity in 2008–2010, which put a lid on many micro strategies due to higher transaction costs. In 2009 and 2010, trading volumes were only around a quarter of what they were in 2004–2007. Volumes in 2008 were heavily impacted by a deleveraging of the

Chart 40 Total trading volume per year, all bonds by region. Percent of total value of bonds.



fixed-income portfolio and so high compared to 2009 and 2010. The jump in 2011 was mainly triggered by uncertainty within the European Monetary Union. From 2012 to 2015, trading volumes stabilised with the new structure on the portfolio management side, and variations from year to year were explained by market opportunities. The implementation of emerging markets in the reference portfolio took place in these years. From 2016, trading volumes increased gradually, due partly to the new setup on the credit trading desk, and partly to increased opportunities in micro strategies as liquidity returned to a new, lower normal than before the crisis.

Trading in interest rate swaps took place on a bilateral basis until 2015 and was a vital instrument for fixed-income strategies in the years before the financial crisis. The restructuring of fixed-income management in 2008 led to an

unwinding of interest rate swap positions in 2008–2009. Since 2010, the fund's use of interest rate swaps has been low relative to bond trading, with the exception of 2011 when market opportunities led to increased trading.

Since 2015, all new derivatives trading has been cleared at the London Clearing House. This activity has mainly been used to express relative value strategies between the pricing of bonds and interest rate swaps. Following best practice in central clearing has meant that the fund has had no bilateral counterparty risk from derivatives trading since 2015.

Chart 41 Total trading volume, interest rate swaps by currency. Billion US dollars.

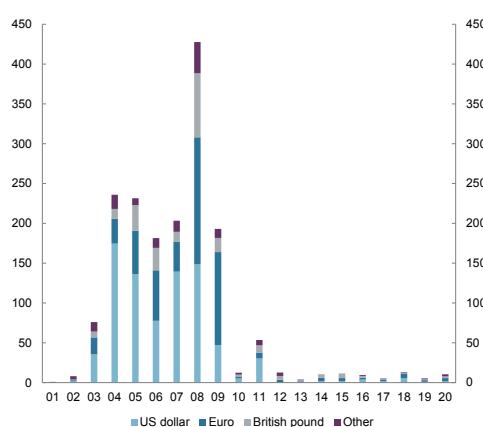
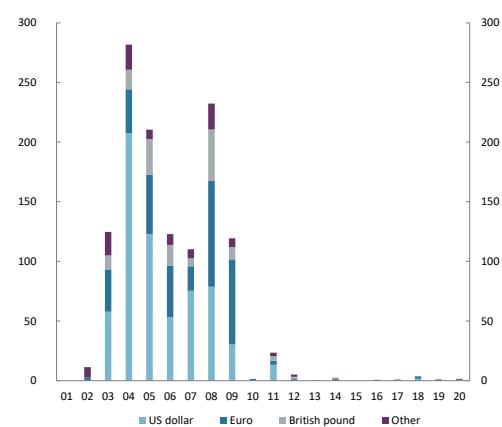
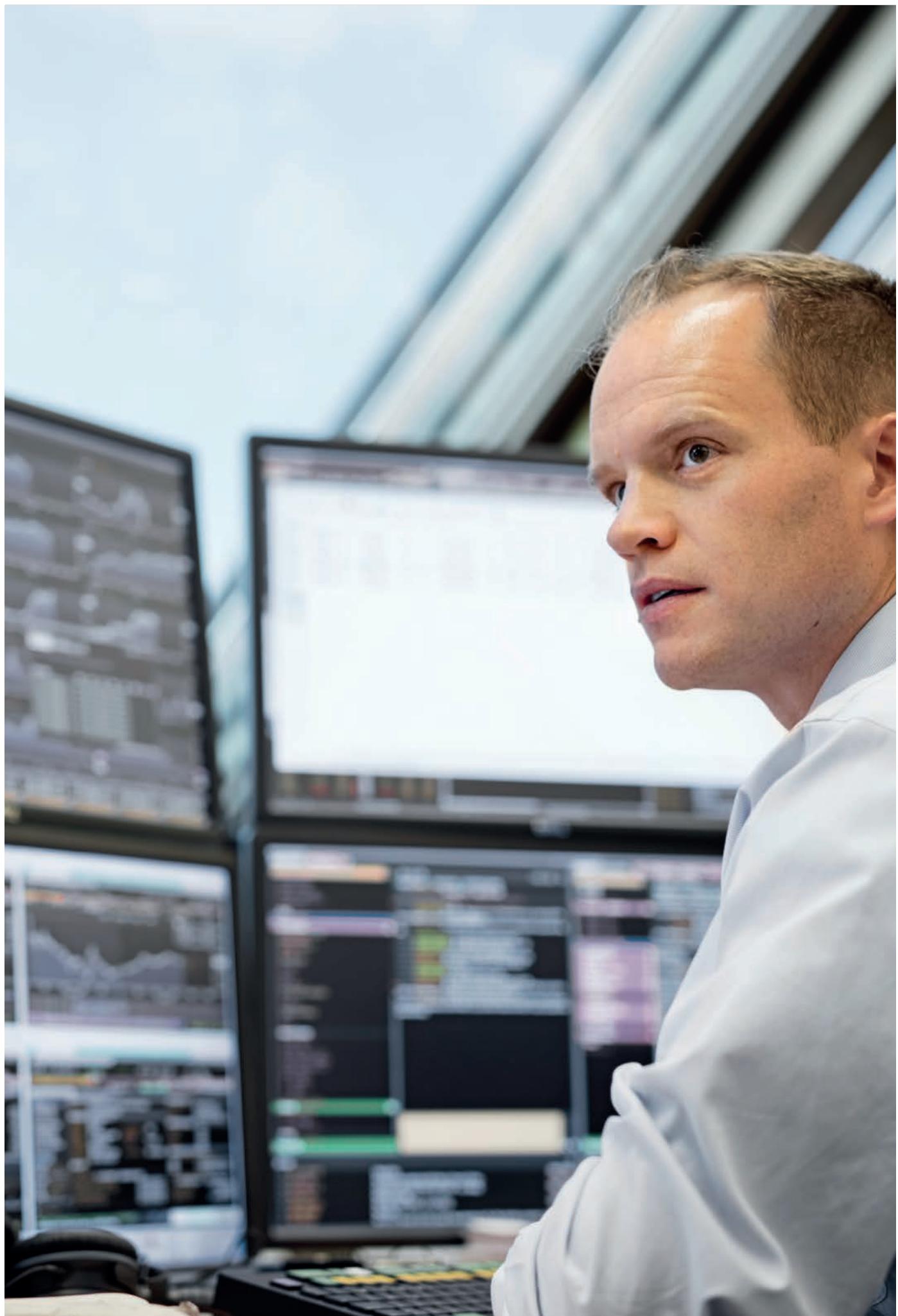


Chart 42 Interest rate swaps volumes by currency. Percent of total value of bonds.





