

A detailed performance analysis

Dynamic Duration: 70 years of evidence

Sustainable Investing Expertise by
ROBECOSAM



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For professional investors
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Introduction

Robeco's duration model has determined the duration positioning of the Dynamic Duration portfolios since 1998. It has thus built a live track record spanning 23 years. The strategy has generally performed well over this period, with strong performance especially in periods when bond yields moved most. That said, this performance comes with considerable volatility. We use a long-term backtest to analyze the performance of the strategy and its volatility.

When the research leading to the creation of the model was performed in the early 1990s, the limited availability of historical bond data was one of the challenges. Our researchers made an effort to collect historical bond returns for several markets. In some cases, they received historical yield data from local sources by fax and calculated bond returns based on these numbers, to increase the available dataset. The availability of historical bond market data has improved since then, and not only because more than 25 years have passed since this first research project concluded. In recent years, a much wider set of historical financial market data has been made available, thanks to researchers digitalizing archives of exchanges, central banks and newspapers. In this paper, we use these data to test our model over a deep sample spanning 70 years of international data, across the major bond markets.

We look at this deep sample for two reasons. First, it provides unique, independent evidence on the efficacy of our model. Data from the past few decades have been scrutinized thoroughly, by us as well as other researchers. Perhaps this scrutiny is too thorough – a concern which relates to an extensive debate amongst scientists warning that many findings in economics, psychology and even in medicine may be false. Scientists are incentivized to find positive results, which increases the probability of finding false positives. Needless to say, we believe this not to be the case for our research. We nevertheless consider it important to verify this. Previously untested bond market data provides us with the key tool for such a test. If our model works also on this truly out-of-sample data, we can rule out p-hacking influences. (To provide a sneak preview of our results: we surely can!). Second, a deep sample allows us to examine the behavior of our strategies with greater confidence. After all, 70 years of data give better insights than 25 years of data.

In the first part of this paper we describe the model, the dataset used for the long-term backtest and the main results. This backtest shows convincingly that the model works – not only in the recent decades, when bond yields experienced a secular decline, but also in the 1960s and 1970s, when bond yields generally rose. More generally speaking, the long data period means that the research sample spans a wide variety of economic circumstances.

In the second part, we use this backtest to analyze the performance delivery of the strategy. We discuss the volatility of the performance, we study whether recent performance predicts future performance and explore how best to employ the strategy. The long data sample allows us to study the stability of returns over periods of multiple years – something that is difficult even with a 23-year live track record.

Figure 1 | Average of the 10-year government bond yields for US, Germany, Japan



Source: Robeco, Bloomberg, Datastream, Global Financial Data

Part 1: The model, the dataset and the main result: confirmation

In this section, we describe the long-term backtest of the model and its main results.

Model description

In accordance with our research philosophy, all variables in the model are based on both strong quantitative evidence and a clear economic rationale. From the onset of our research, we have been looking for structural drivers of bond markets. Researchers, strategists and fundamental portfolio managers together decided to test variables like valuation, trend and macro-economic market drivers like economic growth and inflation. While the results for trend and valuation were straightforward, the macro data posed some problems. This is partly because official statistical data series related to economic growth, like GDP and industrial production, are published with a delay and are prone to revisions. The other constraint is that these data series are by definition backward looking: they describe past growth. Our research showed that growth and inflation are relevant drivers of bond markets, but markets have already discounted these drivers by the time the official statistics are published. For the purposes of predicting bond markets, we thus need forward-looking indicators. Financial market data can be used for this purpose. For instance, equity markets are known to lead economic growth. Equity returns can thus be used to predict growth and hence bond markets. In a similar vein, we use commodity prices to predict inflation and hence bond returns.

We have continued our research since the inception of the model, making several enhancements. These improvements have included the addition of variables, adjusting the data series used as input and refining the calculation of the variables and the way in which we combine the variables into a model score. We have also adjusted the implementation of the model to developments in the bond market. For instance, when we built the model in the 1990s, we still considered France and Germany as entirely separate bond markets. With the introduction of the euro, we adjusted the implementation to reflect the common interest-rate risk shared by these markets. Despite all the enhancements and refinements implemented over the years, the model fundamentals have remained the same. The four variables mentioned at the start of this section – value, trend, equities as growth indicator and commodities as inflation indicator – were already present in the first version of the model and still are part of the current model.

