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The Yield Book

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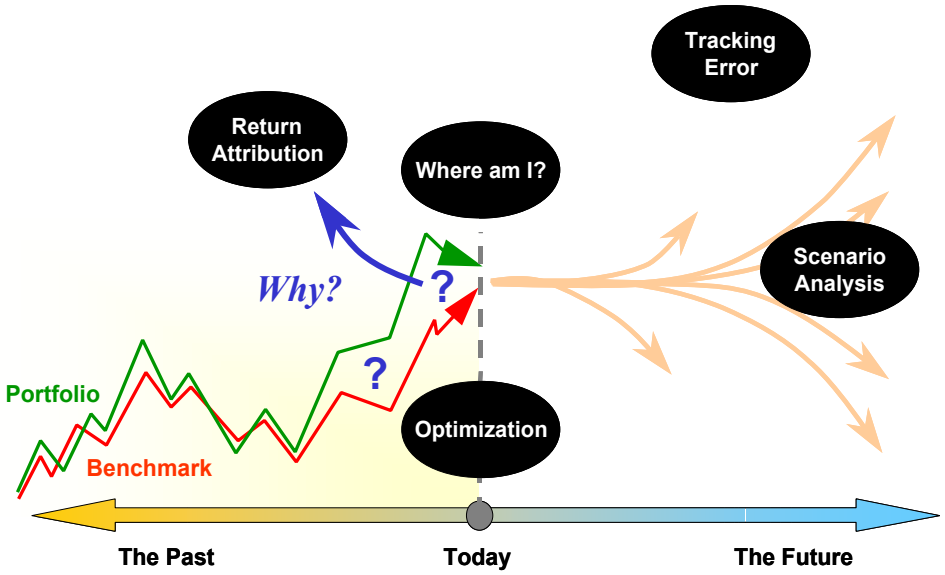
THE YIELD BOOK

Managing a Fixed-Income Portfolio Versus a Benchmark

- **The vast majority of managers, especially externally hired asset managers, manage against a benchmark, usually a market index.**
- **This paper is about how these professionals go about managing a portfolio versus a benchmark, as well as the considerations involved at the sponsor level in selecting a benchmark and writing investment guidelines.**
- **Managers, sponsors, and consultants may also find useful information from the experiences of this author, a former portfolio manager.**



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Managing a Fixed-Income Portfolio Versus a Benchmark

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Selecting a Benchmark

Managers are occasionally included in the benchmark determination process, but more often the decision is external to the manager, originating with the sponsor and/or its consultant. Here are some of the things that ought to be kept in mind when selecting a benchmark.

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Managing a Fixed-Income Portfolio Versus a Benchmark

Introduction

Most institutional asset managers manage versus *something*. In some cases, the manager may be tasked with earning more than the cost of liabilities (banks, insurance companies). Or there may be a defined set of cash flows that must be funded (defined benefit pensions). But the vast majority of managers, especially externally hired asset managers, manage against some sort of benchmark, usually a market index. This paper is about this last group of managers, and how they go about managing a portfolio versus a benchmark.

We will use the term "sponsor" to refer to the keeper of the funds. We can think of a pension sponsor as the "owner" of the funds, although the beneficial owners are those covered by the pension plan.[1] The "manager" is hired by the sponsor to manage the funds. Managers want to know how they will be judged, and sponsors need some way to measure how the managers are performing. As such, a benchmark or index is usually the method selected.

Basically, this report will cover three topics:

- Selecting a benchmark;
- Setting appropriate investment guidelines for the manager; and
- Managing against the benchmark.

The Basics

What Is an Index?

An index is a set of one or more securities and their (relative) weights in a portfolio. Usually, the total return of this index portfolio is used to determine relative performance of a manager, whether active or passive. A good index has a set of objective rules, consistent through time, that determine whether a security is included in an index. These "inclusion criteria" usually include amount outstanding (as a measure of availability, importance in the market, and liquidity), ratings quality, and time to maturity. These criteria can vary by sector even within one index. For example, the size criteria in the Citigroup Broad Investment-Grade (BIG) Index are different for Treasuries, mortgage backed securities (MBS), and corporates. Agencies share the same size criteria as Treasuries.

The major indexes (Citigroup, Lehman) are often referred to as "market" indexes because they are structured to be representative of the market as a whole. But they do not include all securities in the market. There are various "inclusion criteria" applied, which result in some bonds being excluded. Although a comprehensive measure is

[1] No doubt there is a legal trap here. Some companies have "raided" their pension plans to remove surplus, implying they are the owners of the funds. We are just trying to get working definitions of the players here, not legal definitions. So we will call the sponsor the owner of the funds.

desired, it is important for an index to be relevant to investors, and to be replicable in the market. Because indexes are used primarily by large, institutional investors, the inclusion rules have minimum size requirements that exclude smaller issues, since they certainly could not be owned by a large number of investors. Furthermore, the criteria should result in a reasonably stable composition, so that investors are not frequently forced to execute many trades to remain neutral to the index.[2]

Total Return Versus Yield

Total return is a measure across time. In its simplest form, when there are no external cash contributions or withdrawals, it is the rate of return that turns the starting portfolio value into the ending portfolio value. The calculation requires a full valuation of all securities at only the beginning and end points of the measurement interval. When there are external cash flows (contributions and withdrawals), the calculation is more complicated, and there are competing methodologies with different data requirements. The relevant point for this discussion is that it is a measurement over a past time period of the actual performance of a portfolio, using real prices and actual cash flows from the securities.

Yield is an instantaneous (that is, calculated at the moment using current prices) measure of the internal rate of return of the entire portfolio. (Often, it is a market weighted average of the "yield to maturity" of every security in the portfolio. As intuitive as this sounds, this weighted measure is not really a good estimate of the internal rate of return of the entire portfolio, treated as a single entity with all of the component cash flows. A better measure is a weighted average in which both market *and* duration are multiplied to create the weight.)[3] Yield is an estimation of the liquidating return on a portfolio looking forward, with cash flows based on current conditions (including forward rates derived from the current yield curve, etc.) A higher yielding portfolio is not necessarily a better performing portfolio.

Index Versus Benchmark

In most instances, a manager's benchmark is an index. That is, the manager's relative performance will be determined by subtracting the published index total return from the portfolio's total return. If the difference is positive, the manager has "outperformed" the index. If negative, he has "underperformed."

But a manager's benchmark does not have to be an index per se; it can be an index plus a certain number of basis points, or it might be a composite of several indexes, or an index with a particular sector removed. The terms index and benchmark are often used interchangeably, but there is that subtle difference. We will try to be consistent here: We will use the word *index* when we mean a calculated proxy of market performance and we will use the word *benchmark* when we mean the specific measurement of return that is the standard for a particular portfolio. An index is usually constructed by, and its return calculated by, a "disinterested" third party (not the manager or sponsor). A benchmark is specific to a particular asset management contract.

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[2] See "Characteristics of a Good Benchmark" in *Citigroup Global Fixed-Income Catalog — 2005 Edition,* Fixed-Income Index Group, Citigroup, May 26, 2005.

[3] See "Bob's Analytical Corner" in www.yieldbook.com for an article that explains this more fully.

Selecting an Index as a Basis for a Benchmark

Role of the Benchmark

Sponsors (or their consultants) do not select a benchmark without regard to the desired risk profile of the manager's resulting portfolio. Indeed, the selection of a particular benchmark is often rich in information content. The benchmark selection often has implications for the "suggested" duration range for the portfolio as well as the types of securities that may be purchased (see the section entitled "Benchmark Versus Guidelines"). Occasionally, there may be a disconnect between the benchmark and the investment style to be pursued, but generally there is a reasonable relationship. The actual "contractual" relationship is defined in the investment guidelines provided to the manager.

A benchmark provides a neutral position for the portfolio when the manager wants to be neutral to the various sources of risk and return: duration risk, curve risk, credit risk, sector risk, and so on. Anytime a manager feels that value is lacking in the permitted areas of flexibility, a neutral position insulates the portfolio (relative to the benchmark) against various market moves. Some managers will retreat to the neutral position after a period of good performance, so as to preserve the outperformance through the end of the measurement period (month, quarter, or year). Others will use the neutral position to stem further underperformance after a rocky period. The benchmark should be an investable portfolio and should be associated with an appropriate return calculation. If the benchmark does not provide this sanctuary, it is simply not appropriate. For example, if the benchmark uses some sort of geometric return calculation, there is no combination of actual securities that can achieve that return, and the manager is subject to a mathematical bias that may be favorable or unfavorable. It is better if the benchmark looks and acts like a portfolio. With these thoughts in mind, let us turn to the actual selection of a benchmark.

The Appropriate Index

Given our discussion, several questions arise:

- Is there an existing third-party index that is appropriate for the portfolio? (In other words, does it have the correct interest rate risk and sector exposure for the portfolio? Is it constructed from readily available securities, available in sufficient size for an institutional investor? Does it reasonably reflect the investment guidelines from the sponsor?)
- If not, can a suitable index be crafted by adjusting an existing index? For example, can a particular sector be eliminated and render the index a better representation of the appropriate risks for the portfolio?

It is not always apparent what constitutes an appropriate index for a particular source of funds. For example, it might seem appropriate for a pension fund to use an investment-grade market index, such as the Citigroup BIG Index, or the Citigroup Large Pension Fund Index. But the sponsor may use an asset allocation program that allocates a portion of the funds to alternative investments, or to high yield, etc. Or the sponsor may hire specialists and have separate Treasury, MBS, CMBS, and credit managers. Each will be given a different index based on the asset allocation scheme. Without knowing details about the entire asset base (as well as the risk preferences of the sponsor), it will be impossible for an outsider to know outright whether a particular index or benchmark is appropriate or not.