Trading in the market

The fragmented nature of the fixed-income market makes it difficult to adapt to an exchange trading model. The trading desk has explored different trading mechanisms to improve transparency and decrease transaction costs.

The marketplace

The very nature of fixed-income markets has meant that they have always been based on principal-to-principal trading over the counter (OTC). Trading OTC means traders will always know the identity of the counterparty. The opposite of an OTC trade is when a transaction occurs on an exchange, such as the London Stock Exchange. When trading on an exchange, the trader will not know the counterparty, as the exchange will stand in the middle, facilitating the trade. Fixed-income markets consist of many hundreds of thousands of individual bonds and derivatives. Price formation is often driven by large institutions such as asset managers, pension funds, insurance companies and hedge funds (the "buy side"). The active investors in fixed-income markets are larger in size but fewer in number than in the equity market. The equity market also has more retail market participation than the more institutionalised fixed-income market. Banks' market-making desks (the "sell side") have traditionally provided liquidity in fixed-income markets. The sell side having an obligation or intention to quote prices in fixed-income instruments to the buy side is essential for understanding how the fixed-income market and its liquidity work. There is also an interbank market where banks trade with each other in a closed community. Interbank trading can take place directly between the banks or through interbank brokers.

OTC voice trading started to move towards electronic trading venues almost two decades ago. Ever since, there have been multiple attempts from several trading venue providers to create a better way of trading fixed-income instruments. Many of these initiatives have tried to bring more fixed-income market players together by offering one or more new trading protocols. Although there have been more than 100 such initiatives in the last decade, few have succeeded and even fewer have been relevant for large funds. The fund's usage of trading venues is limited to a handful, mainly using the RFQ protocol. Today, most trading venues still have the classic division between banks' market makers being the liquidity provider and buy-side institutions being the liquidity taker. However, there is a continuous push to move away from this structure and challenge the status quo. The fund fully supports multilateral trading venues that can facilitate all-to-all trading using any trading protocol valid for the relevant fixed-income instrument. Developments in the fund's electronic trading are shown in the chart below. As can be seen, the electronic share was below 50 percent up to 2018. The substantial increase in electronic trading from 2019 to 2021 to around 70 percent can be explained by the fund's usage of automated intelligent execution in the hedging of interest rate risk in the corporate bond markets and, to some extent, also outright trading in the US Treasury market.

The trade counterparties

The bankruptcy of the investment bank Lehman Brothers in September 2008 brought the end of market liquidity as we knew it, almost overnight. There had been periods of reduced liquidity before, but the Lehman Brothers bankruptcy was a game-changer, transforming the market environment.

Most liquidity is still provided by banks allocating capital to dedicated market-making of fixed-income products. The risk capacity of banks' market-making desks has never returned to the heights of the years before the financial crisis. The establishment of a fixed-income trading desk in 2008 was very timely in the sense that the execution of fixed-income products became an even more critical part of the investment process, especially in enhanced indexing strategies.

Fixed-income trading is a people business where mutual trust and the relationship between the fund and its counterparties are crucial for cost-efficient execution of trades. Understanding how prices are made and how trading positions are managed on the sell side (banks) is critical for an efficient trading desk on the buy side (asset managers).

Trading bonds has always required many counterparties. Banks must prioritise how to utilise their balance sheet in being a market maker, as capital is expensive in the new regulatory world after the financial crisis. The list of counterparties will therefore be dynamic, depending on which markets counterparties focus on over time. The bond universe is split into sub-sectors within individual currency markets. To be a leading price maker in a sub-sector, a bank must hire specialist traders and allocate risk capital. As capital is scarce, many

banks choose not to be active in all sectors in the bond universe. To ensure that the fund can always access adequate liquidity at a competitive price, five to ten counterparties are required in most sub-sectors of the bond market. This quickly adds up, and counterparties are selected based on strict criteria, ensuring that they are among the leading liquidity providers in their sub-sector of bond trading and that they are willing to provide the service at low cost.

As counterparties most often are in competition for a trade, we can quickly assess whether a counterparty delivers according to our expectations. Regular follow-up of

counterparties is therefore essential to ensure that they are kept on their toes and provide us with the best possible service. As our relationship with our counterparties is of a long-term nature, we emphasise an open and honest dialogue where trading feedback is given both ways. We constantly give counterparties feedback on pricing, and we try to act in a way in the market that does not hurt their trading book. We reiterate being a friendly investor, meaning we expect the best price for the size they can manage without having a price impact. We thus aim to achieve the best price possible for our trading both today and in the future.

Chart 43 Electronic bond trading volume, in percent of total bond trading, 2010–2020.

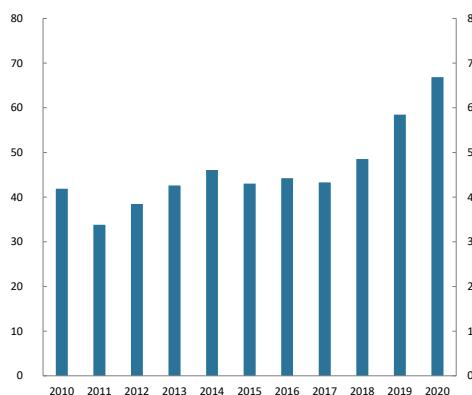
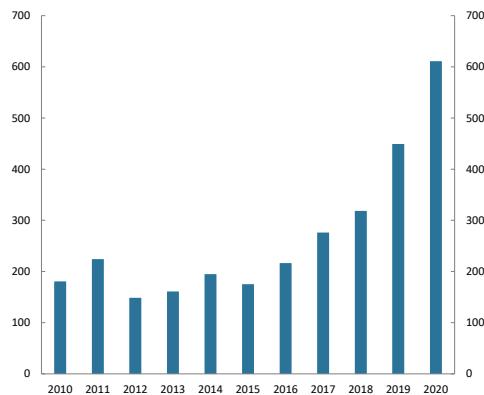


Chart 44 Electronic bond trading volume, 2010–2020.
Billion US dollars.



The trade types/protocols

The description of the trading protocols below paints an overall picture of those that are most important for the fund. It is not a complete list of all available protocols, as every protocol exists in many versions or as a combination of different protocols.