Constructing the long-term backtest

In our Dynamic Duration strategy, we take active positions based on the model signals for the US, Japan and the eurozone bond market. These three large blocks together comprise nearly 90% of the global developed government bond market. We implement overweight and underweight positions using US, Japanese and German bond futures. These active positions can be implemented as an overlay on top of a bond portfolio. Note that wherever we mention performance in this report, we refer to the performance of this overlay. This performance comes on top of the return from the underlying portfolio, i.e. it is a relative performance.

For this backtest, we use ten-year bond futures. Before inception of these futures contracts, we use data for ten-year government bonds. We obtain historical data for bond returns and the variables used in the model from Bloomberg and Datastream. Before the start of the data series from these sources, we use data from Global Financial Data. These data series can be slightly different from those used in our actual model, but in general we are able to find series that measure the right thing – for instance, the price change of a diversified basket of commodities, or the return on Japanese equities.

Another consideration is that, for this long sample, the data is only available on a monthly basis. Our actual variables use higher-frequency data, but they all use lookback periods that are longer than a month, so we can create decent proxies for our variables based on monthly data. We generate monthly forecasts, while in reality our model can react more quickly to new developments during the month. This also implies that we cannot test the intra-month seasonal pattern, but only the annual pattern used in the season variable. Note that while working with historical data does pose

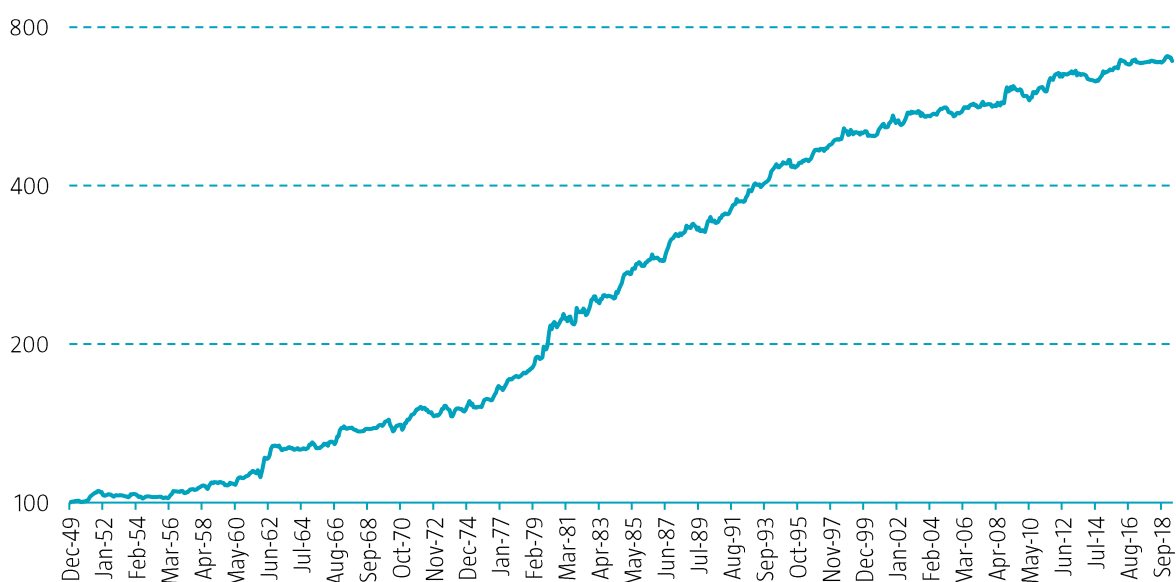
some limitations, this is how we started in the 1990s: our original backtests were also based on monthly data and, in the first few years, we indeed updated the model and adjusted positions only once a month.

Finally, a signal based on the monthly data as of the end of January cannot be implemented precisely at the closing price of January, as it takes some time to gather the data, generate the signals and implement them – although this process has become much quicker over the years. In this backtest, we ignore this delay and assume that we can implement this signal at the January closing price. The only alternative when using monthly data would be to assume that we implement the signals only after a month, at the end of February. While such a long delay is an unrealistic assumption, the backtest results would nevertheless remain positive. So, while these issues will have an impact on the precise results, the results nevertheless are robust and we can draw reliable conclusions about the model from this backtest.

