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Credit Risk Premium

Measurement, Interpretation & Portfolio Allocation

- Over the past 23+ years, the average monthly Investment-Grade Corporate Index excess return has been 4.0bp/m, or approximately 48bp/y. The annualized Sharpe Ratio has been only 0.12. Why has the long-term credit spread premium been so low?
- Index rules have a large effect on reported excess returns. For example, the index removes bonds downgraded below IG. Such bonds, which rarely default, are replete with unrealized spread premium. Allowing the index to ignore this removal rule and be "downgrade tolerant", would have produced an average excess return of 5.7bp/m, or approximately 68bp/y, and a Sharpe ratio of 0.16. Still, why has the long-term credit spread premium been so low?
- Given the large decline in Treasury yields over the past 23+ years, the magnitude of the credit spread premium has been sensitive to the corporate duration measure. Were we using the wrong duration measure? We analyze the spread premium for different measures of corporate exposure to the Treasury curve: analytical duration, default-adjusted analytical duration and empirical duration.
- An investor's relevant spread premium measure depends on the risks to which he wishes to remain exposed. We discuss how investors with different goals, constraints, and views, may prefer different spread premium measures.
- If an investor chooses to use empirical duration, what recommendations can we make for estimating this measure?
- Investors are drawn to corporate excess returns when concerned about rising interest rates, but optimistic about future spread changes. How might the various measures of credit excess returns perform when Treasury yields rise? Our index history (since 1989) reflects a period of declining interest rates. We estimate index corporate excess returns back to 1973 to include periods of persistently rising interest rates. How did the credit spread premium perform then? This period may serve as a cautionary tale for today's investor.
- Are there any general conclusions about the relationship between credit spreads and Treasury yields? What economic mechanism links them?
- Finally, what is the relationship between the various credit spread premia and other risk premia, in particular the Treasury risk premium? How should investors go about determining their optimal combination of corporates and Treasuries? We explore several portfolio construction alternatives and present the historically optimal combination of credit risk and Treasury risk premia. How do these combinations differ from the standard Gov/Corp benchmark?

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The credit spread premium is an important financial variable. Investors use a credit spread premium measure when deciding whether to invest in corporate bonds and when constructing optimal portfolios. Typically, investors prefer a credit spread premium measure that removes the Treasury interest rate curve component of credit total returns. However, measuring this credit spread premium poses some hurdles. The first, of course, is the need to gather corporate bond total returns. Ideally, it would be returns on a broad portfolio of corporate bonds to avoid the credit spread premium including misleading idiosyncratic components. Next, to generate an excess return, an investor must measure the sensitivity of the corporate portfolio to changes in the Treasury curve to determine the duration of the portfolio. With this duration measure, the investor can compute the total return on comparable-duration portfolio of Treasury bonds. The credit spread premium is then the difference between the two returns, which is why the spread premium is often referred to as a credit "excess return".

Historical Reported IG Corporate Index Excess Returns

Figure 1 presents the reported excess returns (net of Treasuries) for the Barclays USD Non-Call IG Corporate Index from July 1989 to November 2012.[1]

FIGURE 1

Barclays Non-Call IG Corporate Index Data: Jul/1989 – Nov/2012

Average ExRet	4.0bp/m	Annual Sharpe Ratio	0.12
St Dev ExRet	118bp/m	ρ(Corp ExRet, Tsy Ret)	-0.33

Note: Average is arithmetic average of monthly reported index excess returns. Source: Barclays Research

Over the past 23+ years, the average monthly excess return was 4.0bp/m. This corresponds to a simple average annual excess return of approximately 48bp/y. More noticeable is that the annualized Sharpe Ratio has been only 0.12. Surely corporate bonds must have done better over such a long period? Why have reported index excess returns been so low? There are several possible explanations:

- **Have Realized Defaults Been Very High?**

Perhaps index excess returns have been low as a result of very large realized defaults over the past 23+ years? This is not the case. In an earlier study,[2] we examined the loss-given default for index bonds over the period and estimated that default losses accounted for approximately a 1.9bp/m (or, approximately, 23bp/y) reduction in reported index excess returns. These default losses were not overly large compared to the average spread at issuance of approximately 119bp/y.

- **Did Index Rules Systematically Understate Credit Excess Returns?**

The IG Corporate Index is not a static buy-and-hold set of bonds. The size of the index has been growing significantly over the years and the composition of the index has been constantly changing because of new issues, maturities, and constituent removals related to various index rules. These index rules can have a large effect on reported index excess returns.[3] Most important, bonds downgraded below investment grade are removed from the index at month end following downgrade – a time when such bonds, which rarely default, are replete with unrealized spread premium. If we were to allow the index to ignore removing bonds downgraded below investment grade, and be "downgrade tolerant" (DGT), we find that reported index returns would have been 5.7bp/m, or approximately 68bp/y,

[1] We use the Non-Callable IG Corporate and the Non-Callable Downgrade-Tolerant IG Corporate Index for analysis given the difficulty of generating default-adjusted duration measures historically for callable bonds.
[2] K.Y. Ng and B. Phelps, "Promised Spreads vs. Realized Returns", June 7, 2011, Conference Presentation, Barclays Research.
[3] See "Capturing the Credit Spread Premium", K. Y. Ng and B. Phelps, Barclays Research, 2010

with a Sharpe ratio of 0.16.[4] Nevertheless, even for a DGT index, the long-term credit spread premium has been low.

- **Was the Index Using the "Wrong" Duration Measure?**

Another possible explanation for the low reported corporate excess returns is that the index's duration measure (OAD) has been too high. Given the large decline in Treasury yields, an overstated duration measure would have tended to produce lower reported index excess returns. For example, if the average "true" duration were 0.5y lower than the reported corporate index OAD, and given the 675bp decline in the 10y Treasury yield, reported index excess returns would have been about 1bp/m higher over the past 23+ years. We investigate the impact of alternative duration measures on the magnitude of index excess returns.

- **Are Low Corporate Excess Returns Attributable to the Long Rally in Treasury Yields?**

Suppose changes in default probabilities are "naturally" negatively correlated with changes in Treasury yields. For example, a fall in Treasury yields may be associated with weakening macroeconomic conditions, which could also be associated with rising corporate default probabilities and widening spreads. In fact, over the data period, the decline in Treasury yields was associated with a widening of the average OAS for the NC DGT Corp index from 93bp to 155bp. So, perhaps low corporate excess returns are fully consistent with the large drop in Treasury yields? In essence, corporates have good hedging properties for other fixed income assets in investor portfolios, which is reflected in persistently low excess returns over a period of declining Treasury yields. This is an issue that we will investigate further.

Measures of the Credit Risk Premium

A corporate bond's total return is driven by many factors: changes in the underlying benchmark (eg, Treasury) interest rate curve, default probabilities, recovery rates upon default, liquidity, and the risk premium demanded by investors. The credit spread premium is defined as the additional return earned by a corporate bond. But, additional to what?

$$\text{Corp ExRet}_t = \text{Corp Total Ret}_t - \text{"?" Total Ret}_t$$

There are several possibilities. The relevant credit spread premium measure for an investor depends on the risks to which the investor wants to remain exposed. As a result, investors with different goals, constraints, and views, may prefer different credit excess return measures. What are some spread premium measures and how are they relevant to different investors?

We assume that investors wish to remove some sort of Treasury curve component from their credit total returns. However, the sensitivity of the credit portfolio to changes in the Treasury curve is not clear-cut, and there are disagreements among investors. While all agree that the value of a corporate bond is determined by a set of default-risky nominal cash flows discounted at a time-varying set of Treasury rates plus a spread, determining the appropriate duration for the bond requires careful consideration of how to capture the sensitivity of a bond's cash flows to changes in Treasury rates.

One duration measure disregards the effect of changes in Treasury rates on the magnitude and timing of these nominal cash flows. In other words, any impact changes to the Treasury curve might have on the bond's default probabilities/recoveries is ignored for the purpose of duration computation and, consequently, of the Treasury curve component of corporate total returns. This is an "analytical duration" of a corporate bond. If the analytical duration

[4] The risk properties of the DGT Index have been very similar to those of the IG Corp Index (see Ng and Phelps (2010)).

Treasury exposure is removed, then the investor remains fully exposed to any changes in the bond's default probabilities and recovery rates. Using an analytical duration produces, by definition, analytical excess returns ($ExRet^{analyt}$). For many macroeconomic-oriented investors wishing to take outright views on changes in default probabilities, analytical excess returns would measure the performance of their views. We will discuss two analytical duration measures.

Another duration measure could fully incorporate the relationship between changes in Treasury rates and changes in future cash flows arising from, for example, changes in default probabilities and recovery rates. This is the "empirical duration" of a corporate bond. The empirical duration is the change in the value of the bond from a shift in the Treasury curve including the change in value arising from changes in the value of cash flows that are correlated with the shift in the curve. Using an empirical duration produces empirical excess returns ($ExRet^{emp}$) which measure the risk to changes in cash-flows that are uncorrelated to changes in Treasury rates. Some investors may prefer to be exposed to empirical excess returns. For example, credit portfolio managers who are not permitted to have any interest rate sensitivity would be a natural user of empirical excess returns as their performance measure. Also, "alpha-only" seekers (ie, those who wish to add an independent stream of returns as a "pure credit overlay" to an existing Treasury portfolio[5]) would buy credit and short Treasuries using empirical durations to determine the hedge ratio.