Bonds and fixed-income derivatives have traditionally been traded by voice over the counter. The expression "voice" comes from agreeing in a size and a price on a tradable instrument over the telephone. Today, agreeing on a price in an electronic message system such as Bloomberg's chat functionality will also be referred to as a voice trade. Trading voice simply means a transaction is not executed on a specific trading venue. Trading voice over the phone was a very demanding process when wanting a quote on a bond from more than one counterparty. Traders either had to have two or more telephone conversations going simultaneously or ask colleagues for help. While waiting for a quote from all counterparties, the first quote would generally expire as time had passed. The first electronic trading venues for buy-side institutions dealt with this problem by simultaneously asking several counterparties in competition.

Request For Quote

The Request For Quote (RFQ) trading protocol is still the most used mechanism for trading bonds. The protocol simply means that the investor asks between one and five market makers for a buy or a sell price in a specific instrument for a certain size. The most common development in almost any bond market has been to go from an RFQ voice market to an RFQ market on an electronic venue.

The RFQ protocol's weakness is that it shows what direction you want to trade to everyone you ask in competition. This is a considerable risk for a buy-side firm, as it can lead to market leakage and front running and make it difficult to execute large sizes. Despite this weakness, the protocol is the only one available for most liquidity offered by banks' market makers. Therefore, the usage of the protocol needs to be carefully calibrated to market liquidity, which again implies that the traders can warehouse risk. Our trading setup is fully designed to cope with that reality.

In 2019, the fund started to use a so-called automated and intelligent version of the RFQ protocol for smaller trades in liquid Treasuries. The protocol simply automates the RFQ process using intelligent criteria for selecting counterparties and pre-defined boundaries for when an execution of a transaction can be accepted.

Other trading protocols

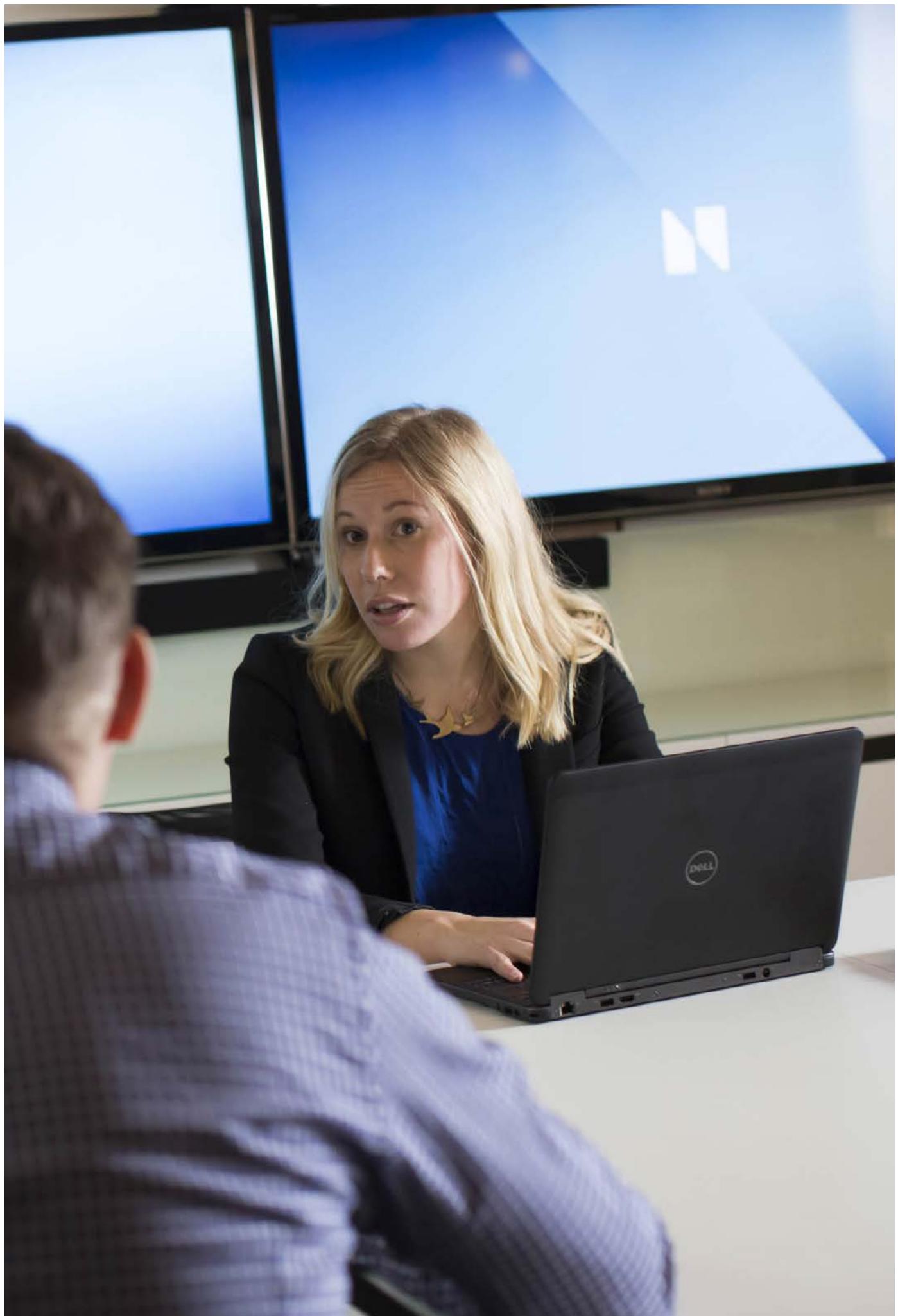
Over the past 20 years, RFQ is the electronic protocol that has had the most success, but a few competing protocols have also been developed, with mixed fortunes. The fund has experimented with several of these protocols to support new initiatives to make the bond market fairer and more efficient.

Because of the RFQ protocol's aforementioned weakness, we have always supported a request for market (RFM) protocol that differs from RFQ in asking for both a buy and a sell price for a specific size in a bond. This way, only the winning market maker gets the information on the direction of our trade. RFM has only recently gained some traction, as most market makers

have been unwilling to support the protocol in the past. This is a healthy development, as it points to a more competitive landscape on the price-making side.

In the last ten years, the fund and other buy-side institutions have discussed how to develop a system where the buy side can trade with both the buy side and the sell side. This protocol is called "All to All," basically meaning that everyone on an electronic platform can deal with each other. The fund has used this protocol to a small extent using a third party as an intermediary, typically the trading venue itself. The challenge with this protocol is that active investors need to be willing to set aside time to quote a price on a platform every time other investors ask for it, either through RFQ or RFM. This is often a problem for buy-side institutions that need to have an order from a portfolio manager before they can trade. Even if they can trade without an order – for example through a liquidity-provisioning mandate – they have to quote a price on multiple bonds daily and compete with banks that have dedicated personnel and infrastructure to deal with market making.

