

Strategic asset allocation in different market environments

WHITE PAPER

For professional investors

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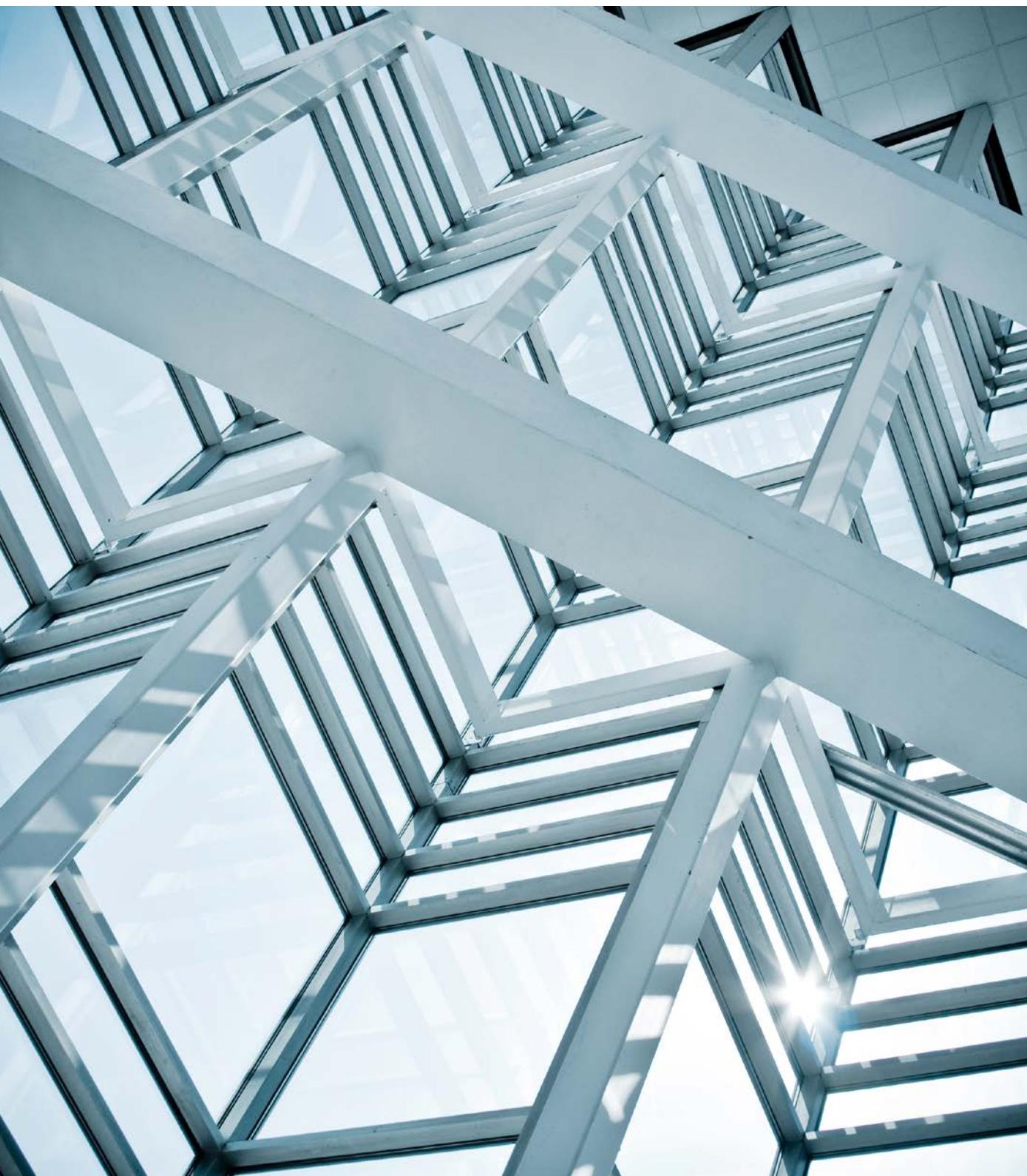
F.A. de Roode

R. Molenaar

DYNAMIC STRATEGIC ASSET ALLOCATION

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Intro | Portfolio allocation is far from trivial and demands thorough investigation by investors. Since market regimes shift over time, investors need to gain insight into the effects of changes to their own portfolios. Robeco has developed the Dynamic Strategic Asset Allocation (DSAA) and the Stress Test (ST) tools to offer customized analyses which help the investor to gain deeper insight into their clients' portfolios, and make them more robust.



Executive summary

In this paper, we explain the need for analyzing strategic asset allocation. Market axioms change over time, leaving portfolios vulnerable. An example is the decision to hedge currency risk. While strategic asset allocation is typically based on long-term expectations, shorter horizon effects are equally important. Therefore, these effects need to be addressed in a portfolio context as well.

To analyze changing market environments in a strategic asset allocation context, we introduce the Dynamic Strategic Asset Allocation (DSAA) and Stress Test (ST) tools. The benefits of the DSAA tool are that it allows portfolio construction with one tool using an extensive database of asset classes. It visualizes the portfolio in multiple market environments, allowing an investor to customize it according to their views about different market conditions, and then to verify the effect that this has on the portfolio. The ST tool allows the investor to 'stress test' his portfolio in historical scenarios in order to address risk in his portfolio. These analyses give insight into how the current portfolio behaves in historical scenarios.

We illustrate the broad analysis that can be addressed with these tools, presenting three investment cases. First, we verify the impact of adding a low volatility strategy to an equity portfolio. Next, we analyze the impact of adding a liquid alternative to a bond equity portfolio. Lastly, we investigate the impact of adjusting the level of interest rate hedging in an institutional context taking into account the liabilities.

A new insight in your portfolio characteristics

Portfolio allocation is one of the most important decisions for return. The construction of the optimal portfolio for an investor is however far from trivial. Since markets fluctuate, a portfolio which is optimal in one market regime may not necessarily be optimal in other regimes. To provide insight into the impact of market environments on clients' portfolios, Robeco's Portfolio and Pension Strategy department has developed the Dynamic Strategic Asset Allocation (DSAA) tool in combination with the Stress Test (ST) tool¹. These tools provide deeper understanding of the behavior of the portfolio in different scenarios and can help to build more robust portfolios for an investor.

¹The DSAA and ST tools were originally designed for institutional investors and has been developed for a wider audience.

