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Excess Return Methodologies: Expanding the Investor Toolkit

Futures-Based Excess Returns

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- **Investors have long used "excess returns" (ie, total returns net of a benchmark yield curve return) to evaluate how much of a bond's or index's performance is due to factors other than interest rates.**

- **Investors are now using excess returns for other reasons as well: as a return measure for alternative strategies that have little interest rate risk, or as a building block for constructing a re-risk-weighted benchmark based on a traditional index such as the US Aggregate.**

- **We begin with reviewing various methodologies for computing excess returns, including that used by Barclays indices. We point out that none of the presented methodologies is replicable by portfolio managers, which impedes their utility for new portfolio applications.**

- **As an alternative to the existing methodologies, we introduce futures-based excess returns defined as the difference between total returns of an index and its "mirror futures index." MFIs are baskets of futures contracts constructed to match an index's OAD-based interest rate exposure. MFI excess returns are replicable by portfolio managers, and so offer investors an opportunity to expand their toolkits.**

- **MFI excess returns do not necessarily match reported index excess returns. Using a single month as an example, we conduct a detailed analysis of the return difference between these two measures. We show that the difference between MFI and index excess returns is very sensitive to the particular shape of Treasury curve movements.**

- **We also discuss futures-based excess returns that use KRD-matching. While MFI-KRD can track index excess returns more closely than OAD-based MFI, they tend to produce volatile, and sometimes large, long and short positions, which could make some investors uncomfortable.**

INTRODUCTION

Investors use excess returns to evaluate how a bond or a bond index is performing versus its underlying benchmark yield curve. Today, however, investors have an interest in excess returns for other reasons as well. Portfolio managers pursue excess returns when they are not allowed, or do not wish, to have interest rate exposure. Because more than 100% of the volatility of the US Aggregate comes from the underlying yield curve, PMs worried about interest rate risk (eg, rising Treasury rates) often want just excess return exposure. Also, given advancements in index technology, some PMs use sector (eg, corporate and mortgage) excess returns in combination with the underlying yield curve return to construct alternative risk-weighted benchmarks that have a desired combination of interest rate and spread exposure. Such alternative benchmarks can also serve as fixed-income mandates for plan sponsors.

A bond's excess return is its total return net of some "matched benchmark" total return:

$$\text{Bond Excess Ret} = \text{Bond Total Ret} - \text{"Matched Benchmark" Total Ret}$$

While many investors use excess returns of this type, there is no universally accepted definition of the terms "matched" and "benchmark." Different definitions produce different excess returns.

Many portfolio managers intuitively measure excess return by dividing it into two components. First, they approximate the "spread" component by multiplying the bond's spread duration by the change in its quoted spread to some benchmark bond (eg, a single "parent" Treasury bond with similar maturity or duration). The second, "carry," component is 1/12 of that spread. The sum of the two becomes the estimate of excess return. This methodology can be taken to the index level by using market value weights to aggregate excess returns across bonds. The appeal of this method is that excess return is always positive when the bond's spread tightens (even without the carry component). As we will see, this is not always true for other excess return methodologies, including the index one.

This intuitive excess return methodology has limitations. It is difficult to define a single benchmark for bonds that amortize or have cash flows sensitive to changes in the benchmark itself. For example, what would be the Treasury parent bond for a 2012 30y FNMA 4%? Do market participants agree? Would the benchmark have to be replaced by another when the MBS duration changes in different interest rate environments?

Index and analytics providers have developed alternative excess return methodologies to deal with these more complicated bond types. However, as we will show, different methodologies may produce very different excess returns. In addition, some of them are not replicable by portfolio managers, which limits the uses of excess returns.

Bond- and index-level excess returns (Index ExRet) published by Barclays cannot be replicated. We argue that investors should consider "mirror futures-based" excess returns (MFI ExRet) and show how to compute them. We then demonstrate that MFI ExRet do not always closely track Index ExRets. To provide better insights and build confidence in futures-based excess returns, we discuss sources of differences between them and Index ExRet.

EXCESS RETURN MEASURES

There are quite a few excess return measures. Investors choose them based on the types of risks they take. For example, a bank that funds itself at LIBOR may prefer an excess return measure that removes the swap curve component from a bond's total return. The bank may have swap-based liabilities, and the swap curve exposure embedded in its assets serves as a hedge. Consequently, an excess return net of the swap curve is a logical choice. In contrast, a corporate bond manager who is part of an Aggregate PM team may prefer excess returns net of the Treasury curve. This PM will typically sell or buy Treasury bonds to cover a corporate bond over/underweight.

For the purposes of this study we assume that investors wish to remove some sort of a Treasury curve component from a bond's total return. This raises another question: exactly what is that Treasury curve component? For example, it is common to decompose changes in the Treasury curve into parallel shift, twist, and butterfly. Differences in excess return methodologies often stem from different components of the Treasury curve movement(s) removed from a bond's total return.

Once this question is answered, the next step in the excess return calculation is to quantify the Treasury return to be removed. The amount is determined by the *ex-ante* sensitivity of the bond's value to changes in the Treasury curve (ie, the Treasury duration). However, there are differences of opinion among investors regarding a bond's duration. Many agree that the value of a corporate bond is determined by a stream of promised nominal cash flows discounted by a set of Treasury rates, plus a spread representing compensation for the default-risk imbedded in the cash flows. Determining the bond's appropriate Treasury duration requires careful consideration of the connection between changes in the bond's spread and changes in the Treasury curve. This issue is particularly consequential for mortgage securities whose cash flows themselves, and not just the spread component of the discount rate, depend on Treasury rates.

One measure, the "analytical duration" of a bond, disregards the effect of changes in Treasury rates on spread, and consequently on the Treasury curve component of a bond's total return. After removing the analytical duration-based Treasury exposure, the investor remains fully exposed to changes in the bond's spread – even if such changes are correlated with Treasury returns. We will call excess returns based on the analytical duration "analytical excess returns." For investors wishing to take outright bets on changes in spreads, analytical excess returns would measure the performance of their active views.

Another duration measure, the "empirical duration," attributes that part of the spread change correlated with changes in the Treasury curve to the Treasury component of total return.[1] The empirical duration is the change in the value of the bond caused by a shift in the Treasury curve, *including* the change in value arising from the correlation between spread changes and shifts of the curve. We will call excess returns based on the empirical duration "empirical excess returns." These measure only the change in the present value of a bond's cash-flows which is uncorrelated to changes in Treasury rates. Some investors prefer to use empirical excess returns. A prime example is credit portfolio managers who are not permitted to take any interest rate risk. Also, seekers of "pure alpha" who want to create a curve-independent credit overlay to an existing Treasury portfolio, buy credit and short Treasuries according to the hedge ratio based on empirical durations.[2]

[1] For a detailed discussion of analytical vs empirical duration for corporate bonds see: "Credit Risk Premium: Measurement, Interpretation and Portfolio Allocation," Barclays Research, 2013.
[2] The choice between analytical and empirical duration is also relevant for TIPS managers.

We will focus on monthly analytical excess returns over Treasuries. In the next section we review several analytical excess return measures including Index ExRet, as well as futures-based excess returns (MFI ExRet). We discuss the construction methodology for each of these measures and why their returns may differ.

Spread Change-Based Excess Returns (SpdChg ExRet)

Many portfolio managers use a simple rule of thumb to estimate a bond's monthly excess return: multiply the spread change by the (negative) spread duration (OASD) and add 1/12 of the bond's spread. For many bonds, this is not a bad approximation. This approach (SpdChg ExRet) is appealing because when the bond's spread tightens, the excess return is positive (even without the carry component).

Although the spread change excess return formula is simple and intuitive for a single bond, it does not apply at the index level. While index-level OAS and OASD are market-value weighted across bonds, using the index OAS change multiplied by the index OASD will not necessarily produce an accurate measure of the spread component of excess return. To see this, suppose the spread curve steepens during the month, with the front-end unchanged. The index average OAS increases. Now, suppose instead that the spread curve flattens with the back-end unchanged. We have the same average OAS increase as before, and the same average OASD. Consequently, for both spread curve changes, the Chg_OAS x OASD methodology will produce the same negative spread component of excess return. However, the first curve change will actually produce the larger negative spread component of excess returns (aggregated bond-level excess returns using market value weights) as the OAS increase applies to the higher OASD bonds. The correct calculation for the Chg_OAS would be to use duration-dollar weights, so bonds with higher OASD × market value will have a higher weight in the Chg_OAS calculation. This added complexity, required to properly compute Chg_OAS at the index level, limits the usefulness of this approach as a rule-of-thumb measure.[3]

Also, SpdChg ExRet is not always reliable for callables and MBS whose excess returns are affected by unanticipated changes in cash flows, such as larger, or smaller, than expected prepayments – while their OAS might remain unchanged.

OAD Bucketing Excess Returns (Bucket ExRet)

Prior to January 2001, the Barclays indices followed an OAD bucketing approach to compute excess returns.[4] This method is very straightforward. All Treasury issues are sorted by their beginning-of-the-month (BOM) analytical duration (OAD) and grouped into ½y duration buckets: eg, 0-0.5y, 0.5-1y. Using market-value weights, the duration and total return for each OAD bucket are computed.

A given bond's duration will fall between the durations of two adjoining Treasury buckets. The benchmark component of the bond's total return is defined as the linear duration-interpolated total return of those two buckets. For example, if the bond's BOM duration is 1.0, and the two closest Treasury buckets have BOM durations and returns of 0.8 and 0.20%, and 1.3 and 0.30%, respectively, then the Treasury component of the bond's total return is 0.24% (ie, 1.0 is 2/5 between 0.8 and 1.3 and 0.24% is 2/5 between 0.20% and 0.30%). A bond's excess return is its total return minus its treasury component return.

[3] See Chapter 30 of *Quantitative Management of Bond Portfolios*, Princeton University Press, 2007.

[4] In non-US markets, OAD-bucketing methodology is still in use to compute the Index ExRet. Up until 2013, bond and index ExRets for EUR indices were computed against blended treasuries of Germany, France, and The Netherlands, even though the OAS was computed versus the German Curve. In 2013 this was changed so that ExRets are against German treasuries only.

Bond-level Bucket ExRets are aggregated using BOM market value weights to produce index-level Bucket ExRets.

Conceptually, this "bucket" excess return methodology loosely approximates what a portfolio manager might do to hedge out a (bullet) bond's Treasury exposure, i.e., short a Treasury whose OAD is close to that of the bond.

KRD-Matching Excess Returns (Index ExRet)

The OAD bucket methodology, however, suffers from the limitations of OAD as a Treasury curve sensitivity measure. A bond's OAD measures its sensitivity to a parallel Treasury curve shift. However, a bond has cash flows across a range of dates, none of which is likely to be the OAD point. If the Treasury yield at its OAD point is unchanged, but yields elsewhere along the curve do change, the bond's value is likely to change as well. This was the motivation for the development of key rate durations (KRD), which measure a bond's sensitivity to changes at various points along the Treasury curve.

Consider a corporate (bullet) bond with an OAD of 3.5, a 2y KRD exposure of 1.50 (or 42.9% of its OAD) and a 5y KRD exposure of 2.00 (57.1%). Figure 1 shows a hypothetical change in the Treasury yield curve at the bond's OAD point and at the two KRD points. The solid line assumes a parallel Treasury curve shift, while the dashed line signifies a steepening of the curve, pivoting at the OAD point (3.5).

For simplicity, let's assume the 2y and 5y hypothetical par Treasuries have KRD^{T}_{2y} = 2.0 and KRD^{T}_{5y} = 5.0, respectively.[5] Because they are par securities with no spread to the fitted Treasury curve, they each have no other KRD exposures. For every dollar of market value of the bond, the KRD-matched Treasury portfolio would contain 1.5/2.0 = 75% of the 2y Treasury and 2.0/5.0 = 40% of the 5y Treasury. As the sum of the Treasury weights exceeds 100%, we need a short 1m T-bill (assumed to have zero duration) "stub" position of 15%.

