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Reaching for yield: selected issues for reserve managers[1]

Managers of official foreign exchange reserves have been facing historically low yields on highly rated government securities, the instruments to which they have traditionally devoted the bulk of their investment portfolios. In mid-August 2003, after eight weeks of rising long-term interest rates, the yield on the two-year US Treasury note still stood at 1.86%, down from a peak of nearly 17% in 1981. It is true that much of the decline since 2001 had been the result of cuts in monetary policy rates, which had served to shift down whole yield curves. Nevertheless, even adjusting for the monetary policy cycle, yields in the major currencies have tended to be substantially lower in recent years compared to those in the previous decade. In these conditions, reserve managers have found themselves seeking instruments with higher yields in an effort to maintain the investment returns to which they had become accustomed.

In considering higher-yielding alternative instruments, reserve managers must ask two basic questions. First, do higher yields actually lead to higher returns?[2] Second, to the extent that higher expected returns are a compensation for taking on greater risk, what is the nature of the risk entailed? In this special feature, we focus on a few selected cases for which these questions seem particularly interesting. These cases involve three alternative portfolios that offer higher yields, namely a longer-duration portfolio, a corporate bond portfolio and a portfolio of higher-yielding currencies. We discuss the issue of increased risk-taking with respect to durations and corporate bonds. In the case of durations, we ask the specific question of whether the present low-yield environment implies a new trade-off between duration and volatility. In the case of corporate bonds, we focus on the challenge of managing a portfolio in which risk is characterised by low probabilities of heavy losses. We finally examine the question of yield and return with respect to currencies. Specifically, do higher yields offered by

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1 The views expressed in this article are those of the authors and do not necessarily reflect those of the BIS or the Netherlands Bank.

2 Yields differ from returns, because the latter include capital gains or losses, which will depend on duration. For the relationship between yield and return, see footnote 5 below. In the case of foreign currencies, returns may also differ from yields because of exchange rate changes.

instruments in certain currencies tend to be offset by movements in exchange rates?

In the discussions below, we limit ourselves to issues of strategic investment over the medium to long term. Hence, we conduct our analysis in terms of averages of returns and measures of risk over extended periods of time. This focus allows us to avoid the tactical question of timing, ie the issue of when precisely reserve managers should undertake a change in positions. Timing depends on when yields or spreads may be expected to rise or fall, and this is an issue on which we offer no guidance. Our focus on investment strategy also means saying nothing about issues of liquidity. While central banks often hold liquid reserves for intervention purposes, the reach for yield really pertains to the investment part of the portfolio.

Duration and volatility: have lower yields changed the trade-off?

For default-free debt securities without the possibility of prepayment, risk is represented primarily by duration. A change in the level of interest rates would affect the market value of longer-duration securities more than that of shorter securities. One possible implication of a low-yield environment is a thinner yield cushion against capital losses. If interest rate volatility has remained the same, then a reserve manager who wishes to avoid negative returns would set a shorter duration target. But is it true that volatility is invariant to the level of yields? From a technical standpoint, the zero lower bound on nominal interest rates should naturally lead to lower volatility.[3] From an economic point of view, an environment of low interest rates may simply be an environment of low inflation. Since lower levels of inflation tend to be associated with reduced variability of inflation, this may lead to lower interest rate volatility. Low interest rates may also reflect a more transparent monetary policy reaction function, which may also serve to dampen volatility.[4]

The zero lower bound should lead to lower volatility

Indeed, there is evidence that as yields have declined so have the volatilities of returns.[5] In the left-hand panel of Graph 1, we compare for one-year investment horizons average volatilities between two periods, a high-

Volatilities are lower across the yield curve ...