A widely used protocol in the equity market is a "central limit order book" (CLOB). In the bond world, this is used to a limited extent in the interbank market, which is closed to the buy side. A CLOB needs a critical mass to work well. Because there are so many different bonds, there will probably not be enough trading for a CLOB to work efficiently for most parts of the bond universe. However, the CLOB protocol is used for financial futures in the bond market, because the standardisation of futures contracts has created a critical mass for the protocol.



Trading functions

As liquidity is dynamic, unobservable and multidimensional in nature, traders must have the autonomy to decide how a trade is executed in the market. We have organised the workflow between traders and portfolio managers in different ways depending on the motivation and characteristics of the trades.

In the beginning, orders were handled on an agency basis only. The trader executed orders in the market as they came in on a best-efforts basis. In the rare case of offsetting orders from the portfolio managers, the traders would obtain market quotes and facilitate an internal cross-trade. Internal crossings between portfolio manager orders have always followed principles for equal treatment. Our enhanced indexing activity has its main focus on replicating the fixed-income benchmark, which means involvement in almost every new issue in the market in relatively small sizes. Other activity deals with more concentrated risk and often less liquid market exposure. All this requires dedicated traders informing portfolio managers about new deals and providing market intelligence on market liquidity.

The transition trades

Restructuring the fixed-income portfolio after the financial crisis to reflect the new reality for fixed-income liquidity was behind the decision to create a transition portfolio in 2008. The transition portfolio represented the pre-crisis era's investment positions that did not fit into the new investment strategy. The portfolio was extensive in volume and number of securities but had a low interest rate sensitivity, as most positions were hedged with derivatives. The task was to unwind these positions in a controlled and patient manner without causing any market impact. This challenge suited the trading desk well, as it was staffed with experienced traders who all had a background as portfolio managers. In this way, the fixed-income trading desk was entrusted with the responsibility to warehouse a significant amount of investment risk for the fund from inception.

The transition portfolio was given a linear benchmark that implied a gradual reduction of exposure, allowing sufficient time to sell bonds, buy back shorts and unwind derivative positions. Benchmarking of the transition portfolio was an effective way of measuring trader performance. During this time, the fund also implemented the decision to change its exposure from 60 to 40 percent invested in fixed-income markets, which required additional trading, although part of this was neutralised by large inflows. A skilled and experienced team of fixed-income traders ensured that this happened safely without any market disruptions. As the trading team was fit for its current purpose, a natural evolution to become a price-maker for the portfolio managers was set in motion.

Chart 45 2009 transition trading volume by region.
Billion US dollars.

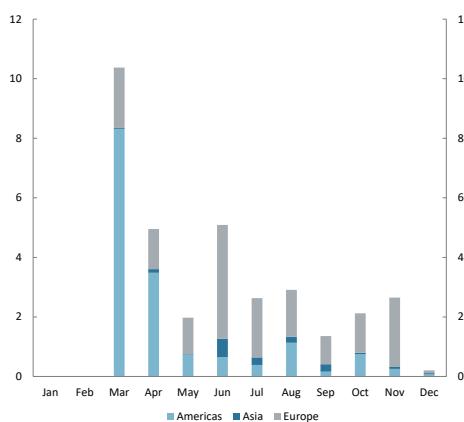
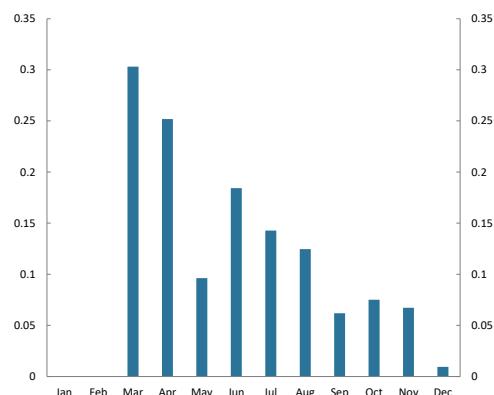


Chart 46 2009 transition trading volume. Percent of total trading volume.



The benchmark trades

Since its inception, the trading desk has been responsible for implementing benchmark changes. These occur following strategy changes from the Ministry of Finance as well as changes to the internal reference portfolios. In the fixed-income markets, it is impossible to perfectly replicate all benchmark changes without paying a very high cost, because of the large number of constituents with variable market liquidity. However, the portfolio managers can replicate the duration and interest rate curve changes in their portfolio by selecting a basket of more liquid bonds in their investment universe. The trading of benchmark implementation orders has always been conducted with full trader autonomy by taking advantage of market knowledge to source

liquidity and time the market. The fund wants to avoid trading exactly when the benchmark changes occur, as passive investors tend to implement their trades at this time. The discretion given to the traders has meant that the fund has avoided leaving large footprints in the market. As the fund's fixed-income portfolio has grown very large, these benchmark changes require trading on a large scale – known as trading in size. The trading desk's ability to trade over time has saved transaction costs and taken advantage of systematic pricing pressures around the benchmark changes.

From spring 2013, this trading concept was taken to the next level by introducing a trading book for benchmark implementations. The portfolio managers would get their benchmark

Chart 47 Benchmark trading volume by region.
Billion US dollars.

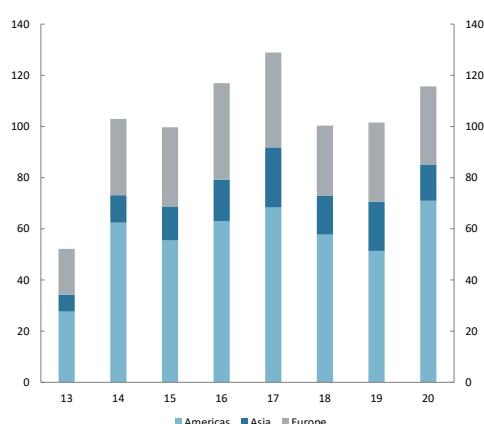
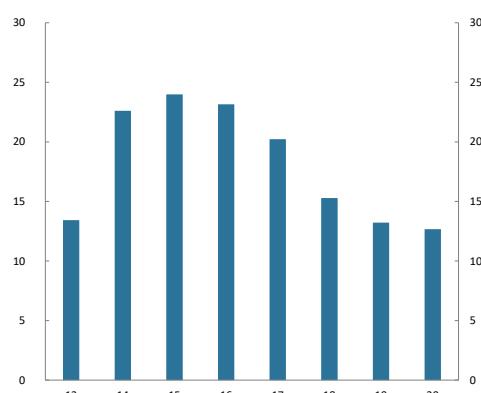


Chart 48 Benchmark trading volume. Percent of total trading volume.



orders filled at the official benchmark price. The trading book would take the other side of these trades. Traders could focus on implementing the orders over time and saving transaction costs for the fund. The implementation cost and traders' performance would crystallise in the performance of the trading book. With this mechanism, traders warehouse a significant part of the fund's duration risk while implementing the benchmark. The trading desk has built systems to monitor the risk minute by minute, ensuring that the traders have a timely overview of the interest rate risk. The trading book was implemented for all benchmark portfolios during the course of 2013 and has been a successful strategy right through to today.