The influence of market regimes on portfolios | The optimal portfolio of an investor depends on his view on the future market regime; i.e. an investor who expects an equity market rally will position his investments toward equity. In the classical mean-variance model (Markowitz, 1952) the view is implemented by incorporating the investor's belief on expected return, volatility and correlation. Given a view on all these parameters, the model will determine the optimal portfolio. In practice, however, it is hard to form a (strong) belief on all these parameters. While intuition can be inferred from past market data, uncertainty with regard to these estimated parameters remains large, since market regimes may shift. As a result, optimized portfolios based on past data may deliver a disappointing performance in future market environments (see e.g. Chopra and Ziemba, 1993).

In this paper, we introduce the Dynamic Strategic Asset Allocation (DSAA) and the Stress Test (ST) tools to evaluate the impact of strategic asset decisions. Robeco's Portfolio and Pension Strategy department has developed these tools to provide a deeper insight in portfolio allocations with the aim of building robust portfolios across market regimes. First, we illustrate the added value of these tools in the portfolio construction. Investment axioms may shift through time as market structures change. To this end, we describe the various market regimes in our tools. Second, we work out three investment cases to explain the wide variety of questions which can be solved with these tools.

Dynamic Strategic Asset Allocation | The DSAA tool shows the risk/return trade-offs of the current and alternative portfolios in various market regimes, whereas the ST tool provides investors ways to evaluate their portfolios in turbulent market scenarios. The ST tool complements the DSAA tool as it provides insight in performance in historical stress periods.

Dynamic strategic asset allocation bridges the gap between tactical and strategic asset allocation. We present an oversight for the different investment horizons in Table 1. Strategic asset allocation requires 'steady state' returns that are projections of the long-term risk and return characteristics of asset classes. The dynamic part of the DSAA tool consists of

analyzing allocations in both a 'steady state' scenario and intermediate medium-term market projections. In Figure A-1 in the Appendix we show a screenshot of the tool.

Table 1: Different horizons in asset allocation

Views on asset allocation	Tactical	Dynamic	Strategic
Scope	Short term	Medium term	Long term
Horizon	<1 year	5 years	>10 year
Scenario	'Tactical'	'2016-2020'	'Steady state'

Source: Robeco.

The 'tactical' scenario is reported in the Robeco Monthly Outlook which is a one-year projection, whereas the '2016-2020' and 'Steady state' are based on the Robeco Expected Returns publication.

The two main goals of the DSAA tool are first, to help the investor analyze his current portfolio across various market regimes, and second to visualize the effect of changing the portfolio weights and/or including different constituents in the portfolio. By analyzing alternative portfolios across various market regimes with different return patterns, the tool can help the investor to identify a better portfolio allocation in terms of risk/return. In this way, the DSAA tool can give insight in how to develop a more robust portfolio over various market scenarios.

The market regimes that have been selected for the DSAA tool can be divided into two categories. In the appendix we provide an overview of all scenarios. The first category contains backward looking, historical scenarios. Examples are the 'long-term historical', and the 'last five years' scenarios. In these scenarios, the investor can verify the characteristics of his current and alternative portfolios in terms of the risk/return trade-off, but also analyze his tail risk. In addition, the risk exposure of his allocation to various sources of risk is also shown for several scenarios. This allows the investor to decompose his portfolio in risk weights rather than money weights, offering the investor insight to the sources of risks in his current allocation.

However, backward-looking scenarios may lead to possible erroneous conclusions on the portfolio allocation. Inference based on past market information is not necessarily representable for the near future. A recent example is the observed decline in interest rates for past decades. Hence, investors need to form an expectation on the future market regime. To help with projections on the possible market developments, the DSAA tool includes three forward-looking market regimes. These scenarios are based on the economic analysis in the yearly Robeco's Expected Returns publications². The medium-term scenarios are based on the main five-years covered by Robeco's outlook for 2016-2020 and an alternative medium-term 'secular stagnation' scenario. The third scenario is the 'steady state' which includes long-term projections of the market. This set of scenarios allows investors to verify their portfolio strategies under expected future market environments with different investment horizons.

² Robeco 'Expected Returns 2016-2020: Behind the curve – The price of normalization'.

Finally, the DSAA tool also allows for adjusting scenarios to the investor's own views on the risk and return.

Benefits of the DSAA tool

- Portfolio construction in one tool
- Visualizing the effect of allocation changes
- Addressing portfolio robustness in various market regimes
- Robeco market views included and customization possible
- Liabilities of institutions can be taken into account

Stress testing the portfolio | The Stress Test (ST) tool allows the investor to analyze his portfolio in turbulent market periods, which complements the DSAA tool as the investor can focus on more specific historical crisis periods. In Figure A-2 in the Appendix we show a screenshot. The ST tool has a large set of both economic and market crises starting in 1986. Examples of economic stress scenarios are economic contraction periods (characterized by US recessions as identified by the NBER) and currency crises, whereas a market stress scenario would be the great financial crisis in 2007-2009. The tool offers an analysis about the performance during the selected stress scenarios and into which asset classes of the portfolio did not perform well.

Another feature of the ST tool is that it allows for detailed drawdown analyses of the portfolio³. In this way, the investor can identify economic and market regimes that are relevant for his portfolio, and verify which allocation leads to a more robust portfolio. By selecting historical stress scenarios the tool is able to show the impact of these events on the portfolio performance. Alternative portfolios can both be evaluated in an asset-only and an asset-liability framework. In an asset-liability context, a pension fund can investigate the effect of the stress event on the funding ratio.

As such, the DSAA and ST tools reinforce each other in gaining insight into a portfolio, and are thus able to help the investor to possibly improve the risk/return trade-off of his portfolio allocation.

³ The drawdown analysis shows the losses of the portfolio during a selected period.

Benefits of the ST tool

- Stress testing of portfolio allocations
- Awareness of portfolio risk in stress periods
- Liabilities of institutions can be taken into account

Database of asset classes | Both tools use the same comprehensive dataset of asset classes, which starts in 1986 and ends in 2015⁴. To address the complicating matter that not all data is available since 1986, we employ statistical methods to backfill our dataset for the unavailable assets (see e.g. Stambaugh, 1997 and Page, 2013). This approach allows us to make a fair comparison between asset classes without restraining the time period to the shortest available data period. Due to this backfill, we can therefore under certain assumptions analyze asset classes in different market regimes.

⁴ The database is based on monthly data and is quarterly updated.