Characteristics of a Good Benchmark[4]

The Citigroup indexes are designed to provide relatively stable and easily replicable benchmarks. We achieve this goal by adhering to the following guidelines:

- **Relevance.** An index should be relevant to investors. At a minimum, it should track those markets and market segments of most interest to investors.
- **Comprehensiveness.** An index should include all opportunities that are realistically available to market participants under normal market conditions while measuring the performance of new investments and existing holdings.
- **Replicability.** The total returns reported for an index should be replicable by market participants. It must be fair to investment managers who are measured against it and to sponsors who pay fees or award management assignments based on performance relative to it. Furthermore, over time, an index must represent a realistic baseline strategy that a passive investor could have followed. Accordingly, information about index composition and historical returns should be readily available.
- **Stability.** An index should not change composition often, and all changes should be easily understood and highly predictable. It should not be subject to opinions about which bonds or equities to include on any particular day. However, index composition must change occasionally to ensure that it accurately reflects the structure of the market. A key virtue of an index is to provide a passive benchmark; investors should not be forced to execute a significant number of transactions just to keep pace.
- **Barriers to entry.** The markets or market segments included in an index should not contain significant barriers to entry. This guideline is especially applicable to an international index in which an included country may discourage foreign ownership of its bonds or participation in its equity market.
- **Expenses.** In the normal course of investing, expenses related to withholding tax, safekeeping, and transactions are incurred. For a market or market segment to be included, these ancillary expenses should be well understood by market participants and should not be excessive. For example, if expenses are unpredictable or inconsistently applied, an index cannot hope to fairly measure market performance.
- **Simple and objective selection criteria.** A clear set of rules should govern inclusion of bonds or markets in an index, and investors should be able to forecast and agree on changes in composition.

This list of desirable characteristics may not be exhaustive, and different investors may place different emphasis on each. In constructing indexes, some desirable characteristics may have to be sacrificed to ensure that others are met. However, it is critical that an index follows objective rules that are well defined so that all interested parties can understand how to apply the information to their particular situation.

It is also important to select the index provider with some care. It is probably wise to use a benchmark from a provider who has been in the business for an extended period of time, who can offer data, history, good service, and has the proper infrastructure to handle index production for a long time. If prices are obtained from traders, they are usually carefully determined from that day's experience, and not just estimated. Finally, the index provider should make data acquisition as easy as possible for the investor.

[4] Excerpt from *Citigroup Global Fixed-Income Index Catalog — 2005 Edition,* Fixed-Income Index Group, Citigroup, 2005.

Selecting a Benchmark

Managers are occasionally included in the benchmark determination process, but more often the decision is external to the manager, originating with the sponsor and/or its consultant. Here are some of the considerations that ought to be kept in mind when selecting a benchmark.

Construction

One of the most important factors is the construction of the benchmark. Is it a single, market-weighted index, or is it a complex composite of more than one index? The construction has implications for the manager and for the appropriateness of the benchmark as a tool to measure the success (or failure) of a manager.

A **market-weighted** benchmark — and most indexes are constructed as market weighted portfolios[5] — has several desirable characteristics. First and most important, a market weighted index or benchmark is "self-adjusting" in that as a sector outperforms, its weighting in the benchmark grows, but it also grows in a neutral portfolio at the same rate. Thus, no rebalancing transactions are necessary to bring the portfolio back into line with the benchmark as a result of market movement. A second and less important factor is that a market-weighted portfolio could be applied to everyone because, in aggregate, it is the portfolio that everyone owns (out of the eligible securities). If the portfolio simply owned its proportional share of all of the securities included in the index, it would own a mini-index portfolio, with a return that matched the index (ignoring transactions costs). But, as mentioned, specific pockets of money may be employed to match a more targeted sector of the market and others may be precluded from owning some of the securities, so this "market index" argument is not the primary reason to select a market-weighted benchmark.

A fixed-weighted benchmark defines specific weights for market sectors, regardless of their market weights. For example, a benchmark return might be calculated by taking 45% of the MBS sector return plus 45% of the corporate sector return plus 10% of the government return. Perhaps the sponsor is saying that overallocation to spread sectors is desirable and is the neutral position for the manager. But as MBSs outperform, for example, they would grow in the portfolio to more than a 45% weight, forcing the manager to sell some MBS at the end of the performance interval just to remain neutral. It is not desirable to have the benchmark portfolio induce trading in an actual neutral portfolio just so that it can remain neutral.

Composite indexes often are constructed as fixed weights of existing indexes, such as 90% of the BIG index and 10% of the capped High-Yield index. This type of fixed weighting of indexes has the same disadvantages as those described for fixed-weight sectors. This author once managed a central bank portfolio that used a fixed weight composite of eight different (mostly Treasury) indexes. It was designed to have a duration of 2.0, but it always seemed like an unnecessarily complicated way to achieve that target. In fact, because the weights were fixed, as the market

[5] This is basically true in the fixed-income world, but not necessarily in equities. For example, the Dow Jones Industrial Index is unweighted as far as the number of shares of each security is concerned, and uses a strange calculation to determine the overall index level.

composition changed (due to changing patterns of issuance) and the durations of the underlying indexes changed because of market level, the duration of the benchmark rose to 2.1, while the guidelines called for a portfolio duration of 2.0.

Rebalancing

Because of the passage of time and normal market events, the composition of an index changes. As securities age, some will become shorter than a year to maturity, the normal cutoff for inclusion, and some may be called, etc. New securities that meet the inclusion criteria will continue to be issued, and procedures to incorporate them into the various indexes have been adopted. If the indexes attempted to reflect everything going on in the markets, these securities could enter the indexes as they were issued and others would leave the indexes as they reached the exit criteria. But the various index providers have determined that an index should not be a moving target for managers and tend to hold the index composition static during the month. Then, toward the end of the month, there is a rebalancing that occurs to reflect the exclusion of some securities and the inclusion of new (or newly qualified) securities.

Index providers typically inform managers about the upcoming changes to the index prior to the end of the month so that managers can be ready to adjust positions if necessary. For example, the duration of the Treasury index used to increase by as much as 0.2 years simply because of the Treasury auction cycles. Newly issued securities, including the 30-year, caused the duration to increase, as did any securities that aged out of the index. Citigroup indexes create a new "profile" on the "fixing day" that is several days before the end of the month.[6] This allows managers some time to plan their transition to the new index values if necessary. There is almost always some index-related trading that takes place near the end of the month, but it is not usually disruptive. The recent downgradings of Ford and GM and their captive finance companies, coupled with new rules from Lehman, caused these bonds to drop out of the Lehman investment-grade indexes, and there was an extremely high volume of trading in these names.[7]

[6] The fixing day is determined so that there are at least four business days after the fixing day and before the end of the month in all of the following regions: Australia, Japan, European Union (specifically, Germany), the United Kingdom, and the United States.

[7] "Index Construction, Ratings Agencies, and the Incredible Shrinking Auto Sector," Citigroup Global Index Strategy Note, available on www.yieldbook.com, May 2, 2005.

Benchmark Versus Guidelines

A total return manager is constantly looking for "value" in the market, but does so with three constraints in mind.

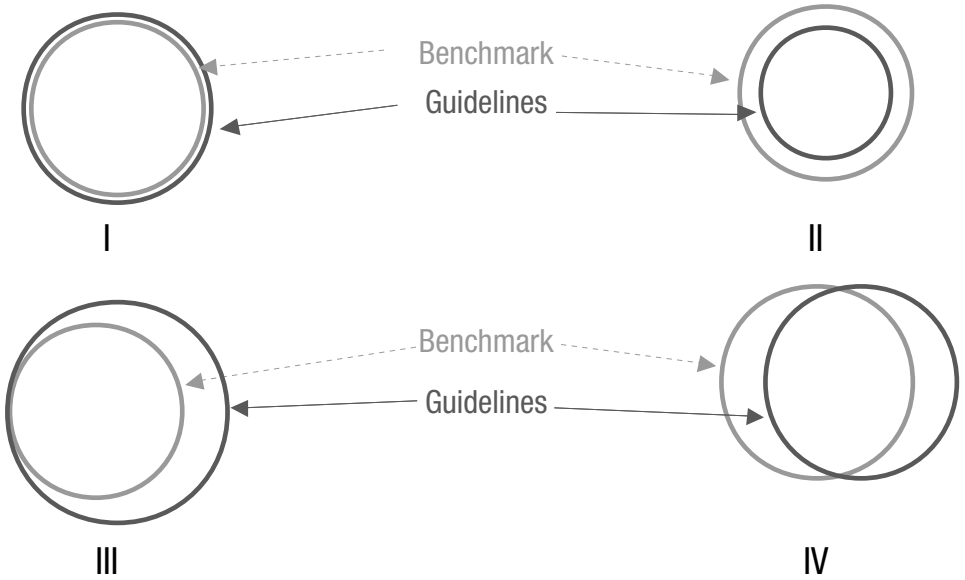
- First, is the potential purchase of a "legal" security for the portfolio; that is, does it meet the guidelines' limits on credit quality, liquidity, sector, etc.
- Second, if purchased (and a suitable candidate security sold if necessary), will the addition of a legal security result in a condition that violates the guidelines in terms of concentration in a bond, name, or sector?
- Third, what does the purchase do to the posture of the portfolio relative to the benchmark? Does it maintain a desired posture or move the portfolio in the right direction?

There is interplay between the guidelines and the benchmark that the manager must constantly consider. How the guidelines are written relative to the benchmark can make the manager's job easier or more difficult. There are basically four situations regarding security inclusion that can exist when considering the benchmark versus the guidelines.

1. Guidelines match the benchmark;
2. Guidelines are a subset of the benchmark;
3. Guidelines offer more flexibility than the benchmark; and
4. Guidelines do not allow all benchmark securities, but also offer some nonbenchmark securities.

See Figure 1 for a pictorial display of these conditions.

Figure 1. Interaction of Guidelines With Benchmark: Securities



Source: Citigroup.

Here, we will consider each situation in turn. We also return to this subject a little later when we discuss whether the guidelines should be written independent of the benchmark or by reference to it.

Guidelines Match the Benchmark

This is a fair but not overly "generous" condition for the manager. If all of the benchmark securities are allowed, the manager can under- and overweight securities and sectors in an attempt to beat the benchmark.