Main result: clear confirmation

The main result from this backtest is a clear confirmation of the forecasting power of the duration model. The following figure shows the cumulative performance of the strategy:

Figure 2 | Cumulative performance of monthly long/short positions based on model outcome, net of transaction costs, 1950-2019



Source: Robeco computations based on financial market data from Bloomberg, Datastream, Global Financial Data. Please note that cumulative performance is shown on a logarithmic scale.

The figure shows that the model consistently adds value. This is true not only in the recent decades, for which we already know the live performance of the strategy, but also in the period before that. The peak in global bond yields occurred in September 1981, as can be seen in Figure 1. It is immediately clear that the model works not only in the period after 1981, with the secular decline in yields, but also in the preceding decades when yields predominantly rose.

Detailed results (not shown here) confirm that the same holds for the individual variables: all variables achieve a positive performance and decent risk-adjusted returns. Each of the variables thus contains useful information for forecasting bond returns. Moreover, each of the variables contains uniquely different information: the correlations between the variables are fairly low, confirming that each variable brings something new to the table.

The consistency of the results is also confirmed when zooming in on the performance in stressful periods for financial markets, such as recessions, periods with high inflation and periods with declining equity markets. The model works well in these times, too. The average performance of the strategy in each of these stressed market states is in fact slightly better than the full-sample average. This is good news: the performance of the strategy is not gained at the cost of losses at inconvenient times.

Our academic paper

Our academic paper¹ related to this white paper uses the same 70-year data period to demonstrate that bond markets are predictable. We do not use the entire duration model in this paper, but instead focus on four variables that have already been documented in previous studies: growth, inflation, value and trend. We use settings that are commonly used in academic literature for these variables rather than the settings from our proprietary model. The academic paper thus demonstrates that bond markets are predictable without revealing details about our model.

The academic paper reaches the same findings: the model delivers strong results not only in recent decades but also in earlier decades with rising yields. It also shows positive performance for all variables tested, as well as strong results in difficult conditions such as recessions.

¹ The academic paper "Predicting Bond Returns: 70 Years of International Evidence", can be downloaded via this link: <https://ssrn.com/abstract=3631109>

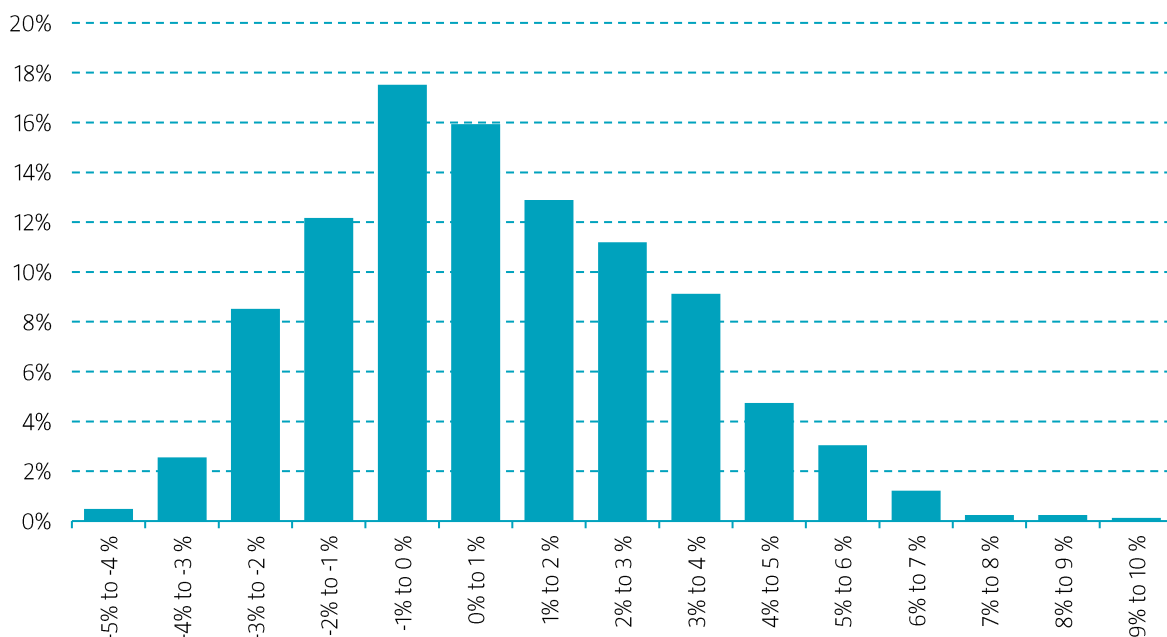
Part 2: A closer look at the performance delivery