The internal pricing trades

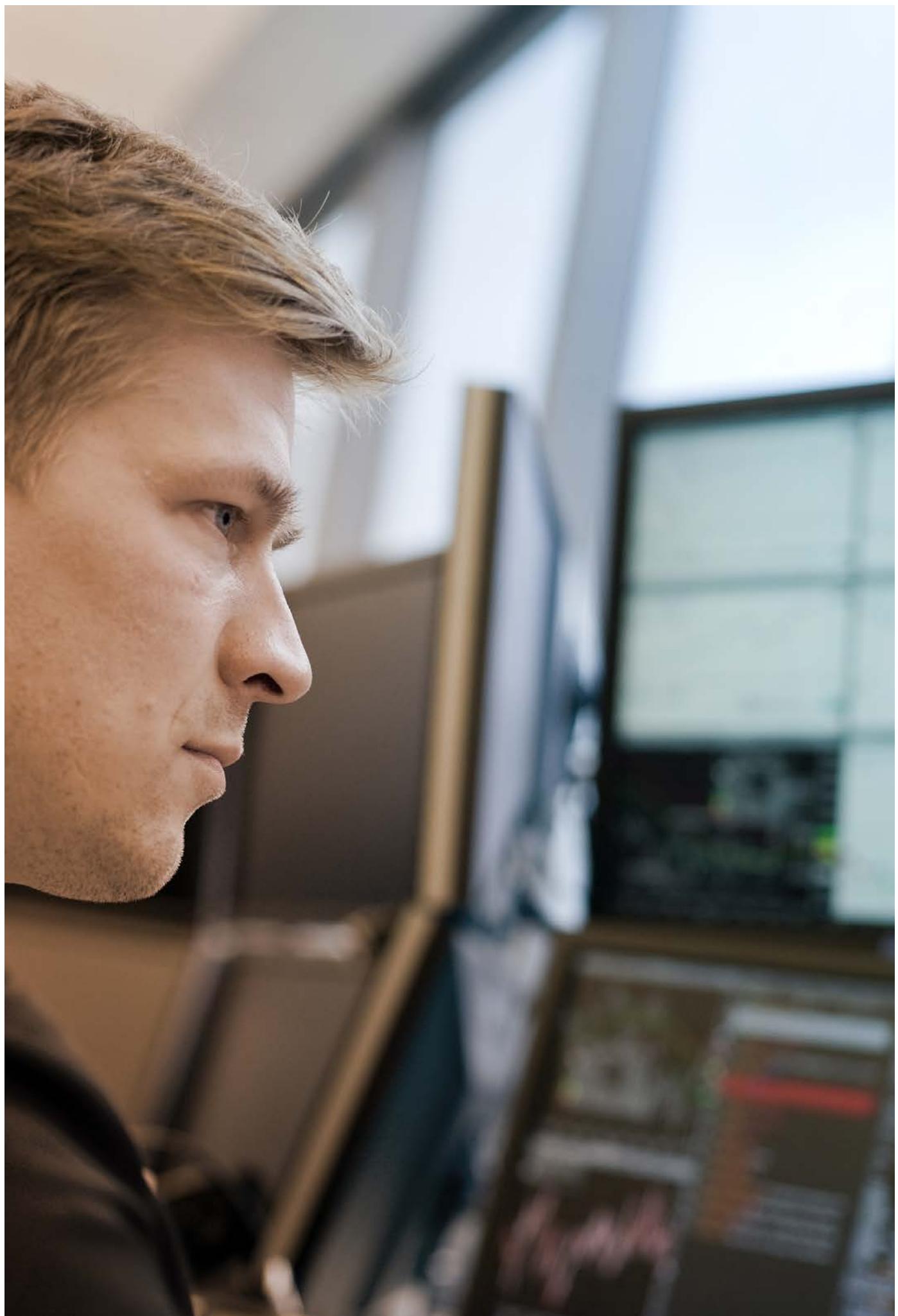
Internal pricing of fixed-income products, where traders make prices for the portfolio managers, has developed organically to deal with possible internal conflicts of interest. In fast-moving markets, the portfolio manager often prefers quick execution of orders, which collides with the trader's autonomy over best execution. In this situation, the trader's judgement will always prevail, as discretion over execution has been a fundamental principle for the trading desk since inception. The first trading book was created in the autumn of 2008 and served as an effective way to measure trader performance. The trading book facilitated internal pricing of government and government-related bonds in the euro area, the UK and the US. The choice of markets was based on the fund's activity and the degree of price transparency. The challenge was to decide on a cost matrix that would reflect a fair transaction cost compensation for the trading desk for dealing in size. A realistic cost matrix that reasonably reflects the actual cost of trading is essential to avoid "over-trading" and so putting the fund into positions that could be costly to execute compared to the expected return on the investment.

This was our first experience with a trading book where traders were directly responsible for internal pricing and managing the risk over time in the market. It was mainly used in the euro area in the first years but in all three major markets from 2011. In Europe, it was used less frequently from 2013, as transaction costs compared to expected returns made immediacy less critical. This led to closer interaction between the trading desk and the portfolio managers, and later the traders were integrated into dedicated investment teams. The experience from transition management and the trading book was, to a large extent, an early step in the transition to the setups that were created

in 2016. As will be described further below, the lessons learned from the trading book led to the development of investment teams including traders in the rates space, internal risk pricing in the credit space, and an improved framework for benchmark implementation.

The liquidity-provisioning trades

Liquidity-provisioning strategies are characterised by a need to be very close to market factors that determine the pricing of bonds and their derivatives. By being constantly active in the market, traders can often spot mispricings resulting from differences in investor preferences. A more systematic approach to different strategies has been developed through years of closer teamwork between traders and portfolio managers. In 2016, a structure was formed under the umbrella of a lead portfolio manager, where traders were given authority to exploit these comparative prices directly in the market. This authority is strictly regulated in an investment mandate under a portfolio manager's surveillance. The objective is to generate an excess return in the portfolio in a controlled manner without any single position accounting for a high proportion of the total risk exposure. A clear advantage of this setup is that the trader can maintain a level of activity in the market in periods where there is less trading required from portfolio managers. Thus, traders can continuously gather market intelligence that can be utilised in the investment teams. Examples of liquidity-provisioning strategies are exploiting inefficiencies at a micro level within the bond universe or systematically capturing primary issuance discounts. Positions are typically short-term in nature but create the foundation for long-term strategies.