During the ensuing month, the Treasury curve changes. Ignoring carry and convexity effects,[6] the change in the value of the KRD-matched Treasury portfolio is:

$$= 0.75 \times (KRD^{T}_{2y} \times chg\_y_2) + 0.40 \times (KRD^{T}_{5y} \times chg\_y_5)$$

$$= 1.5 \times chg\_y_2 + 2.0 \times chg\_y_5$$

If the Treasury yield curve moves in a parallel manner (ie, $chg\_y_2 = chg\_y_5 = chg\_y_{3.5}$), then both the OAD and KRD measures would predict the same change in the value of the bond.

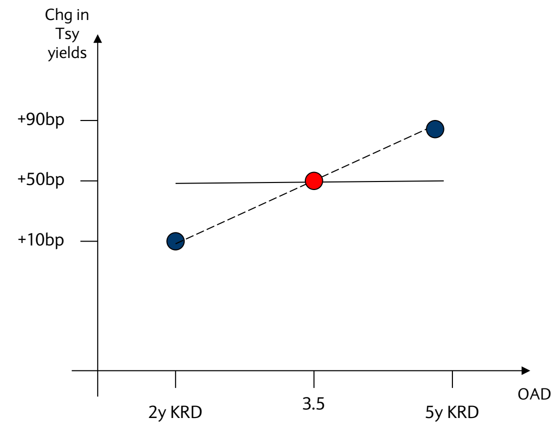
However, if the curve were to steepen/flatten, then the two measures would predict different Treasury component price returns. For example, suppose the curve, as shown in Figure 1, steepens by 40bp on either side of the OAD point. Since the bond has more duration exposure at the 5y point than at the 2y point, the bond will have a larger Treasury component loss. In fact, the KRD measure would calculate the Treasury component's price loss to be 1.5 x 0.10% + 2.0 x 0.90% = 1.95%, whereas the OAD measure calculates the Treasury component's price loss to be 3.5 x 0.50% = 1.75%. Consequently, the KRD-based ExRet will be greater than the OAD-based ExRet.

[5] The 2y and 5y par Treasury bonds likely have OADs slightly less than their maturities (eg, 1.99 and 4.89, respectively). By virtue of being par securities, practically all of their OAD will be at their respective maturity (ie, KRD) points.

[6] Almost all excess return measures ignore matching the asset's convexity with that of the matched-Treasury portfolio. For assets without embedded options, this is not much of an issue as the asset and Treasury portfolio will have roughly similar convexities. For an MBS, however, the matched-Treasury portfolio will have positive convexity while the MBS will likely have negative convexity. Conceptually, the matched-Treasury portfolio could contain Treasury option positions as well.

FIGURE 1

Schematic of Parallel and Non-Parallel Treasury Curve Shifts



Source: Barclays Research

We can estimate the OAD Treasury yield change that would produce the same price return as the KRD-matched Treasury portfolio. This change can be found along the line that connects the 2y and 5y yield changes according to the relative proportions of the two KRDs. In this case, it would be on the dashed line corresponding to 57.1% along the horizontal axis starting at the 2y KRD point, or an OAD of 3.71, which corresponds to a yield change of +55.7bp (which is greater than the 3.5 OAD change of +50bp).

This example highlights why a KRD-matched hedge can do a better job of capturing a bond's Treasury yield curve component of return, compared with hedging using a single hypothetical par 3.5y Treasury with all its duration concentrated at the 3.5 KRD point. KRD hedging picks up any linear (not just parallel) shift in the Treasury curve, whereas OAD hedging captures only the parallel shift. The OAD measure fails to recognize that this bond has relatively more duration weight in the part of the curve whose yield increased more.

The reason for the different performance is that the OAD-based hedge has a different KRD profile than the KRD-based hedge, and the curve moved in a non-parallel fashion. However, despite this potential limitation of the OAD-based hedge, many investors still use it because the KRD-profile of the bond to be hedged can be very similar to the OAD-matched Treasury hedging instrument. This is common, for example, when hedging corporate bonds with similarly priced Treasury bonds of similar OAD. Consider a PM who hedges a 3.47 OAD bullet corporate bond (172967GS), priced at 98.0, with the KRD profile shown in Figure 2. The bond has significant KRD exposure at both the 2 and 5 KRD points. However, a comparable OAD Treasury bond (912828UU), priced at approximately 98.0, also has similar KRD exposures. So, in this case, OAD matching goes a long way to pretty good KRD matching.

However, this is not always the case. Figure 2 also shows another 3.47 OAD corporate bond (694308GN), priced at approximately 122.0, but with a different KRD profile than our example corporate bond. We see bigger KRD mismatches versus 912828UU for this bond. Furthermore, if the PM were to use a 4.97 OAD Treasury (912828MP) and scale the hedge for the 3.47 OAD corporate bond (ie, 0.694 scale factor), then the KRD mismatch would grow (Figure 2).

As we will see, this latter point is an issue with futures hedging: There are only five available Treasury futures contracts. Consequently, the PM may have to use a futures contract whose OAD and KRD profile are very different from that of the bond to be hedged. This is especially true for non-US futures markets with fewer liquid futures contracts. While a scaled OAD hedge will protect the portfolio from parallel curve shifts, it may leave some significant unhedged KRD exposures, making the hedged portfolio vulnerable to non-parallel shifts.

FIGURE 2

Mapping of USD Futures Contracts to OAD Buckets, 30 September 2014

KRD	172967GS Corp	% MV Exposure	FNA06406	% MV Exposure	912828UU UST	% MV Exposure	694308GN Corp	% MV Exposure	912828MP UST	% MV Exp
0.5	0.00	0%	0.16	5%	-0.01	0%	0.04	1%	0.01	0%
2	1.64	47%	0.64	18%	1.72	50%	1.23	35%	0.08	2%
5	1.83	53%	1.10	32%	1.76	51%	2.20	63%	4.50	91%
10			1.28	37%					0.37	7%
20			0.43	12%						
30			-0.11	-3%						
OAD	3.47		3.48		3.47		3.47		4.97	

Source: Barclays Research

MBS securities also suffer from the limitations of the OAD measure. In contrast to corporates, MBS often have their OAD spread widely across many KRD points. MBS returns can be influenced by changes in the Treasury curve far away from their OAD point. For example, while a MBS may have an OAD of 4.0, changes to the 10y Treasury yield could affect the MBS's expected cash flows via changes to the refinancing incentive.

MBS often have a KRD profile very different than any single Treasury bond used as a hedge. Figure 2 shows the KRD profile for a 3.48 OAD 6½%, 30y FNMA (FNA06406). There is no 3.48 OAD Treasury bond with an even remotely similar KRD profile. This same KRD mismatch would occur for any single Treasury futures contract.

Given the sensitivity of the FNMA bond to Treasury curve re-shaping, most PMs would not hedge the FNMA with just a single Treasury bond. Instead, they would use a **portfolio** of Treasury bonds. The KRD-matched excess return methodology comes closer to what an MBS PM might use as a hedge. As mentioned, the FNMA may be sensitive to movements in the 10y Treasury yield (a refinancing benchmark) even though its OAD equals 3.48. If the front-end of the curve remains unchanged but the 10y yield falls, the premium FNMA would likely have positive performance due to lower discount rates, but the performance may be muted due to greater expected prepayments. If the Treasury benchmark against which excess returns were computed does not have an exposure to the 10y point, then the effect of the 10y yield change will not be attributed to the FNMA's benchmark return. It will become part of its excess return, which would be overstated compared to an excess return calculated against a benchmark that includes the 10y yield change. The KRD-matching methodology helps to properly attribute several changes along the Treasury yield curve to the bond's Treasury component of return, and, hence, to the bond's excess returns.

To better capture a bond's Treasury yield curve component of return, Barclays indices have used a KRD-based excess return methodology since January 2001 (and it remains in effect as of this publication's date).

At the beginning of each month, a set of hypothetical par Treasury bonds with maturities ranging from 0.5y to 30y is defined. The coupon rate is determined by Barclays Treasury spline model, which fits a cubic polynomial to the set of yields (excluding on-the-runs) for coupon-paying Treasury bonds.[7]

To compute a bond's excess return, the index first assembles a Treasury portfolio that matches the KRD exposures and market value of the bond. A bond's KRD exposures are measured at the following six points: 0.5y, 2y, 5y, 10y, 20y and 30y.[8] The bond's matched-

[7] For historical background information on Treasury spline models see: "The Lehman Brothers U.S. Treasury Spline Model", R. Axel and P. Vankudre, Lehman Brothers, Government Bond Research, December 1997.

[8] The index computes hypothetical Treasury OAD and KRDs using the standard Barclays cash bond analytics.

duration Treasury portfolio contains (up to) six "hypothetical" par Treasury bonds with maturities corresponding to the six KRD points. Each par bond will have almost all its duration at the key-rate point corresponding to its maturity. For example, the 5y KRD of a 5y hypothetical par Treasury will equal its OAD, while the five other KRDs will be zeroes. To achieve KRD-matching, we solve a set of simultaneous equations to generate the weights for the six hypothetical Treasury bonds and a zero-duration cash position (to ensure market value matching). The matched-Treasury portfolio will almost always have positive weights.[9]

As an example, consider the index security 2009 30y FHLMC 4% (Index generic identifier FGB04009). Its KRD profile is shown in the second column of Figure 3. The third column shows the identifiers for the six hypothetical Treasuries.[10] The next column shows their KRDs, which are also their OADs (because at the beginning of the month, they were par securities). The last column shows the weights for FGB04009's "matched-Treasury portfolio." The weights are determined by dividing the security's KRD by the KRD of the matching hypothetical Treasury. A zero-duration cash position (in this case 1m T-bill) is then added/subtracted to equalize the market values of the matched-Treasury portfolio and the bond. In other words, this cash "stub" position ensures that the weights of the matched-Treasury portfolio sum to 1.0.[11]

FIGURE 3

Construction of a KRD-matched Treasury Portfolio for 2009 30y FHLMC 4% (FGB04009), 29 November 2013

	FGB04009	Hypothetical Treasuries		Matched Tsy Portfolio
Maturity	KRD	POINT Identifier	KRD	weights
6m	0.170	KRBXXX01	0.498	0.34
2y	0.472	KRBXXX02	1.995	0.24
5y	1.085	KRBXXX05	4.888	0.22
10y	1.880	KRBXXX10	9.052	0.21
20y	1.472	KRBXXX20	14.905	0.10
30y	0.059	KRBXXX30	18.602	0.00
		CASB0001		-0.11
OAD	5.030			1.00

Source: Barclays Research

Each day, the index computes the month-to-date (MTD) return of the matched-Treasury portfolio and subtracts it from a bond's MTD total return to produce the bond's MTD Index ExRet.[12] FGB04009's end-of-the month Index ExRet is shown in Figure 4. Using the matched-Treasury portfolio weights (including cash) multiplied by their monthly returns, we obtain a KRD-matched Treasury portfolio total return of -0.95%. The asset's total return was -0.83%, leaving a (published) index excess return of 12bp (Figure 4).

[9] If a cash bond has some negative KRDs (eg, some mortgage bonds in certain environments), then it is possible for the matched-Treasury portfolio to have some negative weights.

[10] These are Barclays Index and POINT identifiers.

[11] This cash stub position can, at times, be large (eg, 30% or more). This happens most often for MBS bonds which have low durations (ie, premium MBS). See Srinivas (2002).

[12] A bond's daily Index ExRet is defined as the difference in its MTD Index ExRet between two days.