Analytical Corporate Excess Returns ($ExRet^{analyt}$: $ExRet^{OAD}$ & $ExRet^{DefAdj}$)

We analyze corporate excess returns using two different analytical duration measures. The most common corporate valuation model recognizes that a corporate bond's promised cash flows are risky and every period the investor loses a fixed fraction of each promised cash flow to defaults, without any change to the timing of those cash flows. In effect, this model assumes the recovery rate in the event of default is zero, otherwise it should recognize that the principal (recovery rate) is paid early in case of default.[6]

This model produces the common "option adjusted duration" (OAD) measure.

$$Dur^{OAD} = (1+r+s)\sum_i i\frac{c_i}{(1+r+s)^i}\frac{1}{P_{corp}}$$

This is the duration measure used by Barclays Indices and in the computation of its excess returns, which we label $ExRet^{OAD}$.[7]

Another corporate valuation approach, which is consistent with the pricing of other credit-risky assets, assumes promised cash flows are risky, but that the recovery value may be non-zero.[8] In the event of default, bondholders receive a (possibly large) recovery amount.[9] Given the possibility of receiving recovery before maturity, Dur^{DefAdj} is almost always ≤ Dur^{OAD}:

$$Dur^{DefAdj} = Avg(Dur^{\text{Zero-recovery Component}}, Dur^{\text{Recovery Component}}) \leq Dur^{\text{Zero-recovery Component}} \approx Dur^{OAD}$$

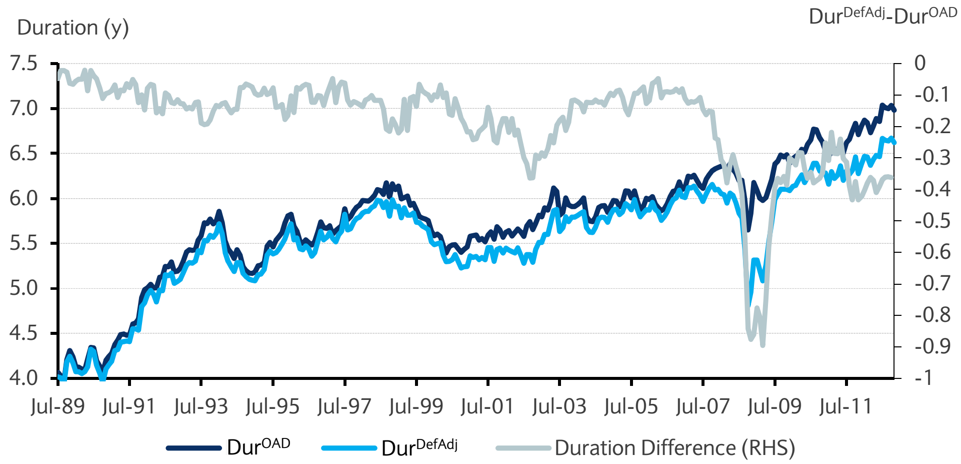
[5] Excess returns based on empirical durations aim to be uncorrelated only with Treasury returns, but they may still be related to other major return streams such as equity returns.
[6] This is sometimes referred to as a one-factor model because only short-term rates have a stochastic dynamic (also called the "BK1" model). See Claus M. Pedersen, "Explaining the Lehman Brothers Option Adjusted Spread of a Corporate Bond," QCR Quarterly, vol. 2006-Q1.
[7] In the Dur^{OAD} equation, r is the Treasury spot rate, s is the spread, c is the stated cash flow, i is the semi-annual period, and P is the dirty price of the bond. Since 2000, the Index uses key-rate durations (KRDs), not OADs, for excess return calculations. In this study we use OAD excess returns throughout to generate a consistent long-term time series of excess returns. In practice, KRD-based ExRets are very close to OAD-based ExRets.
[8] At Barclays, this model is sometimes referred to as the two-factor "BK2" model because of the stochastic dynamic of both the short-term rates and defaults. See Arthur M. Berd, Roy Mashal, and Peili Wang, "Consistent Risk Measures for Credit Bonds," QCR Quarterly, vol. 2004-Q3/Q4, and Claus M. Pedersen, forthcoming, Barclays.
[9] At default, we assume the recovery (R) is a constant percentage of the $PV^{\text{at default}}$ of the principal amount.

The "default-adjusted" duration has the same interpretation as traditional OAD (ie, the weighted time of the present value of the cash flows) except that the weights are the probability-weighted PV of cash flows.[10] $ExRet^{DefAdj}$ equals the corporate total return less the component of return from a matched-Dur^{DefAdj} Treasury portfolio.

Figure 2 shows the time series of Dur^{OAD} and Dur^{DefAdj} for the Barclays Non-Call IG Corporate Index from July 1989 to November 2012. The average difference between the two measures was -0.18, or approximately 3% of the reported index Dur^{OAD}.

FIGURE 2

Analytical Durations (Dur^{OAD} & Dur^{DefAdj}) for the Non-Call IG Corporate Index and Their Difference, Jul/1989-Nov/2012

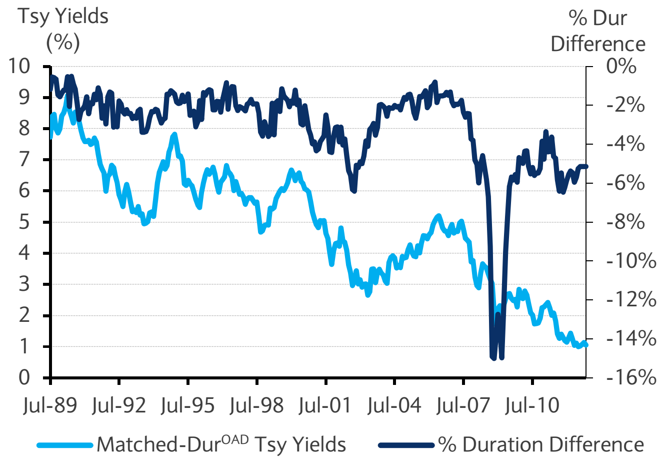


Note: To calculate the Dur^{DefAdj} for the Index, we compute the monthly DV01 (using average index attributes such as price, coupon, and maturity) employing both the Barclays standard one-factor (OAD) and two-factor (DefAdj) corporate valuation models. For the two-factor model we assume a flat hazard rate term-structure and a constant recovery rate in event of default of 40%. We then multiply the ratio of the DV01s by the reported Dur^{OAD} of the index to compute the index Dur^{DefAdj}. Source: Barclays Research

[10] We assume that the default probabilities (h) and recovery value (R) are unaffected by interest rate (r) changes. The model can accommodate default probabilities being correlated with changes in Treasury yields, ie, $\rho(r, h) < 0$. However, there is negligible impact on Dur^{DefAdj}.

FIGURE 3

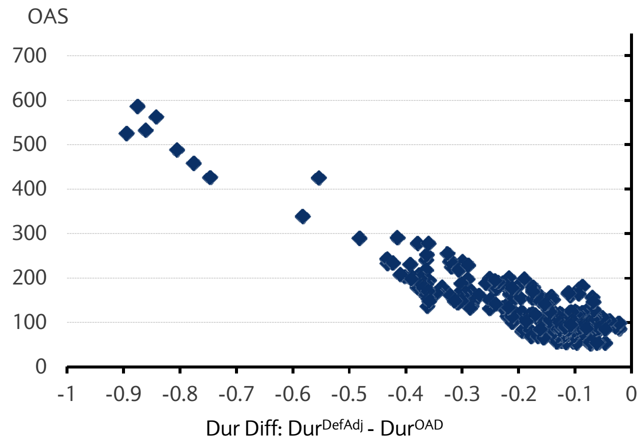
Treasury Yields and the Difference between Dur^{OAD} and Dur^{DefAdj}, for the Non-Call IG Corp Index, Jul/1989-Nov/2012



Note: See notes to Figure 2 for details on the Dur^{DefAdj} computation.
Source: Barclays Research

FIGURE 4

Comparison of OAS and the Difference between Dur^{OAD} and Dur^{DefAdj} for the Non-Call IG Corp Index, Jul/1989-Nov/2012



Note: See notes to Figure 2 for details on the Dur^{DefAdj} computation. OAS is the reported option-adjusted spread for the Non-Call IG Corp Index.
Source: Barclays Research

Figure 5 shows that the average ExRet^{DefAdj} has been approximately 1bp/m greater than ExRet^{OAD} for both the Non-Call IG Corporate Index and the Non-Call Downgrade-Tolerant (DGT) Corporate Index. This pickup for ExRet^{DefAdj} reflects a corporate valuation model that, at times, recognizes that a corporate bond has less sensitivity to changes in rates. Consequently, during periods of declining Treasury yields, this corporate valuation model will attribute less of a corporate bond's total return to changes in Treasury yields, producing a larger excess return.

FIGURE 5

Statistics of Various Non-Call Corp Indices Using Two Different Analytical Duration Measures, Jul/1989-Nov/2012

	Non-Call IG Corporate		Non-Call DGT Corporate	
	Dur^{OAD}	Dur^{DefAdj}	Dur^{OAD}	Dur^{DefAdj}
Average ExRet (bp/m)	4.0	5.1	5.7	6.6
St Dev ExRet (bp/m)	118.1	115.3	125.1	122.3
Annualized Sharpe Ratio	0.12	0.15	0.16	0.19
ρ(Corp ExRet, Tsy Ret)	-33%	-28%	-35%	-31%
Average Dur^{analyt}	5.74	5.55	5.71	5.54

Note: Average is arithmetic average. Source: Barclays Research

This meaningful improvement in excess returns (approximately 12bp/y for both the NC IG and NC DGT indices) was accompanied by a small reduction in volatility, producing an improvement in the annualized Sharpe ratio. Nevertheless, the correlation of ExRet^{DefAdj} with Treasury total returns, while less negative than the correlation of ExRet^{OAD} with Treasury returns, remained significantly negative.

Another illustration of this negative (positive) correlation between ExRet^{analyt} and Treasury returns (yields) is shown in Figure 6 as the average monthly ExRet^{analyt} for months where Treasury yields increased, and for months when Treasury yields decreased. Again, while ExRet^{DefAdj} shows less sensitivity than ExRet^{OAD}, the positive relationship between corporate excess returns and changes in Treasury yields was strong.

FIGURE 6

Average ExRet (%/m) for Non-Call IG Corp Index Conditional on the Change in Treasury Yields, Jul/1989-Nov/2012

	ΔTsy Yields > 0	ΔTsy Yields ≤ 0
$ExRet^{OAD}$	0.44	-0.32
$ExRet^{DefAdj}$	0.37	-0.27
ExRet Diff	-0.07	0.05

Note: The Treasury yield is the end-of-month matched-Dur^{OAD} Treasury yield computed by taking a linear combination of the yields of the Intermediate and Long Treasury indices. The weights are such that the Dur^{OAD} of the Treasury index combination matches the Dur^{OAD} of the Non-Call IG Corp Index. Average is arithmetic average.
Source: Barclays Research

This strong correlation was also not a function of "cash" bonds as we see evidence of negative correlation between CDX returns and Treasury returns (Figure 7). CDX returns have a similar nature as $ExRet^{analyt}$ because both capture the effects of changes in cash flow expectations. However, CDX returns do not depend on a pricing model, thus the observed negative correlation between CDX returns and Treasury returns shows that improvements to the analytical valuation model are unlikely to markedly shrink the negative correlation between $ExRet^{analyt}$ and Treasury returns.