This very long backtest allows us to closely analyze the performance delivery of the strategy. It enables us to study extreme market environments and returns over periods of multiple years. However, we have to face the limits of a backtest. We discussed the limitations of the dataset, for example, the fact that we cannot properly take the implementation lag into account. Furthermore, any backtest is likely to be prone to a degree of lookback bias, that makes results look better than they are. In the remaining part of this study we apply a discount to the backtest results, to correct for the effect of such a bias. In particular, the discount results in performance that is in line with the results realized during the live period.

The distribution of model returns

The Dynamic Duration strategy focuses on duration timing, i.e. positioning for rising or falling yields. We apply the model to the main developed bond markets globally, but we know these markets are correlated. The strategy thus directly addresses the single most important driver of bond returns. It also means, however, that the strategy has only limited breadth. The model performance over shorter time periods thus should be expected to be volatile. This volatility is indeed apparent in the following figure, which shows the distribution of the annual model performances:

Figure 3 | Frequency of 12-month model performances, overlapping periods, discounted backtest, 1950-2019



Source: Robeco computations based on financial market data from Bloomberg, Datastream, Global Financial Data

The model performs well on average: the number of years with positive performance exceeds the number of years with negative performance, and the positive returns are on average larger than the negative returns as well. However, the

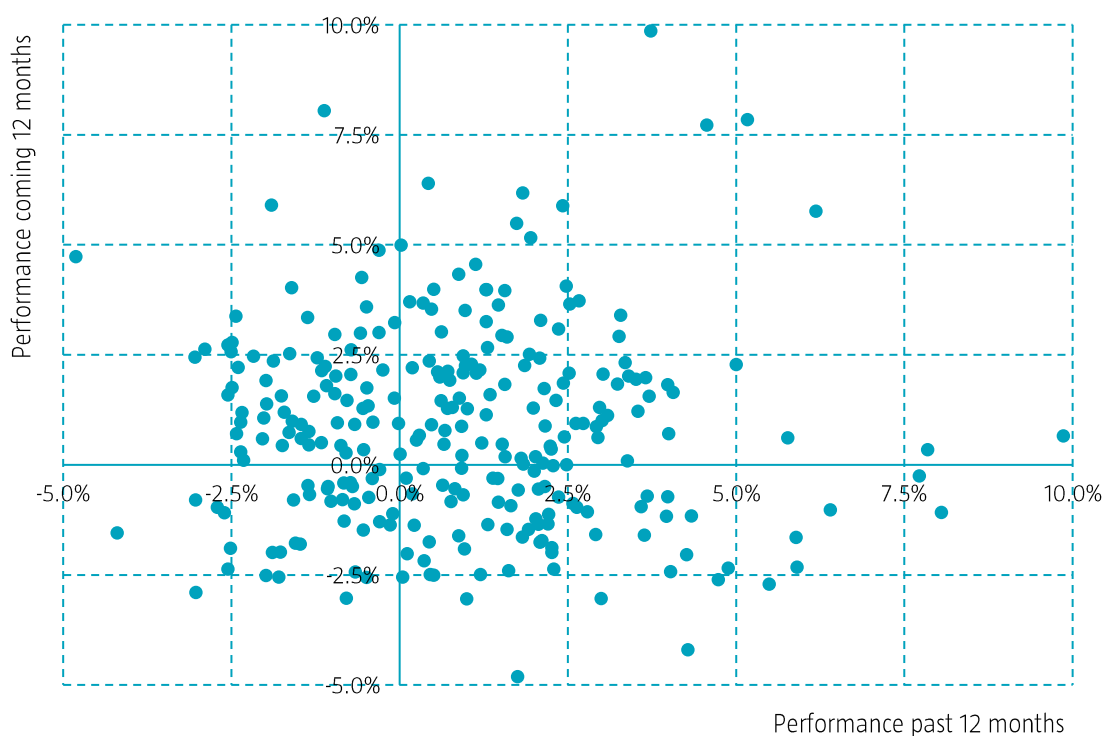
distribution is fairly wide and there are years with sizeable negative returns. Roughly half of the 12-month returns in this analysis fall between -1% and +2%, and 12-month periods with performance below -3% and above +5% both occur in nearly 5% of the cases. This roughly matches the most extreme calendar years in the live period of the model: we have indeed experienced outperformance of more than 6% in 2008 and underperformance of 3% more recently, in 2020.