FIGURE 4

Calculation of Monthly Index ExRet for 2009 30y FHLMC 4% (FGB04009), December 2013

	Hypothetical Treasuries		Matched Tsy Portfolio
	POINT Identifier	TotRet (%)	weights
	KRBXXX01	-0.04	0.34
	KRBXXX02	-0.10	0.24
	KRBXXX05	-1.38	0.22
	KRBXXX10	-1.98	0.21
	KRBXXX20	-1.91	0.10
	KRBXXX30	-1.99	0.00
	CASB0001	0.00	-0.11
FGB04009 TR		**Tsy Ret**	**Index ExRet**
-0.83%		**-0.95%**	**0.12%**

Source: Barclays Research

For index-level excess returns, constituent excess returns are weighted by their BOM market values and then aggregated.

Decomposing a bond's OAD into six KRDs, and matching them to six different hypothetical Treasuries, should produce a better representation of a bond's Treasury curve exposure compared to the earlier OAD-bucketing approach that tends to concentrate at one point on the curve. The improvement should be especially noticeable for MBS which have become a major component of aggregate indices (eg, MBS currently constitute more than 40% of the US Aggregate's market value). For bonds with static, non-amortizing cash flows, such as a bullet corporate, the Bucket ExRet and Index ExRet should be fairly comparable because the bond and match-OAD Treasury hedge will have similar KRD profiles.

As described, the Index ExRet KRD-methodology is straightforward, somewhat transparent, and widely followed by investors. However, there are some nuances:

1. **The KRD-matched-Treasury portfolio is not investable.** Hypothetical par Treasuries do not exist, and their prices and returns are not observable in the market.

   A PM could try to construct a KRD-match Treasury portfolio with real Treasury notes and bonds. But the PM would likely encounter some difficulties. First, the set of Treasury bonds must be determined. Second, of those bonds, any Treasury bond "specialness" would be attributed to an asset's Treasury component of return. The hypothetical Treasuries largely avoid this issue because they are points on a fitted Treasury curve, not actual bonds. Finally, as non-par bonds do not usually have all of their OAD exposure at a single KRD point, the KRD-matched portfolio may contain some short Treasury positions. Generally, the PM would be unlikely to generate the same total return as that of the matched-Treasury portfolio used in the index excess returns calculation.

2. **Index ExRets are sensitive to re-shaping of the Treasury yield curve.**

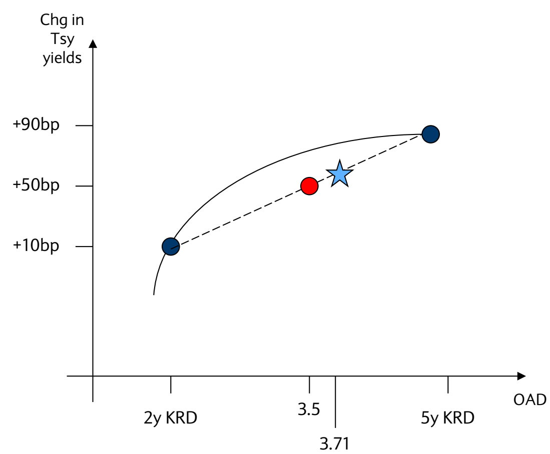
   As discussed earlier, the advantage of the KRD-matched approach lies in capturing linear shifts of the yield curve as opposed to just parallel shifts. However, the Treasury yield curve can, of course, move in a non-linear fashion.

A non-linear yield curve change between KRD points (eg, a "bowing out"/"bowing in" – sometimes called "butterfly") will likely cause the KRD methodology (as well as the OAD methodology) to fail to fully capture a bond's Treasury component of return.

Continuing with our example, suppose actual Treasury yield changes (represented by the solid curve in Figure 5) bow out. In other words, suppose there is a larger rise in yields at the 3.71 OAD point than estimated by the KRD-matched Treasury portfolio. We see this graphically as the curve lies above the star along the dashed line. Consequently, the bond's actual Treasury component of return is more negative than that estimated by the KRD-matched Treasury portfolio, which means that the bond's index excess return will be understated.[13] If the bowing is sufficiently large, then the bond may have a negative excess return – even if the bond's spread to the Treasury curve tightened.

FIGURE 5

Effect of Yield Curve "Bowing" on Ability of KRD-matching to Match Treasury Component of Return



Source: Barclays Research

The effect of Treasury curve "butterfly" changes on Index ExRets could be mitigated by adding additional KRD points. However, this is not likely. For bonds with several KRD points, there may be both bowing-out segments and bowing-in segments, so the bond's overall excess return effects could be somewhat offset.

As a real-world example of the effect of curve bowing on Index KRD-matched ExRets, in April 2004 the ABS Index (OAD = 2.64) experienced 3bp of OAS tightening and had an OAS carry for the month of approximately 5bp. However, its excess return was -8bp, whereas investors were expecting roughly +13bp. This "anomaly" was caused by the Treasury curve bowing out between the 2y and 5y duration points.

3. **Published Index ExRets are "unfunded" returns.** An index's KRD-matched hypothetical Treasury portfolio is assumed to be a funded portfolio that earns both a coupon and price return. In other words, there is an assumed cash investment in the portfolio. Same goes for the index. Because both the index and the KRD-matched Treasury portfolio are funded, the reported Index ExRet (the difference in return between the two) is an "unfunded" return as zero net cash is required to generate this return.

   When comparing Index ExRets to returns on funded positions (or indices), investors need to add a "funding" component to the ExRet series.

[13] In our example, if the curve bowed inward, the Index ExRet for the bond would tend to be overstated.

4. **To aggregate Index ExRets over time, investors should not compound periodic Index ExRets.** Such a practice incorrectly assumes that Index ExRets are a funded position and that the cumulative Index ExRet at the end of a holding period equals the amount of cash earned on a position.

   To see the possibility for error, assume you invest $100 in an index that earns the following monthly total returns: 10%, 20%, and -5%. For these three months, suppose the published Index ExRets are 1%, 2%, and -0.5%. These ExRets imply that the monthly returns on the matched-duration hypothetical Treasury portfolio are 9%, 18%, and -4.5%.

   The initial investment will grow to $100 × (1.10) × (1.20) × (0.95) = $100 × 1.25400, for a cumulative compounded cash gain of $25.4. The cumulative compounded total return on the matched-duration Treasury portfolio is $100 × (1.09) × (1.18) × (0.945) = $100 × 1.21546, or a gain of $21.546. The difference, $25.4 – $21.546 = $3.854, is the amount of cash the investor would have in his pocket after holding the two portfolios (one long, one short) over the three months.

   Note that in the second month, the investor earns an excess return equal to the difference between the total return on the BOM long position ($110) × 1.20 = $132.0 and the total return on the beginning of the month short position ($109) × 1.18 = $128.62, for a new gain of $3.38. The investor benefits, in this case, from the positive excess return **on the full BOM investment** ($110), not just the excess return from the first month plus the beginning of the holding period investment ($101).[14]

   This is why, in this case, the compounding of the first two monthly excess returns ($100 × (1.01) × (1.02) = $100 × 1.0302) creates a cash gain of only $3.02 which is less than the $3.38 calculated above.

   To compute compounded Index ExRets over time, the investor should calculate the compounded TR for the index and subtract the compounded total return of the matched-Treasury portfolio. However, this method neglects the funding difference between the long and short positions. In effect, the long position borrows cash and buys the bonds. The short position lends the cash obtained from selling bonds. At the beginning of the holding period the long and short positions have the same market value, so the cash funding gain and loss cancel each other. However, thereafter the long and short positions are unlikely to have the same market value. In the example above, the market value of the long position after the first month is $110 while the value of the short position is $109. Consequently, there is a net short funding position of $1, which is an added cost. This cost (sometimes it could be a gain) should be reflected in the excess return calculation, but rarely is.

   Also, as a reminder, the cumulative $3.854 gain is an unfunded return. Essentially, the investor sold the Treasuries short and used the full cash proceeds to buy the bonds. So, the $3.854 should correctly be viewed as a “mark-to-market” gain. To compare the cumulative Index ExRet performance versus a funded investment, one should add a funding return component (on the initial $100) to the cumulative Index ExRet.

   For some applications it might be more appropriate to sum monthly excess returns. For example, suppose an investor allocates a notional $100 market value to a strategy of going long bonds and short the KRD-matched Treasury portfolio. Although there is no net investment, the strategy resets the notional amount of each leg back to $100 at the beginning of each subsequent month. In this case, the monthly “mark-to-market” is

[14] See Chapter 30 of *Quantitative Management of Bond Portfolios*, Princeton University Press, 2007.

earned on a constant underlying notional, so there is never a net long/short funding position, nor is there any compounding of excess returns as there would be if the underlying position size changed with market returns. For our example, the cumulative three-month mark-to-market would be $1 + $2 - $0.5 = $2.5.[15] Again, this is an unfunded return.

OAD-Matched Futures-Based Excess Returns (MFI ExRet)

We define an index's (or a bond's) futures-based excess return (MFI ExRet) as its total return minus its corresponding Mirror Futures Index (MFI) total return:

$$\text{MFI ExRet} = \text{Total Ret}_{\text{index}} - \text{Total Ret}_{\text{MFI}}$$

To produce MFI ExRets for an index we must first construct the index's MFI – a basket of futures contracts and a cash deposit. Each index has its own MFI.[16] While many details of the MFI construction methodology are available in another research publication,[17] we provide a brief review using the USD Aggregate Index as the example.

We construct the MFI using OAD-matching. However, OAD-matching is not a requirement of a futures-based excess return. In fact, as we will discuss, one could use KRD-matching (à la the Index ExRet methodology) to construct the MFI.

To construct the Aggregate MFI, we assign its constituents to one of five OAD buckets based on their BOM OAD. We then assign a *single* futures contract to each OAD bucket. For USD bonds, we define five OAD buckets and assigned futures contracts as shown in Figure 6.[18]

FIGURE 6

Mapping USD Futures Contracts to OAD Buckets, 29 November 2013

OAD Bucket	Mapped Futures Contract	Futures OAD
[0-3)	TU ("2y" futures)	2.06
[3-5)	FV ("5y" futures)	4.45
[5-7.5)	TY ("note" futures)	6.62
[7.5-15)	US ("bond" futures)	11.57
[15+	WN ("Ultra" futures)	16.81

Source: Barclays Research

We determine the MFI weights using the market value contribution to OAD for each of the five OAD buckets and the five futures contracts:[19]

$$\text{MFI Weight}_{\text{OAD bucket}} = \text{ContrOAD}_{\text{Aggregate OAD bucket}}/\text{OAD}_{\text{futures}}$$

The actual number of contracts depends on the futures' price and its notional contract size.[20]

[15] This result is not that close to the compounded excess return as the returns were quite large (ie, the difference between arithmetic and geometric returns).
[16] MFIs are also available for non-USD and customized indices. Barclays publishes MFI returns for various popular indices on its Barclays Live web site. They are also available on Bloomberg.
[17] "Barclays Mirror Futures & Duration Hedged Benchmarks," Barclays, September 2013.
[18] The bucket definitions and futures market assignments are reviewed by the Index Group each year. Any changes are announced well in advance.
[19] Futures OADs are computed using the Barclays Futures Model which models potential changes in the yield curve and estimates a new CTD bond for each possible change. For details see: "US Treasury Bond Futures Model Update," POINT, Barclays, 19 March 2012.
[20] We construct a MFI for an individual bond just as we do for an index, except that a bond would only have one futures contract in its MFI, corresponding to its OAD bucket. This would apply to an MBS bond as well.

Because futures contracts are unfunded instruments,[21] we assume each MFI futures position has a companion 1m cash deposit (T-bill) with a zero duration. If the total cash deposit position in an MFI does not equal the total market value of the corresponding index, a cash "stub" position (either positive or negative) is included in the MFI. This stub position ensures that the MFI weights sum to 100%.