Extensive database

- Most asset classes available
 - Swap curve: nominal, inflation
 - Equity: developed markets, emerging markets, factor investing
 - Bonds: government, investment grade, high yield, emerging markets
 - Alternative: commodities, real estate, hedge funds, private equity
 - Currencies: major currency markets
 - Robeco capabilities: factor investing in equity and fixed income, multi-asset quant products
- Long history of all included asset classes

Risk exposures in a historical market regime | In portfolio construction it is generally important to achieve diversification over various sources of risk instead of reliance on a particular type of risk. One example is that equity risk is a major source of risk in traditional balanced portfolios. To illustrate how the DSAA tool can be used to construct more balanced portfolios, we analyze two strategic portfolios in a historical scenario. In the first portfolio, we start with an allocation of 40% euro bonds and 60% world equity⁵.

⁵ In this paper we do not include currency hedging as this requires a more detailed customized analysis

Figure 1 | The impact of portfolio changes on the risk exposure

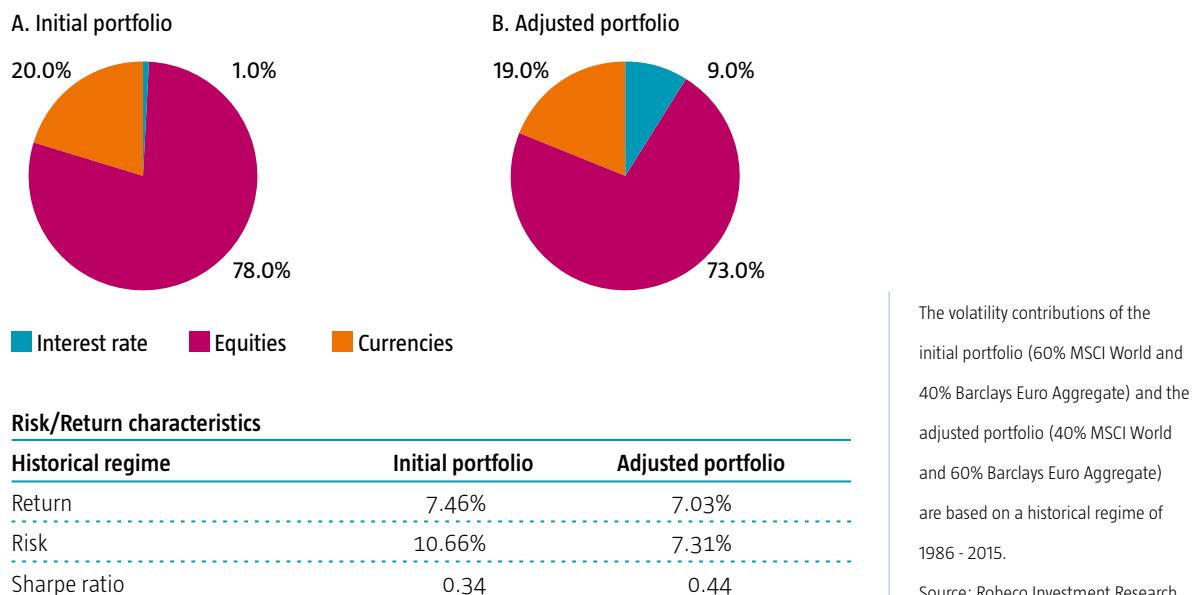


Figure 1 A shows that the risk contributions of the assets classes are substantially different from their money weights. Money weights typically do not reflect the risk contribution of the asset classes to a portfolio. While 40% of the portfolio is allocated to euro bonds, only 1% of the risk is contributed by bonds. Equity dominates the portfolio with a contribution of 78%. Investing in world equity also introduces currency risk. Figure 1 A shows it will be an important risk component in the portfolio, as 20% of risk contribution stems from currency exposure. Additional analysis needs to be done whether currency exposure in the current portfolio is optimal for the investor.

To show the impact of money weights shifts on risk contributions, we use an alternative adjusted portfolio of 60% euro bonds and 40% world equity. While the money weights of the allocation change substantially, Figure 1 B shows that the relative risk contributions remain quite similar. The risk contribution of euro bonds increases with 7.5%-pts to 9%, whereas the equity allocation remains to dominate the risk contribution of the portfolio with 73%. The risk/return characteristics of the portfolio do change however. Initially, the portfolio had 11% volatility, but this is reduced to 7% volatility. Similarly, the expected return of this portfolio drops due to the lower weight of equity in it. Overall, the portfolio's Sharpe ratio has increased from 0.34 to 0.44. Market environments may also affect the risk contribution of asset classes because correlations and volatilities can change. Therefore, the DSAA tool allows the investor to analyze the risk contribution of his portfolio in various market regimes.

Market axioms shift in time: currency hedging

Market developments require reassessment of a portfolio. Currency hedging was standard practice for euro investors prior to 2008 as it substantially reduced volatility of the portfolio (see e.g. Black, 1989). To visualize the volatility effect, Figure 2 shows that using a currency hedge while investing in the MSCI World index would have led to volatility reductions between three and five percentage points up to May 2008. Since currency hedging also improved returns, it was a straightforward strategic decision to hedge currencies in portfolios. However, market dynamics changed afterward, causing the currency hedge to add volatility.

Figure 2 shows that over the period starting in 2008, currency hedging added about three percentage points of volatility. Due to the devaluating euro in this period, the currency hedge also became costly. This shift may not be long lasting. Recently, as can be seen from Figure 2, it is again attractive to hedge currencies from a volatility perspective. The return component of the currency hedge also needs to be addressed in order to decide whether to hedge currencies in portfolios. Therefore, the decision to hedge currency is not a straightforward one in the current market regime. The DSAA tool enables investors to analyze their portfolio in different market environments to accommodate changes in market axioms.

Figure 2: The impact of currency hedging on the volatility of the MSCI World



The MSCI World in Euros is currency unhedged, whereas the returns of the MSCI World in local currency is a proxy for the currency hedged returns. The rolling volatility is determined using monthly data and a 3 years window. The volatility difference is denoted by the blue bars. Before 1999 the Euro is approximated by the Deutsch Mark.

Source: Robeco Investment Research.

As we have seen, portfolio construction is far from trivial and demands special attention from investors. Robeco offers its expertise and allocation tools to develop customized analysis which helps the investor to gain deeper insight in the portfolio. To illustrate examples of analyses with the DSAA and ST tools, we present three investment cases in the next section.