Is performance predictable?

One may wonder whether the performance of our strategy is predictable. Many investors apparently believe that good years are likely followed by another good year, and bad years by another bad year. Over the years, we have observed that clients are more likely to select the fund or add to their holdings after a strong year than after a weak year. While this behavior seems perfectly natural, we can test the validity of the underlying assumption. Is the strategy indeed more likely to outperform when recent performance has been strong? And is it better to avoid the fund when recent performance has disappointed?

To test this, we test whether there is a relation between the model returns of the previous 12 months and the next 12 months. We use the data for all 12-month periods ending at a calendar quarter end. The following figure shows the results, with past performance on the horizontal axis and the performance in the following year on the vertical axis:

Figure 4 | Relationship between returns over past 12 months and coming 12-month period, quarterly observations, discounted backtest, 1950-2019



Source: Robeco computations based on financial market data from Bloomberg, Datastream, Global Financial Data

It is clear that there is no relationship at all (the correlation is -0.04). A strong year can be followed by a weak year, but also by another strong year. The same holds for quarterly returns, and also when we try to use the previous year's returns to predict the returns for the next quarter. The odds are no different after a strong year than after a weak year. We simply cannot predict near-term performance based on recent performance.

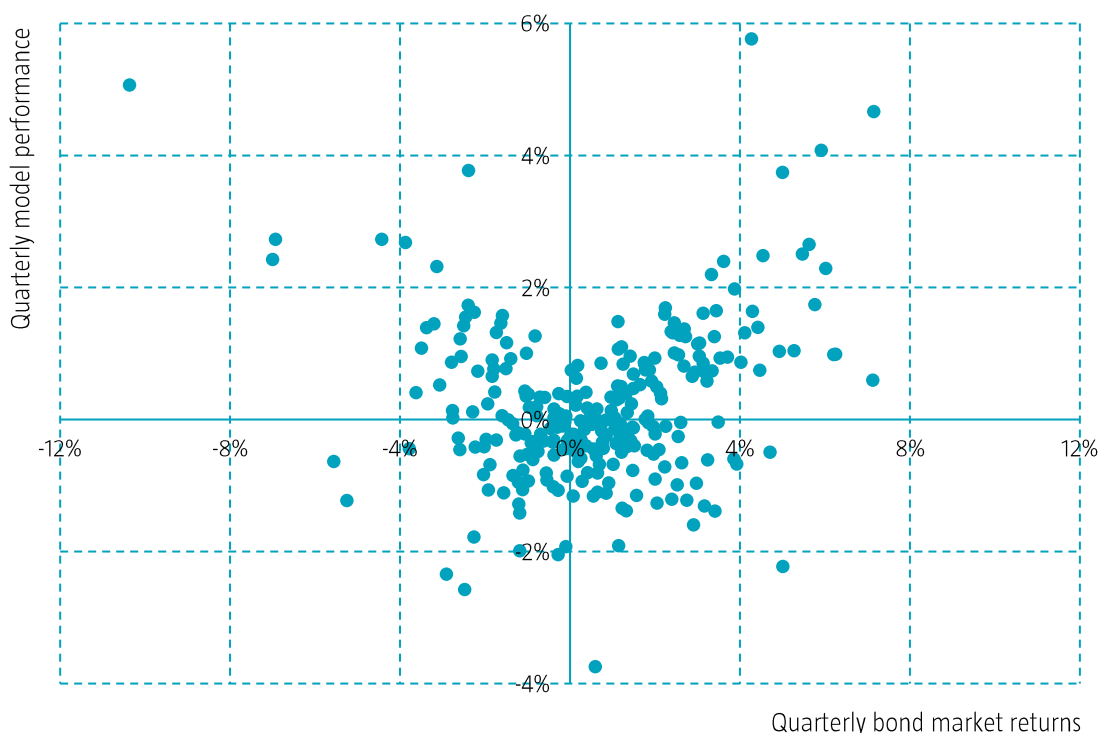
This means that clients who enter the fund after a strong year do not have better odds of outperformance. Nor do they face weaker odds; they face the same odds as clients entering after a weaker period. While we understand that strong performance in recent quarters feels reassuring, it in fact conveys little additional information about future performance. It also means that it is not a bad sign if recent performance has been weaker – this does not predict further weakness.