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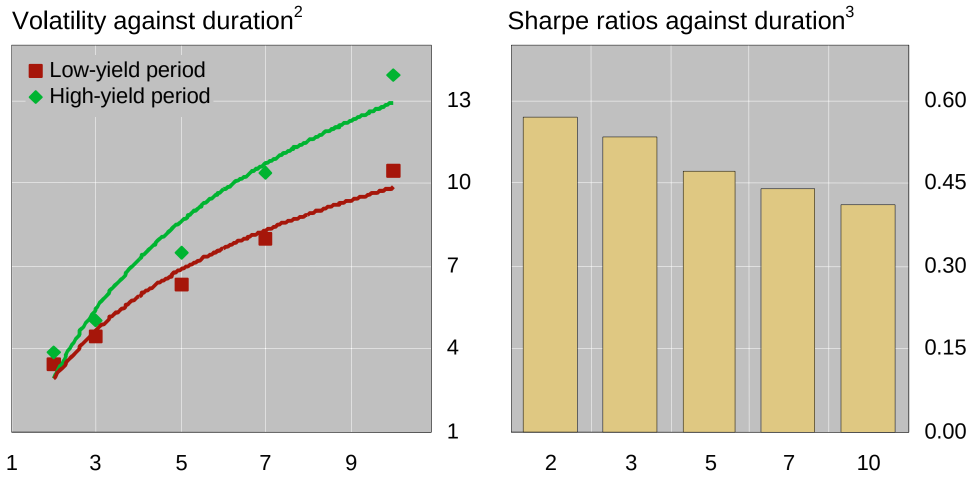
[3] This is one reason why models of interest rate movements incorporate the so-called "square-root process", in which volatility is specified to be proportional to the square root of the level of interest rates. In this case, an interest rate close to zero would imply a volatility close to zero. See, for example, Cox et al (1985) and Gong and Remolona (1997).

[4] Indeed, Ait-Sahalia (1996) provides evidence that such volatility depends on both the monetary regime and, within a regime, on how far the interest rate is from its mean. There is also strong evidence for mean reversion in interest rates within a regime, suggesting that when interest rates are close to the trough in a period of monetary easing, the distribution of interest rate changes is likely to be skewed to reflect the likelihood of a reversal in the policy stance. Moreover, Borio and McCauley (1996) document that bond yield volatility depends asymmetrically on the direction of price changes, where rising yields lead to higher volatility.

[5] Note that the concept of volatility relevant to investors is the volatility of *returns*, not the volatility of percentage changes in yields. The relationship of return to yield is well approximated by $r_{t+1} = y_{t+1} + D_t\left(y_t - y_{t+1}\right)$, where r_{t+1} is the return at the end of the holding period, y_{t+1} and y_t are the yields at the end and beginning of the holding period respectively and D_t is the duration. The relationship is exact for zero coupon bonds.

Volatility and Sharpe ratios for different durations[1]



[1] The sample is split into two periods. The high-yield regime is defined as the period from January 1984 to December 1993, whereas the low-yield period runs from January 1994 to December 2002; for the calculation of returns or yields, zero coupon government yields were used. [2] Volatility on the vertical axis; calculated as the standard deviation of the return, in percentages. [3] Sharpe ratios on the vertical axis; for the low-yield period.

Sources: National data; BIS calculations. Graph 1

yield period from January 1984 to December 1993 and a low-yield period from January 1994 to December 2002. As we would expect, the graph shows that in both periods longer duration is associated with higher volatility. More importantly, the graph shows consistently lower volatilities across the duration spectrum during the low-yield period. On average, volatility in recent years is about three quarters of the average volatility in 1984–93. Assuming this volatility pattern continues to hold, a reserve manager with a given volatility target – or equivalently, a given value-at-risk standard – would now be able to extend duration without taking on more risk.