Analysis of three investment cases

To portray the wide variety of portfolio analyses that the tools are able to shed light on, we present three investment cases. In the first case, we show the impact of including a low volatility equity strategy in an equity portfolio. Next, we focus on how liquid alternatives can add value in a balanced portfolio. Lastly, we illustrate the effects of interest rate hedging in a pension fund's context with liabilities using a LDI fund. We will focus in this analysis on the impact of adding such strategies in a portfolio context rather than the individual products⁶.

Choices of economic scenarios | To evaluate sensitivities to various economic scenarios, we mainly focus on two market regimes in the analysis⁷. The first scenario will be a historical scenario of the last five years⁸ in which we observed a market environment with strong equity performance and low volatility. In response to the financial crisis, many central banks have enacted policies which have contributed to declining interest rates. As a result, both equity and bond performance were quite strong in this regime.

Our second scenario is forward looking and is based on our Expected Returns publication⁹. In the five-year forward-looking scenario, we expect a behind the curve scenario for the world economy, in which the hangovers from the financial crisis will lift further. Policy rates will be raised, although central banks will adopt a gradual approach, accepting inflation instead of hurting the recovery by a more aggressive monetary tightening. By accepting inflation to eventually overshoot their targets to a limited extent, central banks risk getting 'behind the curve', which is our central scenario. The strengthening economic growth and return of inflation creates a more favourable environment for equities compared to bonds. Also, sovereign bonds are even more expensive compared to equities. Given the somewhat stretched valuations, we expect below historical average returns in the major asset classes.

Case 1: inclusion of a low volatility equity strategy in an equity portfolio | In our first analysis, we look at the effect of including low volatility equity in an equity portfolio. A low volatility strategy aims to achieve a lower volatility over longer horizons than the market cap-weighted market index, yet at a similar return. Typically, the long-term market beta of a low volatility fund is around 0.7, thus reducing volatility substantially. In a strong downward market, a low volatility strategy will outperform the index, whereas the strategy tends to stay behind in a strong upward market.

To show the impact of a low volatility fund in an equity portfolio, we start with a 100% world equity portfolio. In the last five years, world equity had a strong performance with an average return of 13% compared to an historical performance of 8%. The volatility was also substantially lower; 11% instead of an historical volatility of 18%. As a result of the strong upward market, a low volatility strategy had a lower performance than the market in this

⁶ Robeco capabilities are used as an example of implementing such a strategy.

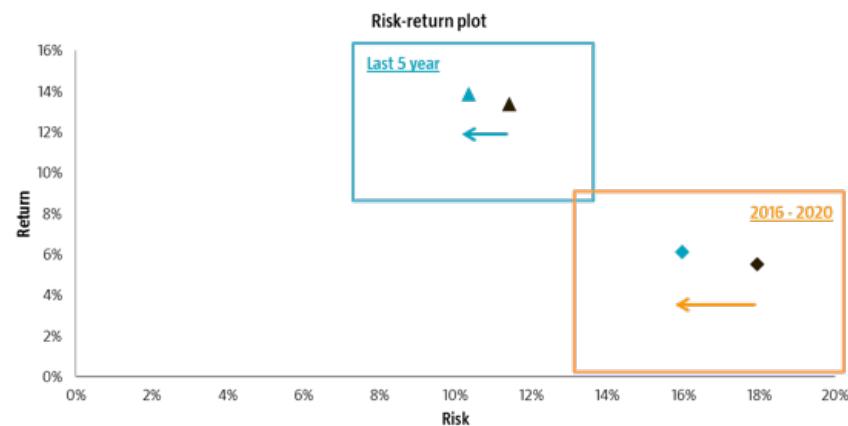
⁷ For brevity's sake, we include only two scenarios; additional scenarios can be seen in Table A in the Appendix.

⁸ The last five years denotes the period 2010 Q3 to 2015 Q3 in this analysis.

⁹ Our forward looking five-year scenario is based on the 'Expected Returns 2016-2020: Behind the curve – The price of normalization.'

period. To investigate the effect of adding a low volatility strategy to the portfolio, we replace 50% world equity with Robeco Conservative Equity.

Figure 3: A low volatility equity proposition in various market regimes



The black marker denotes the 100% MSCI World portfolio and the blue marker the 50% MSCI World and 50% Robeco Conservative Equity portfolio. The scenario 'last five years' denotes the period from 2010 Q3 to 2015 Q3, and '2016-2020' denotes Robeco's Expected Returns view for the next five years. Source: Robeco Investment Research.

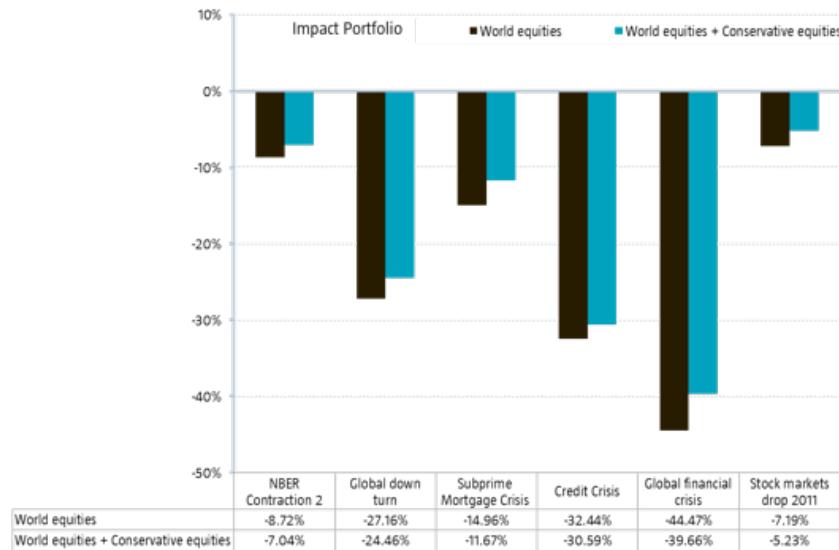
Using the DSAA tool, we can show the risk/return characteristics of this portfolio proposition in the 'last five years' and the 'next five years'. Figure 3 shows that indeed in the last five years the portfolio with Conservative Equity has a slightly lower return due to the strong performance of world equity. Since the volatility of world equity is relatively low, the volatility reduction is less strong than it would have been over a longer horizon. The volatility of the portfolio has dropped from 11.4% to 10.4%. As a result of including Conservative Equity, the Sharpe ratio increased in this period from 1.13 to 1.30.