Guidelines Are a Subset of the Benchmark

This is an inherently unfair situation in which the manager is expected to match or outperform a benchmark without being able to own all of the securities in the benchmark. Obviously, if the "forbidden" securities outperform the rest of the securities in the benchmark, the manager is at a severe disadvantage by not being permitted to own them. In this author's opinion, if the guidelines properly reflect the risk posture of the sponsor (that is, the guidelines are not "wrong"), then the benchmark is inappropriate.

Guidelines Offer More Flexibility Than the Benchmark

This is the best situation for the manager, who may find it beneficial to underweight securities in the benchmark while purchasing securities outside the benchmark. Presumably, with a talented manager, this adds the potential for extra return to the portfolio. In this situation, any purchase of a nonbenchmark security constitutes an overweighting.

Guidelines Do Not Allow All Benchmark Securities, But Also Offer Some Nonbenchmark Securities

In this case, while some of the benchmark securities are off limits, this is at least partially compensated by allowing a different class of nonbenchmark securities.

This author managed a large portfolio for a large industrial pension plan. The guidelines prohibited split-rated BBB securities, but the benchmark was the Salomon (now Citigroup) BIG index, which includes split-rated BBB securities. For a number of years in the 1990s, these were the best performing credit securities during a period of general spread tightening. Needless to say, it was frustrating to be compared to a benchmark that included those securities while being unable to own them. Having said that, the guidelines did allow the purchase of ARMs, some foreign securities, and certain CMOs, none of which were in the benchmark, but in this case the selection was quite limited and did not offset the missing split-rated bonds.

Obviously, the potential of the additional allowed securities must be compared to the prohibited benchmark securities over the long term to determine whether these guidelines bias the results up or down.

Other Guideline Considerations

Guidelines are written to include many more terms than simply the securities permitted. There are concentration guidelines, which might be simple or complex. For example, there might be limits on a sector, or subsector, such as BBB securities. These concentration limits might be absolute (no more than 6%) or relative to the benchmark (no more than 1.5 times the proportion in the benchmark, or the benchmark percentage +/-5%). Relative limits make more sense in that they "self-adjust" to changes in the benchmark, and do not get "out of sync" as the market changes.[8]

Occasionally, simple guidelines are combined into complex ones. For example, this author managed several portfolios for a municipality that had certain guidelines that we can approximate here by saying "no more than 10% in sector A" and "no more than 10% in sector B." These were supplemented by a clause that said "no more than 15% in A and B together." One of the two compliance systems the author used was incapable of coding this type of constraint.

This same municipality had a complex benchmark calculated as 60% of the Merrill Lynch 1-3 Year Treasury Index, and 40% of the Merrill Lynch 1-3 Year AAA/AA Index. At that time, Associates Corp. (later purchased by Citigroup) constituted 27% of the Merrill Lynch 1-3 Year AAA/AA Index, and thus a neutral portfolio would hold 10.8% in Associates paper. This would violate a concentration guideline that prohibited more than 10% in any one name. Thus, while the discrepancy was slight, a manager could not own the benchmark portfolio.

The same municipality had one aspect of its guidelines that would be of great benefit to all parties concerned if it were adopted. Every security guideline contained a phrase something along these lines: "The portfolio may hold bonds, *except those that do not promise a return of par at maturity*, that have a maturity of . . . "

This effectively prohibited managers from buying certain structured securities that would otherwise appear to meet the letter of the guidelines but not their intent. For example, a manager may be prohibited from buying high-yield bonds. But it might be possible to buy a structured note, issued by FNMA, FHLMC, or FHLB, that would carry a AAA rating but might have a final payoff based on the performance of a high-yield index. The bond itself qualifies as investment grade but carries all the risk of the high-yield sector. A number of managers, even of public funds, apparently used this ruse to leverage portfolios with some clever structured notes that might pay way less than par at maturity, but which were nevertheless rated AAA because of the issuer. See the section below entitled "What Does AAA Mean Anyway."

Additional guideline limits are often placed on the duration of the portfolio. As with security and sector guidelines, these might be absolute or relative to the benchmark. These guidelines usually declare the duration limits, but usually do not specify how the duration is to be calculated. One would expect a manager to use the same analytic system for reporting that is used for managing the portfolio. It is possible that a portfolio within limits using one system would be out of compliance if measured with a different system. For most portfolios that contain more than Treasuries and agencies, effective duration is the measure of choice. Most accounting (as opposed to portfolio management) systems, if they provide duration at all, provide either

[8] Guidelines written in the 1990s, when corporates represented about 20% of the BIG index, might have limited exposure to 25%. In today's market, that maximum exposure would represent a market weight.

Macaulay or modified duration, both of which are inappropriate. If sponsors receive accounting statements from the manager or custodian, this should be kept in mind.[9]

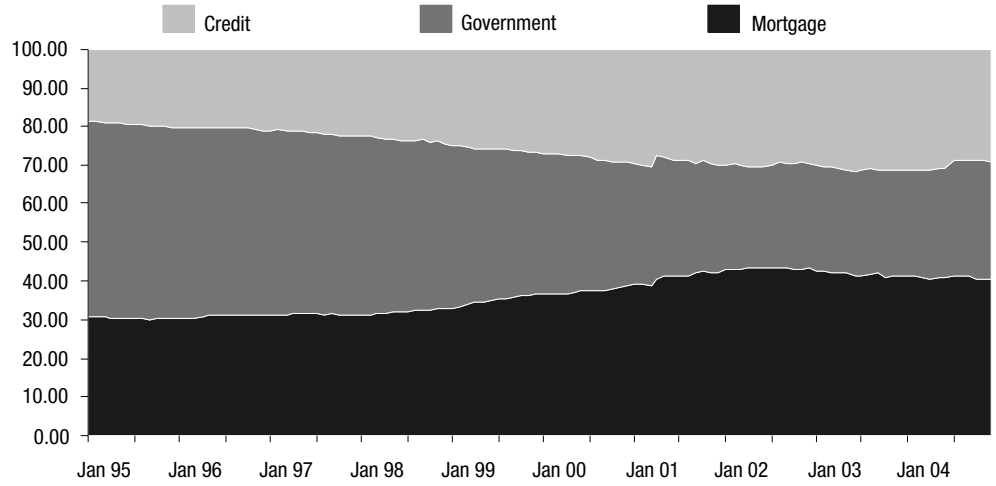
What Does AAA Mean Anyway?

Many an investor sees a triple-a rating as a guarantee that "I'm going to get my money back." Not necessarily! The rating simply implies that the rating agency is very confident that the issuer has the resources (whether it be income, assets, etc.) to be able to meet its obligation in the bond indenture. A structured note that promises a return tied to the performance of the S&P 500, for example, does not promise par. The rating agency just evaluates whether the issuer is likely to be able to pay off the promised amount regardless of where the S&P index might go.

Should Guidelines Be Written to Mimic the Benchmark/Index?

Certain guidelines should be written relative to the benchmark, as described earlier. Changes to the benchmark "flow through" to the guidelines automatically, and no changes are necessary. One obvious candidate is major sector limits defined as some function of the benchmark sectors. Over time, these sector weightings change as market issuance patterns change, and it would be foolish to continually rewrite the guidelines to catch up to natural changes in the benchmark. Generally, these sector weightings change (as shown in Figure 2) in a gradual but not necessarily glacial fashion. Assuming that the sponsor wants the portfolio to be able to purchase bonds that reflect "the market," reference to the benchmark makes sense. The guidelines will always be current.

Figure 2. Proportions of Major Sectors in BIG Index



Source: Yield Book.

[9] The author discovered this during the following exchange about one month after the inception date of the account:

Sponsor: You know that the duration can't be greater than 2.5, right?
Manager: Yes.
Sponsor: I just received an accounting statement, and used its durations to calculate the portfolio duration, weighting each position by its market value. Is that the proper way?
Manager: Yes
Sponsor: I calculated a duration of 3.9. Tell me this isn't happening.
Manager: It's not. . . .

Index providers make changes to their index criteria periodically, and these changes affect which securities are included in the index. How often do index rules change? Changes are somewhat infrequent, and normally reflect changes in the market. Both Citigroup and Lehman, for example, recently increased the minimum size of corporate issues to reflect the larger issue size in the market. Similar changes were also made to the agency inclusion rules. Normally, these changes are incremental, in that that they do not drastically change an index or even a sector. For example, when Citigroup increased the minimum corporate size to $250 million, the corporate sector went from 26.93% of the BIG index to 25.91%.

While index providers attempt to capture "the market" with their indexes, it is important to remember that the rules are arbitrary (but hopefully well thought out).[10] Credit quality inclusion rules provide a good example of this arbitrary process. Until October 1, 2003, both the Citigroup BIG and the Lehman Aggregate included bonds that were rated investment grade by either Moody's or S&P. Lehman then changed the rule to require an investment-grade rating by both agencies.[11] If sponsors had written the quality guidelines in the "relative to the index" mode, they would have delegated to Lehman the minimum quality decision. When Lehman changed the rules again in early 2005 to include Fitch and require a minimum of two investment-grade ratings, the sponsor would have once more delegated this slight downgrading of credit quality to the index provider. If the sponsor is totally comfortable with the decision to delegate this responsibility and the party to whom it is delegated, then it makes sense to write the guidelines with reference to the index. Our feeling is that quality is one of those areas where the sponsor should be more proactive, to keep the portfolio limits within the sponsor's risk preferences, rather than those of another party with no fiduciary responsibility.

We recognize that there is a slight inconsistency here, namely leaving the sector weightings to the index provider (based on its credit policy) while independently maintaining the quality decision. As long as the sector weightings are broadly defined (as in corporates, for example, as opposed to subcategories like autos or banks), this inconsistency is tolerable, and preferable to delegating a primary risk factor to an outside party.

Interestingly, when Lehman announced its most recent change, several managers were quoted as saying it would take them too long to get their sponsors to change their guidelines to reflect the change. This is puzzling. Sponsors should write guidelines that make sense, and they do not need to change them when an index provider (arbitrarily) changes its rules. We see changing well thought out guidelines solely to match changes from an index provider as clearly letting the tail wag the dog.