… but Sharpe ratios are better for shorter durations

Another way to decide on duration is to consider the trade-off between risk and return in deviating from a benchmark portfolio. This trade-off may be measured by the Sharpe ratio, which consists of the excess return achieved by deviating from the benchmark divided by the volatility of this excess return. To illustrate the problem, we consider a benchmark portfolio of three-month US Treasury securities and calculate Sharpe ratios for a shift into longer durations. We calculate excess returns by taking the average of realised monthly excess returns from January 1994 to December 2002 resulting from adding different durations to the benchmark portfolio.[6] We consider the addition of two-, three-, five-, seven- and 10-year durations. Note that if similar calculations are done with other benchmarks, the Sharpe ratios may change. As shown in the right-hand panel of Graph 1, the calculated Sharpe ratios range from about 0.40 to 0.60, with the shorter durations providing the higher ratios.

[6] This is an *ex post* calculation of excess returns. In theory, the Sharpe ratio is about *expected* excess returns, and the calculation assumes that these returns can be measured by past experience. See, for example, Sharpe (1966).

Hence, while volatility seems to be lower in general, one gets less "bang for the buck" as one goes further out in duration. In the above analysis, the desirability of extending duration would depend on whether the reserve manager focuses on meeting a volatility target or on maximising a measure of the trade-off between risk and return. These two decision rules give different answers in the data set investigated here.

Credit risk and skewness: the challenge of diversification

Corporate spreads are wide relative to expected losses ...

Another way to increase expected returns is to take on credit risk. Corporate bond spreads tend to be much wider than would be implied by expected losses from default, so corporate bond portfolios do offer a high potential for enhanced returns. For example, as shown in the left-hand panel of Graph 2, the spread between yields on triple-B corporate bonds and US Treasury securities averaged about 203 basis points during 1998–2002. During the same period, the average probability of default for these bonds was about 0.5%, and the average recovery rate given default was 50%. Hence, the spread was more than eight times the expected loss from default as measured by the average loss over five years.[7]

... because default risk is hard to diversify

Corporate spreads are largely a compensation for bearing credit risk, and one reason why they are so wide is that actual losses from default can easily differ substantially from expected losses. Moreover, such risk of unexpected loss is evidently difficult to diversify away. To illustrate, consider a hypothetical portfolio worth a total of $10 million and divided equally among 1,000 different triple-B names.[8] Assume further that these names have identical default probabilities and independent default times (that is, defaults that are uncorrelated).[9] The right-hand panel of Graph 2 shows the probabilities of varying amounts of default losses for this portfolio given the triple-B default probability of 0.5% and recovery rate of 50%; the dark bar indicates an expected loss from default of $25,000. However, as the graph also shows, the probabilities of greater losses are significant. For example, 1% value-at-risk represents a 1% probability that losses would exceed $50,000. As corporate bond portfolios go, one with 1,000 names is already unusually large, and yet our example shows that it could still be poorly diversified in that unexpected losses remain significant. By contrast, in the equity market a portfolio with 30 different stocks can often be considered well diversified.

Even 1,000 names may not be enough

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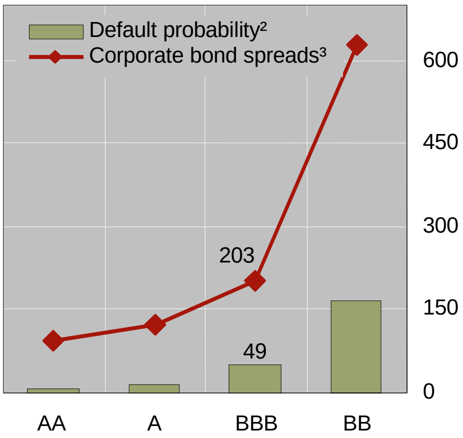
7 Indeed, there are investment strategies that attempt to arbitrage between spreads and expected default losses. The most prominent example of these strategies is the collateralised debt obligation (CDO), in which low-rated bonds are pooled together in a securitisation to create highly rated securities. Elton et al (2001) find that a significant portion of the spread can be accounted for by taxes.

8 To keep things simple, we account only for the probability of default. In practice, losses can also arise from downgrades and wider spreads. Indeed, it is important to integrate credit and market risk in risk management. Duffie and Singleton (2003), for example, show how this might be done.