Given the current market environment, we expect lower future returns on equity, although with a higher volatility. Adding Conservative Equity to the portfolio in such a market environment can therefore be beneficial. Figure 3 shows that we expect that inclusion of the low volatility strategy will result in a volatility reduction in the coming five years for the overall equity portfolio. In terms of Sharpe ratios, this would lead to an improvement of 0.22 to 0.27.

Another way to analyze the proposition is to use the Stress Test tool. To visualize the extent to which a low volatility strategy can offer downward protection, we evaluate the strategy in past turbulent markets. Figure 4 compares the outcome of the ST tool for the two portfolios in six stress periods. In general, a low volatility strategy can offer protection in (prolonged) stress periods.

² Robeco 'Expected Returns 2016-2020: Behind the curve – The price of normalization'.

Figure 4: A low volatility equity proposition in stress scenarios



The black columns denote the 100% MSCI World portfolio and the blue columns the 50% MSCI World and 50% Robeco Conservative Equity portfolio. The dates of the stress scenarios are given in the Appendix. The first two scenarios are based on simulated returns for the portfolio with Conservative Equity; the remaining scenarios are based on the live track record. Source: Robeco Investment Research.

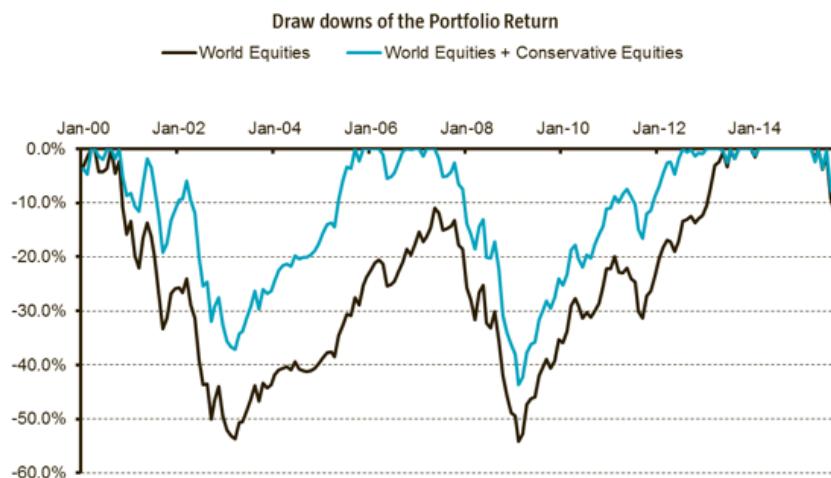
From Figure 4, we observe that in most stress scenarios, Conservative Equities can offer downside protection. During the NBER contraction period in 2001, the economy of the US had its first contraction since the 1990s. The portfolio with only world equities dropped by about 8.7%, whereas the portfolio with Conservative Equities has a smaller loss of 7%. While the differences between the impacts can vary, in most stress scenarios Conservative Equities could have absorbed some of the stock market shocks.

To further analyze the effect of including a low volatility strategy, or any strategy in general, we can also look at the drawdowns of the portfolio. Figure 5 shows the drawdowns of the world equity portfolio, and the world equity portfolio with Conservative Equity over a period starting in 2000. This period is characterized by two large drawdowns, the first one starting in 2000, the second drawdown occurring around 2008. Adding Conservative Equity to this portfolio would have reduced the drawdown lengths and their severity. Around October 2005, the portfolio with Conservative Equity has recovered from the drawdown starting in 2000. While this analysis shows that a low volatility strategy can offer downward protection for equity portfolios in a stress period, specific effects on a portfolio can differ from this investment case.

This investment case has shown how a low volatility strategy can be evaluated using the

DSAA and the ST tools. In the DSAA tool we specifically investigated how a portfolio with Conservative Equity behaves in various market regimes, whereas in the second part of our analysis we focused on stress periods and the downward protection. Similar analysis can be done for other factor strategies and can be extended to portfolios with a larger diversity of assets. In the next investment case we look into a Robeco GTAA proposition in a portfolio with equity and bonds.

Figure 5: Drawdowns in a low volatility equity proposition



The black line denotes the 100% MSCI World portfolio and the blue line the 50% MSCI World and 50% Robeco Conservative Equity portfolio. The results in the period up to September 2006 are based on simulated returns for the portfolio with Conservative equity, afterward they are based on the live track record. Source: Robeco Investment Research.

Case 2: Liquid alternatives in a strategic portfolio | Recently, liquid alternatives have gained attention from investors. One definition of liquid alternatives is that this asset class contains the category of mutual funds that seek to deliver absolute returns without resorting to illiquid investments. Investments in the more illiquid hedge funds may lead to longer lock-up periods and prevent investors from accessing their assets when they need to. Liquid alternatives are typically implemented using highly liquid instruments such as futures and other derivatives. Examples of such a strategy are a managed futures strategies or Commodity Trading Advisors (CTAs).

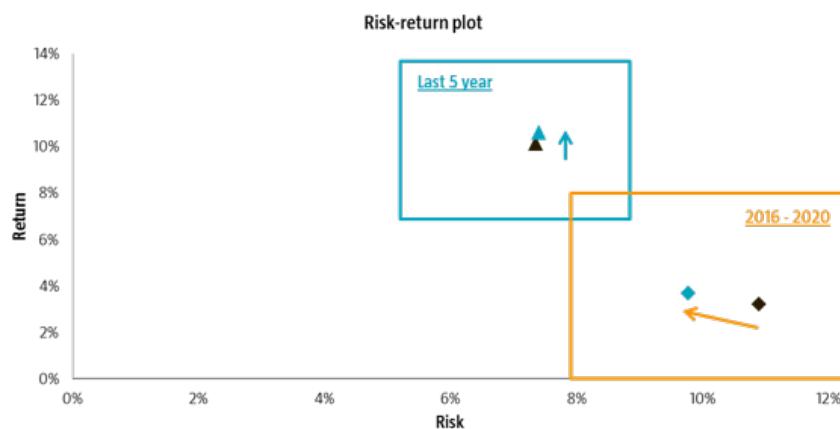
Robeco GTAA is a liquid alternative that aims to deliver absolute returns by exploiting mispricings between and within global asset classes. In general, tactical asset allocation strategies have as their objective to deliver a positive performance by overweighting well-performing asset classes and underweighting the least performing ones. Since liquid alternatives use derivatives, short positions can be taken to profit from either downward

trends in asset classes, or relative underperformance compared to other asset classes. Due to their design, these strategies can offer upward return potential and downward protection in bear markets.