[10] When the minimum sizes were changed in 2004, there was considerable internal debate about whether the minimum should be raised to $300 million. While there were persuasive arguments to keep the increased level to only $250 million, where it now stands, the decision to go to $250 million was no less arbitrary than $300 million. One could argue that $250 million was arbitrary and reasonable, $300 million was arbitrary and defensible, and $500 million would have been arbitrary and unreasonable.

[11] We are not sure what prompted this change, as it was our opinion at the time, and still is, that the majority of quality guidelines defined "investment grade" by reference to an investment-grade rating by either S&P or Moody's.

Beating the Benchmark

To beat a benchmark, a manager must successfully do one or more of the following:

1. Overweight the good performers in the index;
2. Underweight the bad performers;
3. Include good performing nonindex securities;
4. Make good duration decisions;
5. Take good curve positions;
6. Be right about volatility;
7. Use leverage (when it works);
8. Use dollar rolls and enhanced cash; and
9. Trade down in credit and/or liquidity

Any time there is an overweight, there must be (in aggregate) a corresponding underweight.

Overweight the Good Performers in the Index

If a manager can overweight his benchmark's good performers, he may well beat the benchmark. The key is the performance of the securities that are underweighted. If the underweighted securities are "market" performers in aggregate, then the portfolio will outperform the benchmark. (This assumes that there is not also an overweight to a poorly performing sector.)

Let us create an example that will illustrate these points. We assume that there are three sectors — A, B, and C — and that each sector earns r_A, r_B, and r_C, respectively. The weights of the sectors in the benchmark are W_A, W_B, and W_C.

The return on the benchmark will be:

$W_A * r_A + W_B * r_B + W_C * r_C$ = Benchmark return = RI

If the portfolio weights in the sectors are w_A, w_B, and w_C, where

$w_A + w_B + w_C = 100\%$,

then the portfolio return will be:

$w_A * r_A + w_B * r_B + w_C * r_C$, assuming the portfolio earns index sector returns and the manager's security selection contributes nothing to excess return.

The excess return will depend solely on the weights and the sector returns:

$(w_A - W_A) * r_A + (w_B - W_B) * r_B + (w_C - W_C) * r_C$.

If the manager overweighted sector A such that $(w_A - W_A)$ is positive, that will contribute to excess return so long as r_A is greater than the benchmark return. However, also factoring into the result is where the underweighting occurs. If r_A is greater than the benchmark return, then at least one of r_B and r_C must be below the benchmark return (they cannot all be above the average). If they are both below the benchmark average, then it is obvious that the manager's weightings have added to

performance. A good sector has been overweighted and one or two bad sectors were underweighted. But if, say, r_B is well below the index average and r_C is way above, then underweighting sector C can cause the overall portfolio to underperform.

Quite simply, the more a sector outperforms the overall benchmark, and the greater the overweight to it, the greater the contribution to outperformance. As long as the contribution to outperformance is not offset by overweighting a poor performing sector, the effect should be beneficial.

What Exactly Is a "Good Performer"?

In the section above, we defined "good performing" sectors as those for which performance exceeded the index. When we get to individual issues, the criteria are different. Duration plays a large role in discriminating between a good and an average or underperforming asset. (We cover this in more detail in a paper on return attribution.)[12] We must somehow make allowance for the fact that longer duration securities perform better when the market rallies and vice versa. Just because a security gives a high return as a result of its long duration does not make it a good performer. We have to ask how it should have done given the market move. Perhaps its spread actually widened, and had that happened in an unchanged market, we might have a different sense of performance. For a duration-constrained manager or a duration-neutral manager, the purchase or continued holding of every security uses up some of the total "duration budget." Performance must be compared in light of how much of the duration budget the security represented. A duration-neutral manager always has to balance the purchase of a long duration security with a shorter duration security, and this has many implications related to the shape of the beginning yield curve, the change in shape of the curve over the performance horizon, etc. Without defining it here, suffice it to say that "good performance" should mean that the security outperformed on a "duration-adjusted" basis.

Underweight the Bad Performers

This is essentially a corollary to the first point — overweighting good performing sectors. Underweighting a bad performing sector contributes by limiting the amount that does not earn the average, which is then hopefully invested in one or more sectors that do outperform. The math is essentially the same as in the outperform scenario.

Include Outperforming Nonindex Securities

One of the benefits of investment guidelines that allow investment in one or more sectors outside the benchmark is the possibility of making these investments when a sector outperforms. For domestic investment-grade portfolios, these sectors are likely to include high-yield bonds and/or emerging market debt (as well as CMOs, ARMs, and other MBS derivatives). As in the discussion above, **the net result of including such a sector depends on where the underweightings occur.** If the underweighting is spread over the entire investment-grade sector, so that the return foregone is the index return, then including a sector that performs better than the index will add to performance. If,

[12] Single *Currency Return Attribution,* Citigroup, December 2003.

however, the nonbenchmark sector outperforms by 100bp, but a sector that outperforms by 150bp is underweighted to make room, the overall effect is negative.

Avoid the Bad Performing Nonindex Securities

This is undoubtedly good advice, but it does not help to beat the index. Since the nonindex securities' returns are not in the benchmark (by definition, they already have a weighting of 0%), they *cannot* be underweighted in favor of better performing sectors.

Make Good Duration Decisions

If a manager can time the market, extending duration to longer than the benchmark before the market rallies and shortening duration to less than the benchmark before the market falls, the portfolio should easily beat the benchmark. In a volatile market, this can be so powerful that poor performing securities (on a duration-adjusted basis) can fill the portfolio, and yet the portfolio will still outperform. Of course, during calm periods, it may be that this bad selection of securities underperforms regularly.

If there are managers who can regularly perform this timing magic, they remain well concealed. Those who do it really well have probably opened hedge funds, where the fees are much higher and the guidelines much less restrictive (or are managing their own money from their yachts in the Caribbean!).

The Duration-Neutral Manager

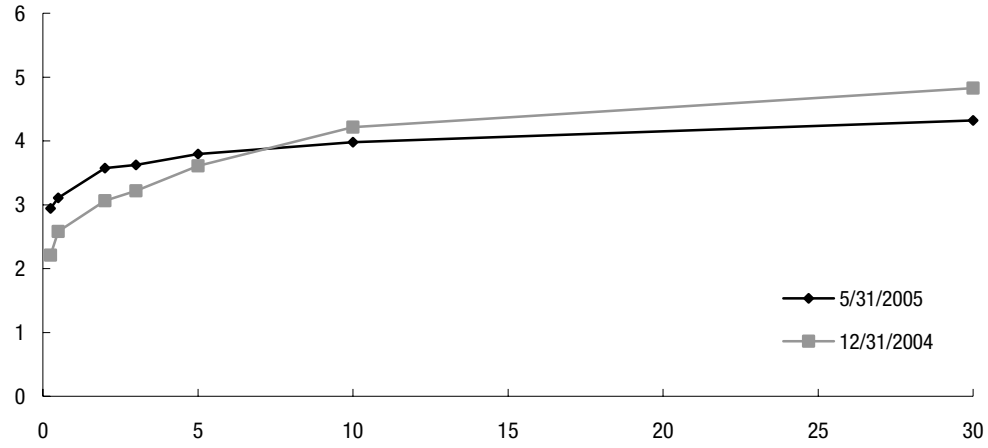
Some managers are, by policy choice, duration neutral. In essence, they have said that predicting interest rates cannot be done consistently (at least by them) and they will attempt to beat the index by a combination of sector and issue selection (and the other items in this section with the exception of duration positions). The duration-neutral manger almost never makes one sizable trade, unless the duration of the bond sold is the same as the one purchased. Often, it is necessary to trade two or more on either the buy or sell side of the trade to stay duration neutral. The best salespeople recognize this and propose trades in that framework. For example, it is futile to suggest buying a long duration CMO and selling shorter duration collateral because of an extra few basis points in OAS. The manager realizes that if he does that trade, he must also buy something shorter to offset the longer duration, and he is unlikely to find a shorter security that will not dilute the OAS pickup in the long end. The manager appreciates salespeople who recognize this constraint, and who prop trades with the whole duration-neutral trade incorporated.

Take Good Curve Positions

Whether long, short, or neutral in terms of overall duration, managers must also determine how that duration is to be structured across the maturity spectrum. There are many ways to have a duration of 5.0, from owning five-year zeros to a portfolio with assets all along the curve to the extreme barbell portfolio of cash and long bonds. While duration (versus the benchmark) will determine the (relative) performance of the portfolio in the case of a parallel shift, the curve positioning will help determine the relative performance when the curve move is not parallel.

In a normal, upward-sloping (and curving) yield curve, there is usually a cost associated with the extreme posture of the barbell. Usually, the overall yield of the barbell portfolio will be below that of a portfolio more weighted toward the "belly" of the curve. In a parallel move, the barbell, which has more convexity, will normally outperform. But the "carry" of the "belly-weighted" portfolio will be higher, so investors normally put on these structures based on some view on likely rate volatility. (This is not a volatility estimation, per se, which is described in the next section.) The barbell may also reflect a particular curve position — for example, that the long end will outperform the short end (the curve flattens). As this is being written in early June, it is a good time to reflect on how nonparallel the yield curve movement has been so far this year. The three-month T-bill is up in yield by about 72bp, while the long end is down 48bp, as shown in Figure 3. Even the duration-neutral manager who "had a flattener on" would have performed well.

Figure 3. Yield Curve Flattening — First Five Months of 2005



Source: Yield Book.

Be Right About Volatility

Some instruments trade with more sensitivity to volatility than others. Those most affected by volatility include a wide variety of derivatives (caps, floors, swaptions, and structured notes), MBS (and their cousins, CMOs), and callable and putable bonds. When the holder of such an instrument is "short" an interest rate option (as are holders of MBS and callables), he is said to be "short volatility" since an increase in volatility will hurt the position. Holders of interest rate driven put options (as opposed to credit driven) would be "long volatility." These volatility overlays to the basic portfolio position will help determine the relative performance to a benchmark, which will have its own sensitivity to volatility based on the composition of the benchmark. Regardless of how a manager assembles the volatility position — whether by holding instruments that have volatility embedded in them or whether purchased outright for volatility sensitivity — being right about changes in the volatility surface and expressing that in the structure of the portfolio will add performance.