FIGURE 7

Correlations of Various $ExRet^{analyt}$ Measures with Treasury Returns, by Sub-Period, Mar/2004-Nov/2012

Period	CDX	$ExRet^{OAD}$	$ExRet^{DefAdj}$
2004 Q2 - 2007 Q2	-7%	-23%	-16%
2007 Q3 - 2009 Q2	-36%	-40%	-33%
2009 Q3 - 2012 Q3	-65%	-62%	-59%

Note: CDX is the total return of the Barclays CDX IG 5y OTR Unfunded Index. $ExRet^{OAD}$ and $ExRet^{DefAdj}$ are for the Non-Call IG Corp Index. Treasury returns are the matched-Dur^{OAD} Treasury returns for the Non-Call IG Corp Index.
Source: Barclays Research

Why are $ExRet^{analyt}$ negatively correlated with Treasury returns? After all, are we not hedging out Treasury yield curve exposures? However, if changes in the macroeconomic environment drive Treasury yields and corporate default probabilities/recoveries in opposite directions,[11] then we would "naturally" expect $\rho(ExRet^{analyt}$, Treasury returns$) < 0$. There may be a behavioral reason as well. During periods of "risk aversion" investors may sell credit assets and buy Treasuries, and vice versa during periods of "risk seeking".

The negative $\rho(ExRet^{analyt}$, Treasury returns$)$ has two important implications for portfolio managers:

1. Corporate bonds have total return hedging properties in a fixed-income portfolio, and

2. $ExRet^{analyt}$ is not a "pure" credit alpha since it reflects this hedging benefit.

Investors using $ExRet^{analyt}$ in their asset allocation analysis may need to recognize the potential for persistently low or high corporate excess returns, depending on the Treasury cycle.

Empirical Corporate Excess Returns ($ExRet^{emp}$)

Investors can choose to remove the impact of any hedging benefits of corporate bonds in excess returns, by constructing excess returns that are unrelated to Treasury returns. By doing so, investors may expect to see higher excess returns, compared to $ExRet^{analyt}$, when

[11] See, for example, Darrell Duffie and Kenneth Singleton, *Credit Risk*, Ch. 7., Princeton University Press, 2003.

Treasury returns are positive. To generate these empirical excess returns, the investor must first construct a duration measure that includes the entire impact of changes in the Treasury curve on corporate returns, both from discounting and the relationship between changes in Treasury yields and the magnitude and timing of corporate cash flows. This type of duration measure, typically called an "empirical duration" (Dur^{emp}), is estimated via regression:

$$\text{Corp Total Ret} = \alpha + \beta_{emp} \times \text{Tsy Total Ret} + \varepsilon$$

$$Dur^{emp} \equiv \hat{\beta}_{emp} \times Dur^{analyt}$$

$ExRet^{emp}$ equals the corporate total return less the return on a matched-Dur^{emp} Treasury portfolio. To be more precise, we take the return on a matched-Dur^{OAD} Treasury portfolio and scale it, using the estimated empirical beta coefficient, to account for the impact of rates on cash flows.[12]

Assuming that the empirical duration measure, proxied by the estimated empirical beta value, correctly captures the impact of changes in the Treasury curve on corporate returns, then the $ExRet^{emp}$ for a corporate bond will be a pure credit "alpha". This is so because $ExRet^{emp}$ reflects the return impact of idiosyncratic issuer events and the incremental effects of all macroeconomic factors on the bond's credit risky cash flows that cannot be explained by changes in the Treasury curve. If the empirical duration measure is doing its job properly, we should expect to observe $\rho(ExRet^{emp}, \text{Treasury Returns}) \approx 0$.

Constructing an Empirical Duration Measure (Dur^{emp})

The empirical duration regression leaves many open choices for investors. What period should the regression cover? What data frequency (eg, monthly, weekly, or daily data) should be used? Should the regression period include in-sample (ie, forward-looking) observations, or use only backward-looking information, or both? Should observations be equally weighted, or should more weight be given to more recent observations?

We examine three empirical duration measures using monthly data from 1989-2012:

1. **Fixed, in-sample empirical duration** using all information (including forward-looking information).

The estimated fixed, in-sample empirical duration beta, used to adjust the analytical duration, is a single value for all periods. This model, even though it uses forward-looking information, is valuable for its simplicity. If empirical beta is truly fixed over time, one could achieve the performance of this model also out of sample by using a short initial period to learn about the value of the beta. As Figure 8 shows, the fixed, in-sample empirical duration beta was 0.70 in 1989-2012.

2. **Dynamic, in-sample empirical duration** using forward- and backward-looking information.

A dynamic, in-sample empirical duration measure is a time-varying beta estimated using a weighting scheme that gives more weight to observations in proximity (both forward and backward) to a given date. If the true beta varies over time, a dynamic measure is superior to the fixed-value one because it gives more weight to relevant information in exchange for

[12] Some investors may estimate an empirical duration by regressing corporate total returns on changes in Treasury yields, rather than on Treasury total returns. That method raises a host of issues related to the choice of the maturity point for yields, eg, that maturity point may not necessarily match the empirical duration.

being a less stable measure. The results of this measure can be viewed as an upper bound of what can be achieved out of sample (ie, just using backward-looking information) because forecasting a dynamic measure poses more difficulty than forecasting a static one.

To estimate a dynamic, in-sample empirical duration beta we use a bell-shaped weighting scheme centered on the current observation, with a standard deviation of 3.5 months. This weighting scheme was optimized to make the rolling $\rho(ExRet^{emp}$, Treasury Returns$) \approx 0$.

As Figure 8 shows, the dynamic, in-sample empirical duration beta varies considerably over time, with an average value of 0.73, slightly higher than that of the fixed, in-sample estimated beta value. Unlike the Dur^{DefAdj}/Dur^{OAD} ratio, the Dur^{emp}/Dur^{OAD} (ie, $\hat{\beta}_{emp}$) is not as closely tied to the corporate OAS level: $\rho(\Delta(Dur^{emp}/Dur^{OAD}, \Delta OAS) = 0.52$ versus 0.93 for $\rho(\Delta(Dur^{DefAdj}/Dur^{OAD}, \Delta OAS)$.

3. **Forecast empirical duration** using only backward-looking information.

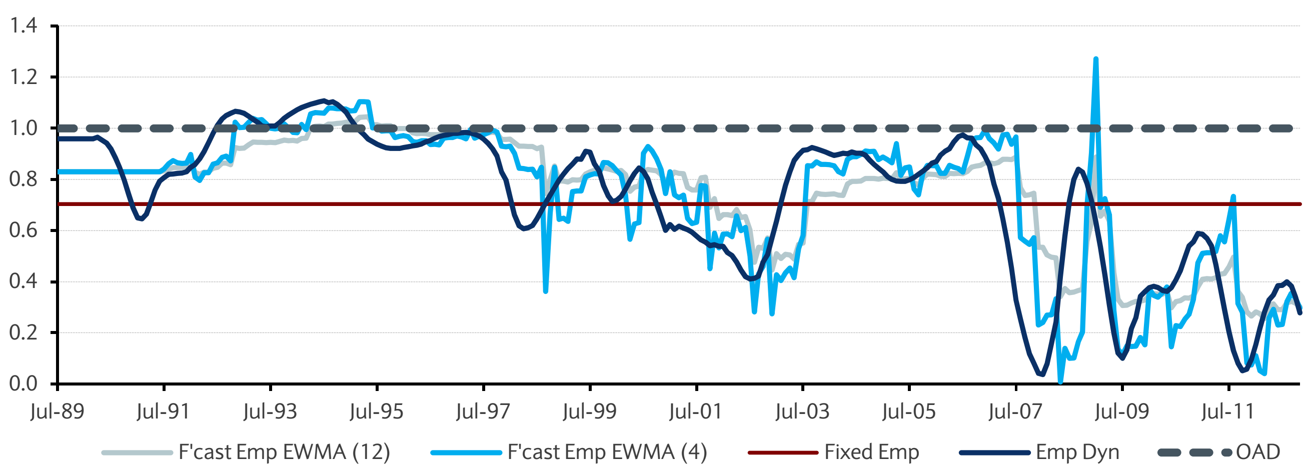
For an investor to capture the potential benefits of a dynamic empirical duration requires dynamic forecasting. We estimate a forecast empirical beta[13] measure each period using past Treasury and corporate returns. For the next period, the empirical duration measure is re-estimated using one additional month of information.

Forecast empirical duration measures can apply a variety of weighting schemes to past returns, depending on how much relative importance should be given to more recent observations. Longer weighting schemes produce smoother and less extreme empirical duration betas while shorter weighting schemes produce a beta closer to the dynamic, in-sample beta. We use exponentially-weighted moving average (EWMA) weighting schemes with a half-life of either 4 or 12 months.

Figure 8 shows the various empirical duration betas for the Non-Call IG Corporate Index from July 1989 to November 2012.

FIGURE 8

Evolution of Various Empirical Duration Betas for the Non-Call IG Corp Index, Jul/1989 – Nov/2012



Note: OAD empirical duration beta equals 1.0 by definition. Fixed in-sample empirical duration beta is computed over the entire sample by regressing corporate index total returns on matched-Dur^{OAD} Treasury total returns. Dynamic in-sample duration beta is computed using a weighted regression with a Normal (0.0, 3.5 month) weighting kernel centered about the current observation. Both forecast empirical durations (EWMA(4) and EWMA(12)) are computed using a weighted regression with exponentially decaying weights (4m or 12m half life, respectively) on past observations. Source: Barclays Research

[13] Analytical duration, the other term in the empirical duration, is computed only from past information.

Except for the fixed, in-sample beta, the other three empirical betas (dynamic in-sample, forecast EWMA(4), and forecast EWMA(12)) are volatile, ranging from almost 0.0 to 1.2. Generally, the empirical duration betas are less than 1.0, and rise and fall similarly. If the goal of the forecast beta is to be close to the dynamic in-sample one, then the aggressive scheme (EWMA(4)) comes closer, at the expense of higher volatility. But even EWMA(4) lags its target significantly, arguing for a more sophisticated model that is beyond the scope of this paper.[14]

Although we chose the dynamic, in-sample beta as the forecast target, we have not answered the more relevant question: how to select the best empirical duration measure.