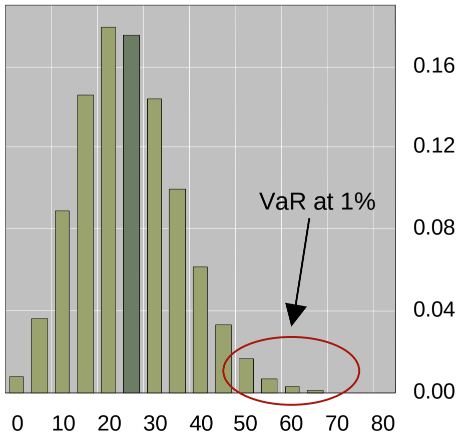
9 We discuss the role of correlations below.

The pricing of default risk

US corporates by credit rating[1]



Probabilities of default losses[4]



[1] Average for the period 1998–2002; in basis points. [2] Probability of default within one year as calculated by Standard & Poor's. [3] Option-adjusted spread for US corporate bonds with five to seven years to maturity; for triple-B, all maturities. [4] Probability density on the vertical axis; losses in units of $1,000 on the horizontal axis; the darker bar represents the expected loss in US dollars for a portfolio of 1,000 US triple-B corporate bonds.

Sources: Bloomberg; Merrill Lynch; Standard & Poor's CreditPro; BIS calculations. Graph 2

Correlations are higher for lower-rated names

It is important to understand the role a correlation in defaults would play in the risk of a corporate bond portfolio. Such a correlation would naturally limit the scope for diversification. In the extreme, a portfolio with 1,000 names but with 100% default correlation would have the risk profile of a portfolio with a single name. In practice, it is difficult to estimate default correlations with any precision. Market participants often assume that for firms in the same industry such correlations are significant, while for firms in different industries correlations are small.[10] Correlations are also likely to be higher between low-rated names than between highly rated names.[11] Such correlations are also likely to vary over time, increasing for precisely those periods when the benefits of diversification are most sought after. To estimate such correlations more accurately, some market participants rely on models that attempt to derive these correlations from the degree to which sharp downward movements in equity prices coincide between firms.

However, while such correlations limit the scope for diversification, they are not what makes corporate bond portfolios difficult to diversify. After all, equity returns tend to be much more highly correlated than default risk. And yet, as mentioned above, a small equity portfolio can be well diversified in that the idiosyncratic risk of individual stock returns is negligible, while a large

[10] For example, in evaluating CDOs, Moody's assigns so-called "diversity scores" to the pool of collateral. These scores reflect the default correlations the rating agency sees, and the scores tend to differentiate mainly between correlations within an industry and correlations between firms in different industries.

[11] Zhou (1997) and Gersbach and Lipponer (2003), for example, show that credit losses are more highly correlated for debt with higher probabilities of default. This means that as credit quality declines over the cycle, default correlations would also rise.

corporate bond portfolio is likely to remain poorly diversified in that unexpected losses from default are significant.

The essential characteristic of credit risk that makes diversification so difficult is the asymmetry in the distribution of returns that this risk generates. In particular, the return distribution for a corporate bond portfolio is characterised by a rather long tail on the left, representing low probabilities of heavy losses from defaults or rating downgrades. In other words, the distribution is negatively skewed. By contrast, equity returns tend to show a much more symmetric distribution, in which the probabilities of large losses tend to be matched by the probabilities of large gains. It is the skewness in returns that presents the reserve manager with the challenge of diversifying a corporate bond portfolio.

Corporate bond returns are negatively skewed

Instruments in other currencies: do higher yields mean higher returns?

At present, most central banks manage their reserves by fixing their currency allocations, with a substantial portion devoted to US dollar-denominated highly rated fixed income assets. Until recently, these assets have offered rather low yields. Can we gain by deviating from these currency allocations to tilt towards assets in currencies with higher yields? The hypothesis of uncovered interest rate parity suggests that on average there should be no gain: currencies with higher yields are likely to depreciate such that the loss from the exchange rate offsets the gain from the yield differential. In its strict form – where the maturity of the instruments matches the investment horizon – the hypothesis is empirically found not to hold.[12] However, reserves are often placed in securities with maturities that exceed the investment horizon, and to our knowledge the uncovered interest rate hypothesis has not been tested for this case.