To illustrate the benefits of including liquid alternatives in a strategic portfolio, we start with a portfolio that consists of 60% world equities and 40% euro bonds. This portfolio had attractive risk/return characteristics in the last five years, with an annualized Sharpe ratio of 1.32. In this period, both bonds and equity performed well. An equity bull market started in March 2009, and interest rates were declining over this period as well. In this period we observed average returns of 13% for world equity, with a volatility of 11%, whereas euro bonds delivered an average return of 5%, with a volatility of 4%. To see the effect of adding Robeco GTAA to this portfolio, we include 10% GTAA by reducing the equity part of the portfolio by 6% and the bond allocation by 4%. This allocation ensures the remaining portfolio holds a similar equity vs. bond ratio as before.

Even though the equity and bond market were favorable for the original portfolio, Figure 6 shows that adding GTAA would have improved the risk/return characteristics of the portfolio. In the last five years, GTAA is able to improve the Sharpe ratio of the portfolio from 1.32 to 1.38. The average return of GTAA over this period was 14%, with a volatility of 16%. Given the low volatility of equities and the strong performance of both constituents of the portfolio, the effect of adding a GTAA strategy is less strong.

Figure 6: The GTAA proposition in various market regimes



The scenario 'last five years' denotes the period from 2010 Q3 to 2015 Q3 and '2016-2020' refers to Robeco's Expected Returns view for the next five years. Source: Robeco Investment Research.

Given the current market environment (i.e. low starting interest rates), we expect that the

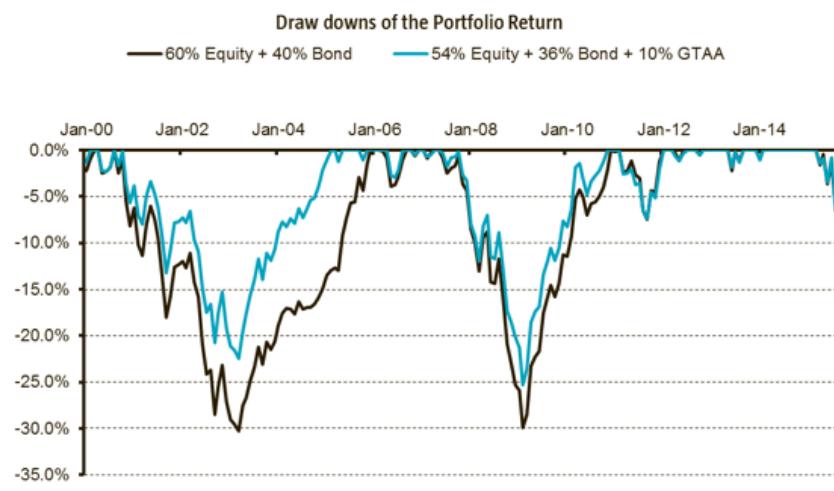
60% world equities and 40% euro bonds portfolio will perform less well in the coming five years. Since we expect that interest rates will show a steady rise over this period, a tactical asset allocation strategy can position itself to profit from interest rate increases. Using short positions in the bond futures, the strategy can offer protection to increasing yields which a long-only fund cannot. For equity allocation a similar short positioning can be used to profit from decreasing equity markets. A GTAA strategy will apply these positions dynamically by means of tactical over- and underweightings depending on the market environments.

Figure 6 shows that adding GTAA to the portfolio can have a stronger impact on the return characteristics of the portfolio than in the last five years due to the market environment. We would expect a Sharpe ratio improvement from 0.15 to 0.22. In this way, GTAA can offer downward protection in the portfolio to the rising yields and weaker equity market performance.

Using the ST tool, we can further investigate the performance of the portfolio in stress scenarios. Figure 7 identifies two major drawdowns in the portfolio, which are the global downturn at the end of 2002 and the financial crisis in 2008¹⁰. Adding GTAA to the portfolio would have reduced both the size of the drawdown and the length of the recovery time in both periods. For example, in the aftermath of the IT crisis in 2002 the portfolio drawdown was about 30%. The portfolio with the GTAA strategy would have reduced the severity of the drawdown to 22%. One of the elements of a liquid alternative strategy is to aim to offer this downward protection. Overall, adding a liquid alternative can improve risk/return characteristics as previously seen. The DSAA tool and ST tool can guide the investor on the optimal level of alternative allocation.

¹⁰ Note that this conclusion is based on partly simulated portfolios returns.

Figure 7: Drawdowns in the GTAA proposition



The black line denotes the 60% world equities and 40% euro bonds portfolio and the blue line the 54% world equities portfolio, 36% euro bonds and 10% Robeco GTAA portfolio. The period up to April 2010 is based on simulated portfolios; afterward it is based on the live track record. Source: Robeco Investment Research.

Case 3: Interest rate hedging | In our last case we look into interest rate hedging for an institutional investor with liabilities. The DSAA tools allow us to take the future cash flows of the fund into consideration and to evaluate the effect of portfolio choices in terms of funding ratio risk. For this example, we take the cash flows of an average pension fund in the Netherlands with a starting funding ratio of 120%. The initial strategic portfolio of this pension fund is a 60% fixed income allocation and 40% MSCI World equity allocation. The fixed income allocation consists of Euro Aggregate bonds and the Robeco Liability Driven Investment 40 (Robeco LDI 40) strategy so that the level of the interest rate hedge is 50%.

Robeco LDI 40 is a fund that enables institutional investors to hedge their nominal pension liabilities. By investing in nominal interest rates swaps over various maturities the fund is able to match the returns of the future cash flows of institutional investors. One characteristic of the fund is the high duration, which allows investors to increase their duration of assets.