Trading specialisation

Trader specialisation has been key for a successful trading desk. Trading across currency and bond sectors requires a different focus and distinct skillset.

From inception, the trading desk prioritised specialisation due to the complexity of covering many products in different markets. The principal-to-principal nature of fixed-income markets requires traders to communicate with several people on the sell side, depending on the product and geographical market location. When a trader needs to source a price from several counterparties to secure a competitive environment and best execution, it quickly adds up to many dozens of touchpoints, even just covering a few products in a couple of markets. The natural specialisation of traders in each region was between the corporate bond market and the rates market (defined as all bonds outside the corporate bond market, such as government, government-related and covered bonds). In the corporate bond market, as in the equity market, investors focus on individual companies' idiosyncrasies. In the rates market, the credit risk is considered relatively small. Investors mainly focus on interest rate risk and relative pricing between bonds with similar characteristics. This difference in skills needed means that entirely separate teams cover the corporate and the rates markets. As the fund's trading desk has always been leanly staffed, we have ensured some cross-training, but specialisation has always been vital.

The rates trading

The fund's trading in rates covers 11 developed government bond markets (US, Canada, euro area, UK, Sweden, Denmark, Switzerland, Japan, Singapore, Australia and New Zealand). The euro area itself consists of 19 different countries. Even though these bonds are denominated in the same currency, they are often traded by different desks on the sell side. Relationships need to be established with every desk to ensure the best execution. In addition to government bonds, the following sectors are traded in developed markets: supranationals, sovereigns, agencies, local authorities and covered bonds. Agency bonds are bonds either with a direct or indirect government guarantee or from issuers that are publicly owned, while sovereign bonds are government bonds issued in foreign currencies. Since 2008, the trading desk has traded mortgage-backed securities only in connection with transition portfolios.

After establishing the trading desk in 2008, we saw a gradual and natural development of more interaction between portfolio managers and traders in the investment process. Traders who got involved early in this process gave input on the best ways to implement the strategy in the markets in terms of liquidity. This development had its origin in the management of the euro markets, where traders' early involvement had proven successful. During 2016, a formalised structure between portfolio managers and the rates traders was established globally. As the fund only manages bonds and derivatives for one client, there is no conflict of interest from organising traders into specific portfolio management teams across markets. The rates traders' participation in the investment process has ensured that investment strategies are aligned with what is possible in the market in terms of avoiding excess trading costs and minimising price impact.

Chart 49 Total trading volume per year, all government bonds by region. Billion US dollars.

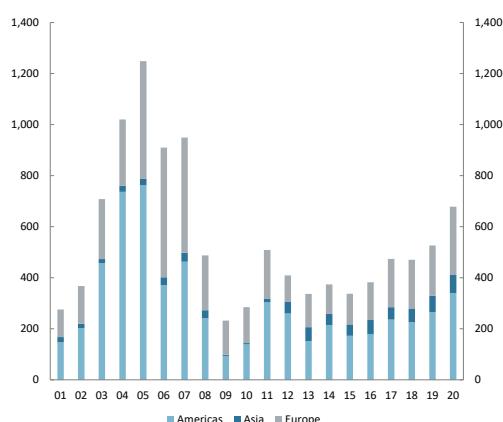


Chart 50 Total trading volume per year, all government bonds by region. Percent of total value of bonds.

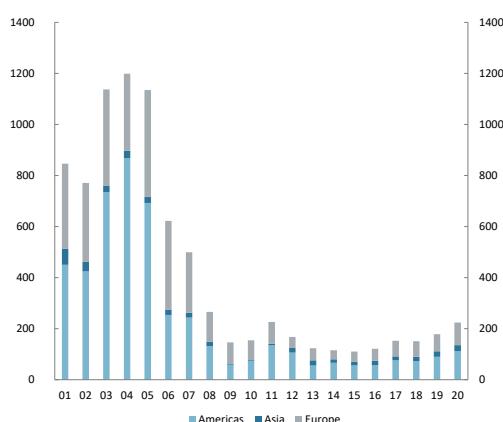


Chart 51 Total trading volume per year, all government-related bonds and securitised bonds.
Billion US dollars.

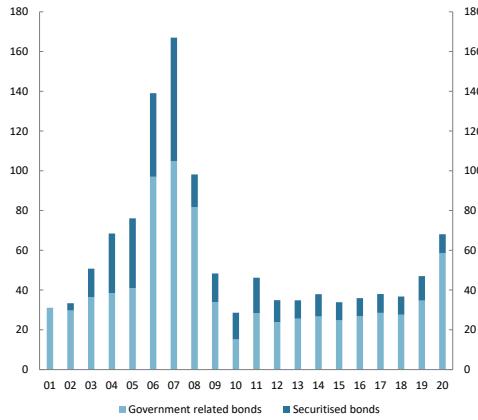
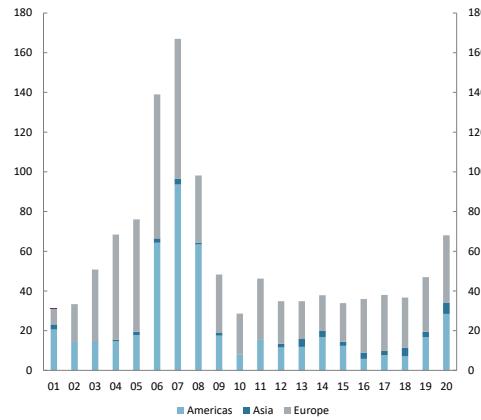


Chart 52 Total trading volume per year, all government-related bonds and securitised bonds by region.
Billion US dollars.



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Chart 53 Total trading volume all government-related and securitised bonds. Percent of total value of bonds.

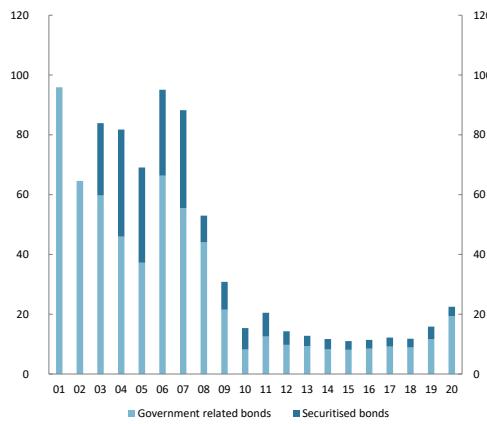
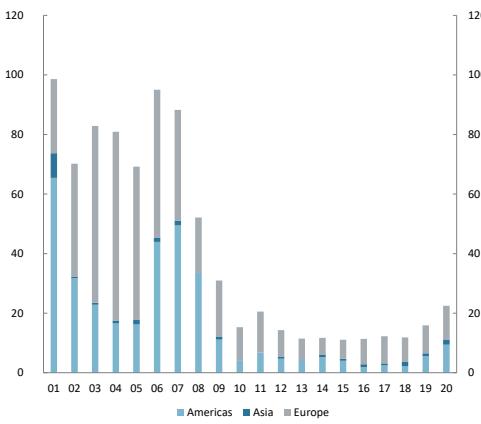


Chart 54 Total trading volume all government-related and securitised bonds by region. Percent of total value of bonds.