Selecting the "Best" Empirical Duration Measure

Ideally, the best empirical duration measure should produce $ExRet^{emp}$ with:

1. Low volatility (ie, low root-mean-square of the forecast errors in the $\hat{\beta}_{emp}$ regression); and

2. Zero correlation with Treasury returns;

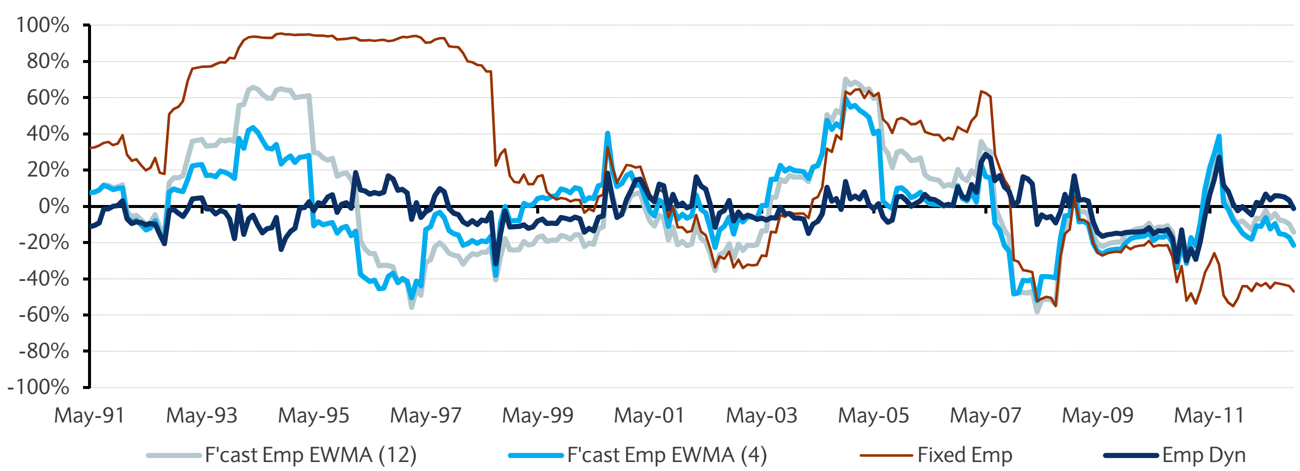
Both qualities (#1 & #2) should also be observed in sub-samples[15]; sub-samples can also be non-consecutive conditional periods, such as all months with positive changes in yields.

Figure 9 shows the results for the 24-month rolling correlations of $ExRet^{emp}$ with Treasury returns for the various empirical duration measures. The fixed, in-sample empirical duration beta produced periods of very large positive and negative correlations. In addition, the fixed, in-sample beta produced a realized $ExRet^{emp}$ volatility (4.1%/y) which was greater than that for the dynamic, in-sample beta (3.7%/y). These results suggest that a dynamic (either in-sample or forecast) empirical beta is a more appropriate specification.

The dynamic, in-sample beta produced a $\rho(ExRet^{emp}$, Treasury returns$) \approx 0$ over time, and the rolling correlations are all within the [-40%, 40%] 95% confidence bounds. As mentioned earlier, the optimal bell-shaped weighting scheme had a standard deviation of 3.5 months.

FIGURE 9

Rolling Correlations of Various $ExRet^{emp}$ with Treasury Returns, Trailing 24 Months, May 1991-Nov 2012



Note: Correlations are computed using 24m of past matched-Dur^{OAD} Treasury total returns and $ExRet^{emp}$ which, in turn, are computed using the relevant empirical duration beta (see notes to Figure 8). $ExRet^{emp}$ are adjusted for any net funding cost/benefit when the empirical duration beta does not equal one.
Source: Barclays Research

[14] Gabudean and Schuehle (2011) present a framework for forecasting volatilities using data at frequency higher than the forecast horizon, eg, using daily data to forecast volatilities at the monthly horizon.
[15] We examine 24 month trailing correlations which should lie in the range [-40%, 40%], 95% of the time, if returns are normally distributed and the hypothesis of zero correlation is not to be rejected.

The dynamic, in-sample results suggest that a good forecast model should be relatively "aggressive" in terms of the weight given to more recent observations (eg, EWMA(4)). The EWMA(4) forecast model produces $\rho(ExRet^{emp}$, Treasury returns$) \approx 0$ over time, and almost always within the [-40%, 40%] 95% confidence bounds. However, the estimated betas are more volatile than the dynamic, in-sample estimated betas, which would lead to more transaction costs (ie, frequently altering the matched-Dur^{emp} Treasury portfolio).

Figure 10 presents $ExRet^{emp}$ for the dynamic, in-sample and EWMA(4) forecast empirical durations for the Non-Call IG Corporate Index and the Non-Call DGT Corporate Index. (We repeat the earlier results for Dur^{OAD} and Dur^{DefAdj} for ease of comparison.)

Note that the average Dur^{emp} is considerably shorter than either of the analytical duration measures, almost 25% shorter on average. The empirical duration measure is picking up a considerable amount of negative correlation between changes in default probabilities and changes in Treasury yields. As a result, the correlation of $ExRet^{emp}$ with Treasury returns should be close to zero. In fact, the realized correlation of $ExRet^{emp}$ with changes in Treasury returns is close to zero (-0.03), as desired (Figure 10).

FIGURE 10

Statistics of Various Non-Call Corp Indices, Jul/1989– Nov/2012

	Non-Call IG Corporate				Non-Call DGT Corporate			
	Dur^{OAD}	Dur^{DefAdj}	$Dur^{emp\ dyn}$	$Dur^{emp\ f'cast}$ EMMA(4)	Dur^{OAD}	Dur^{DefAdj}	$Dur^{emp\ dyn}$	$Dur^{emp\ f'cast}$ EWMA(4)
Average ExRet (bp/m)	4.0	5.1	15.2	12.8	5.7	6.6	17.8	15.3
Annual Avg ExRet (bp/y)	48.1	61.1	182.7	153.0	67.9	79.6	214.1	184.1
St Dev ExRet (bp/m)	118	115	102	111	125	122	107	117
Annualized Sharpe Ratio	0.12	0.15	0.50	0.38	0.16	0.19	0.56	0.44
ρ(ExRet, Tsy Total Ret)	-33%	-28%	-3%	-3%	-35%	-31%	-3%	-2%
Average Duration	5.74	5.55	4.27	4.28	5.71	5.54	4.09	4.09

Note: Average is arithmetic average of monthly reported index excess returns. Source: Barclays Research

Figure 11 shows the average monthly $ExRet^{emp}$ for months where Treasury yields increased, and for months when they decreased. Unlike $ExRet^{DefAdj}$ and $ExRet^{OAD}$, $ExRet^{emp\ dyn}$ shows less of a positive relationship between corporate excess returns and Treasury yields.

FIGURE 11

Average $ExRet^{analyt}$ and $ExRet^{emp\ dyn}$ (%/m) for Non-Call IG Corp Index Conditional on the Change in Treasury Yields, Jul/1989-Nov/2012

	ΔTsy Yields > 0	ΔTsy Yields ≤ 0
$ExRet^{OAD}$	0.44	-0.32
$ExRet^{DefAdj}$	0.37	-0.27
$ExRet^{emp\ dyn}$	0.26	0.06

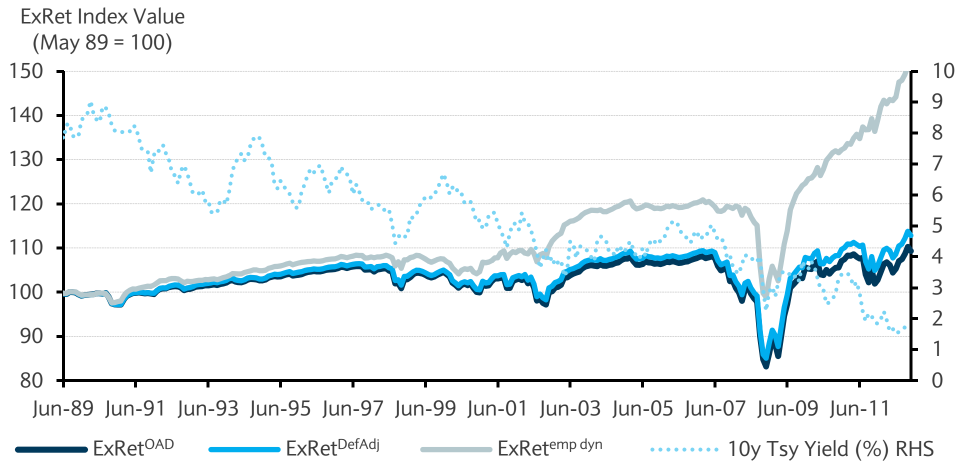
Note: The Treasury yield is the end-of-month matched-Dur^{OAD} Treasury yield computed by taking a linear combination of the yields of the Intermediate and Long Treasury indices. The weights are such that the Dur^{OAD} of the Treasury combination matches the Dur^{OAD} of the Non-Call IG Corp Index. Average is the arithmetic average of monthly reported index excess returns. Source: Barclays Research

The empirical duration measure removes any hedging benefit from corporates. Consequently, given the decline in Treasury yields over the past 23+ years, we would expect $ExRet^{emp}$ to be greater than $ExRet^{analyt}$. This $ExRet^{emp}$ would be a better measure of the credit "alpha" as it does not include the cost of this hedging benefit.

Figure 10 shows that for the Non-Call IG Index the average ExRet$^{emp\ dyn}$ (15.2bp/m) was much larger than either ExRet^{analyt} (5.1bp/m or 4.0bp/m), with noticeably lower volatility (similar results hold for the Non-Call DGT Index). As a result, the annualized Sharpe ratio surged to 0.50, vs. 0.12 or 0.15 for the two analytical measures. Figure 12 shows the cumulative excess return performance for the various duration measures.