Can we explain performance after it materialized?

While we cannot predict when model performance will be above or below average (we have tried other potential predictors than just recent performance), we can explain (after the fact) when model performance is stronger. We have observed that the Dynamic Duration strategy in its live track record performed best when bond markets moved most. This makes sense, as the strategy is essentially a form of market timing. Periods with bigger market moves offer better opportunities for market timing.

The same relation holds for the backtest results. The following scatter plot of the returns per calendar quarter shows the global bond market return on the horizontal axis, and the model performance in that quarter on the vertical axis.

Figure 5 | Quarterly model performance and bond market returns, discounted backtest, 1950-2019



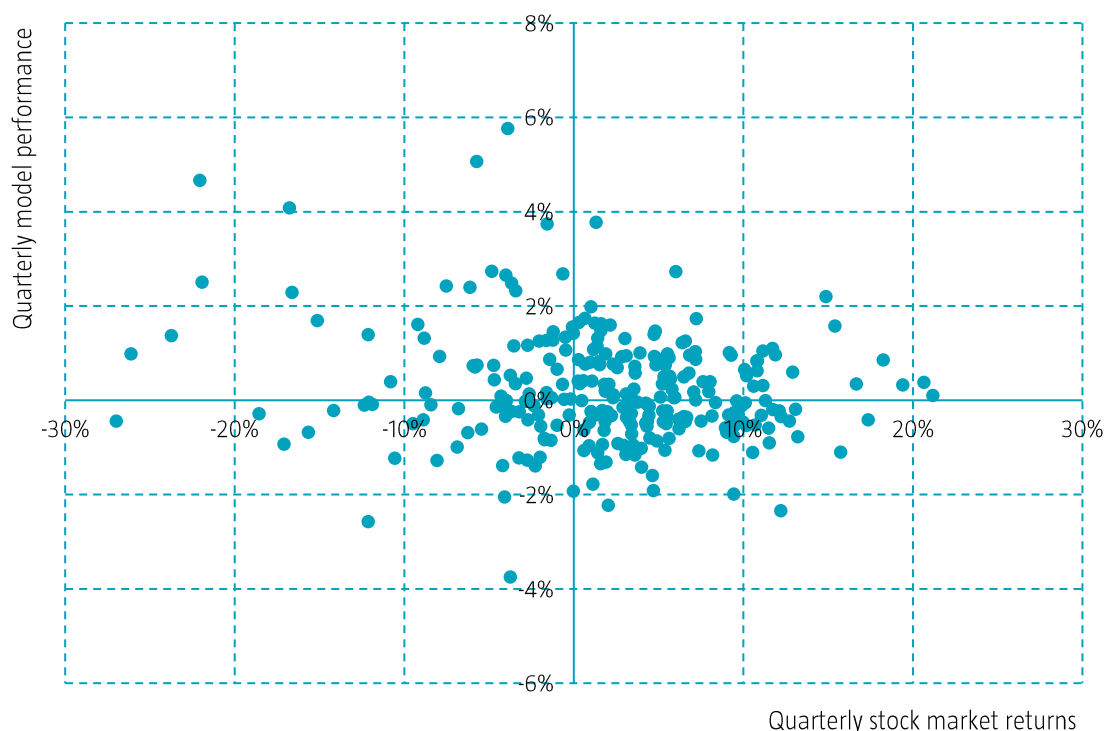
Source: Robeco computations based on financial market data from Bloomberg, Datastream, Global Financial Data

The dots show a V-shaped pattern. In the middle of the graph, where quarterly bond market returns are close to zero, the model performances are also modest. Both to the left (periods with large negative bond returns) and to the right (periods with large positive bond returns) we see larger model performances. The model is not infallible, so there are negative model performances under all market circumstances but, generally speaking, the model signals are more accurate and model performance is stronger when markets move more strongly – irrespective of whether yields move up or down².

As a special case of this relationship, we see strong model returns when equities and other risky assets plunge. This can be seen in the following scatter plot, where we show for each calendar quarter the performance of the stock market (on the horizontal axis) and the performance of the model (on the vertical axis).

² Note that we are not just observing larger performance in times of larger volatility. Risk-adjusted performance and success ratios are also higher in periods with large market moves. Furthermore, large market moves in a quarter is not the same as high volatility: a steady increase in yields with low volatility can also result in a large market move.