Do exchange rates move to offset yield differentials?

Do higher yields lead to higher returns once exchange rate movements are taken into account, particularly for longer-maturity instruments? For present purposes, we compare returns on government bonds denominated in euros (Deutsche marks for the pre-euro period), pounds sterling, Japanese yen and US dollars. We examine yields and returns for the period January 1994 to December 2002, calculating returns in terms of US dollars. We fix the investment horizon at one year while comparing returns for securities with a five-year duration. If the uncovered interest rate parity hypothesis holds, yield differentials should have no effect on differential returns, because differences in yield should be offset by changes in the exchange rate.

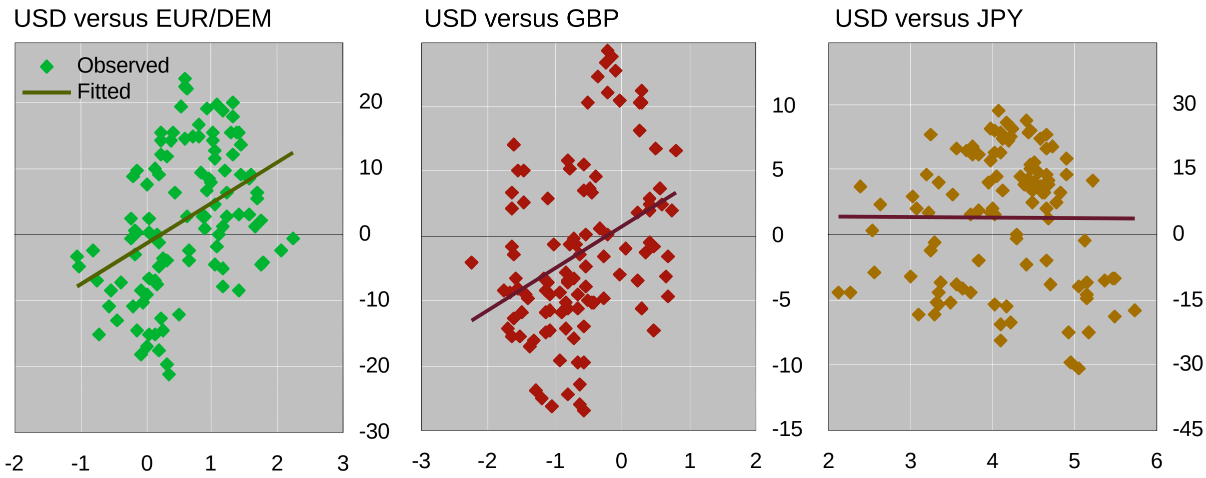
We look at bond returns instead of short-term yields

The results are striking for the sample period considered. For yield differentials between the euro and dollar and between the pound and dollar,

[12] The body of evidence against uncovered interest rate parity is quite large. One of the most careful tests is provided by Hansen and Hodrick (1980). More recent investigations of this issue include Flood and Rose (1999) and Brooks et al (2001). The literature thus far relies on tests using maturities that match the holding periods, for example a one-year instrument for an investment horizon of one year.

Return differentials against yield differentials for five-year bonds[1]

January 1994–December 2002; in annual percentage rates



[1] The return differential (shown on the vertical axis) is defined as the return on the US Treasury security minus that on the other currency government bond in US dollar terms. The yield differential (horizontal axis) is the difference between the nominal yields. The fitted line is based on an OLS estimate of $r^{US}_{t+1} - r^{J}_{t+1} = \alpha + \beta(y^{US}_{t} - y^{J}_{t})$, where $r^{US}_{t+1} - r^{J}_{t+1}$ is the return differential between the US dollar and the other currency and $y^{US}_{t} - y^{J}_{t}$ is the corresponding yield differential.