FIGURE 12

Cumulative Non-Call IG Corporate Index ExRet Performance for Various Duration Measures, Jul/1989 – Nov/2012



Source: Barclays Research

As discussed earlier, the "right" spread premium measure depends on the risks to which the investor wishes to remain exposed. The traditional analytical excess return measures (ExRet^{OAD} or ExRet^{DefAdj}) imply that the investor wishes to remain exposed to any change in default probabilities/recoveries, including those that are correlated with changes in the Treasury curve. This is a natural view for many macroeconomic-oriented credit investors, but it implies (based on history since 1989) that corporate excess returns will be negatively correlated with Treasury returns, and, consequently, are not a pure measure of the credit alpha over Treasuries.

Some credit investors may wish to forego the hedging benefits of corporate bonds by using an empirical duration measure. For these investors, the "right" corporate spread premium measure is the one that retains exposure only to changes in default probabilities uncorrelated with changes in the Treasury curve. Because the hedging benefit is removed, empirical corporate excess returns will typically be greater than analytical excess returns during periods of declining Treasury yields as the cost of the hedging benefit is transformed into performance.

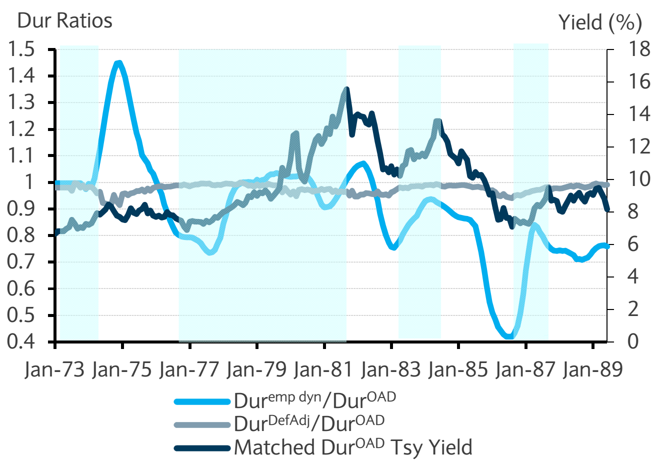
The Long-Term Credit Risk Premium: Jan 1973-Nov 2012

We have examined corporate excess returns from July 1989 to November 2012, a period in which Treasury yields posted a large secular decline. Over the period, the 10y Treasury yield fell from 8.02% to 1.97%. ExRet^{analyt} were low in this period because of a negative relationship between changes in default probabilities/recoveries and changes in Treasury yields, which was not reflected in the duration measure. Thus, as Treasury yields fell, ExRet^{analyt} lagged, while ExRet^{emp}, on the other hand, was considerably larger.

What might investors expect if Treasury yields were to persistently increase? If the relationship between changes in default probabilities and changes in Treasury yields were to persist, the ExRet^{analyt} should be relatively large (the hedging benefits will add to the credit spread premium this time, not subtract), and exceed ExRet^{emp}. Indeed, investors have expressed interest in

FIGURE 13

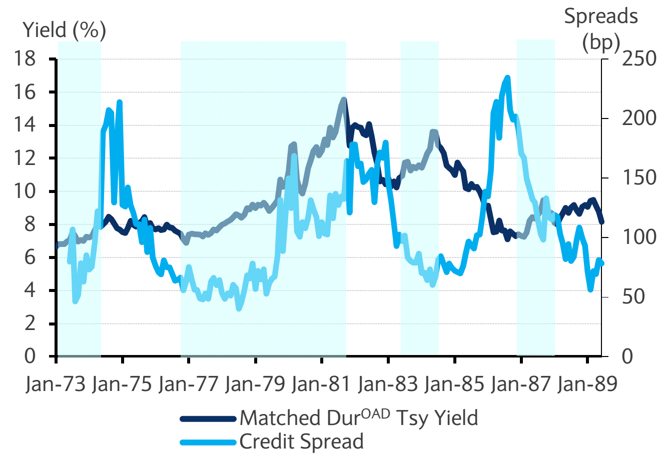
Duration ratios (betas) for the IG Corp Index & Matched-Dur^{OAD} Treasury Yields, Jan/1973-Jun/1989



Note: Dur^{DefAdj} is the BK2 model analytical duration and $\text{Dur}^{emp\ dyn}$ is the dynamic in-sample empirical duration. Matched-Dur^{OAD} Treasury yield computed from a composite portfolio of Intermediate and Long Treasury indices whose duration (to worst) matches that of the IG Corp Index. Shaded areas represent periods of rising Treasury yields. Source: Barclays Research

FIGURE 14

Relation between IG Corp Index Spreads & Matched-Dur^{OAD} Treasury Yields, Jan/1973-Jun/1989



Note: IG Corp Index spread is the BK2 model spread to matched-maturity Treasury curve. Matched-Dur^{OAD} Treasury yield computed from a composite portfolio of Intermediate and Long Treasury indices whose duration (to worst) matches that of the IG Corp Index. Shaded areas represent periods of rising Treasury yields. Source: Barclays Research

Dur^{OAD}-hedged corporate exposure to take advantage of expected rising Treasury yields along with a view of continued strong corporate performance.[16]

However, can we be sure that the correlation between default probabilities and Treasury yields will, in fact, persist? What evidence do we have that such will be the case in a persistently rising Treasury yield environment?

To examine periods of rising Treasury yields, we generate our three duration measures, Dur^{OAD}, Dur^{DefAdj}, and $\text{Dur}^{emp\ dyn}$, from 1973 to 1989. We focus on the dynamic, in-sample measure of Dur^{emp} because its associated $\text{ExRet}^{emp\ dyn}$ are statistically-well behaved and provide an upper bound for forecast models. This period contained long stretches of rising Treasury yields, both nominal and real. In particular, 10y Treasury yields increased +930bp (nominal) and + 395bp (real) from January 1973 to September 1981.[17]

Figure 13 shows the ratios ($\text{Dur}^{DefAdj}/\text{Dur}^{OAD}$ and $\text{Dur}^{emp\ dyn}/\text{Dur}^{OAD}$), as well as the 10y Treasury yield over the period. (The shaded regions indicate periods of rising Treasury yields.) As expected, the $\text{Dur}^{DefAdj}/\text{Dur}^{OAD}$ ratio, which is closely related to spreads, was always ≤ 1, ranging from 0.9 to 1.0. We also see that the $\text{Dur}^{emp\ dyn}/\text{Dur}^{OAD}$ ratio (ie, empirical beta) ranges widely from roughly 0.4 to 1.4, similar to the 1989-2011 period. Sometimes the ratio was considerably greater than 1.0, usually when spreads and Treasury yields moved in the same direction (Figure 14). Indeed, a beta greater than one signifies a positive correlation between the ExRet^{analyt} and Treasury returns, which we can interpret as a positive correlation between spread changes and Treasury yield changes.

How Stable is the Negative Correlation of Corp Spreads and Treasury Yields?

During 1978-81, Treasury yields rose persistently and the correlation of changes in corporate spreads and Treasury yields was positive (Figure 15). This experience directly contradicts the typically assumed negative correlation (observed in 1989-2012) and pushes us toward a

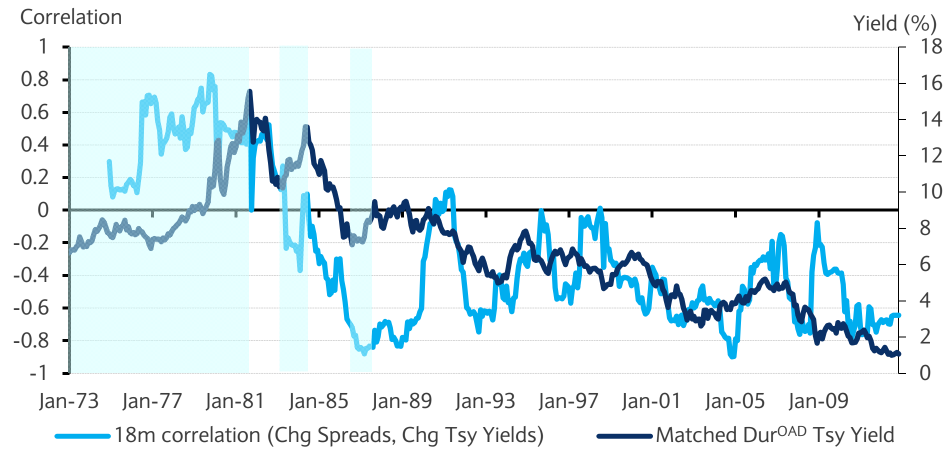
[16] Such investors may have an interest in Treasury futures-based, duration-hedged versions of their current credit benchmarks.

[17] For Barclays' method of generating long time series for real Treasury yields, see: M. Pond and C. Mirani, "TIPS: Predicting History", Barclays Research, March 13, 2009.

better understanding of the relationship between changes in corporate spreads and Treasury yields. Why the change in the correlation pattern?

FIGURE 15

Correlation between IG Corp Spreads and Matched-Dur^{OAD} Treasury Yields & Level of Matched-Dur^{OAD} Treasury Yields, Jan/1973-Nov/2012



Note: IG Corp Index spread is the BK2 model spread to matched-maturity Treasury curve. Matched-Dur^{OAD} Treasury yield computed from a composite portfolio of Intermediate and Long Treasury indices whose duration (to worst) matches that of the IG Corp Index. Correlation is measured over trailing 18 months. Shaded areas represent periods of rising Treasury yields prior to 1989. Source: Barclays Research

We conjecture that there was a change in nature of macroeconomic shocks that affected the relationship between changes in corporate spreads and changes in Treasury yields. Using annual data from Moody's and the Federal Reserve, Figure 16 shows that IG defaults (captured in corporate spreads) have been negatively correlated with growth (changes in real GDP) and have had lower sensitivity to inflation (changes in CPI). In contrast, changes in Treasury yields have been positively correlated with both growth and inflation.