The MTD return of an MFI futures position is calculated by dividing the current closing futures price by the BOM closing futures price, and subtracting 1.0. This is the MTD return on a $1 implied market value futures position, called the unfunded futures return. To this unfunded return we add the MTD return on the funding position (T-bill) and arrive at the futures' MTD funded total return. We sum these funded returns across all the positions in the MFI, applying their respective BOM weights, to compute the MTD MFI total return (Figure 7).

FIGURE 7

Month-to-Date US Aggregate Mirror Futures Index Total Return, December 2013

OAD Bucket	Index OAD	Index MV (%)	Futures Contract	MFI Weights (%)	MTD Futures Ret (%)
[0-3)	1.94	26.99	TUH4	25.42	-0.22
[3-5)	3.98	26.16	FVH4	23.40	-1.33
[5-7.5)	6.17	26.20	TYH4	24.43	-1.86
[7.5-15)	9.87	16.08	USH4	13.70	-1.86
[15+	17.26	4.58	WNH4	4.70	-2.07
			USD T-bill	8.36	0.00
			MTD Agg MFI Return	100%	-117.23 bp

Source: Barclays Research. Index OAD and MV(%) are as of 30 November 2013.

The MFI return calculation makes no adjustment for margin or transactions costs. The opportunity cost of initial margin is ignored, as is any opportunity cost/gain from any MTD variation margin. Also, we assume that the month-end price equals the closing exchange price, and make no allowance for any slippage between a closing price that an investor might realize and the closing exchange price.[22]

The MFI ExRet methodology is straightforward and transparent. However, as with Index ExRets, there are some nuances:

1. **The MFI is replicable.** A PM can easily replicate its return using liquid, exchange-traded futures contracts. Replicability is the main appeal of MFI and a key difference between MFI ExRets and Index ExRets.

2. **MFI ExRets are sensitive to re-shaping of the Treasury yield curve.** Earlier we discussed how non-parallel Treasury curve changes can cause Index KRD-matched excess returns to differ from OAD-matched excess returns if the underlying hedge portfolios have different KRD exposures. Similarly, we should also expect the difference between MFI and Index ExRets to be sensitive to non-parallel Treasury curve changes.

   The MFI versus Index ExRet mismatch is sensitive to non-parallel shifts and could be noticeable, depending on the underlying index. As there are only five futures contracts, an index OAD bucket may have to be hedged with a Treasury futures contract whose OAD is very different. While the futures position is scaled to match the bucket's OAD, there is no assurance that the scaled position will have a KRD profile similar to that of the index bucket.

[21] We ignore initial margin requirements.
[22] Barclays offers investors algorithmic tools to manage their futures execution at the close.

For example, consider the MBS Index: The OAD-matched Treasury futures portfolio for the 3-5 OAD bucket (with a duration of 4.06) will be just the 5y futures with an OAD of 4.45 (Figure 8). The MFI requires that we scale the futures position to achieve OAD-matching. An MBS Index OAD bucket with a 4.06 OAD will be hedged with (91.2% = 4.0/4.45) of the 5y futures contract. The MFI position for this bond will be a 91.2% of the market value position in the 5y futures and 100% market value position in cash.

While the OAD of the futures position matches that of the Index bucket, how do their KRD profiles compare? Figure 8 shows that there is a meaningful mismatch: short 2.19 at the 5y KRD and long 1.61 and 0.52 at the 10y and 20y KRD points, respectively. We would expect a difference between MFI and Index ExRets if there is a non-parallel shift in the Treasury curve between 5y and 20y OAD points.

FIGURE 8

Residual KRD Mismatches from MFI OAD-matching, MBS Index, 3-5y OAD Bucket, 29 November 2013

	scale factor	OAD	6mo KRD	2yr KRD	5yr KRD	10yr KRD	20yr KRD	30yr KRD
MBS 3-5 OAD bucket		4.06	0.17	0.64	1.21	1.61	0.52	-0.02
5y Tsy futures		4.45	-0.01	0.73	3.73			
scaled futures	0.912	4.06	-0.01	0.66	3.40			
net KRD exposure		0.00	0.17	-0.03	-2.19	1.61	0.52	-0.02

Source: Barclays Research

Given the tendency for MBS to have a more dispersed KRD profile than OAD-matched Treasuries, the MBS Index would be expected to have the largest KRD mismatches with its MFI. At the Aggregate Index level, however, the KRD mismatches are likely to be less severe, but still meaningful because of the MBS large weight in the Aggregate (Figure 9). As shown, the Aggregate MFI has an overweight of almost 0.5 at the 5y KRD point and a comparable underweight at the 30y KRD. Consequently, a large negative Treasury return at the 5y KRD point, or a large positive return at the 30y KRD point, will likely lead to the MFI underperforming the KRD-based Treasury component of the Aggregate Index.

We could use KRD matching for the construction of the MFI. (We discuss this later in the MFI-KRD section.) However, unlike hypothetical par Treasury bonds that have only one KRD exposure at their maturity point, a futures contract is not typically par-priced and so will have more than one KRD exposure. Constructing a KRD-matched portfolio of futures contracts requires solving a system of simultaneous equations to equalize the KRD profiles of a futures portfolio and the index. While this is not difficult,[23] it raises

FIGURE 9

Residual KRD Mismatches from MFI OAD-matching, Aggregate Index, 29 November 2013

	OAD	6mo KRD	2yr KRD	5yr KRD	10yr KRD	20yr KRD	30yr KRD
Aggregate Index	5.56	0.10	0.75	1.41	1.38	1.03	0.90
MFI (OAD-matched)	5.56	0.00	0.70	1.87	1.41	1.14	0.44
net KRD exposure	0.00	0.10	0.05	-0.46	-0.03	-0.10	0.46

Source: Barclays Research

[23] In fact, for the L-KRD-matched portfolio of interest rate swaps in the Barclays Replicating Bond Index (RBI) baskets, we solve a system of simultaneous equations. While a mirror swap index uses par swaps, these swaps are not par-priced versus the Treasury curve. Nevertheless, swap index prices are close to par so their L-KRD exposures are closely clustered around their maturity. This is usually not the case for futures contracts.

other issues. For example, it is quite possible that to hedge the Index's 15+ OAD bucket, with its positive 20y and 30y KRD exposures, the MFI would have to go long the Ultra futures, short the bond futures and long the 10y futures. Having long and short positions in the futures replicating portfolio may be unappealing for some investors.

3. **MFI ExRets are sensitive to movements in the cash-futures basis. T**he MFI uses the nearby futures contract, and rolls to the next contract at the month-end before the quarterly expiration month. Consequently, there is no assurance that the MFI always holds "fairly priced" futures contracts. While there is normally a tight relationship between the cash market (especially the CTD bond(s)) and futures contracts, the basis between these two markets can fluctuate. As a result, the futures return can differ from the underlying cash Treasury market return, irrespective of movements in the Treasury curve, if futures "richen" or "cheapen" relative to cash Treasuries.

   There is lively arbitrage between the cash and futures Treasury markets, with many participants and lots of capital. This keeps abnormal cash-futures basis moves in check. However, during 2008-09, this arbitrage broke down for an extended period of time. Usually, replicating the Treasury index with futures produces monthly tracking errors of just a few basis points. However, tracking errors exploded during that period (Figure 13) as futures became very cheap versus cash. What happened? When futures are cheap, the arbitrage trade is to buy futures and sell Treasuries. One obtains Treasuries to sell by reversing them via repo. However, investors hoarded Treasuries, and repo rates were close to zero. This meant that investors who were able to reverse in Treasuries could "fail" to return them and get away with only a small penalty. Naturally, Treasury holders were reluctant to place their bonds out on repo, which made closing the cash-futures basis via arbitrage difficult. As a result, futures remained "cheap" to cash bonds.

   While the cash-futures basis is normally well behaved, MFI ExRets are sensitive to basis movements, which can contribute to MFI ExRet deviating from Index ExRet. However, a PM can replicate MFI ExRet but not Index ExRet. So, although MFI ExRets are sensitive to changes in the cash-futures basis, a PM looking to replicate futures-based excess returns can insulate himself from these basis movements by simply executing the MFI basket.

   A related issue is a change to the CTD bond(s) underlying the futures contract. We construct the MFI at BOM and hold it for the ensuing month. However, movements in the market may cause a change in the underlying CTD. This change may alter the OAD of the futures contract and cause weaker MFI tracking performance if interest rates subsequently change. For example, large increases in rates generally cause the duration of cash bonds to fall. However, increased rates may lead to a new CTD cash bond(s) with longer duration. Even though the cash index and MFI were duration matched at the beginning of the month, the movement in rates may cause an OAD divergence and poorer tracking versus Index ExRets for the remainder of the month.

4. **The MFI ExRet is an unfunded excess return.** Both MFI and KRD-matched Treasury portfolios are "funded" portfolios. Since the underlying index itself is a funded return, both MFI ExRet and Index ExRet are unfunded returns. As mentioned earlier for Index ExRet, unfunded excess returns should not be compounded.

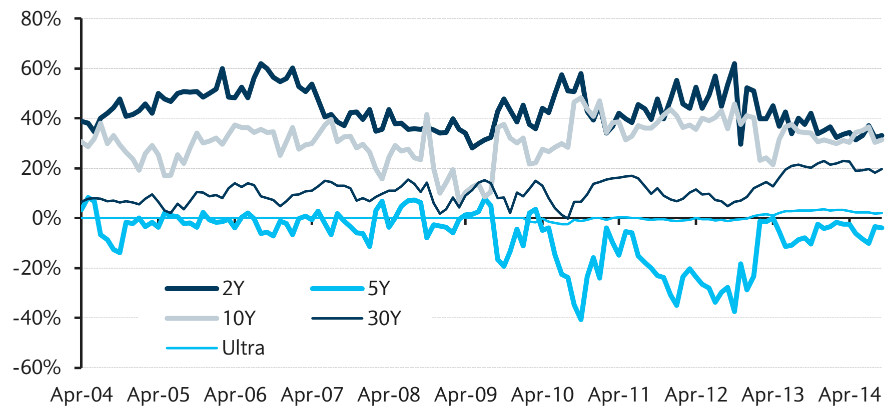
KRD-Matched Futures-Based Excess Returns (MFI-KRD ExRet)

We can use KRDs to construct a futures replicating basket. Not only would these futures-based, KRD-matched excess returns ("MFI-KRD ExRets")[24] better reflect the Treasury component of returns, but also they would be fully replicable by PMs.

As discussed above, a possible drawback of MFI-KRD ExRets is that the weights of the futures basket will likely contain short positions. Figure 10A shows the MFI-KRD Index weights for the MBS Index since 2004. From 2010 to 2012, the futures KRD-matched portfolio contained a -30% allocation to the 5y futures with +40% to +50% allocations to both the 2y and 10y futures, along with a +10% to +20% allocation to the bond futures.

FIGURE 10A

Futures Weights, MFI-KRD MBS Index. April 2004 – September 2014

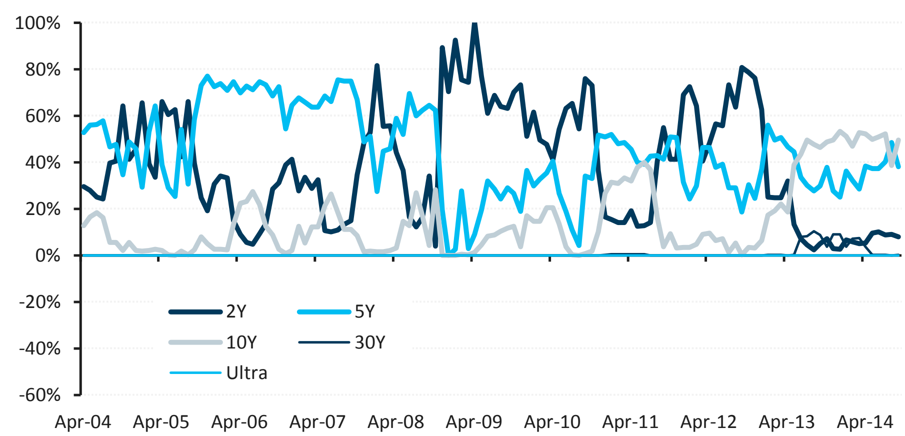


Source: Barclays Research

Figure 10B shows the MFI Index weights for the MBS Index since 2004. While the weights are all positive, they are volatile, especially between the 2y and 5y futures contracts.