Sources: National data; BIS calculations. Graph 3

not only do we reject our version of the uncovered interest rate parity hypothesis but we also find that return differentials exceeded yield differentials by large amounts. As shown in Graph 3, a 10 basis point yield differential between euro and dollar bonds meant a 62 basis point differential in returns, while the same yield differential between sterling and dollar bonds led to a 32 basis point differential in returns. It happens that during this period the higher-yielding currency also tended to be the appreciating currency. Hence, exchange rate movements served to magnify the effect of yield differentials on returns.[13] Note, however, that this phenomenon did not extend to yield differentials between yen and dollar bonds. In this case, the outcome was roughly consistent with the hypothesis: exchange rate movements tended to just offset the yield differentials.

Higher-yielding currencies offer scope for enhancing returns

Our results suggest only that there may be some scope for enhancing returns by considering higher-yielding currencies. On the one hand, yield differentials are generally not offset, and indeed may often be reinforced, by currency movements. On the other hand, the relationship does not seem to be reliable for all currencies and may not hold for all periods.

Another issue to consider in deviating from one's currency allocation is the benefits of diversification in reducing risk. As is well known, a low correlation between returns on different assets in a portfolio can reduce the volatility of

[13] For this sample period, conducting the test using one-year government bonds, so that the maturity matches the investment horizon, leads to qualitatively similar but weaker results. The tendency of higher-yielding currencies to appreciate seems to be more strongly associated with long-term yields than with short-term ones.

returns of the overall portfolio. To what extent is this gain from diversification present in returns across currencies? In general, for the major currencies fluctuations in exchange rates contribute more to the volatility of bond returns than do movements in interest rates. For example, over the 1994–2002 sample period, the volatility of returns in US dollar terms on a two-year German government bond was two and a half times the volatility for a two-year Treasury note. Although the correlation between returns is low between German government bonds and US Treasuries, the gain from diversification is limited by the fact that the return volatilities are so far apart. Note, however, that if the reserve manager calculates returns in local currency, there may be more scope for diversification, since here the difference in volatilities across foreign currencies would not be so pronounced.

Exchange rates can add volatility to bond returns

Conclusion

The alternatives available to reserve managers who are seeking higher yields include extending their duration benchmark, investing in corporate bonds and shifting towards instruments in higher-yielding currencies. For each of these alternatives, we raise specific issues about either risk or return. In none of these cases do we by any means resolve the issue. The intention here is limited rather to providing analyses that would allow a reserve manager to pose important questions in more focused ways.

For the alternative of extending the duration benchmark, we find that the critical risks have changed in a way that seems favourable to the reserve manager. In particular, we find that as yields on highly rated government securities have declined, so have the relevant return volatilities for any given duration. This means that an unchanged value-at-risk standard would allow the reserve manager to take advantage of the higher yields offered by longer durations. At the same time, however, the trade-off between risk and return also seems to have changed in a way that may not favour longer durations. One particular measure of this trade-off, the Sharpe ratio, seems to recommend durations not longer than two years. The question then becomes the appropriate standard for judging risk and return.

In the case of corporate bonds, we argue that the main challenge is one of diversification in the face of skewness in returns. Such skewness – representing the risk of small probabilities of large losses – makes corporate bond portfolios rather difficult to diversify. The good news is that this difficulty is reflected in corporate spreads that are much wider than would be implied by expected losses from default.

Finally, in the case of currency allocations, we find that, over a long sample period, exchange rates on average move in favour of the higher-yielding currencies, thus resulting in return differentials that magnify the yield differentials. Our analysis applies to the common case in which the instruments considered have longer maturities than the investment horizons. We find results that are stronger than the usual rejections of the hypothesis of uncovered interest rate parity in which maturities and investment horizons are kept equal. Given our findings, the open question becomes the reliability of these results for a given currency pair and their robustness for different currency pairs.

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