FIGURE 16

Correlation of Major Assets' Performance with Macroeconomic Variables, 1953-2011

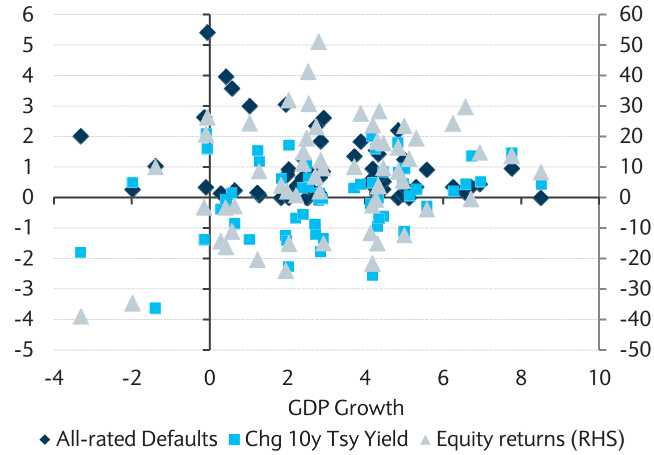
1953-2011 Annual Data	All-rated Defaults	Chg 10y Tsy	Equity TotRet - Cash
Corr w/ GDP Growth	-33%	29%	33%
Corr w/ Inflation	-12%	34%	-28%

Note: End-of-Year Real GDP, Seasonally Adjusted from Bureau of Economic Analysis, Dept of Commerce (downloaded from FRED); End-of-Year CPI-U Seasonally Adjusted Index from BLS (downloaded from FRED); and All-rated Defaults from Moody's, Exhibit 31.
Source: Moody's, Bloomberg, Federal Reserve St. Louis, Barclays Research

Figure 17 and Figure 18 give a more detailed picture of the relation to macroeconomic variables of Treasury yield changes, defaults, and equity returns. (Many investors treat corporates similarly to equities because both respond favourably to growth; hence, we added equities to our analysis.)

FIGURE 17

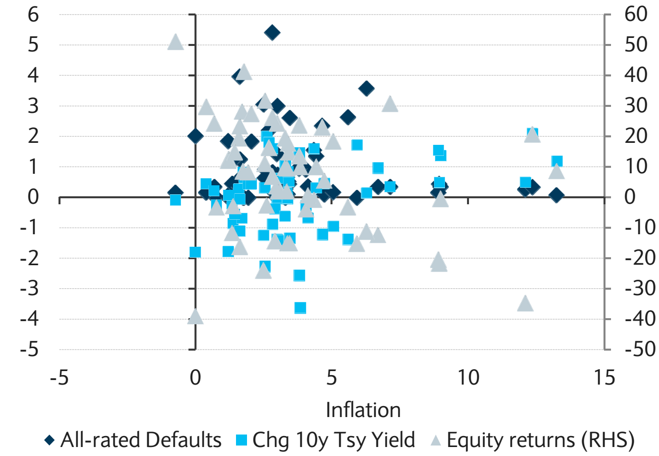
Relationship of Asset Class Performance with Real GDP Growth (%/y), *1953-2011*



Note: End-of-Year Real GDP, Seasonally Adjusted from Bureau of Economic Analysis, Dept of Commerce (downloaded from FRED); and All-rated Defaults from Moody's, Exhibit 31.
Source: Moody's, Bloomberg, Federal Reserve, Barclays Research

FIGURE 18

Relationship of Asset Class Performance with CPI Inflation (%/y), *1953-2011*



Note: End-of-Year CPI-U Seasonally Adjusted Index from BLS (downloaded from FRED); and All-rated Defaults from Moody's, Exhibit 31.
Source: Moody's, Bloomberg, Federal Reserve, Barclays Research

GDP growth (Figure 17) has well-defined and well-known relationships with all three asset classes: Higher GDP growth, fewer defaults, higher Treasury yields, and higher equity returns. In contrast, higher inflation (Figure 18) is associated with higher Treasury yields, low defaults, and lower equity returns. While equities seem to underperform during high-inflation periods, credit, as reflected in default behavior, does well. Treasuries underperform during high-inflation periods.

To investigate whether credit excess returns (rather than realized defaults) relate to the macroeconomic environment differently than equities or Treasuries do, we use the yields of Moody's Baa Corporate Index to construct corporate annual total returns. We assume a constant maturity of five years for the index (results are robust if we assume a 10y maturity). Next, we subtract the total return of a constant 5y maturity Treasury bond. We call the result "Corp Spread ExRet (5y)".

Figure 19 confirms the previous results that Treasuries performance is inversely related to either inflation or GDP growth, while equities performance relates positively to higher growth and negatively to inflation. Corporate excess return performance, on the other hand, relates strongly to growth but has little relationship to inflation. Figure 19 also shows the relationship to macro variables of changes in the corporate spread measure, constructed simply as the yields on Moody's index less 5y Treasury yields.

FIGURE 19

Correlation of Asset Class Returns with Macroeconomic Variables, 1953-2011

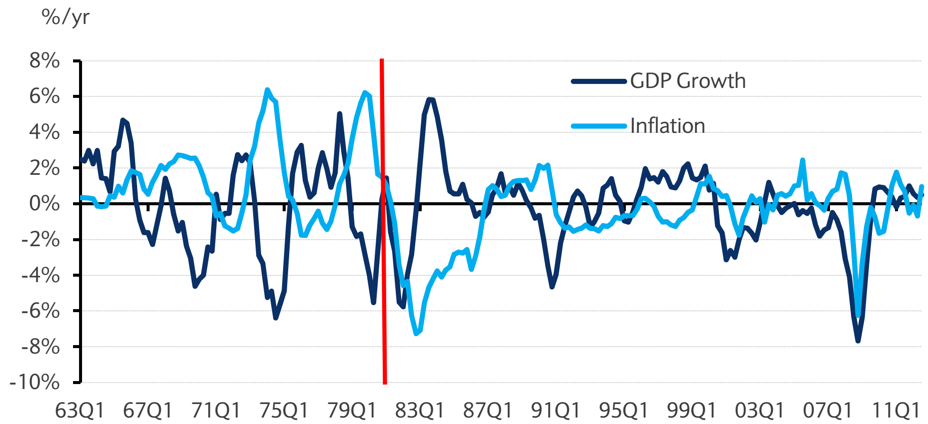
1953-2011 Annual Data	Chg 10y Tsy Yield	Chg Corp Spread (5y)	Tsy 10y TotRet-Cash	Corp Spread ExRet (5y)	Equity TotRet-Cash
Corr w/ GDP Growth	29%	-58%	-28%	46%	33%
Corr w/ Inflation	34%	10%	-39%	-9%	-28%

Note: End-of-Year Real GDP, Seasonally Adjusted from Bureau of Economic Analysis, Dept of Commerce; End-of-Year CPI-U Seasonally Adjusted Index from BLS; Cash is 1m LIBOR.
Source: Moody's, Bloomberg, Federal Reserve, Barclays Research

Because corporates and Treasuries relate differently to growth and inflation, if there is a change in the relationship between growth and inflation we might expect a change in the relationship between credit excess returns and Treasury returns. Figure 20 presents smoothed GDP growth and inflation data from the start of 1963 to the end of 2011. From Q1/1973 to Q3/1981, the correlation between GDP growth and inflation was -0.70. This negative correlation likely stemmed from supply shocks (eg, commodity price shocks), causing a leftward shift of the aggregate supply curve, which, when combined with a somewhat accommodative Federal Reserve, would produce low growth simultaneously with higher inflation. As mentioned, the ρ(changes corporate spreads, changes Treasury yields) was > 0 during this period.

FIGURE 20

Smoothed, De-Meaned Macroeconomic Variables, GDP Growth & CPI Inflation, Q1/1963-Q3/2012



Note: Real GDP, Seasonally Adjusted from Bureau of Economic Analysis, Dept of Commerce (downloaded from FRED); CPI-U Seasonally Adjusted Index from BLS (downloaded from FRED). We construct the smoothed value for a given quarter as a weighted average of quarterly realizations from 2 quarters prior to 2 quarters after it. The current quarter realization gets a weight of 40%, realizations from near quarters get 20% each, and the quarters further away get 10% each, i.e. the weighting scheme is [10 20 40 20 10]. Quarterly realizations are quoted as annual numbers for easier reference. Source: Federal Reserve, Barclays Research

From Q4/1981 to Q3/2012 the correlation between GDP growth and inflation was -0.02, with some notable periods of very positive correlations, reflecting an environment of a more credible anti-inflationary Federal Reserve and large government spending and tax reductions (positive demand and supply shocks). The diminished importance of inflation left growth as the main driver of the corporate spread-Treasury yield relationship. During this period, ρ(changes corporate spreads, changes Treasury yields) was < 0, driven by their opposite exposure to GDP growth.

From a scenario analysis perspective, the 1973-1989 period offers a cautionary tale for investors with a view of rising Treasury yields and expectations of strongly positive corporate analytical excess returns. To illustrate this, we generated $ExRet^{OAD}$, $ExRet^{DefAdj}$ and $ExRet^{emp}$ for the IG Corp Index back to 1973. For January 1978-September 1981, the 10y Treasury yield increased +806bp while the 10y real yield increased +432bp. Based on the July 1989-November 2012 experience, an investor might expect $ExRet^{analyt}$ to have been very positive. However, $ExRet^{analyt}$ was negative (-0.6% annually for $ExRet^{OAD}$ and -0.8% for $ExRet^{DefAdj}$) due to the “reversal” in the corporate spread-Treasury yield correlation (Figure 21). $ExRet^{emp}$ also suffered and had similar performance as $ExRet^{analyt}$, most likely because of default probabilities rising faster than empirically projected given the rise in yields.

FIGURE 21

Return Statistics for Various Returns of the IG Corp Index, Jan/1978-Sep/1981

Jan 1978-Sept 1981	Corp TotRet - Cash	Tsy TotRet - Cash	$ExRet^{emp}$	$ExRet^{OAD}$	$ExRet^{DefAdj}$	Cash	Chg 10y Tsy Yield (bp)	Chg 10y Real Yield (bp)
Avg. Annual Ret	-13.0%	-12.4%	-0.8%	-0.6%	-0.8%	10.9%	806	432
Volatility	11.5%	11.3%	2.2%	2.3%	2.3%			
Ann. Sharpe Ratio	-1.13	-1.10	-0.38	-0.25	-0.35			
Correl w/ Tsy Returns	0.98	1.00	0.01	0.03	0.20			

Note: Average annual return is 12x the arithmetic average of monthly returns. Volatility of monthly returns is annualized. Cash is 1m Libor.
Source: Barclays Research

Since 1989, the experience has been one of regularly declining Treasury yields and a negative correlation between changes in corporate spreads and changes in Treasury yields. However, as the 1973-1989 period demonstrates, during years of persistently rising Treasury yields, this correlation has switched signs. Thus, investors anticipating rising yields, and, consequently, large positive corporate analytical excess returns, may be disappointed.