Use Leverage (When it Works)

Depending upon the type of account, leverage is sometimes allowed. In a levered account, borrowed money is used to purchase additional securities. Leverage contributes to return if the average return on the borrowed funds exceeds the cost of the borrowed funds. While it may be difficult to define which securities were purchased with borrowed funds and which ones were purchased with the normal account funding, let us assume for a minute that we can. As long as these levered securities earn more than the money borrowed to buy them, excess return will be added to the portfolio, even if the return on the securities is less than the index return! Even if the overall portfolio (including leverage) earns less than the benchmark, it is possible to outperform the benchmark on an "unlevered" basis.[13] So long as the total dollars (pick your favorite currency) earned divided by the account equity exceeds the benchmark, the account outperforms. In this case, it is clearly leverage (not management skill) that creates the outperformance. (One can argue that the manager's skill is in determining when to leverage and when not to, rather than in selecting bonds and sectors. If this pattern is verifiable over time, perhaps the manager should be in charge of leverage timing and someone else should be managing the portfolio.)

Some leverage is clearly temporary, as when securities are financed with repo. If the manager decides that market conditions are not favorable, excess securities can be sold and the leverage can be unwound. This permits greater flexibility, but the leverage costs cannot be predicted. One often hears that such leverage will be beneficial "so long as the curve stays positive" and the fund's longer-term assets have a higher yield than the cost of the borrowed funds. This is simply not correct. We will suppose that the curve is positive by 300bp, and that short-term borrowing is accomplished at 3% and longer-term assets are purchased at 6%. If the whole curve shifts up 100bp, three things happen, even though the curve remains 300bp positive:

1. The cash flow of the previously purchased longer-term assets remains constant (coupon).
2. The cash outflow to fund those assets rises by 100bp, squeezing the net income received.
3. Most importantly, the assets have suffered a large drop in value, the severity depending on the duration of those assets. For total rate of return accounts, that loss (whether realized or unrealized), will flow through to total return.

Other forms of leverage can be permanent. For example, some closed end funds issue preferred stock to create the leverage. The preferred receives a dividend, but does not share in the fortunes of the portfolio. If the portfolio does well, and the "extra" assets earn more than the all-in cost of the preferred, extra value is created for the shareholders. Once again, any incremental performance versus the funding cost adds to the equity value, regardless of whether the performance of the excess assets exceeds the fund's benchmark.

[13] In essence, the benchmark for the levered securities is the cost of funds borrowed, and the "benchmark" for the levered asset portfolio is a weighted average between the real benchmark and the cost of levered securities.

The Effect of Leverage on Duration

One might think to ask this question: If a manager adds leverage without adjusting the previously owned portfolio, what does this do to the duration of the portfolio? Well, this is not the correct question to ask. The duration of the assets can increase or decrease, depending upon the incremental assets added to the portfolio, but the duration *from the portfolio owner's viewpoint* will rise. Let us assume that the portfolio duration is 5.0, which exactly matches the benchmark, and 20% more assets are added from leverage that have a duration of 4.0. The new duration of the assets appears to be 4.83,[14] and is now less than the benchmark. Is the manager "short," and will the portfolio outperform if the market declines? The answer, of course, is no. The fund will underperform. While the assets have a duration less than the benchmark, the "equity" (net fund assets) has a duration that is longer than the benchmark. Another way to think about this is to remember that, in a falling market, the original portfolio will lose just enough money to match the benchmark's (percentage) loss, but the extra assets will lose value, too, causing even more loss to the equity.

The equity duration can be calculated by dividing the "duration dollars" (duration times market value) by the equity value, as follows:

$$4.83 * 120 / 100 = 5.8!$$

We could also use a market weighted duration calculation here, where the weights are relative to the net asset value instead of the gross portfolio. Using this method, we have:

$100\% * 5 + 20\% * 4 = 5.8.$

So, Which Duration Should We Use?

A manager (we will call him "manager one") employing temporary leverage has to ask himself why he is using leverage. If manager one thinks that interest rates are relatively stable, and he is using leverage for extra income, then his duration will not matter much as long as he is correct. But if he wants to insulate the portfolio from unanticipated shocks to rates, he will have to match the equity (net asset value) duration to that of the benchmark. His competitor (manager two) across town who is using permanent leverage faces the same choice, although manager two cannot enter and leave the leverage game as manager one can. In effect, manager two must also use the equity duration to match the benchmark duration in order to be neither "long" nor "short" the benchmark.

This use of the equity duration brings up another issue: portfolio structure. For a portfolio with gross assets of 120 to have the same overall dollar volatility as a benchmark portfolio worth 100, the duration of the entire asset base must be shorter. In essence, this means that some of our earlier comments need to be modified. Remember when we said that the curve was 300bp positive, measured from the funding cost to the longer-term assets? Now we will need to measure our curve spread to a shorter point on the curve, to match our lower asset duration that is

[14] Assets now total 120. 100/120, or 83.33% have a duration of 5.0. 20/120, or 16.66%, have a duration of 4.0. The market-weighted duration is: 0.8333 * 5 + 0.1666 * 4 = 4.83.

associated with the longer benchmark portfolio duration. The apparent advantage of leverage will be slightly lower.

It is difficult to be neutral to the benchmark when leverage is engaged. Consider the following example. A manager has no leverage, and perfectly matches the benchmark in terms of duration, partial durations, and sector weightings. Next, money is borrowed and the funds are invested overnight. The portfolio is still basically neutral to the benchmark, with the exception of the funding and overnight assets, but these do not affect the match of the other assets to the benchmark. Now, if the manager decides to employ the funds but still wants to be "duration dollars" neutral as described above, the entire portfolio must be restructured and shortened. While overall dollar duration can be preserved if desired, it will be difficult if not impossible to maintain neutral sector weightings, neutral sector duration contributions, and neutral partial durations. It is not that this should be a goal of the manager, especially since he may be adding leverage because of a favorable view of the market, or sectors of it. But it demonstrates the added complexity of managing a portfolio with leverage.

Using Dollar Rolls and Enhanced Cash

One favorite way for managers to add performance is to use dollar rolls in the MBS sector.[15] Dollar rolls provide a method to gain exposure to the MBS sector (for specific agency-coupon-maturity instruments) without having to take delivery. The portfolio manager initiates a forward buy transaction, and then "rolls" the position forward to a subsequent month prior to taking delivery. Dollar rolls can enhance portfolio return in two basic ways. First, dollar rolls themselves sometimes offer attractive pricing, especially when CMO demand is brisk.[16] The effect of the dollar roll, in contrast to an actual MBS purchase and delivery, is that the manager still has the funds. When dollar rolls are attractively priced (that is, the "drop" is larger than pure economics would suggest), the cash can be invested in money market instruments and the portfolio will wind up with a higher total value at the next settlement date compared with owning actual pools.[17] Second, many managers will invest the cash in some sort of enhanced cash program, from short asset backed securities (ABSs), ARMs, etc. These instruments provide a higher yielding, low duration alternative to cash investments. Of course, any duration longer than the time to next settlement date of the MBS can be deemed a form of leverage. In addition, this strategy involves slightly more credit risk, possibly in the instrument purchased, and surely in the forward delivery contract, however slight.

Some managers use dollar rolls as the means to accomplish leverage. Rather than outright borrowing funds, they simply divert some funds intended for MBS (or sell actual MBS positions) and substitute the dollar roll. This frees up funds to purchase any allowable asset. The leverage can be unwound quickly if necessary.

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[15] See *Dollar Rolls — In Practice and Theory,* Robert Young, Citigroup, July 1, 2004.

[16] Even aggressive formation of mega pools can create a squeeze that benefits dollar rolls.

[17] In addition, the dollar roll does not involve holding multiple pools, with the associated back office settlement and accounting effort.

Dollar rolls do not create portfolio magic. As mentioned, there are potential credit issues to acknowledge. And while dollar rolls allow the portfolio to avoid some of the complications of owning MBS outright, they also may preclude some of the benefits of owning MBS. For example, it may appear that dollar rolls are cheap by 1/32 of a point per month. This does not seem like much, but a full year would result in 12/32 of excess performance, or 37.5bp on the amount involved. At the end of each month, when managers are scrambling for basis points, this contribution can be very helpful. But it is also possible that owning actual MBS might be better. As pools age, they often tend to trade with some premium to TBA pools. If one-year-old pools trade at a 12/32 premium to TBA, it would appear that holding actual pools might add 1/32 per month versus TBA pricing as the pools age. This would match the contribution from the dollar roll, and effectively eliminate the dollar roll's *apparent* pricing advantage.

Trade Down in Liquidity or Credit

By construction, the indexes have fairly large issues available to institutional investors. Nevertheless, there are varying degrees of credit quality and liquidity in the included issues. Managers will not venture into the lesser credits or less liquid securities without being "paid" for doing so. This payment comes in the form of higher yields (or higher option adjusted spreads).

Some index securities and many nonindex securities suffer from lower liquidity. This can be the result of small size, meaning that the security trades very infrequently, making the security harder to price fairly. Lower liquidity can also result from a complex structure, as in some CMOs and structured notes. One of this author's former portfolio manager colleagues used to impose a "10bp rule" when salesmen offered complicated spread product. The rule stated that for every minute it took the salesman to explain the structure to him he would tack on an extra 10bp in required spread to make the security attractive to him. His reasoning was that if it required a long "story" to sell it to him, he would have to face the same thing when he wanted to sell the bond. Due to its lack of immediate liquidity, he wanted the extra spread or price break up front. The merits to this approach became obvious to this author and were quickly adopted, although it is arguable whether 10bp per minute is sufficient compensation!

What if One Consistently "Out-Yields" the Index?

It has been said that, over time, the total return of a market index has to be close to the average coupon rate. This is because bonds enter the index very close to par (usually in the month following issuance) and they leave the index close to par (when they age to less than one year in remaining maturity). Thus, the return has to be close to the coupon rate for any given bond, and to the weighted average coupon rate for an entire index. Several small complications[18] make this less than a global truth, but their effects are minor compared to the size of most indexes. So, is it reasonable to assume that if you always have a higher portfolio yield than the index you will outperform?