FIGURE 10B

Futures Weights, MFI MBS Index. April 2004 – September 2014



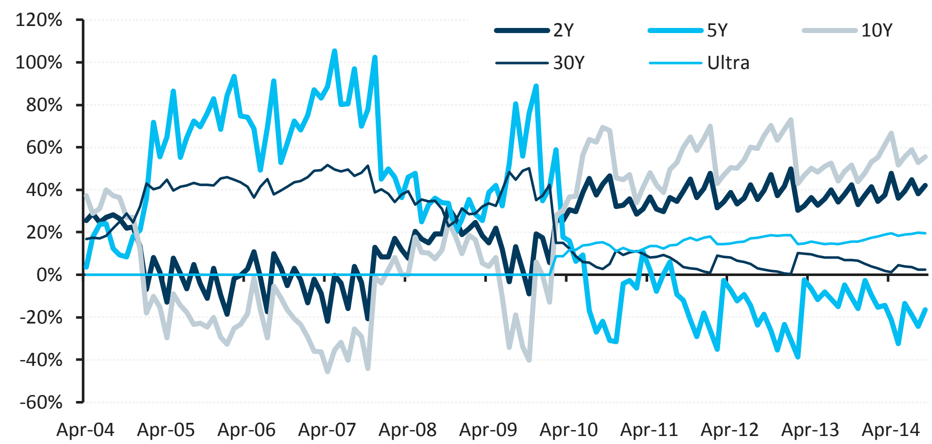
Source: Barclays Research

[24] We label these excess returns "MFI-KRD ExRet" to avoid confusion with the published MFI returns which are OAD-matched. Also, to achieve KRD matching when there are six KRD points but only five futures contracts, we aggregate the 6m and 2y KRD exposures.

The MFI-KRD MBS Index is not the only index with occasionally extreme weights. Figure 11A shows the MFI-KRD weights for the IG Corporate Index. In 2007, the futures KRD-matched portfolio contained almost 100% of 5y futures with a -40% allocation to 10y futures. Figure 11A also shows that the introduction of the Ultra contract to the futures basket in March 2010 nicely reduces large futures allocations to some futures contracts.[25] Figure 11B shows that the weights for the IG Corporate MFI are all positive and much more stable.[26]

FIGURE 11A

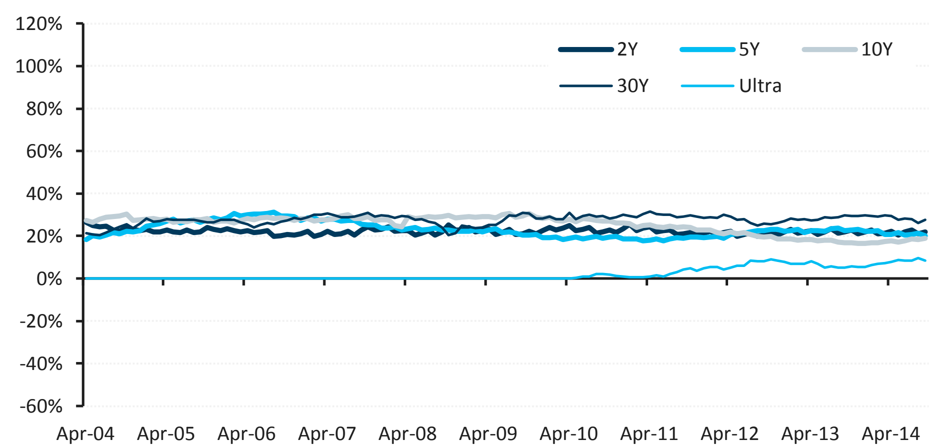
Futures Weights, MFI-KRD IG Corporate Index. April 2004 – September 2014



Source: Barclays Research

FIGURE 11B

Futures Weights, MFI IG Corporate Index. April 2004 – September 2014



Source: Barclays Research

Figure 12A shows the MFI-KRD weights for the Long IG Corporate Index. For the first half of the period, the MFI-KRD basket had a +300% and +200% allocation to 5y and 30y futures, respectively, and a -300% and -200% allocation to 10y and 2y futures, respectively. Such extreme futures allocations run two risks: Heavy reliance on the accuracy of the analytics that measure the futures' durations and high exposure to cash-futures basis changes in certain contracts.

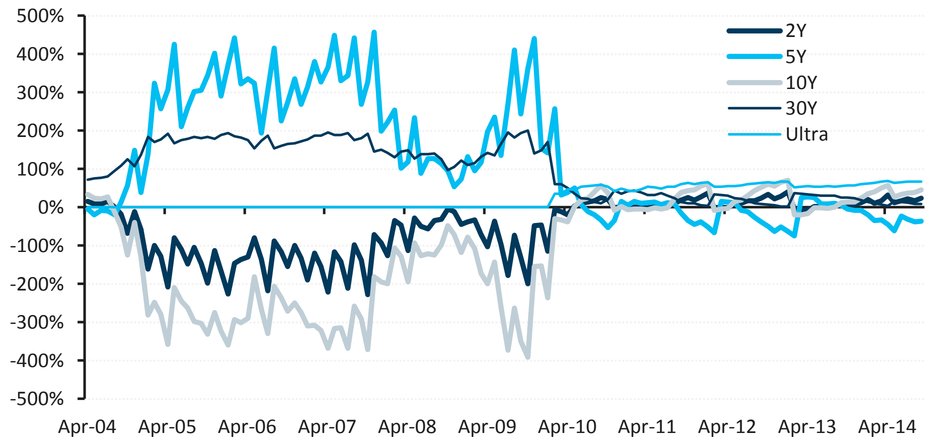
[25] There are many possible variations on the MFI construction process. For example, we could try to achieve KRD-matching but constrain the solution to only produce positive futures weights. Also, while the MFI includes the Ultra contract, some investors choose to use MFIs without the Ultra due to liquidity concerns.

[26] Readers will notice the saw-tooth pattern in futures weights. This reflects the tendency for the futures duration to increase at each quarterly roll.

Figure 12A dramatically highlights the utility of using the Ultra contract for futures replication of long duration indices. The presence of the Ultra takes a great deal of pressure off the other futures contracts to achieve KRD-matching. Nevertheless, there are still some large positive and negative futures weights.

FIGURE 12A

Futures Weights, MFI-KRD Long IG Corporate Index. April 2004 – September 2014

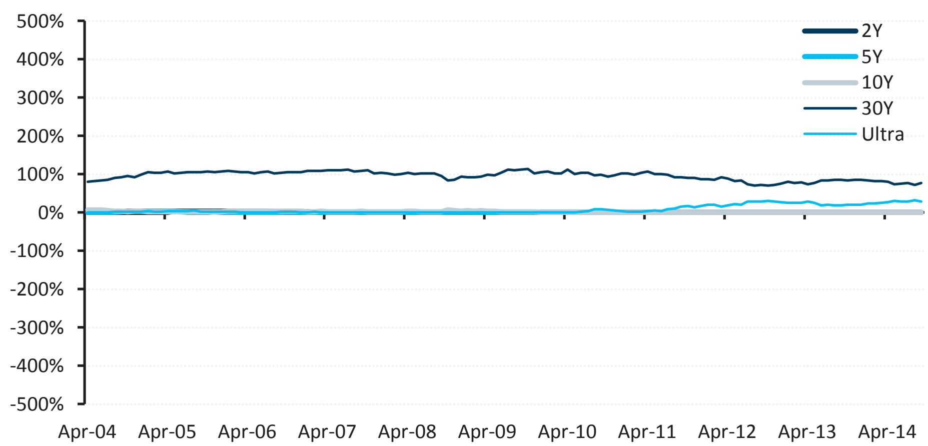


Source: Barclays Research

Figure 12B shows that OAD-matching produces a much smoother, and always positive, futures allocation pattern for the Long IG Corporate Index.

FIGURE 12B

Futures Weights, MFI Long IG Corporate Index. April 2004 – September 2014



Source: Barclays Research

For some PMs (and their clients) extreme futures weights, with alternating signs, arising from KRD-matching are a bit unnerving. However, in the next section we show that MFI-KRD ExRets have generally – but not always – tracked Index ExRet better than MFI ExRets. And, as with MFI ExRet, MFI-KRD ExRet are fully replicable. However, investors will have to evaluate the trade-off between the tolerance for extreme futures weights and the desire for better tracking performance versus published Index ExRets.

Also, it is not always feasible to construct KRD-matching MFIs for non-US markets. In fact, OAD-matching remains the only option for most non-US markets because of the limited numbers of available futures contracts and low liquidity.

FUTURES-BASED EXCESS RETURNS: PERFORMANCE

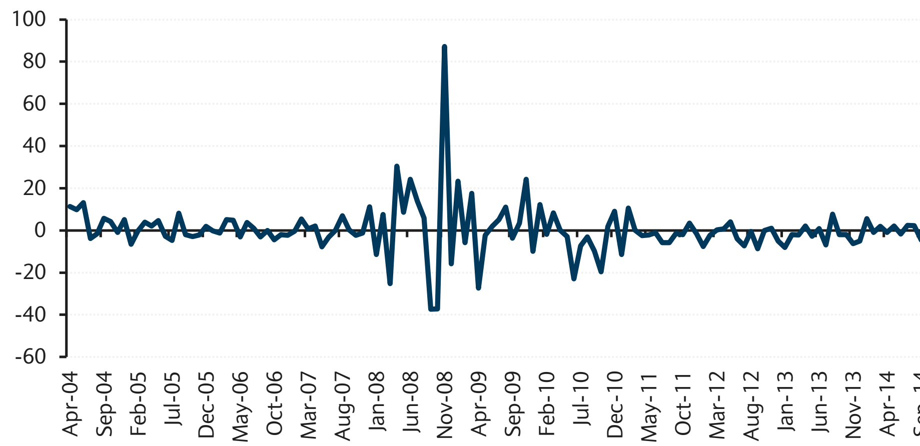
We now examine the performance of futures-based excess returns – not only over time but also relative to Index ExRets. Of particular interest is to understand the market conditions that may cause the two to deviate from each other. We first discuss MFI ExRets and then, as a case study, examine the difference between MFI and Index ExRets for the Aggregate Index in December 2013. Finally, we discuss the relative performance of MFI-KRD ExRets.

How Well Does the Treasury MFI Track Cash Treasury Market Returns?

The ability of an MFI to track the Treasury market is key to its utility. One way to assess this is to examine how well the Treasury MFI tracks the Treasury Index. Figure 13 shows the time series of the monthly return differences between the Treasury MFI and the Treasury Index since April 2004.

FIGURE 13

MFI vs Treasury Index, Total Return Differences, April 2004 – September 2014, bp



Source: Barclays Research

For April 2004 – September 2014, the average monthly tracking error between the Treasury MFI and the Treasury Index was 0.3bp, with a monthly TEV of 12.4bp. The largest monthly tracking error was 87.3bp in November 2008. Excluding September 2008 – March 2009, the average monthly tracking error was 0.0bp, with a TEV of 8.1bp and a maximum monthly tracking error of 30.5bp. Overall, the MFI tracks the cash Treasury market pretty well. This result bolsters confidence that an index's MFI is adequately capturing the Treasury component of returns, even though each Treasury futures is represented by just a few deliverable bonds.