Optimal Combination of IG Corporates and Treasuries

Fixed income investors often wish to determine an “optimal” amount of corporate bond exposure to add to their Treasury portfolio. Some investors simply choose to adopt the Barclays Gov/Corp Index as their benchmark [34% Corp/66% Gov as of 12/2012] and let the benchmark’s relative market capitalizations determine their corporate allocation. Alternatively, investors could independently arrive at their desired corporate bond allocation via portfolio analysis. In this section, we perform a simple portfolio allocation analysis to determine the optimal allocation to corporates in a corporate/Treasury portfolio using either corporates’ total returns or some of its ExRet versions.

Investors can perform their portfolio allocation analysis at the “asset class” level or at the “risk premium” level. The asset class level analysis would form portfolios using corporate and Treasury total returns as the data input. The risk premium level analysis would form portfolios using risk premia (or sources of return), such as corporate excess returns, and Treasury returns. As we will show, sometimes these two approaches will produce the same answer, sometimes a different answer.

When using corporate risk premium in asset allocation, the question is whether we should perform the analysis using corporate $ExRet^{analyt}$ or $ExRet^{emp}$. The two ExRet measures have different properties (volatility, correlations, and performance), which potentially lead to a different optimal portfolio mix of corporates and Treasuries. For investors that have macro views and forecast changes in default probabilities, using $ExRet^{analyt}$ is a natural choice as it is easy to formulate active views in the portfolio versus the benchmark. The challenge with this choice, however, is that correlation between $ExRet^{analyt}$ and Treasury returns, which directly affects the optimal allocation, is volatile and changes with the macroeconomic environment. This correlation must be estimated. Also, it is hard to formulate a “no view”, base-case for $ExRet^{analyt}$ performance. The “no-view” case typically reflects how much return investors demand to hold $ExRet^{analyt}$. However, in light of their negative correlation (since 1989, at least) to Treasuries, adding corporate $ExRet^{analyt}$ to a Treasury portfolio can reduce portfolio risk. Hence investors may, at times, be satisfied even with a meagre performance of the $ExRet^{analyt}$ position.

For investors who have no macroeconomic views on changes in corporate cash flows, but who expect corporates to have some positive return net of Treasury exposure, $ExRet^{emp}$ is a natural choice. $ExRet^{emp}$ is close to a pure credit alpha. Often, investors assume that unrelated sources of return have similar risk-adjusted performance. Hence a natural base-case view for $ExRet^{emp}$ performance is for $ExRet^{emp}$ to have the same Sharpe ratio as Treasuries. Also, by construction, it is safe to assume $\rho(ExRet^{emp}$, Treasury returns) = 0. Unfortunately, investors are still required to do some work (as was the case with the $ExRet^{analyt}$) because the empirical duration must be estimated, most likely with a dynamic model. Furthermore, in contrast with the $ExRet^{analyt}$ case, in this case it is difficult to impose views about default probabilities/recoveries because $ExRet^{emp}$ loses the natural economic interpretation that $ExRet^{analyt}$ has.

As an initial exercise, investors may choose to perform a "static", "one-shot" optimization using all the available data. There is no updating of the volatilities, correlations and expected returns each period. The solution to this "static" problem is then the desired allocation, which the investor may hold fixed until a decision is made to revisit the optimization. We can interpret this solution as a simple trading rule that is optimal in hindsight.

Alternatively, we could examine a "dynamic" optimization using forward-looking and/or backward-looking information. For these dynamic optimizations, some or all of the optimization parameters (eg, volatilities, correlations and expected returns) are updated each period and a new optimization is performed. Even though such an exercise is beyond the scope of this paper, the portfolios we construct with $ExRet^{emp}$ do incorporate some dynamic information through the estimation of the empirical duration beta. For such portfolios, the portfolio's Treasury allocation varies because the amount of Treasuries needed to construct $ExRet^{emp}$ from corporate total returns varies over time.

To examine the optimal combination of corporates and Treasuries we use a simple mean-variance set-up with "static" portfolio inputs. For the corporate allocation we use the Non-Call DGT Index as our corporate market proxy. For Treasuries, we use the matched-Dur^{OAD} Treasury returns associated with the Non-Call DGT Index because we use these Treasury returns to construct $ExRet^{emp}$ as well. Our goal is to solve for the optimal weight (w) to corporates (see Gabudean, et al (2012)):

$$w = \Lambda^{-1}\Omega^{-1}S$$

where Λ = a diagonal matrix of volatilities, Ω = the correlation matrix, and S = Sharpe ratios. The weights are normalized to sum to 100%.

The portfolio construction process must make assumptions regarding expected returns, correlations and volatilities:

- Expected returns (or, Sharpe ratios). Choices are:
  - Historical Returns.
  - Assume equal Sharpe ratios. For $ExRet^{emp}$ this is a reasonable assumption as the corporate $ExRet^{emp}$ Sharpe ratio is close to that for Treasury returns. However, for $ExRet^{analyt}$ this is not reasonable as it is generally much lower (or higher) reflecting its historical hedging role in different Treasury yield environments.
  - Specific investor views. This is well suited for $ExRet^{analyt}$ as they are intuitive and closely tied to economic growth. This is not the case for $ExRet^{emp}$.
- Correlations. Choices are:
  - For total returns: fixed correlations. They are not historically fully justified; also, small errors may have large impacts on solution because of the high correlation level.
  - For $ExRet^{emp}$, we may assume zero correlation (by design) so effectively we are incorporating dynamic correlations between corporate and Treasury total returns.

  - For $ExRet^{analyt}$, correlations are macro regime dependent, so we may use either dynamic historical correlations or incorporate views (if you have them).

- Volatilities:

  - We use fixed, in-sample historical volatilities. This is a reasonable assumption in our view, even though it uses hindsight, because volatility dynamics can be fairly well forecast. Moreover, a good forecasting model should perform even better than the fixed, in-sample volatility because it incorporates the dynamic nature of volatility.[18]

Figure 22 shows the results of various optimizations. First, we show results for an investor that does a "one shot" optimization over corporate and Treasury total returns. Over the past 23+ years, the optimal combination of corporates and Treasuries has been 65/35, very different from the 30/70 allocation in the market-weighted Barclays Gov/Corp Index. This combination achieved a modest increase in risk-adjusted performance (Sharpe ratio) of 0.03 over the Sharpe ratio of corporates alone (0.72). The pick up in the Sharpe ratio has been limited by the high correlation between the two portfolio components (66%). However, the Gov/Corp index has a lower Sharpe ratio (0.70) than corporates alone, showing that it does not fully capitalize on the diversification opportunities between corporates and Treasuries.

Next, if the investor were to use corporate $ExRet^{OAD}$, in lieu of corporate total returns, in the static optimization, the Sharpe ratio results are the same (shown in the "OAD" column) because $ExRet^{OAD}$ is a static long-short portfolio (+100%, -100%) of corporates and Treasuries: the portfolio has a Sharpe of 0.75 and a the net allocation to Treasuries is 35%. To make allocations comparable across portfolios, we translate the allocations to ExRet and Treasuries into allocations to corporates and Treasuries and re-scale them to sum to 100%. We name the resulting allocation to Treasuries as "Average Net Weight to Treasuries". For example, the optimal combination of $ExRet^{OAD}$ and Treasuries is 39/61, which is implemented as a 39 cents allocation to corporate bonds and a 61-39 = 22 cents allocation to Treasuries. Thus, the net allocation to Treasuries is 22/(39+22) = 35%, the same as the optimal allocation to Treasuries in the optimal corporate bond/Treasury portfolio.[19]

The point here is that if volatilities, correlations and expected returns are set to historical values, then it does not matter if total returns or excess returns are used in the optimization when excess returns are a static combination of corporate total returns and Treasuries.

If we replace $ExRet^{OAD}$ with the dynamic, in-sample $ExRet^{emp\ dyn}$ the static optimization (see second column – Corp $ExRet^{emp\ dyn}$) improves as the $ExRet^{emp\ dyn}$ measure incorporates some dynamic correlation when estimating the $Dur^{emp\ dyn}$ each period. This suggests that there are better diversification opportunities between corporates and Treasuries on a dynamic basis than is implied by the static 66% correlation over the entire sample. So, we might reasonably expect to do better by performing a dynamic optimization. The 0.86 Sharpe ratio is an upper bound on what a model that dynamically forecasts Dur^{emp} might achieve. Indeed, our $ExRet^{emp}$ measure derived from a EWMA(4) forecast model for empirical duration beta (see third column) achieves a Sharpe of 0.78. While both portfolios with $ExRet^{OAD}$ and $ExRet^{emp\ EWMA(4)}$ make use of in-sample (ie, forward-looking) average returns and volatilities, the latter achieves a better Sharpe ratio (0.78 vs 0.75) because of the dynamic nature of the correlations and despite the fact that the former model uses look-ahead information.

[18] For more details on volatility forecasting see Gabudean and Schuehle (2011).
[19] The portfolio of $ExRet^{OAD}$ and Treasuries can be interpreted as a de-levered version of corporate and Treasuries portfolio because the allocations to $ExRet^{OAD}$ and Treasuries translate into allocations to corporate bonds and Treasuries that sum to less than 100%.

How do these results compare to the performance of the Barclays Gov/Corp Index, shown in the last column of Figure 22? The index's allocation is based solely on market capitalization. This is a common concern for plan sponsors: "Is my benchmark an optimal portfolio?" For the past 23+ years, all portfolios performed better than the Gov/Corp index, albeit with the benefit of hindsight. Also, the total returns of the Gov/Corp Index had a long-term correlation of 0% to reported NC DGT Corp $ExRet^{OAD}$, which oddly implies that changes in the credit environment had no effect, on average, on the index's returns.