[18] Some bonds may enter after an upgrade and may be priced above or below par. Others may depart after a downgrade and depart at much less than par. Still others may be called at a premium or be the subject of a tender offer, etc.

Many managers seem to believe this, because many are habitually overweight spread product at the expense of Treasuries and agencies. It may be that Treasuries and agencies are overpriced because of a number of investors who must own them and cannot own spread product. If this is true, then it seems like a good risk-return tradeoff to move some funds from Treasuries/agencies into spread product. This probably does pay off in the long term *if the manager can keep the account* after spread product periodically causes underperformance versus the benchmark.

How much can an increase in spreads hurt? Let us take a look at an example we frequently use in our firm's training program:

A manager is considering the purchase of a ten-year Treasury or a ten-year corporate bond. The corporate offers a spread of 80bp above the ten-year Treasury. If he buys the corporate, how much can spreads widen with a three-month horizon and leave him with the same return the Treasury would have provided?

The answer is a surprisingly low 3bp (actually a little under 3bp). For newcomers to the fixed-income market, this may not seem possible. How could 80bp in spread be eliminated by a 3bp widening? Well, 80bp of spread will produce only an extra 20 cents of income over the three-month horizon (per $100). Both the corporate and Treasury will have a duration of approximately 8, so a 3bp move will cause a 24 cent loss on the bond, more than eliminating the income advantage. Remember, we are measuring spread widening, so it really matters very little whether the extra 3bp of spread occurs at the current market level or 100bp higher or lower. The duration will change slightly, but not enough to change the answer. **The lesson is clear: Income takes a long time to earn, but spread widening can eliminate value overnight.**

So, managers making the spread decision must be prepared for those times when spreads widen. If they have enjoyed many years of outperformance before spreads hurt their performance, they are probably not in too much danger. But if a massive spread widening takes place in a new account that is overweight spread product, there will be a very uncomfortable meeting between the manager and sponsor.

Looking for Basis Points: Overweighting Spread Sectors Versus 20/20 Hindsight

Just how much does overweighting spread product produce in return? We looked at a portfolio over the ten-year period from 1995 to 2004 to determine what was available. We assumed that the manager overweighted credit by 5% (absolute) and MBS by 5% (absolute) and underweighted Treasuries by 10%. We made no adjustment for the fact that the resulting portfolio usually had a different duration than the index. We rebalanced the portfolio monthly. For this ten-year period, the index had an average annual return of 7.75%, while the "spread overweight" portfolio had a corresponding return of 7.81%. It appears that a simple and modest overweighting scheme will not produce head-turning returns.[19]

[19] Simple math can also lead you to this conclusion. If the spread sectors offered a yield spread of 100bp versus Treasuries, allocating an extra 10% to these sectors would add only 10bp to the annual yield. Over a one-year period, with spreads changing, it would be difficult to predict the relative performance. But over ten years, the change in spreads probably averages out, and we are left with just the yield effect. If we use OAS as a proxy for spread, the average MBS OAS was 56bp over the ten years, and the average corporate OAS was 120, for an average spread pickup of only 88bp.

We then took the same data (monthly returns by major sector) and assumed that the manager was able to predict which sectors would be the best and worst performing every month, and allocated 5% away from the worst performing into the best performing. Over the same ten years, the 20/20 portfolio returned 8.28%, beating the index by 53bp annually. Clearly, the capture of performance is much more efficient than simply earning a little extra income. Of course, anyone could do the spread overweight, and very few could do the 20/20 weighting consistently. The point is that if you are good at security selection and sector selection, you can add a lot of return to a portfolio. Even the modest overweightings in this example produce a return well in excess of annual institutional fees for fixed-income portfolios.

Why do managers scramble for basis points? Over the same ten-year period, using data compiled by Callan, a manager in the fourth quartile would have needed only a 42bp improvement to move into the first quartile of managers. Only 86bp separated the bottom decile from the top decile.[20] Every basis point is important.

One more source of return is the elimination of inefficient trading. Every "wasted" 1/32nd represents over 3bp on the amount involved. If portfolio turnover is 100%, saving that 1/32nd on every trade improves the performance by 3bp.

Masking Credit Risk With a "Credit Barbell"

How should credit risk in a portfolio be measured? If one cares about how much par amount is "at risk," a par-weighted measure might be appropriate. Indeed, this is how credit risk is usually measured. Some numeric value is assigned to each rating category, and these values are multiplied by the par amounts in each category (and subsequently divided by total par amount) to determine the average credit rating.

Managers seeking to get maximum benefit from their credit picks when credit exposure is being measured this way will tend to buy short high-quality paper and long lower-quality paper. This is the barbell. Most of the exposure is in the long duration area, where an upgrade or narrowing in spread has the most effect. While the low-quality par exposure might be matched by the par amount of high-quality exposure, this is misleading. On a spread duration basis, this is a riskier portfolio than the par-weighted calculation would indicate. Any credit problems can have enormous price and return consequences based on the long duration. A better measure of credit risk — as it affects a total return portfolio — would be based on credit-spread duration.

[20] Callan Associates Inc., fourth quarter 2004 survey for core bond style.

The Manager's Tool Kit

Benchmark Comparison

When managing against an index, there are several questions that a manager asks, and several tools used to answer them. The first question is "Where are we?" This refers to the positioning of the portfolio relative to the benchmark. Most analytical systems offer this basic profiling and provide reports on the portfolio's duration, curve exposure, and sector weightings relative to the benchmark. This profile report is usually the first thing a manager refers to when trying to assess exposure — whether after a series of trades or prior to the release of significant economic data. During a more deliberate analysis, this same sort of breakdown will be analyzed at more detailed levels of the portfolio, including sector and subsector levels, especially after an index is reconstituted at the end of the month.

The profile report seems simple, with index statistics subtracted from those of the portfolio to result in net exposure. But while some of the analysis is simple (comparing sector weights, for example), the duration, curve exposure, and OAS comparisons rely on the underlying term structure and prepayment models. The value of the report depends on the accuracy and robustness of the models. A second element of value depends on the flexibility in reporting the exposures. The Yield Book™ offers tremendous flexibility in creating sectors and can report on two different sector schemes at once. For example, in a multicurrency portfolio, one can look at exposures to Industrials (Canada), Industrials (Euro), Industrials (Japan) etc. Or it could be Japan (Industrials), Japan (Financials) . . . US (Financials). This kind of flexibility can be of tremendous value, especially for a "bottom-up" manager. While the "top-down" manager will normally decide what the sector weightings should be, and will use the report to verify that the weightings are in line, the bottom-up manager may use the report to discover what the weightings are.

We often characterize this profiling analysis to clients as "verifying that the biases you intended to make are actually in place in the portfolio, and discovering the unintended biases that can creep in during portfolio construction," and then deciding if you can live with them.

A small portion of an example benchmark comparison report is shown in Figure 4.

Figure 4. The Yield Book — Benchmark Comparison Report

THE YIELD BOOK
Benchmark Comparison Report

Asset Class / Sector	Issues	-Portf Dist(%)- Par	Market	Average Coupon	Avg Life	YTM	YTC	S&P	Dur	Eff Dur	Eff Cnvx	OAS	Spread	Cell Sensitivity
TOTALS														
Net	31	100.00	100.00	4.23	16.4 Yrs.	2.58	2.58	AGN	4.42	4.25	0.97	34	56	4.25
Baseline	4311	100.00	100.00	6.14	6.0 Yrs.	3.87	3.80	AAA	4.17	4.00	-0.12	56	119	4.00
Difference:		0.00	0.00	-1.91	10.4 Yrs.	-1.29	-1.22		0.25	0.25	1.09	-22	-63	0.25
Treasury														
Net	7	20.83	25.59	4.62	2.9 Yrs.	1.59	1.59	GOV	2.04	2.06	0.25	1	0	0.53
Baseline	280	24.09	25.59	5.77	8.2 Yrs.	3.35	3.19	GOV	5.69	5.74	0.70	11	15	1.47
Difference:		-3.26	0.00	-1.16	-5.2 Yrs.	-1.76	-1.60		-3.66	-3.69	-0.46	-10	-15	-0.94
Agency														
Net	7	23.49	19.27	2.59	10.8 Yrs.	2.15	2.15	AGN	4.49	4.81	0.95	17	23	0.93
Baseline	603	14.38	14.27	5.11	6.1 Yrs.	3.22	3.06	AGN	4.49	4.35	0.27	38	42	0.62
Difference:		9.11	5.00	-2.52	4.7 Yrs.	-1.07	-0.91		0.00	0.46	0.69	-21	-19	0.31
Mortgage Pass-Through														
Net	9	30.76	38.42	7.00	1.5 Yrs.	2.09	2.09	AGN	1.46	0.71	-0.03	-0	60	0.27
Baseline	266	37.79	36.42	6.35	2.2 Yrs.	3.67	3.67	AGN	1.96	1.56	-1.31	12	185	0.57
Difference:		-7.03	2.00	0.66	-0.7 Yrs.	-1.58	-1.58		-0.50	-0.85	1.27	-13	-125	-0.30
Credit														
Net	8	24.92	16.72	2.02	51.2 Yrs.	5.74	5.74	A	14.76	15.10	4.40	182	172	2.52
Baseline	3076	22.96	22.94	6.84	9.8 Yrs.	5.21	5.20	A-	5.81	5.74	0.58	187	180	1.32
Difference:		1.96	-6.22	-4.82	41.3 Yrs.	0.52	0.53		8.95	9.36	3.82	-5	-8	1.21

Source: Yield Book.

The profile report requires detailed issue level data on the benchmark. If the index provider makes these data easily accessible, it should be a simple task to load the data into the analytical system and perform the analysis. If the provider makes the data difficult to obtain (that is, it is an index "nonprovider"), there are two basic alternatives. See the section entitled "Managing Across Index Providers: Implications of One Provider's Index and Another's Analytics."

Scenario Analysis

The next question the manager faces is "Where are we going?" This refers to how the portfolio might perform in the future. The first tool for this task is scenario analysis.