Which Treasury Index OAD bucket has experienced the greatest MFI tracking error volatility over time? To examine this we create five Treasury indices, corresponding to each of the five MFI OAD buckets, for example, a 3-5 OAD Treasury Index, etc. We then construct the corresponding MFI for each of these five Treasury indices and measure the monthly MFI tracking errors. We include the Ultra contract in March 2010. Before March 2010, we use the bond futures contract for the 15+ OAD bucket.

FIGURE 14

MFI Tracking Performance vs US Treasury Index, by OAD Bucket, April 2004 – September 2014

	OAD Bucket					
w/ Ultra since 3/2010	**[0, 3)**	**[3, 5)**	**[5, 7.5)**	**[7.5, 15)**	**[15+**	**Overall**
Avg TE (bp/m)	-0.2	1.4	2.3	-1.5	-2.6	0.3
TEV (bp)	7.1	16.0	17.6	31.7	18.3	12.4

Source: Barclays Research

Figure 14 shows that the longer OAD buckets, especially the 7.5-15 OAD bucket, have generally experienced somewhat higher tracking error volatility. For the 7.5-15 OAD bucket, the average monthly tracking error has been -1.5bp with a 31.7bp standard deviation. The wider OAD bands of the longer duration buckets may contribute to a greater opportunity for the curve to move in a non-parallel fashion and produce higher TEV. Besides, longer maturity futures contracts may have greater volatility of the cash-futures basis.

How helpful is the relatively new Ultra futures contract for MFI tracking performance? Figure 15 compares the MFI tracking performance since March 2010 with and without the Ultra contract. The figure shows that the Ultra futures contract has reduced the TEV for both the longer duration buckets and the overall index (to 6.0bp from 9.2bp).

As almost 70% of the Treasury Index market value is in the first two OAD buckets, it is their average monthly return underperformance since March 2010 that largely explains the MFI's relative underperformance. Overall, despite large movements in the level and shape of the Treasury curve over time, the MFI with four (or five) futures contracts has tracked the cash Treasury Index reasonably well.

FIGURE 15

MFI Tracking Performance vs US Treasury Index, by OAD Bucket, March 2010 – September 2014

w/o Ultra	OAD Bucket					
since 3/2010	**[0, 3)**	**[3, 5)**	**[5, 7.5)**	**[7.5+**		**Overall**
Avg TE (bp/m)	-1.8	-1.4	-1.3	0.4		-1.3
TEV (bp)	3.8	6.0	10.5	38.6		9.2
w/ Ultra						
since 3/2010	**[0, 3)**	**[3, 5)**	**[5, 7.5)**	**[7.5, 15)**	**[15+**	**Overall**
Avg TE (bp/m)	-1.8	-1.4	-1.3	-3.8	-2.6	-2.1
TEV (bp)	3.8	6.0	10.5	33.0	18.3	6.0

Source: Barclays Research

MFI ExRet vs Index ExRet – December 2013 Case Study

Although the MFI tracks the cash Treasury market, this does not necessarily mean that MFI ExRets will closely track Index ExRets. For December 2013, the Aggregate MFI ExRet was +60bp whereas the Aggregate Index ExRet was only +43bp. Our goal in this section is to explain in detail this 17bp difference.

To do so we use a bit of algebra to break down the MFI-Index ExRet difference into two components as follows:

ExRet Diff

= MFI ExRet – Index ExRet

= (Index TR – MFI (OAD-matched to Index) futures Portfolio TR)

– (Index TR – Index (KRD-matched to Index) Tsy Portfolio TR)

= Index (KRD-matched to Index) Tsy Portfolio TR – MFI (OAD-matched to Index) futures Portfolio TR

= – [MFI (KRD-matched to Index) futures Portfolio TR – Index (KRD-matched to Index) Tsy Portfolio TR]

– [MFI (OAD-matched to Index) futures Portfolio TR – MFI (KRD-matched to Index) futures Portfolio TR]

= – ["how a futures portfolio, KRD-matched to Index, performed vs a cash Tsy portfolio, KRD-matched to Index"]

– ["how a futures portfolio, OAD-matched to Index, performed vs a futures portfolio, KRD-matched to Index"]

This decomposition allows us to isolate the component of the ExRet difference owing to the performance of futures versus the cash market, and the component owing to the different degrees of success in matching the underlying Index Treasury curve exposures by the OAD-matching and KRD-matching approaches:

Step 1. Futures vs. Cash Treasuries
"How KRD-matched Futures Portfolio Performed vs. KRD-matched Treasury Portfolio"

Futures Total Return vs. KRD-matched Treasury Portfolio Total Return

+

Step 2. OAD-KRD Difference in ExRet Methodology
"How OAD-matched Futures Portfolio Performed vs. KRD-matched Futures Portfolio"

OAD-matched Futures Total Return vs. KRD-matched Futures Total Return

Step 1: Futures vs Cash Treasuries. In the first step, we want to know how futures performed versus the cash Treasury market. We do this one futures contract at a time. Using a contract's KRDs, we construct a matched-KRD cash Treasury portfolio consisting of six hypothetical KRD Treasuries (and cash). We then compare the total return of the futures contract against that of its KRD-matched cash Treasury portfolio.

The futures may outperform or underperform its KRD-matched Treasury portfolio for two reasons. First, the futures may outperform or underperform its cheapest-to-deliver cash Treasury bond.[27] This is often referred to as a change in the cash-futures basis. Second, the CTD may outperform or underperform the futures' Treasury Portfolio because of bowing in the Treasury yield curve between the futures' KRD points (as discussed in the section on KRD-matching).

Regarding movements in the cash-futures basis, we use the 5y futures contract as an example. According to the Barclays Futures Pricing Report (available on Barclays Live), the net basis for this contract rose by 0.3 32nds, indicating that the futures contract cheapened by roughly ¾bp versus its cash market fair value based on its cheapest-to-deliver bond (Figure 16).

[27] For simplicity, the CTD is often used to represent the set of deliverable cash treasury bonds for the futures.

FIGURE 16

Changes in the Cash-Futures Basis, December 2013

		Net Basis					
futures	Fut Price 29_Nov_13	29-Nov-13	31-Dec-13	chg_32nds	points	bp	futures
2y	110.15	0.3	1.2	0.9	0.02813	2.55	cheapened
5y	120.92	0.6	0.9	0.3	0.00938	0.78	cheapened
10y	125.38	3	1.1	-1.9	-0.05938	-4.74	richened
bond	130.75	1.1	1.3	0.2	0.00625	0.48	cheapened
ultra	139.13	-1.8	-0.1	1.7	0.05313	3.82	cheapened

neg net basis: futures rich

pos net basis: futures cheap

Source: Barclays Research

The second reason for futures outperforming or underperforming the KRD-matched Treasury portfolio is that the underlying cheapest-to-deliver cash bond may outperform or underperform the corresponding futures' KRD-matched Treasury portfolio because of bowing in the Treasury yield curve.

For example, the 5y futures contract's CTD at the beginning of December 2013 was the 1s of 5/2018 with a BOM duration of 4.43. As shown in Figure 17, this futures contract (whose OAD = 4.45) had the following KRD exposures: 0.73 2y KRD and 3.73 5y KRD. As a percentage of the futures OAD, the contract had a 36% weight to the 2y KRD and a 76% weight to the 5y KRD, in addition to a cash stub position (-11%) with zero duration (Figure 18).

FIGURE 17

US Futures OAD & KRDs, 29 November 2013

Futures:	OAD	6mo KRD	2yr KRD	5yr KRD	10yr KRD	20yr KRD	30yr KRD
2yr	2.06	0.01	1.99	0.06	0.00	0.00	0.00
5yr	4.45	-0.01	0.73	3.73	0.00	0.00	0.00
10yr	6.62	0.00	0.06	3.82	2.75	0.00	0.00
bond	11.57	0.01	0.08	0.34	5.25	5.88	0.00
ultra	16.81	0.00	0.02	0.08	0.32	7.01	9.46

Source: Barclays Research

FIGURE 18

KRD-Matched Treasury Portfolio, Weights, Five US Futures Contracts, 29 November 2013.

Futures:	6mo	2yr	5yr	10yr	20yr	30yr	1mo
2yr	0.02	1.00	0.01	0.00	0.00	0.00	-0.03
5yr	-0.01	0.36	0.76	0.00	0.00	0.00	-0.11
10yr	0.01	0.03	0.78	0.30	0.00	0.00	-0.12
bond	0.02	0.04	0.07	0.58	0.39	0.00	-0.11
ultra	0.00	0.01	0.02	0.04	0.47	0.51	-0.04

Source: Barclays Research

During December, the CTD's yield increased by 33bp, while the 2y and 5y KRD Treasury yields increased by approximately 8bp and 33bp, respectively. Using the futures KRD weights, the implied yield increase for the KRD-matched portfolio would have been approximately 28bp. In other words, the CTD underperformed its matched-KRD portfolio by (33bp – 28bp) x 4.43 = 22bp in return. Combined with the cheapening of the futures contract vis-à-vis its CTD, the 5y futures underperformed its KRD-matched Treasury portfolio by approximately 23bp. This approximation is close to the actual performance difference (-24bp) shown in Figure 19.

FIGURE 19

Futures Contract Performance vs Its KRD-Matched Treasury Portfolio, December 2013

Futures Contract	Futures Total Return (bp)	Futures KRD-matched Treasury Portfolio Total Return (bp)	Futures Outperformance (bp)
2yr	-21.9	-12.1	-9.8
5yr	-133.0	-109.0	-24.0
10yr	-185.6	-168.3	-17.3
bond	-186.3	-200.6	14.3
ultra	-206.5	-200.5	-6.0
1m	0.0		

Source: Barclays Research

Figure 19 shows the futures outperformance or underperformance versus the cash Treasury market for all five futures contracts. To determine how much this contributed to the MFI – Index ExRet difference, we set the weight of each futures contract's relative performance to what it would have been, by sector, if we had used KRD-matching to construct the KRD-matched futures portfolio. In this way, we measure the contribution to the MFI – Index ExRet difference based solely on futures versus the cash market, without the results being affected by any methodological differences between the OAD and KRD approaches.

Each sector of the Aggregate has different weightings to each of the five contracts. Consequently, Step 1's contribution to MFI – Index ExRet difference will vary by sector as we will show in the tables that follow.

Step 2: OAD-KRD Difference in ExRet Methodology. Step 1 accounts for the futures outperformance or underperformance versus the cash Treasury market as a component of the MFI – Index ExRet difference. Step 2 examines how the MFI's OAD-matched futures portfolio performed against a KRD-matched futures portfolio. Not only do these two futures portfolios have different weightings to the various futures contracts, but also they likely have very different KRD profiles. Depending on how the Treasury yield curve shifts, there may be very different performance across the five futures contracts, which will affect the relative performance of the two futures portfolios. This performance difference reflects the OAD-KRD difference in ExRet methodology.

As the pattern of KRD differences varies by sector of the Aggregate Index, Step 2's contribution to MFI – Index ExRet difference will also vary by sector, as we will show in the following tables. We examine each of the three major Aggregate sectors separately: Treasury (35.7% of the Aggregate's total market value as of 12/31/2013), Corporate (22.3%) and MBS (29.1%). Together, these three sectors account for 87.1% of the Aggregate.

Treasury Sector

For December 2013, Treasury MFI ExRet was 5bp whereas reported Index ExRet was 0bp. How do we explain the MFI ExRet underperformance?