FIGURE 22

Return Statistics for Mean-Variance-Optimal Portfolios of Treasuries with Various Returns of the Non-Call DGT IG Index, Jul/89-Nov/2012

			Optimal Portfolios of NC DGT Corp with Treasuries Using					
Jul 1989-Nov 2012	Corp Tot Ret - Cash	Tsy Tot Ret - Cash	Corp Tot Ret - Cash	Corp $ExRet^{emp\ dyn}$	Corp $ExRet^{emp\ EWMA(4)}$	Corp $ExRet^{OAD}$	Corp $ExRet^{DefAdj}$	Gov/Corp Index - Cash
Annual Ret	3.88%	3.21%	3.64%	2.61%	2.55%	2.21%	2.24%	3.04%
Volatility	5.42%	5.10%	4.88%	3.03%	3.26%	2.97%	3.01%	4.32%
Sharpe Ratio	0.72	0.63	0.75	0.86	0.78	0.75	0.75	0.70
Avg Weight Corps	100%	0%	65%	56%	48%	39%	40%	30%
Avg Net Weight Tsy	0%	100%	35%	1%	24%	35%	34%	70%
Correl w/ Corp TR	100%	66%	96%	96%	95%	96%	96%	88%
Correl w/ Tsy Ret	66%	100%	84%	73%	80%	84%	84%	93%
Correl w/ Reported ExRet				67%	58%	21%	25%	0%

Note: To make allocations comparable across portfolios, we translate the allocations to Corp ExRet and Treasuries into allocations to corporates and Treasuries and then re-scale to make them comparable to other portfolios where the weights sum to 100%. The allocation to Treasuries, "Average Net Weight Tsy" represents the proportion of Treasuries in a fully funded portfolio. For example, suppose the optimal combination of $ExRet^{OAD}$ (in this case duration beta = 1) and Treasuries is 39/61. This is implemented with a 39 cents allocation to corporate bond excess returns (long 39% corporates and short 39% duration-matched Treasuries) and a 61-39 = 22 cents net allocation to Treasuries. The portfolio weights do not sum to 100%. Thus, we re-scale the net allocation to Treasuries as 22/(39+22) = 35% to arrive at the average net weight to Treasuries when the corporate and Treasury weights sum to 100%. The "Government" portion of the Gov/Corp index includes a small component of Aaa-rated government-related agency issues. Source: Barclays Research

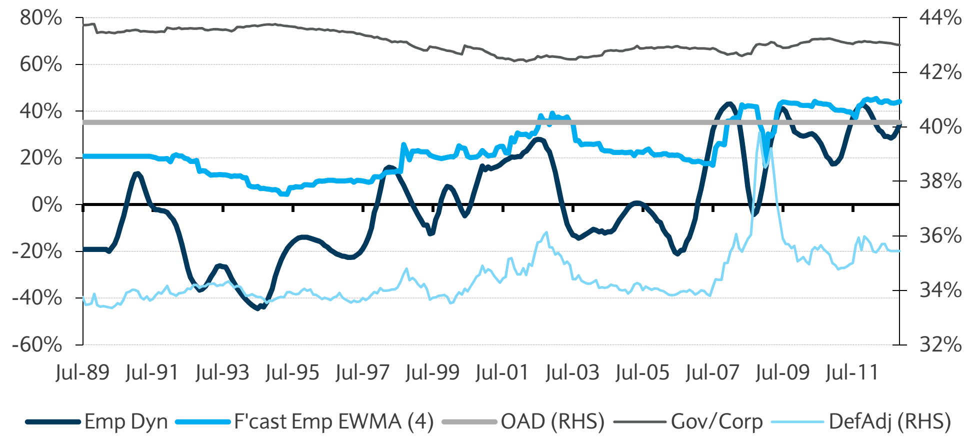
Figure 23 illustrates the behavior of the net allocation to Treasuries for our various optimized portfolios. Even though they were constructed using ExRet, the portfolios discussed in this section can be implemented as portfolios of corporate bonds and Treasuries with allocations 1-X / X, where X is the net weight to Treasuries. Notice how the $ExRet^{emp\ dyn}$ portfolio had a net allocation of almost zero, on average, to Treasuries, with large swings over time. In contrast, the Barclays Gov/Corp Index had a rather stable 70% allocation to Treasuries.

Corporates provide a valuable addition to a Treasury portfolio. The optimal combination depends on forecasts for volatilities, correlations and expected performance. Various specifications of ExRet lend themselves to certain scenarios: $ExRet^{analyt}$ are more appropriate when investors have views on default expectations while $ExRet^{emp}$ are more appropriate when investors seek portfolio risk premium building blocks with similar performance. Furthermore, all portfolios seem to benefit from a dynamic estimation of correlations, ie, the diversification benefits between corporates and Treasuries vary over time. Last, in hindsight we should have held significantly more corporates than their market capitalization implied.[20]

[20] Clearly, this may not be true for portfolios containing equity and high yield. This is a current area of research.

FIGURE 23

Net Weight to Treasuries for Various Corp/Treasury Portfolios, as % of Total Net Allocation, Jul/1989 – Nov/2012



Source: Barclays Research

Conclusion

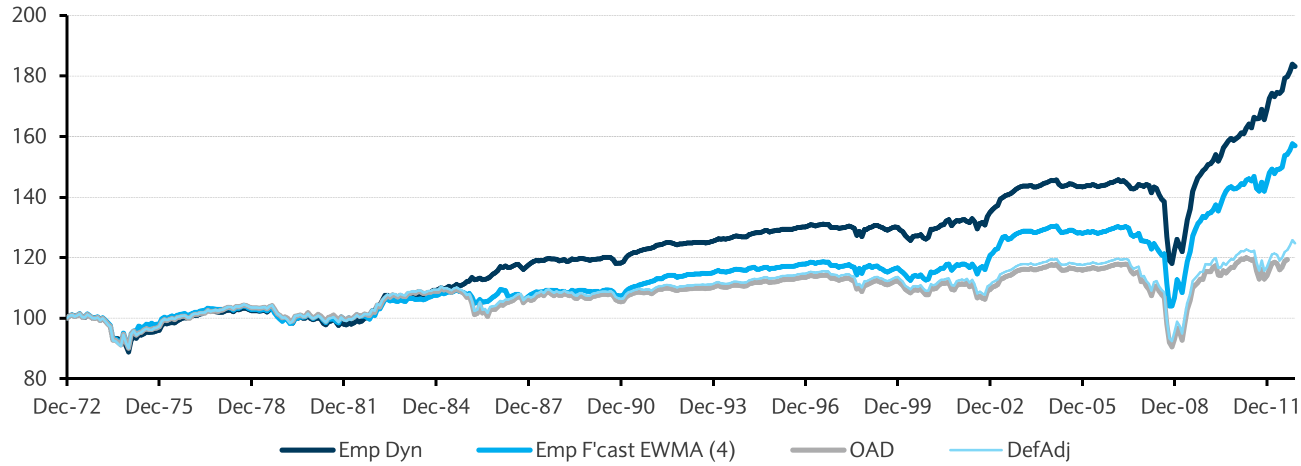
For many investors, analytical excess returns conform to their macro views: They wish to be exposed to any change in corporate default probabilities/recoveries, including any change correlated with changes in Treasury yields. While changes in default probabilities/recoveries may, at times, be correlated with changes in Treasury yields, these investors are willing to have their corporate spread premium reflect, either positively or negatively, the impact on returns of any correlated movements in corporate spreads and Treasury yields.

Other investors want a corporate excess return uncluttered by the effects of correlated movements in corporate spreads and Treasury yields. For these investors, their duration measure includes the impact of any correlation, leaving them with a corporate spread premium uncorrelated with Treasury returns. While such views are typically difficult to express and requires estimating the empirical correlation, these investors consider themselves as engaging in a pure credit overlay strategy.

Since January 1973 (almost 40 years), the $ExRet^{emp\ dyn}$ for the IG Corporate Index has been approximately 160bp/y (or, about 100bp/y larger than $ExRet^{analyt}$). Figure 24 shows the relative cumulative performance since 1973. With a Sharpe ratio of 0.48 (Figure 25), $ExRet^{emp\ dyn}$ compares favorably with the Treasury risk (ie, duration) premium. If alpha is to represent a return absent any beta exposure, then $ExRet^{emp\ dyn}$ is a measure of the credit alpha over Treasuries.

FIGURE 24

Cumulative Performance of Various ExRet Measures for the IG Corporate Index, Jan/1973 – Nov/2012



Source: Barclays Research

FIGURE 25

Return statistics of various returns of the IG Corporate Index, Jan/1973 – Nov/2012

Jan 1973-Nov 2012	Corp Tot Ret - Cash	Tsy Tot Ret - Cash	$ExRet^{emp\ dyn}$	$ExRet^{OAD}$	$ExRet^{DefAdj}$	Cash	Chg 10y Tsy (bp)	Chg 10y Real Yield
Annual Return	2.4%	1.9%	1.6%	0.6%	0.6%	5.9%	-492	-348
Volatility Monthly Rets	7.3%	7.2%	3.3%	3.8%	3.8%			
Ann. Sharpe Ratio	0.33	0.26	0.48	0.15	0.17			
Correl w/ Tsy Ret	0.86	1.00	0.03	-0.23	-0.18			

Note: Average annual return is 12x the arithmetic average of monthly returns. Volatility is annualized. Source: Barclays Research

References

Berd, A. M., R. Mashal, and P. Wang. “Consistent Risk Measures for Credit Bonds,” QCR Quarterly, vol. 2004-Q3/Q4, Lehman Brothers.

Gabudean, R., and N. Schuehle. (2011). *Volatility Forecasting: A Unified Approach to Building, Estimating, and Testing Models*, Barclays Research.

Gabudean, R., A. Staal, and A. Lazanas. (2012). *Investing with Risk Premia Factors: Return sources, portfolio construction, and tail risk management*, Barclays Research.

Ilmanen, A. (2011) *Expected Returns: An Investor's Guide to Harvesting Market Rewards*, Wiley Finance.

Moody’s. *Corporate Default and Recovery Rates, 1920-2010.*

Ng, K. Y. and B. Phelps. ”Capturing Credit Spread Premium”, Barclays Research, 2010.

Pedersen, C. M. “Explaining the Lehman Brothers Option Adjusted Spread of a Corporate Bond,” QCR Quarterly, vol. 2006-Q1, Lehman Brothers.

Pond, M. and C. Mirani, “TIPS: Predicting History”, Barclays Research, March 13, 2009.

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