Scenario analysis allows the manager to specify a number of parameters in the future and view the portfolio's performance relative to the benchmark in the various scenarios. Most investors think of scenario analysis as "up and down 300, by 100" referring to an analysis that looks at seven scenarios, with rates down 300, down 200, down 100, flat, up 100, etc. While somewhat useful, one can argue that this does little more than illustrate the duration and convexity values already calculated. The real power in scenario analysis is revealed when a number of other parameters are changed to reflect either likely shifts or stressed values that might occur in a period of crisis. Investors who lived through the Asian currency crisis and subsequent Long-Term Capital Management meltdown remember vividly what happened to volatility and spreads as investors shunned spread product and sought the safety of Treasuries. If a scenario analysis can be set to simulate these types of conditions, it can be extremely useful to portfolio managers and risk managers.

Scenario Analysis on The Yield Book

The Yield Book has an extraordinarily powerful scenario analysis capability. It has many canned "scenarios" including parallel and nonparallel ones, some of which are based on principal components,[21] and are totally customizable. Shift timing can be immediate, gradual or at the horizon, and there can be single or multiple shifts over the horizon. Shifts can be relative to the par curve or forward curves. Managers and analysts can change spreads for each scenario, and these spread changes can be determined by issue, sector, and subsector, etc. Volatility can be changed as well to affect derivatives and bonds with embedded calls. All of this gives a richer set of scenarios and relative performance for decision-making purposes.

The Yield Book's scenario analysis is so powerful and flexible that it has become the backbone for two more sets of analytics we are going to discuss, namely tracking error and return attribution. In tracking error, we have hundreds of "risk factors" that vary during multiple scenario runs to realistically simulate the myriad possibilities that might play out as rates change, spreads move, currencies realign, the volatility surface changes, current-coupon spreads change, etc. Realistic scenarios that conform to the covariance structure, applied to both the portfolio and the benchmark, produce a distribution of relative performance with associated statistics, including tracking error.

We use the same flexibility for return attribution. For this task, we set the conditions that prevailed at the start of the period (rates, currencies, spreads, volatilities, prepay expectations, etc.) and then allow them to change, in sequence, until conditions and the horizon reflect those at the end of the period. As each variable changes, the increment to performance is measured and recorded, for both the portfolio and the benchmark.

Tracking Error[22]

Ex-ante tracking error essentially measures how tightly the portfolio is expected to perform relative to the benchmark. More precisely, it is the standard deviation of the distribution of differences in expected returns versus the benchmark. There are several ways to estimate this statistic that vary in complexity, data requirements, speed, and validity. Low tracking error indicates a portfolio that is not likely to deviate from the benchmark performance too drastically, while high tracking error indicates that more or less risks are being taken (deliberately or not) and that performance is more likely to vary from the benchmark. Low tracking error is not a goal in itself (close to zero tracking error can be obtained by a large index fund). Guidelines that strictly limit portfolio structure to mimic the benchmark will typically produce low tracking error and little probability of any significant outperformance. Managers who have more flexibility — like the manager with a BIG index benchmark but the flexibility to invest in high yield and emerging markets — will naturally have more tracking error when that flexibility is exercised.

[21] See *Principles of Principal Components*, Citigroup, January 31, 2000.

[22] Much more detail on The Yield Book's implementation of tracking error can be found in *A Common Framework for Estimating Tracking Error of Fixed Income Portfolios,* William Herman, The Yield Book, Citigroup, April 1, 2005

One of the interesting aspects of tracking error is that there is some ambiguity about the best way to estimate it. By itself, this is not significant, but because more investment guidelines are including tracking error as a constraint, at least some objective description of the methodology or acceptable vendors should probably be specified in the guidelines or an addendum.

Profiling a portfolio versus a benchmark can identify some of the sources of risk relative to a benchmark, using simple arithmetic to highlight differences. But profiling does not measure the effect of these differences as they are likely to play out in the real world. Overall tracking error, in contrast, quantifies the net effect of all of the sources of risk (at least those that can be identified and estimated). Moreover, it is possible to identify a series of risks in the profiling process, but if they have beneficial correlation properties, tracking error will show that the net sum of the risks is less than one might expect.

There are three popular risk budgeting tracking error measures included in the Yield Book implementation:

- **Incremental tracking error** measures the effect that including a particular sector has on the overall tracking error. In a BIG index benchmarked portfolio, the corporate sector, for example, will generally have a negative value, indicating that including this sector in the portfolio has lowered the overall tracking error. The high-yield and emerging markets sectors would more likely have positive values, indicating that their inclusion is adding to overall tracking error.
- **Marginal tracking error** indicates the change that would occur to overall tracking error if a particular sector were increased in size by a small amount. As such, it can be used by managers seeking to reduce overall tracking error or in transactions without undue effect on the overall tracking error. For example, if the portfolio has an underweight of corporates and the underweight is not "offset" by a long duration posture, it is likely that the marginal tracking error of the corporate sector is negative, meaning that adding more will lower overall tracking error.
- **Component tracking error** measures the relative contribution of each defined sector to the total tracking error. The sum of the component tracking errors for all of the nonoverlapping sectors will equal 100%.

Tracking Error and the Multicurrency Portfolio

Multicurrency managers have a more difficult task in terms of duration. The overall duration of a multicurrency portfolio is not the market-weighted average of the component currency durations, unless you make the unrealistic simplifying assumption that the volatility of all of the currencies is equal and the correlation of any currency with any other is 1.0. When faced with a "real-world-like" covariance matrix and volatilities, the usual portfolio duration calculation is clearly misleading. One way for the manager to avoid problems is to have no riskier currency positions and have portfolio currency market weights equal those of the benchmark. In such a case, profiling will give the manager the information he needs. But real-world managers with various investment positions will find that profiling merely exposes the under- and overweights relative to the index and does nothing to quantify their effect. Tracking error is uniquely positioned to capture the difference between portfolio and benchmark and quantify it in terms of likely effect (as long as you define standard deviations and confidence intervals as measures of "likely"). Because it includes a covariance structure, the potentially diversifying effects of multiple currencies is captured and compared to the benchmark mix of currencies.

Return Attribution[23]

While profiling provides a static snapshot of the portfolio relative to the benchmark, and tracking error identifies the future possibilities of performance relative to the benchmark, performance attribution provides an analysis of actual performance relative to the benchmark. It is important for managers to be able to dissect the performance into its components: what contributed to success and what hurt the portfolio. If the overall management of the portfolio is spread among groups — for example, if overall duration policy is set by an investment committee and overall sector weightings are set by an asset allocation committee — attribution makes it possible to properly evaluate the contribution of each party to the overall relative return. It also identifies which decisions actually came into play. For example, a large duration difference might have been assumed in the portfolio, but if interest rates did not change, this would have little effect on the overall net return.

[23] See "Single Currency Return Attribution," Bob Kopprasch and Gijs Treimanis, The Yield Book, Citigroup, December 15, 2003.

Managing Across Index Providers: Implications of One Provider's Index and Another's Analytics

Most managers manage against a variety of benchmarks from long and short to domestic and global to high grade and high yield, and it is unlikely that one index provider is used exclusively. At any given time this author had portfolios benchmarked against indexes provided by Citigroup, Lehman, Merrill Lynch, and J.P. Morgan. The analytics platform used was The Yield Book, and we used Yield Book analytics regardless of "whose" index was the target.

"Cross managing" does make life more interesting for the manager. There are several implications:

1. Depending upon the "friendliness" of the various providers or the size of the customer, the first problem may be simply obtaining a list of all of the bonds in the index with their associated weights and prices. (Some sponsors do not realize that they put managers in a difficult position by specifying an index provider who does not make the data easily available.)
2. Assuming the list can be obtained or can be reverse-engineered, the manager will have to run analytics on the entire set of bonds with whatever frequency seems prudent. Many firms will do this daily.
3. Primarily in the MBS market (and somewhat less so in other structured product), the effective durations will differ from one analytical system to another. This means that the index provider will publish a duration for the benchmark and that the manager will have to maintain a different calculated duration in order to be neutral.

Obtaining Index Constituent Data

Index providers do not share identical vision as to distribution of their indexes. Some, like Citigroup, provide a self-service Web site (www.yieldbook.com) with history, current profile composition (categorized by maturity, country of issuance, credit, etc.), and issue and sector level data. (See the Appendix for information on how to obtain these data, including subscriptions to reports and customized data requests.) Merrill Lynch provides a wide array of data on Bloomberg <Gov't> IND <GO>. Other index providers limit data distribution to customers only. As a result, a manager may find it difficult to obtain data that are truly needed for fund management. In fact, if guidelines specify index values as limits, severe compliance issues can arise. In cases like this, sponsors must work with managers to either obtain data for them or rework the guidelines to reference an index the manager can access. Another source of data is data vendors, like Barra, Wilshire, etc. They often buy data and redistribution rights from index providers and make the data available to their subscribers. See the Appendix for a list of data vendors who redistribute Citigroup indexes.

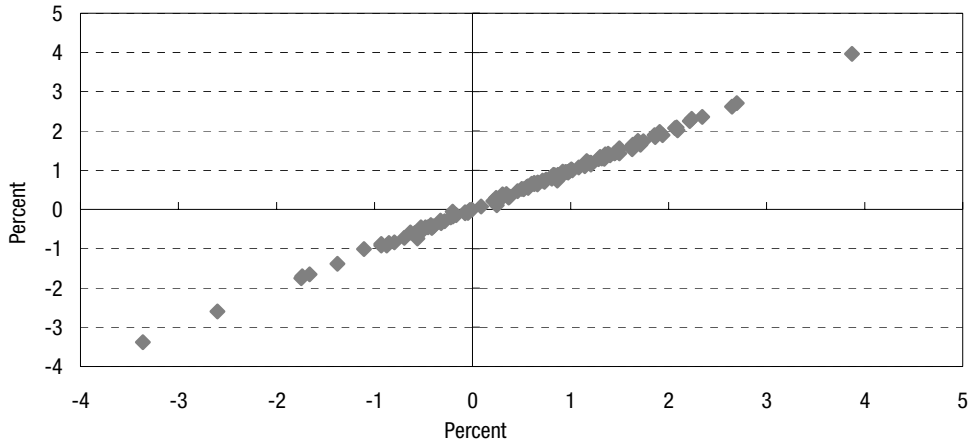
Reverse Engineering an Index

Because the index rules are published, one can reverse engineer the index as long as there is an accessible database of the fixed-income universe. This may not be precise, but since the "missing" bonds are likely to be smaller issues, representing a small fraction of the index, it is certainly close enough to manage against. The other issue associated with reverse engineering is pricing the securities. Outside vendors can be used and, since they are relied upon for month-end valuations by many firms and custodians, we can assume that the prices are acceptable.