Figure 6 | Quarterly model performance and stock market returns, discounted backtest, 1950-2019



Source: Robeco computations based on financial market data from Bloomberg, Datastream, Global Financial Data

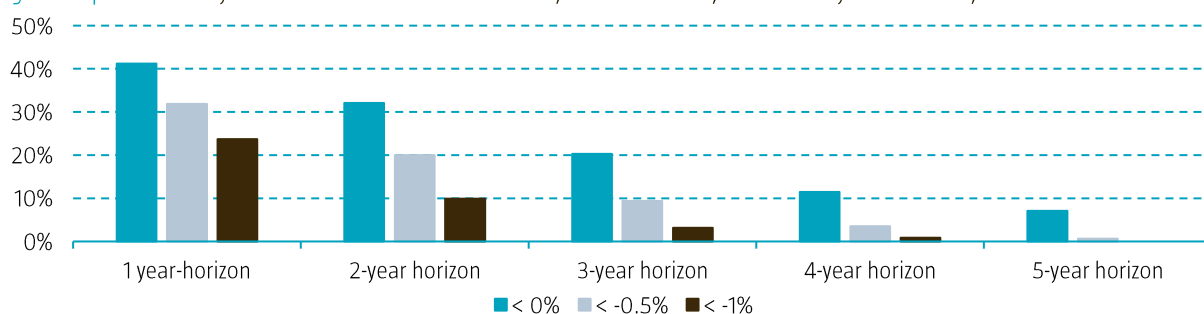
Most of the dots fall to the right-hand side of the graph, reflecting that equities have risen in most calendar quarters. In these more benign periods, bond market moves have generally been smaller. While the model has generally performed well in these periods (most dots are above the horizontal axis), the strongest model performances have not occurred in these calendar quarters. The biggest performances have been gained when equity markets fell (to the left in the graph). While there are fewer dots to the left, the dispersion is wider, indicating that the moves in bond markets were bigger in these periods. This explains why the model has on average performed more strongly in the weakest periods of equity markets.

The strong model performance in periods when equities fell makes the strategy more valuable in the context of a multi-asset portfolio, as it helps to cushion the losses in these periods. The Dynamic Duration strategy thus strengthens the diversification benefits of government bonds versus risky assets like equities. While we know that we can generally expect better performance when markets move more, we cannot predict beforehand whether markets will move a great deal or not. So, we cannot use this relationship to predict model performance.

Strong hands to reap the benefits

The following figure shows the probabilities of having a negative return, or an annualized return below -0.5% or even below -1% over periods ranging from one to five years – again using overlapping periods.

Figure 7 | Probability of annualized returns below 0%, -0.5% and -1%, over 1 to 5-year horizons, discounted backtest



Source: Robeco computations based on financial market data from Bloomberg, Datastream, Global Financial Data

The probability of a negative performance in a single year is ca. 40%. We also see that larger negative performances are quite possible for periods of 1 or 2 years. This can be explained by the limited breadth and the resulting volatility inherent to the strategy, and by the fact that markets need to move for the strategy to be able to perform. If the model doesn't get a market move right, and yields do not move much in the subsequent period, then it will take some time before the performance can be recovered. For longer periods, the probabilities of (large) negative performances are lower. Nevertheless, negative performances remain possible, also over three-year periods. Therefore, strong hands are required to reap the full benefits of the strategy

Conclusion

We used a deep historical dataset that was recently made available to backtest our duration model. This backtest demonstrates that our model works well over 70 years of data. The model has generated 0.7% annualized alpha in the 23 years of live trading, and it performed well in the original backtest. Together, these two periods are marked by the secular decline in yields. This longer backtest shows that the model worked equally well in the 1950s, 1960s and 1970s, when yields were predominantly in a rising trend. The model has typically added most value in periods when bond yields moved most, including recessions and weak periods for risky assets like equities.

The long backtest also confirms that model performance can be volatile. Circa 15% of the annual performances are below -2%, and even over 3-year periods model performance can be negative. However, recent performance does not predict model performance for the coming months or year.

The strategy's average outperformance and especially the performance when markets move most – both when yields rise and when they fall strongly – make it valuable in a portfolio context. But strong hands are a requirement. In order to reap its full benefits, investors need to hold on to the strategy also through weaker periods.

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