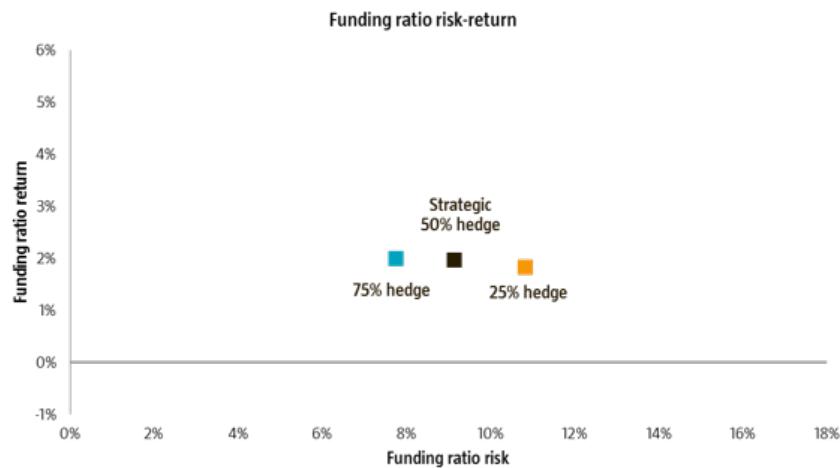
In this analysis, we investigate two adjustments of the interest rate hedge. We increase the hedge to 75% of the liabilities in the first case, whereas in the second analysis we lower the hedge to 25%. Typically, the optimal level of the interest rate hedge is determined by an Asset Liability Management study using a long-term investment horizon. To approximate such an environment, we use our steady state scenario to analyze the impact of adjusting the interest rate hedge when using a long-term investment horizon. In the steady state, we expect no substantial impact on the return of the funding ratio¹¹. Hedging of the liabilities will thus mainly affect the funding rate risk.

Figure 8 confirms that the level of the interest rate hedge has a strong effect on the funding rate risk. A higher hedge ratio will therefore typically decrease the funding ratio risk while at the same time the return will be (slightly) higher in the steady state environment. For example, increasing the interest rate hedge with 25% lowers the funding ratio risk from about 9% to 8%. Lowering the hedge instead will increase the funding ratio risk to 11%. While nominal interest rate hedging may improve the funding ratio risk, it may worsen the quality of the hedge of liabilities in real terms¹².

¹¹ Due to an upward sloping term structure in the steady state additional hedging will result in higher funding ratio returns.

¹² Additional analysis not included in this publication shows that a higher interest rate hedge will not perform well in unexpected inflationary periods.

Figure 8: Interest rate hedging on a longer investment horizon



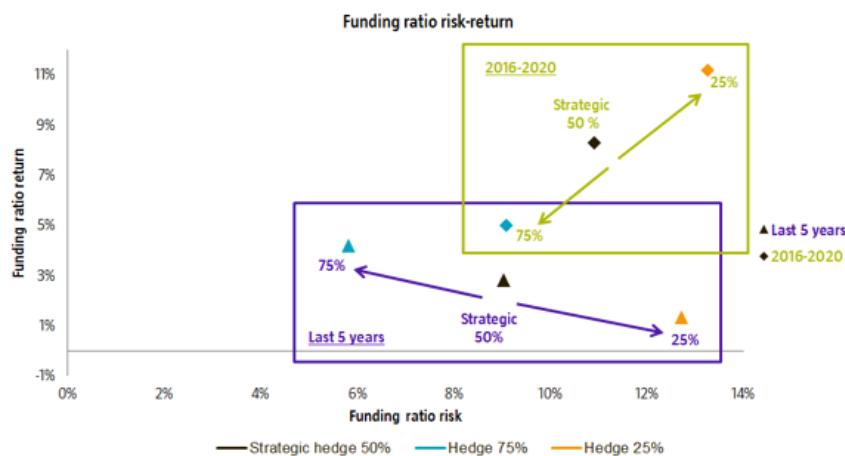
The steady state scenario is based on a forward long term horizon expectation. Source: Robeco Investment Research.

Since interest rates have decreased in the last five years, increasing the interest rate hedge turned out to be a beneficial decision. Swap instruments can protect the purchaser from downwards movements in the interest rate yield. Hence, in a regime with upward movements of interest rates, hedging can be costly. To shed light on the impact of its effectiveness and what institutions might face in the current market environment, we repeat our analysis in different market scenarios. We use as in the previous analyses both the last five years and the next five years scenarios, and show the differences in impact in Figure 9. In the last 5 years, increasing the interest rate hedge would indeed have resulted in a strong risk reduction and a positive return contribution.

In the current market environment, interest rates are relatively quite low. An upward trend for interest rates is included in our scenario for the coming five years. In the '2016 - 2020' scenario we expect a strong upward movement in the interest rates. Hence, in case interest rates are hedged, there will be a negative effect on the funding rate return¹³. Figure 9 shows the different effects between the two scenarios. In terms of volatility reduction, hedging liabilities can still substantially reduce uncertainty in the funding ratio, although at higher (expected) costs.

¹³ The negative effect occurs only if the interest rate increase is more than the implicit rise that is currently already priced in in the forward curve.

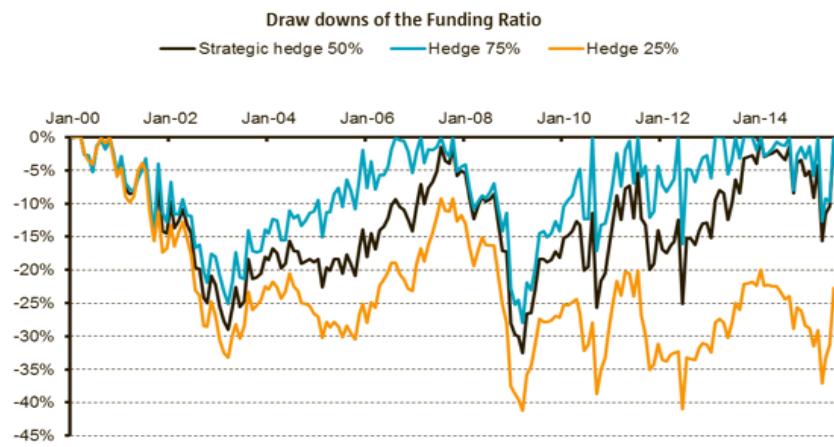
Figure 9: Interest rate hedging in two economic scenarios



The scenario 'last 5 years' denotes the period from 2010 Q3 to 2015 Q3 and '2016-2020' Robeco's Expected Returns view for the next five years. Source: Robeco Investment Research.