The credit trading

Since 2001, the fund has traded in the corporate bond markets in the US, the UK and the euro area. The focus has been on investment-grade bonds (rating at least BBB-), with only a small fraction being traded in high-yield bonds (rating below BBB-). Sectors traded are mainly financials, industrials and utilities.

Credit portfolio managers typically face higher transaction costs than portfolio managers in more liquid rates markets. A portfolio manager can change the portfolio's credit market exposure efficiently by participating in the primary market. Some significant changes were made in 2016 to the trading processes and how traders acted in the credit markets to facilitate more efficient portfolio management.

The primary market is when an issuer comes to the market with a bond for the first time or when the issuer increases the size of an existing bond. New issuance in corporate bonds is mainly done via syndicated bond offerings, where the issuer appoints a panel of underwriting banks to manage the debt offering. After a bond is sold in the primary market, the bond is freely tradeable between investors in the secondary market. Being successful in obtaining good allocations in primary markets and trading in size in the secondary markets is a demanding exercise. Trading in size over a short time horizon in the secondary market can become a costly strategy.

The credit trading desk takes full responsibility for achieving the portfolio managers' desired allocations in the primary market. The traders handle all allocations and hedging on behalf of the portfolio manager.

Providing the portfolio managers with an internal price for all orders allows the portfolio managers to focus on investment decisions and leave implementation to the traders. After the internal transaction is done, the credit traders will design a strategy for implementation in the market, including hedging of interest rate and credit risk. They will follow strict guidelines for how much time they can use. The credit desk's internal price will be a function of several factors determined by the underlying liquidity in the bond they price. On rare occasions, a trader and a portfolio manager will fail to agree on a price, and the order will be executed on an agency, best-efforts basis.

Credit traders have a liquidity-provisioning mandate to explore relative value strategies and market-make a small part of the fund's portfolio. This gives the traders the market insight they need to set a fair price for the portfolio managers through the internal pricing book described above. The mandates seek to make money, and the traders are incentivised to run these strategies in a very disciplined manner. For the fund, however, the main value is in the traders knowing their markets and so being well equipped for larger implementations of credit investment decisions.

Chart 55 Total trading volume per year, all corporate bonds by sector. Billion US dollars.

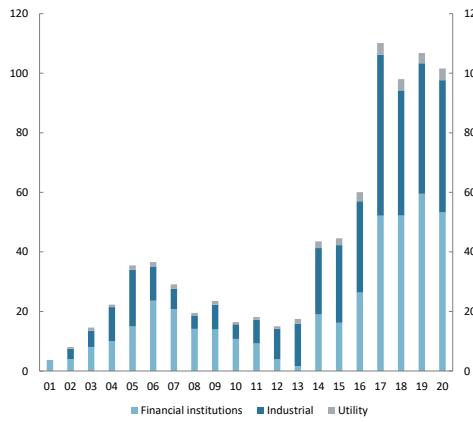


Chart 56 Total trading volume per year, all corporate bonds by region. Billion US dollars.

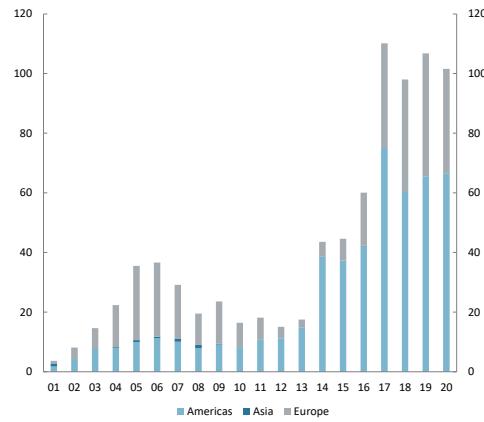


Chart 57 Total trading volume per year, all corporate bonds by region. Percent of total value of bonds.

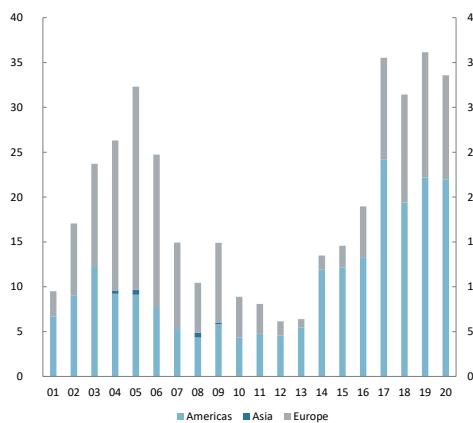
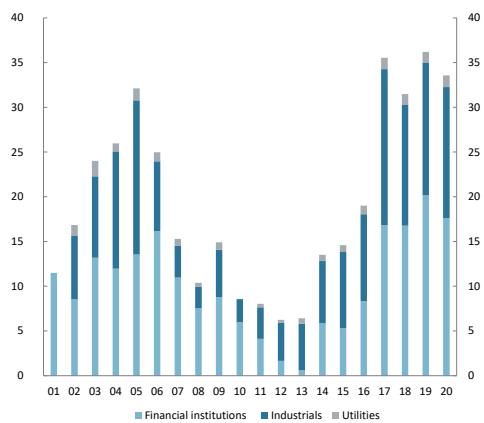


Chart 58 Total trading volume per year, all corporate bonds by sector. Percent of total value of bonds.



The emerging market trading

Expanding into emerging markets in 2011–2013 took the fund into 19 new local government bond markets: Taiwan, China, South Korea, India, Indonesia, Malaysia, Philippines, Thailand, Russia, Turkey, Israel, South Africa, Poland, Czech Republic, Hungary, Colombia, Mexico, Chile and Brazil.

The Ministry of Finance's decision to include emerging markets in the benchmark required the trading desk to quickly develop new skills to become operational. Due to the principal-to-principal nature of fixed-income markets, this

meant setting up new counterparties, understanding local regulatory requirements, collecting information about the significant players, and learning these markets' price mechanisms. In addition to a rearrangement of trader specialisation, frequent travelling to new local markets was necessary to build relationships with new counterparties and gain a deeper understanding of the regulatory framework and general market characteristics.