Step 1: From the analysis shown in Figure 19, we know how each futures contract performed versus its KRD-matched Treasury portfolio. To determine how much this contributed to the MFI – Index ExRet difference, we weight each futures contract's relative performance by what its weight would have been if we had used KRD-matching to construct a KRD-matched futures portfolio. The top row of Figure 20 shows the futures weights in a KRD-matched futures portfolio for the Treasury Sector of the Aggregate. Multiplying these weights by the respective futures-cash performance (from Figure 19), and then adding across all futures contracts, we see that -(-13bp) of the MFI-Index ExRet tracking error difference was due to futures versus cash Treasuries, which includes both changes in the cash-futures basis and the CTD tracking of its KRD-match Treasury portfolio.[28]

Step 2: We compare the futures weights using OAD-matching and KRD-matching. The middle row of Figure 20 shows the MFI's OAD-based futures weights (the first row shows the KRD-based futures weights). Relative to the Treasury Index, the MFI was underweight the 2y, 10y, and Ultra contracts and overweight the 5y and bond contracts. Multiplying these weight differences by the relevant futures total returns (from Figure 19), and then adding across all futures contracts, we see that -(+4bp) of the MFI-Index ExRet tracking error difference was due to the KRD mismatches arising from the difference in the OAD-KRD matching methodologies. The net -4bp hides some larger differences across the futures positions. For example, the MFI has a large overweight (26.0%) to the 5y futures compared with the KRD-matched futures portfolio. The 5y futures had a total return of -133bp, which contributed -35bp to the MFI's relative performance. In contrast, the MFI had a large underweight (29.8%) to the 10y futures, which contributed +55bp to the MFI's relative performance.

Overall, we estimate that the MFI ExRet outperformed Index KRD ExRet by 9bp (13bp – 4bp). However, we know this figure should be 5bp for the Treasury Index. Why the discrepancy? The Treasury Index is a bit unusual in that, by convention, the Treasury Index ExRet is set to zero. However, our 9bp of MFI ExRet outperformance assumes that Treasury ExRet followed the normal Index KRD ExRet methodology.[29]

Separately, we determined that Treasury Index ExRet would have been -4bp if the Index had normally computed Treasury Index ExRets. This, in turn, implies a MFI-Index ExRet difference of 9bp, which is what we estimated.

[28] Figure 19 shows the futures return versus cash return difference. Since these returns are subtracted from an index's total return to generate an excess return, the futures vs cash return is the negative of the futures-based excess return vs cash-based excess return.

[29] The Barclays Treasury curve, generated from the Treasury spline model, is fitted to a selected set of yields, and that set does not include all the Treasuries in the index. Most notably, on-the-runs and some illiquid bonds are excluded. Investors often mistakenly think that the Treasury curve and the Treasury index are the same. This is not so. The Treasury Index may actually have excess return over the Treasury curve, although the Index convention is to set Treasury excess returns to zero.

FIGURE 20

MFI – Index ExRet Difference Decomposition, Treasury Sector, December 2013

	Futures Contract						
	2y	5y	10y	bond	ultra	1m	Total
Tsy Sector's futures weights to match Tsy Index KRDs	51.0%	-4.4%	44.3%	-7.4%	12.6%	4.0%	
Futures vs Cash Tsy Perf (from Fig. 19)	-9.8	-24.0	-17.3	14.3	-6.0		
1. Futures vs Cash Performance Contribution	-5.0	1.1	-7.7	-1.1	-0.8		-13
Tsy MFI's OAD-matched futures portfolio wts	40.0%	21.5%	14.5%	6.7%	9.2%	8.1%	
diff with Tsy's KRD-matched futures wts	-11.0%	26.0%	-29.8%	14.1%	-3.4%	4.2%	
Futures Total Return (from Fig. 19)	-21.9	-133.0	-185.6	-186.3	-206.5		
2. ExRet diff. due to OAD-matched futures Portfolio vs KRD-matched futures Portfolio	2.4	-34.5	55.3	-26.3	7.1	0.0	4
Tsy MFI ExRet vs Tsy Index ExRet							9

Source: Barclays Research

Non-Treasury Sectors

We perform the same estimation exercise for the two major non-Treasury sectors of the US Aggregate: Corporate and MBS.

For December 2013, the Corporate MFI ExRet outperformed Corporate Index ExRet by approximately 12bp. The Corporate Index Return was -16bp, and its KRD-matched Treasury Return was -119bp. Consequently,

⇨ Corporate Index ExRet = +103bp

The Corporate Index MFI Total Return was -131bp, so

⇨ Corporate MFI ExRet = +115p

Figure 21 presents the results using the same two-step decomposition process described earlier. The MFI ExRet outperformed Index ExRet by approximately -(-10bp) stemming from futures underperforming the cash Treasury market. The 10bp is comparable to the 13bp experienced by the Treasury Index despite different futures weights used to match the KRD profiles of the two indices. For example, the Corporate Index has a 6.5% weight to the bond contract compared to -7.4% for the Treasury Index. In addition, Corporate has a 33.0% weight to the 2y contract compared to 51.0% for Treasury. As it happened, the futures versus cash performance for these contracts was not very large, so the futures weight differences did not matter so much.

In terms of the MFI – Index ExRet difference arising from OAD versus KRD matching, the Corporate Index had similar OAD-KRD futures weights differences as the Treasury Index except for the bond and Ultra contracts. The Corporate Index had much higher weight to the bond contract but a lower weight to the Ultra contract. However, as the total returns for these two contracts were roughly comparable, the MFI – Index ExRet difference for the Corporate Index (2bp) was similar to that for the Treasury Index (-4bp).

FIGURE 21

MFI – Index ExRet Difference Decomposition, Corporate Sector, December 2013

	Futures Contract						
	2y	5y	10y	bond	ultra	1m	Total
Corp Sector's futures weights to match Corp Index KRDs	33.0%	-2.8%	43.8%	6.5%	15.5%	3.9%	
Futures vs Cash Tsy Perf (from Fig. 19)	-9.8	-24.0	-17.3	14.3	-6.0		
1. Futures vs Cash Performance Contribution	-3.2	0.7	-7.6	0.9	-0.9		-10
Corp MFI's OAD-matched futures portfolio wts	20.9%	22.3%	16.5%	29.5%	5.4%	5.4%	
diff with Corp's KRD-matched futures wts	-12.1%	25.1%	-27.3%	22.9%	-10.1%		
Futures Total Return (from Fig. 19)	-21.9	-133.0	-185.6	-186.3	-206.5		
2. ExRet diff. due to OAD-matched futures Portfolio vs KRD-matched futures Portfolio	2.6	-33.3	50.7	-42.7	20.8	0.0	-2
Corp MFI ExRet vs Corp Index ExRet							12

Source: Barclays Research

For December 2013, the MBS MFI ExRet outperformed MBS Index ExRet by approximately 42bp – much larger than for the Corporate Index. Specifically, MBS Index Return was -47bp and the KRD-matched Treasury Return was -102bp:

⇨ MBS Index ExRet = +55bp

The MBS Index MFI Total Return was -144bp, so

⇨ MBS MFI ExRet = +97p

Figure 22 shows that the main reason for the large MFI – Index ExRet difference for the MBS Index was the large difference in futures weights between OAD and KRD matching. Compared with KRD-matching, OAD-matching produced much lower weights to the 2y contract (4% vs 34%) and bond contract (9% vs 21%), but much higher weights to the 5y contract (28% vs -2%) and 10y contract (49% vs 30%).

The MBS Index has most of its market value weight in the 5y and 10y OAD buckets. However, the 5y futures contract has meaningful 2y KRD exposure, and the 10y futures contract has most of its OAD at the 5y KRD point. When using KRD-matching, adding 10y futures contracts simultaneously adds considerable exposure to the 5y KRD. In fact, using the 10y futures adds so much 5y KRD exposure that the KRD futures portfolio must short the 5y contract. However, the 5y contract has meaningful exposure to the 2y KRD. So to match the 2y KRD exposure of the MBS Index, the KRD futures portfolio needs a large positive allocation to the 2y contract to offset the short 5y futures position's impact on the 2y KRD exposure. This is a good example of how KRD matching can lead to long and short positions in the futures portfolio.

FIGURE 22

MFI – Index ExRet Difference Decomposition, MBS Sector, December 2013

	Futures Contract						
	2y	5y	10y	bond	ultra	1m	Total
MBS Sector's futures weights to match MBS Index KRDs	34.1%	-2.3%	30.3%	21.4%	3.2%	13.4%	
Futures vs Cash Tsy Perf (from Fig. 19)	-9.8	-24.0	-17.3	14.3	-6.0		
1. Futures vs Cash Performance Contribution	-3.3	0.6	-5.2	3.1	-0.2		-5
MBS MFI's OAD-matched futures portfolio wts	4.0%	27.7%	48.6%	8.9%	0.0%	10.8%	
diff with MBS's KRD-matched futures wts	-30.1%	30.0%	18.3%	-12.6%	-3.2%		
Futures Total Return (from Fig. 19)	-21.9	-133.0	-185.6	-186.3	-206.5		
2. ExRet diff. due to OAD-matched futures Portfolio vs KRD-matched futures Portfolio	6.6	-39.9	-34.0	23.4	6.6	0.0	-37
MBS MFI ExRet vs MBS Index ExRet							42

Source: Barclays Research

The MFI ExRet outperformed Index ExRet by approximately 42bp. 37bp of that was caused by the difference between OAD and KRD matching, which produced large differences in their respective futures portfolios. Given the large variation in futures total returns (-22bp for 2y versus -186bp for 10y), the dissimilarities in futures positions led to a relatively large MFI – Index ExRet difference.

For the Aggregate Index, the MFI – Index ExRet difference was approximately 17bp. We have explained that 9bp came from Treasury (35.7% weight), 12bp from Corporate (22.3%) and 42bp from MBS (29.1%). Weighting each of the MFI – Index ExRet differences across sectors, we account for approximately 18bp.

We saw that in all three sectors, the KRD futures portfolio has an overweight to the 2y contract compared with the MFI OAD portfolio, as a result of the need to offset the short 5y futures position (which, in turn, was caused by the long 10y futures position). Consequently, we might expect that Index ExRet performance would tend to improve (deteriorate) relative to the MFI ExRet if there were a period of Treasury curve steepening (flattening) as the 2y futures would outperform (underperform) the longer maturity futures contracts.

A bowing of the Treasury curve may also affect the MFI – Index ExRet difference, but the direction is difficult to predict as it depends on where the bowing takes place as well as on the pertinent market value exposures.

Finally, we expect that a pure parallel shift in the Treasury curve is likely to have a neutral effect on the MFI-Index ExRet difference, as both the MFI and Index futures portfolios will have similar returns.

In the last section, we analyze cumulative returns for the various excess return measures and empirically assess the historical sensitivity of the MFI – Index ExRet difference to particular types of Treasury yield changes.

Futures-based Excess Returns: OAD-matching or KRD-matching?

Figure 23 presents the monthly mean, standard deviation and maximum/minimum returns for the Index, MFI and MFI-KRD ExRet measures across four important USD indices. While all three ExRet measures have comparable volatilities and extreme returns, we see that the MFI ExRet have generally underperformed Index and MFI-KRD ExRet over the period, especially for the MBS Index.