The second alternative is to use another provider's similar index, with or without adjustments. Firms who are unable to obtain Lehman Aggregate data often use the Citigroup BIG Index as a substitute. In the past, these two indexes were especially close in composition, and returns over time were very similar. In recent years, as a result of the inclusion of more ABS and CMBS in the Lehman Aggregate, some managers have added proxies of those sectors to the BIG index to make the approximation closer.

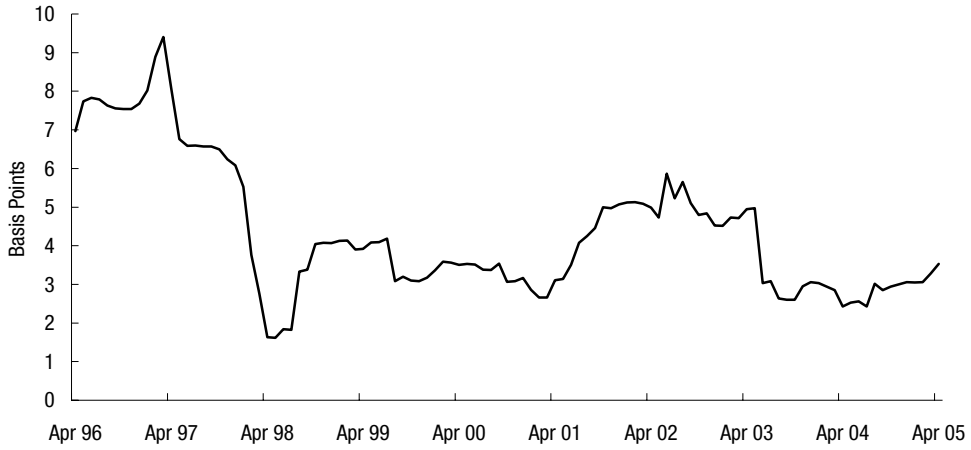
Just how closely do the Citigroup BIG index and the Lehman Aggregate track one another? See Figure 5 to see how closely these two indexes have tracked (without adjustments). In Figure 6 we show the monthly tracking error, calculated on a 12-month rolling basis.

Figure 5. Citigroup BIG Index Versus Lehman Aggregate, May 95–Apr 05



Sources: Lehman Brothers and Citigroup.

Figure 6. Monthly Tracking Error — BIG Index Versus Lehman Aggregate Rolling 12-Month Values



Sources: Lehman Brothers and Citigroup.

In the earliest periods on the chart, Citigroup (Salomon at the time) and Lehman used different pricing times on the last day of the month: Salomon used 5 p.m. and Lehman used 3 p.m. On at least one occasion, that timing difference contributed to about 15bp of difference in the returns. (Of course, that difference was almost completely reversed at the end of the following month, since each index had a different starting pricing level.) Citigroup switched to 3 p.m. in April 1997 to match the futures closing time (and, coincidentally, Lehman's). This "error" of 15bp in each of two successive months led to the artificially high tracking error shown on the left side of Figure 6.

On the face of it, it is almost surprising that they are as close as they are. In addition to the closing time difference, consider how Lehman and Citigroup have changed the minimum size requirement for corporates and Treasuries, as shown in the Figure 7.

Figure 7. Citigroup BIG and Lehman Aggregate — Changes in Minimum Size and Quality Requirements

	Citigroup BIG	Lehman Aggregate	
Created	1985	1986	
Backdated to	1980	1976	
	Credit Sector		
Date of Change	**Minimum Size**		
1985	$25MM	$1MM	1985
Jan 88	$50MM		
		$25MM	Aug 88
		$50MM	1991
		$100MM	1994
1995	$100MM		
		$150MM	Jul 99
Apr 01	$200MM		
Jul 04	$250MM	$250MM	Jul 04
	Minimum Quality		
Jan 88	BBB- or Baa3	Baa3 (Moody's only)	Jan 88
		BBB- or Baa3	Prior to Oct 03
		BBB- AND Baa3	After Oct 03
		2 out of 3 of S&P, Moody's, Fitch must be investment grade	Jul 05
	Treasuries		
	Minimum Size		
1985	$25MM	$25MM	1985
1988	$50MM		
		$100MM	Jan 90
Jan 95	$1Bilion		
		$150MM	Jul 99
		$250MM	Jul 04

Sources: Lehman Brothers and Citigroup.

Coping With Duration Differences

One of the most apparent complications of cross managing is that the index provider is publishing one duration while the manager's analytical system is producing a different value. The differences should be negligible in Treasuries and negligible or small in corporates, but can be significant in MBS. The manager has to simply ignore the duration from the index provider and rely on that produced by the analytical system. It seems obvious that the portfolio and the benchmark have to be evaluated on the same framework so that the manager knows whether he is long or short.

Coping With Duration Bias: What if the OAS/Duration Models Are "Wrong"

Let us suppose for a moment that a particular analytical system's durations for MBS are longer than the way the market trades.[24] If the portfolio is structured closely relative to the index, the portfolio will act very much like the index, despite the fact that the duration is "wrong." But if the structure is different in terms of sector weightings, we need to consider how this impacts the duration. Say that MBSs are

[24] See "A Look at a Variety of Duration Measures," The Yield Book, Citigroup, July 2004.

underweighted and Treasuries are overweighted, so that the overall duration of the portfolio — as measured by the "biased" durations — still equals the index duration. Now the portfolio will no longer act like the index for simple shifts of the yield curve, because the artificially high MBS durations have been replaced with real high duration securities.

If we take the example one step further, let us imagine that the analytical system has a different type of duration bias: low coupon securities have durations that are too long and high coupon securities have durations that are too short. In a case like this, even if the mortgage sector has a neutral weight, the distribution of securities relative to the bias will impact whether the portfolio's behavior is long or short, even if the calculated duration equals the benchmark. Obviously, managers need to be aware of the potential quirks in *any* analytical system and adjust accordingly. This is even more critical when using IOs and POs and other instruments with extreme duration values.

Conclusion

Managing a portfolio versus an index can be complicated. Over the years, the securities and the analyses have grown more complex. At the same time, indexes have changed and similar indexes have changed relative to one another. Managers find that fairly small performance differences can distinguish them from their competitors in both directions, so the intensity of the competition has increased. Managers seek better tools to analyze portfolios and indexes, individual securities, and their likely future and historical performance.

It is a game worth winning, for the managers' clients and the managers themselves. Sustained long-term outperformance almost always results in an increase in assets, a corresponding increase in fees, and better infrastructure for the manager.

Appendix. Where to Find the Citigroup Fixed-Income Indexes

Our indexes are widely followed and widely published. We employ many methods of distribution to allow for easy access to our indexes. In this section, we highlight the distribution channels that incorporate our index products. Although the main vehicles that we use to distribute index information are the Citigroup Fixed-Income Index Web site and The Yield Book, one can get extensive information from several external sources. The level of data carried by these services varies from monthly sector level returns to details on the individual security holdings of each index. As with all aspects (components) of our products, we would be happy to supplement this information in any way.

Figure 8. Where to Find the Citigroup Fixed-Income Indexes

Citigroup	
Citigroup Fixed-Income Index Web site (http://www.yieldbook.com)	Citigroup DIRECT Web site (http://fidirect.citigroup.com)
The Yield Book®	Citigroup SmithBarney (http://www.smithbarney.com/fii)
Total Rate-of-Return Indexes (Citigroup Monthly Publication)	
International Market Indexes (Citigroup Monthly Publication)	
Financial News Organizations	
Bloomberg SBI<GO>; SBBI<GO> (Downloadable)	Global Money Management (Biweekly)
Reuters pages SOLR-Z	Global Finance (Monthly)
The Economist (Weekly)	International Financing Review (IFR) (Weekly)
Borsen Zeitung (Daily)	Latin Finance (Monthly)
Il Sole-24 Ore (Daily)	Financial Times (Daily)
Data and Analytic Vendors	
ABIC	Micropal
Albridge Solution	Mitsubishi Asset Brains
Bank Hapoalim	Mobiüs Group
Bank of New York	MoneyMate
BARRA	Morningstar, Inc.
Blackrock	Nikkei Quick Information Technologies
Brainpower	Nikko Financial Intelligence
Burlington Hall Asset Mgmt, Inc.	Nomura Funds Research & Technology
Capital Mgmt Sciences (CMS)	Nomura Research Institute
CDA Investment Technologies	Quantec Investment Technologies
Confluence Technologies	QUICK Corporation
Daiwa Institute of Research	Ratings & Investments
Datastream International	Reuters Ltd.
DPG	Richards & Tierney
Effron	RIMES Technologies
eVestment Alliance	RiskMetrics
FactSet Data Systems	Russell/Mellon Analytical Services
Financial Express	Shaw Data Services
Fininfo/Europerformance	State Street Bank and Trust
GreenHill Partners	Strategic Financial Solutions (Pertrac)
Haver Analytics	Sunguard/Frontier Analytics
Ibbotson Associates	Towers Data Systems
Interactive Data Corporation	Trust & Custody Services Bank
Investor Force	UFJ Trust Bank
Japan Pension Navigator	Vestek
Japan Trustee Services Bank	Watson Wyatt K.K.
JP Morgan Chase Custodian	Wilshire Associates
Master Trust Bank of Japan, Ltd.	Wilson Associates
Mellon Bank	Zephyr Associates, Inc.

Source: Citigroup.

Disclosure Appendix A1

ADDITIONAL INFORMATION AVAILABLE UPON REQUEST

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