Investing in emerging fixed-income markets imposed a completely new set of challenges on the traders. Some of these new markets are

Chart 59 Local emerging market trading volume by region. Billion US dollars.

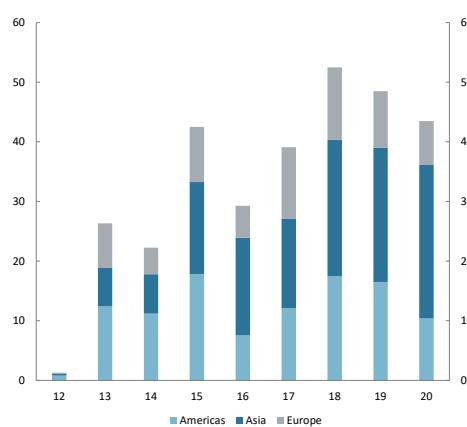
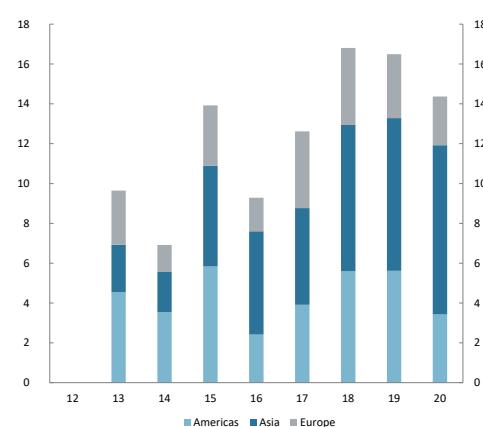


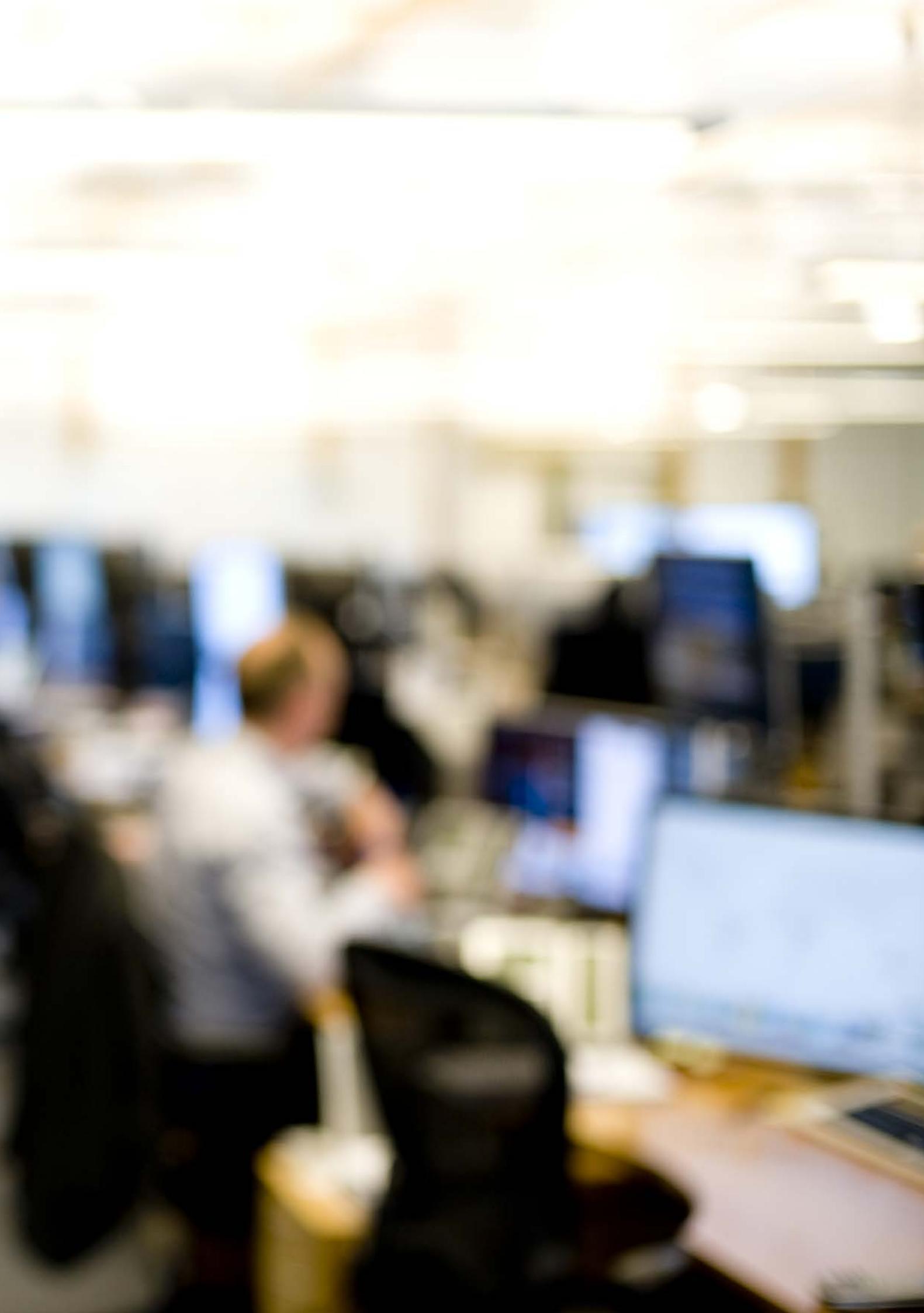
Chart 60 Local emerging market trading volume by region. Percent of total value of bonds.



heavily regulated, and the traders need to stay in compliance with the diverse sets of rules in each market. Unlike in freely traded markets, traders now had to take several preventive measures before executing a trade with a counterparty. To comply with local regulation and act as a friendly investor in these less mature markets is of utmost importance to be able to explore investment opportunities in a sustainable manner. This means, in practice, high awareness of liquidity constraints in each market to avoid a large footprint, and managing foreign exchange transactions in close connection with bond trading.

Due to extensive regulatory requirements for trading in many of these markets, and a new setup on the portfolio management side with several sub-mandates, it was decided not to proceed with liquidity-provisioning strategies in a trading book. Instead, the traders work closely with the portfolio managers and support them with advice on liquidity and investment opportunities. Today, the rates traders cover trading in emerging markets alongside trading in developed markets.











Design: Scandinavian Design Group

Photo: Getty Images, AdobeStock, Nils Stian Aasheim, Hans Fredrik Asbjørnsen,
Norges Bank Investment Management

Paper: Gallerie art matt 150 g

Production: 07 Media AS





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