FIGURE 23

Statistics, MFI, Index & MFI-KRD ExRets, Aggregate, Treasury, Corporate and MBS Indices, April 2004 – September 2014

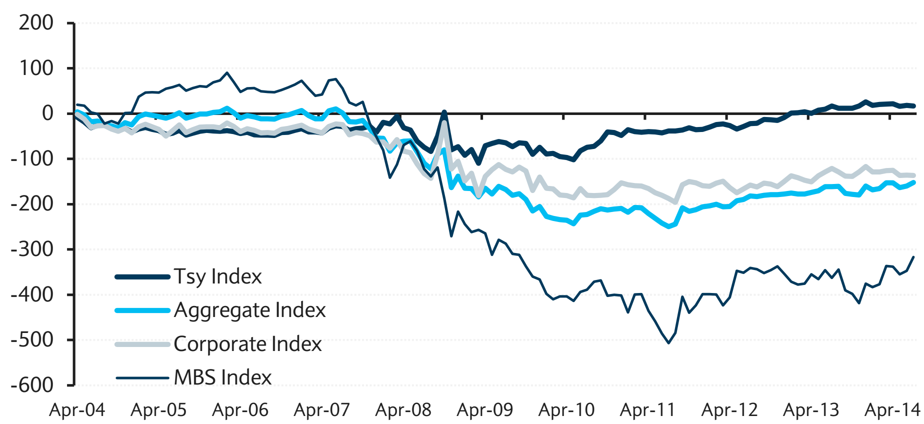
	Treasury Index			Aggregate Index			Corporate Index			MBS Index		
	Index ExRet	MFI ExRet	MFI-KRD ExRet	Index ExRet	MFI ExRet	MFI-KRD ExRet	Index ExRet	MFI ExRet	MFI-KRD ExRet	Index ExRet	MFI ExRet	MFI-KRD ExRet
Average	0.0	-0.3	-0.2	3.3	2.0	3.2	7.1	5.8	7.5	4.7	2.1	4.4
Std.Dev.	0.0	12.4	13.8	53.6	57.7	56.2	164.3	165.4	165.8	40.0	49.5	42.9
Min	0.0	-87.3	-89.9	-252.0	-256.5	-251.4	-838.4	-785.3	-802.7	-163.2	-228.9	-157.1
Max	0.0	37.3	38.2	153.8	172.2	185.4	538.6	586.8	592.5	96.5	140.9	110.5

Source: Barclays Research

Figure 24 shows the cumulative difference between MFI and Index ExRets for the four indices since April 2004. The cumulative differences were small leading up to the fall of 2007, but later MFI ExRet have generally underperformed Index ExRet.

FIGURE 24

Cumulative MFI ExRet – Index ExRet Difference, Aggregate, Treasury, Corporate and MBS Indices, April 2004 – September 2014

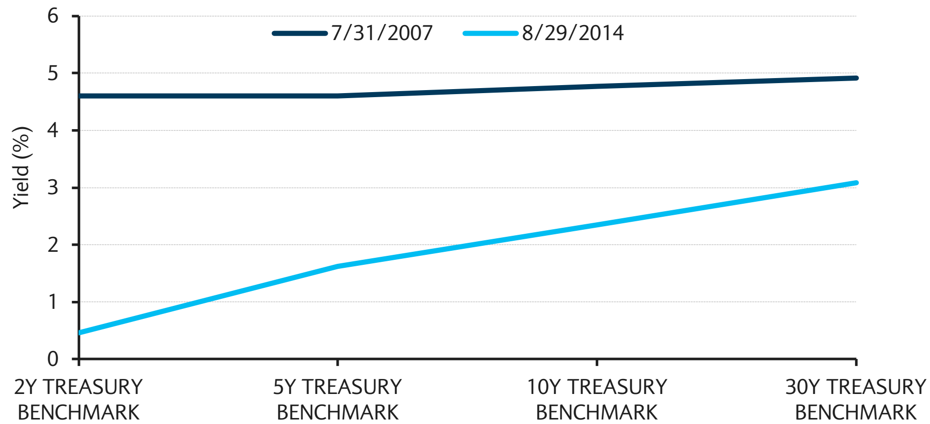


Source: Barclays Research

As discussed, we expect MBS MFI ExRet to underperform Index ExRet when there is a steepening in the Treasury yield curve. Figure 25 shows that, since 2007, there has been a substantial steepening, which likely goes a long way to explain the large cumulative MFI – Index ExRet difference.

FIGURE 25

Treasury Yield Curve, July 2007 and August 2014



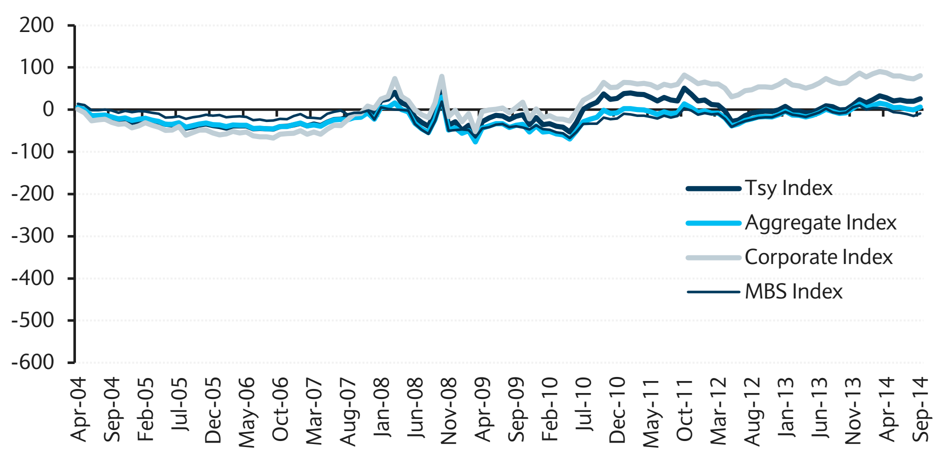
Source: Barclays Research

Figure 26 shows that MFI-KRD ExRets have tracked Index ExRets much more closely. Compared with MFI ExRet, MFI-KRD ExRet are less sensitive to curve steepening. We also see that the Corporate MFI-KRD outperformed Index ExRet, whereas MFI ExRet underperformed. Corporate MFI ExRet underperformance occurred in 2008-09 when the curve became particularly steep. In contrast, MFI-KRD outperformance began in mid-2010 when the Ultra contract was first employed in our futures replication. Why might the introduction of the Ultra affect the relative MFI-KRD ExRet performance?

Unlike the other indices, the Corporate Index has significant exposure to the long end of the curve. The Ultra contract has tended to have similar exposure to the 20y and 30y KRD points, while the bond contract has similar exposure to the 20y and 10y KRD points. So once the Ultra contract became available, KRD-matching produced a tendency for the Ultra contract to lead to a lower weight to the bond contract compared with OAD-matching. A quick glance back at Figure 21 shows that MFI-KRD has a 6.5% weight to the bond contract compared with 29.5% for the MFI. Their relative weights are reversed for the Ultra contract.

FIGURE 26

Cumulative MFI-KRD ExRet – Index ExRet Difference, Aggregate, Treasury, Corporate and MBS Indices, April 2004 – September 2014



Source: Barclays Research

Consequently, any flattening of the curve between the bond and Ultra contracts is likely to help MFI-KRD relative to MFI. Since April 2010, the 10-30 Treasury yield spread has flattened by 18bp.

We expect changes in the shape of the Treasury yield curve, especially twisting and bowing, to be a major driver of MFI – Index ExRet differences, while parallel shifts are less likely to affect them.

To test this we regress monthly MFI – Index ExRet differences on the following measures of changes in Treasury curve shape:

Parallel shift: ¼ × (chg_yield 2y + chg_yield 5y + chg_yield 10y + chg_yield 30y)

Twist: chg_yield 30y – chg_yield 2y

Butterfly: ½ × (chg_yield 2y + chg_yield 30y) – chg_yield 10y

In the regression we include changes in Corporate and MBS Index OAS.[30] Ideally, the MFI – Index ExRet difference would not be sensitive to changes in OAS if both measures were doing a good job capturing the Treasury component of a bond's total return.

Figure 27 shows the regression results. The Treasury results are artificial as the Index ExRet are set to 0%. The regression results (t-stats in italics) support the conjecture that the MFI – Index ExRet difference is very sensitive to changes in the Treasury curve. Between 34% and 53% of the variance in the difference can be explained by changes in the curve. As expected, a steepening of the curve causes the MFI ExRet to underperform Index ExRet. Historically, more bowing of the curve, *ie,* a butterfly shift, has also made MFI ExRet underperform. While the coefficient on the parallel shift factor is positive and sometimes significant, re-running the regression without this factor (not shown) shows that it has little effect on the explanatory power of the regression. Notably, excess return differences are not sensitive to changes in OAS levels of the spread sectors.

FIGURE 27

Regression Results, Sensitivity of MFI-Index ExRet Difference to Tsy Yield Curve Movements and Sector Spread Changes, April 2004 – September 2014

	constant	parallel shift	2-30 twist	2-10-30 butterfly	chg_Corp_OAS	chg_MBS_OAS	R^2
Treasury	-0.24	1.91	1.07	**-35.11**	0.05	0.07	0.11
	-0.23	*0.28*	*0.18*	***-1.98***	*0.94*	*0.72*	
Aggregate	-1.40	12.33	**-34.48**	**-64.45**	0.01	0.02	0.34
	-1.38	*1.94*	***-6.00***	***-3.82***	*0.31*	*0.25*	
Corporate	-1.33	6.51	**-30.78**	**-154.66**	0.01	0.07	0.47
	-1.05	*0.81*	***-4.24***	***-7.27***	*0.24*	*0.65*	
MBS	-2.76	**22.30**	**-84.41**	**-56.44**	-0.02	-0.02	0.53
	-1.81	***2.31***	***-9.70***	***-2.21***	*-0.28*	*-0.15*	

Source: Barclays Research

As one might expect, we see a different pattern of Treasury yield curve sensitivities for MFI-KRD – Index ExRet differences. Figure 28 shows the regression results. Overall, we see lower R^2s indicating that the MFI-KRD – Index ExRet difference is less sensitive to changes in the Treasury curve. Notably, parallel and twist movements are not significant (except for parallel shifts and the MBS index). As expected, the only significant sensitivity is to butterfly shifts.

[30] We perform this regression at the index-level, not the individual OAD bucket level. For more precision, we could regress OAD bucket (MFI ExRet – Index ExRet) differences on curve changes within the OAD bucket to avoid curve effects for the entire Treasury curve being offset in different OAD buckets.

FIGURE 28

Regression Results, Sensitivity of MFI-KRD-Index ExRet Difference to Tsy Yield Curve Movements and Sector Spread Changes, April 2004 – September 2014

	constant	parallel shift	2-30 twist	2-10-30 butterfly	chg_Corp_OAS	chg_MBS_OAS	R^2
Treasury	-0.22	-3.24	4.82	-53.32	0.00	0.08	0.16
	-0.19	*-0.45*	*0.74*	***-2.79***	*-0.03*	*0.83*	
Aggregate	-0.06	6.32	6.31	-57.16	0.01	0.08	0.31
	-0.06	*1.01*	*1.12*	***-3.46***	*0.21*	*0.91*	
Corporate	0.52	6.65	5.55	-88.20	-0.02	0.18	0.32
	0.38	*0.78*	*0.72*	***-3.89***	*-0.27*	*1.56*	
MBS	-0.10	13.33	9.05	-43.75	0.02	0.02	0.37
	-0.11	***2.38***	*1.79*	***-2.96***	*0.59*	*0.28*	

Source: Barclays Research

CONCLUSION

Each of the presented excess return methodologies has merits and shortcomings.

The Bucket ExRet is best for well-defined, fixed-cash-flow bonds. The Treasury buckets are constructed with all the securities in the Treasury index, which makes them somewhat investable. However, this methodology is not suitable for MBS or callable securities.

The KRD-matched Index ExRet improves on the above by considering Treasury curve movements at more points on the curve. However, it still leaves some gaps, which may result in bowing in or out. Moreover, hypothetical Treasuries are not investable.

Even though Treasury futures baskets are constructed from a few deliverable Treasury securities, they show very good tracking performance against the Treasury market. Another, and important, reason for portfolio managers to consider a futures-based MFI ExRet is its biggest advantage – investability.

The OAD-matched MFI ExRet has the same flaw as the Bucket ExRet, ie, it is not well suited for MBS or callable securities. While KRD-matched MFI ExRet can mitigate this problem somewhat, the MFI futures portfolio may end up with negative weights in some futures baskets, which necessitate short positions. These short positions may be large for certain MFIs, depending on the underlying index.

Overall, the MFI (OAD-matched) ExRet works well mainly on large indices with maturities covering all parts of the Treasury curve. MFI futures weights are always positive and are of reasonable magnitude. In months where there are large twists and butterfly shifts in the Treasury curve, the MFI ExRet may differ significantly from Index ExRet.

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