Next, we verify the effect of interest rate hedging on drawdown analysis. Figure 10 highlights the effects of interest rate hedging on the funding ratio. The magnitude of the funding ratio drawdown is smaller for a higher interest rate hedge in the period from 2000 to 2015. Over this period, the funding ratio of the fund experiences several drawdowns which start in the early 2000s. A higher level of interest rate hedge would not only have reduced the drawdown of the funding ratio, it would also have improved the pace of recovery and reduced the severity of it. Decreasing the level of interest rate hedging would have resulted in a large impact on the funding ratio.

Figure 10: Interest rate hedging on a longer investment horizon



The black diagram denotes the strategic hedge of 50% interest rate, the blue mark the 75% hedge and orange mark the 25% interest rate hedge of the liabilities. The LDI 40 returns are based on simulated portfolio returns. Source: Robeco Investment Research.

Overall, additional interest rate hedging is preferred in an historical long-term scenario. On a shorter horizon with increasing interest rates, the funding rate of an institution can be harmed by this approach. Uncertainty around the current direction of yields requires the investor to monitor his level of interest rate hedging. The DSAA and ST tools can help to assess and quantify these risks for instance by analyzing the effects in Robeco's 'Secular stagnation' regime. In this regime the interest rates will decrease while stocks will show small negative returns. A reduction of the interest rate hedge would in this scenario have adverse effects.

Appendix

Table A-1: Examples of market regimes used in the DSAA tool

Scenarios in the DSAA tool

<i>Historic scenarios</i>	<i>Description</i>
Historical	Monthly data from 1986 Q1 to 2015 Q3
Last 10 years	Monthly data from 2005 Q3 to 2015 Q3
Last 5 years	Monthly data from 2010 Q3 to 2015 Q3
Economic outlook	
2016-2020	Based on the Robeco market outlook for 2016-2020
Secular stagnation	A worst case scenario with a global economic downturn
Steady state	The long-term investment outlook

Table A-2: Examples of stress scenarios used in the ST tool

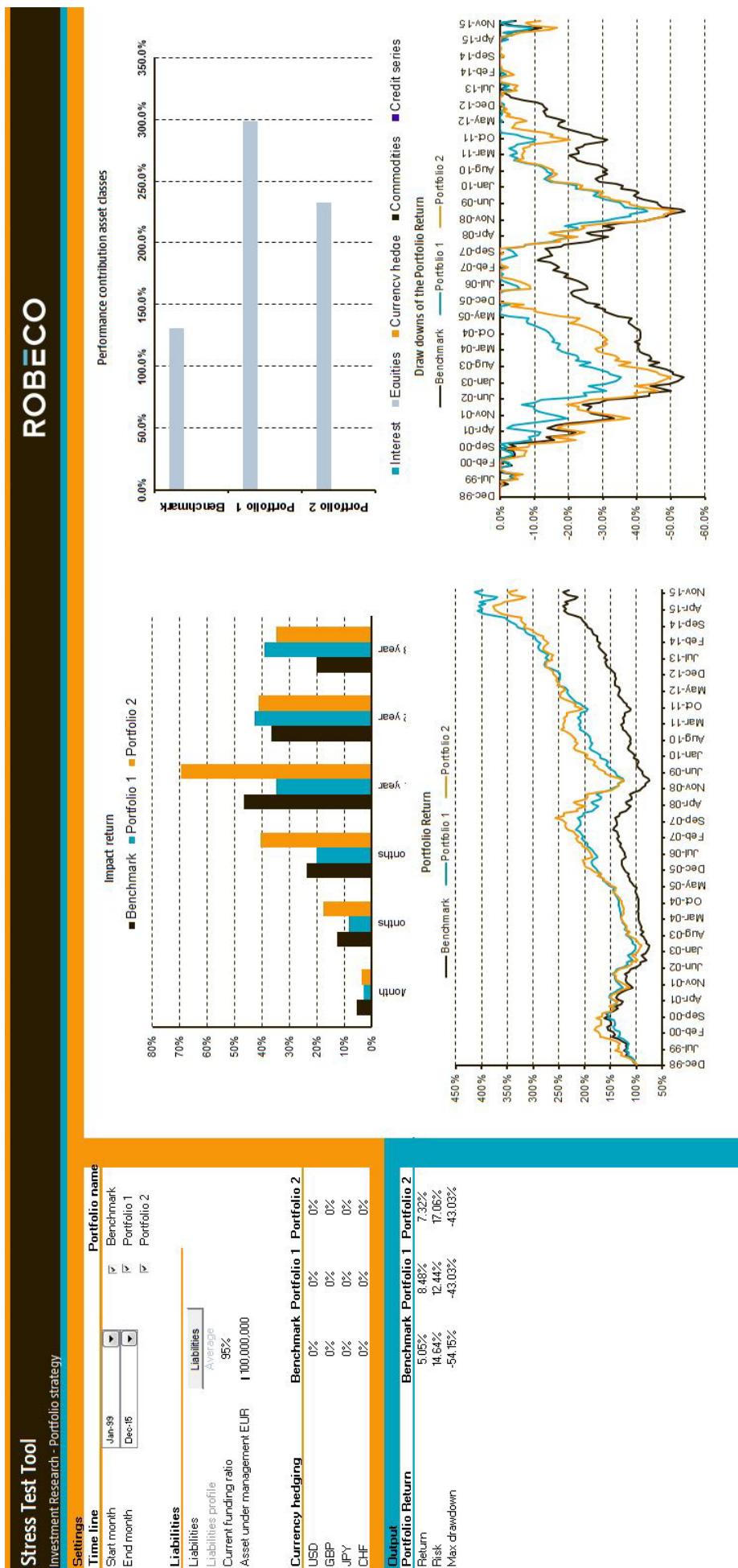
Scenarios in the ST tool

<i>Stress scenarios</i>	<i>Description</i>	<i>Start</i>	<i>End</i>
NBER Contraction 2	The US Economic contraction (NBER)	Mar-01	Nov-01
Global down turn	Equity markets	Mar-02	Oct-02
Subprime Mortgage Crisis	First part of the financial crisis	Dec-07	Aug-08
Credit Crisis	Second part of the financial crisis	Sep-08	Mar-09
Global financial crisis	Extensive period of the financial crisis	Aug-07	Mar-09
Stock markets drop 2011	First drop after equity bull market in 2009	Aug-11	Aug-11

Figure A1: Screenshot DSAA tool



Figure A2: Screenshot ST tool



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F.A. de Roode



R. Molenaar

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Contact

Robeco (Headquarters)

P.O. Box 973
3000 AZ Rotterdam
The Netherlands
E contact@robeco.com