

# Why use bond indexes?

BY CHRISTIAN RAGNARTZ<sup>1</sup>

*Monetary and Exchange Rate Policy Department, Sveriges Riksbank.*

*Formulation and delegation of risk mandates based on a bond index have become increasingly common in the management of bond portfolios. Though widely used, bond indexes do not have as obvious a theoretical or empirical grounding as equity indexes, despite the fact that much of the existing literature in the field claims that this is the case. The purpose of this article is thus to explain the concepts that have caused misunderstandings and to describe how bond indexes should actually be used.*

Many major international financial institutions design and distribute bond indexes. These indexes often cover a large number of issues for whole markets and are thus “broad market indexes“. During the 1980s and 1990s it became increasingly common to use these indexes to structure portfolio management. Today they are considered a natural element in the management of bond portfolios. However, general knowledge and research on this subject are not as advanced as in the equivalent field of the stock market. This is remarkable, especially since the aggregate value of outstanding bonds in the world probably exceeds the value of the world’s shares.<sup>2</sup>

## The problem – approaches to risk and return

In the Capital Asset Pricing Model (CAPM) launched by Sharpe,<sup>3</sup> Lintner<sup>4</sup> and Mossin,<sup>5</sup> the market portfolio plays a central role. Not only is this portfolio effec-

<sup>1</sup> Paul Söderlund, Peter Hördahl and Paul Klinkert provided valuable opinions on various drafts of this article.

<sup>2</sup> See Reilly and Wright (1997).

<sup>3</sup> See Sharpe (1964).

<sup>4</sup> See Lintner (1965).

<sup>5</sup> See Mossin (1966).



tive, in the sense that it yields the highest possible expected return at a given risk level. In its pure form, it also implies that investors need no other alternatives than access to a securities fund that corresponds to the market portfolio, and a risk-free asset. In addition, the risk premium on each individual asset will be determined by the covariance with the market portfolio, the famous Beta.

---

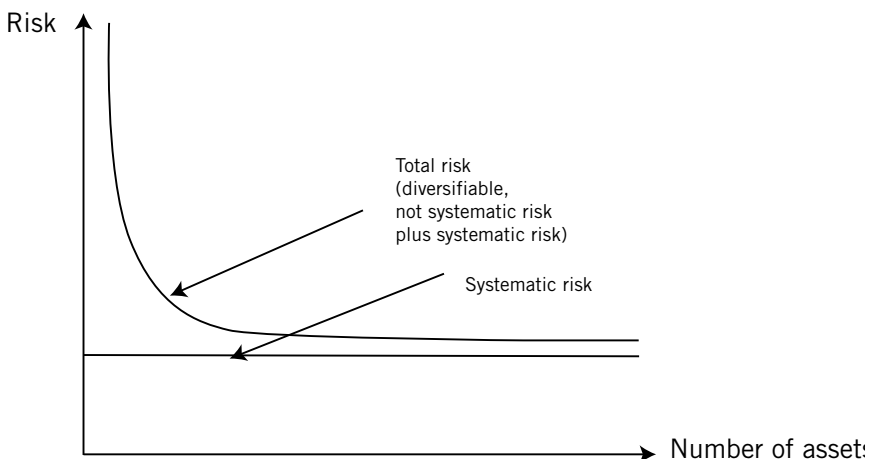
**In its pure form CAPM implies that investors need no other alternatives than access to a securities fund that corresponds to the market portfolio, and a risk-free asset.**

---

Although CAPM is based on very specific assumptions, some of its findings have been applicable in practice. This is probably because it has identified an important fact: that it should be possible to eliminate diversifiable risk in well-functioning markets precisely by means of diversification, without any real costs. The market should therefore only set a premium on market risk, that is, undiversifiable risk. No investor should be interested in holding anything but well-diversified portfolios, and the market portfolio is precisely this.

These discussions have applied largely to the stock market, which has been used as an approximation of the total market portfolio. Empirically, this analytical framework has shown itself to work satisfactorily in the stock market. This is probably because unsystematic risk may be substantial for individual equities, and the potential gains from diversification may thus be large. Discussions concerning market portfolios can be summarised in a simple term – holding more assets reduces total risk level. The unique risks of individual assets cancel each other out, and the only remaining risk is the systematic “market risk”.

**Chart 1. The relationship between the number of assets in a portfolio and unsystematic risk**



---

**The relationship came into use among investors at an early stage, laying the groundwork for the use of equity indexes as a reference portfolio.**

---

contains a large number of equities and thus achieves a high degree of covariance with the market as a whole.

The relationship came into use among investors at an early stage, laying the groundwork for the use of equity indexes as a reference portfolio. Although an equity index does not necessarily contain “all assets” (approximated by all equities), it usually contains

## Risks in the bond market

---

**A bond index often came to be used in the same way as an equity index, that is, as an approximation of the market portfolio. However, it is dubious whether the application of this approach to bond portfolios is particularly relevant.**

---

reasoning, the total bond portfolio could function as an approximation of a portfolio containing “all assets”, in the same way as with equities. However, it is dubious whether the application of this approach to bond portfolios is particularly relevant, especially in the case of bonds with mainly low or non-existent credit risks. The simple reason is that unsystematic risk is close to non-existent in such portfolios. Diversification gains are thus limited.

In spite of this, many analyses focus on bond indexes, stating that such an index includes a large number of bonds and should thus represent a well diversified “market portfolio”. Arguments applicable to the stock market are apparently being borrowed without great reservations. In the worse case, this may lead to large, unnecessary transaction costs if a portfolio manager tries to replicate a bond index that is actually irrelevant.

---

**Experience shows that yield curve movements are summarised by a few simple factors.**

---

can more or less be ignored, but the systematic risk in bond portfolios is also easier to quantify than in share portfolios. Bond prices are apparently affected mainly by what happens to the yield curve. Experience shows that yield curve move-

Systematic risk should thus dominate bond portfolios to a much greater extent than equity portfolios. Not only is unsystematic risk so insignificant that diversification effects



ments are summarised by a few simple factors.<sup>6</sup> First, the general *interest rate level* may change, causing parallel shifts in the yield curve. Second, the *steepness* of the yield curve may change, that is, the difference in the interest rates of short-term and long-term bonds. Third, the *curvature* of the yield curve may change.

### DIVERSIFICATION EFFECTS

How large, then, is diversifiable risk in bond portfolios? McEnally and Boardman<sup>7</sup> have conducted a study of the diversification effect, using a selection of 515 corporate bonds of varying creditworthiness. They designed 1,000 random portfolios with a given number of issues, based on their varying credit ratings. As expected, McEnally and Boardman found that the number of issues required to diversify away unsystematic risk varied when portfolios were classified by creditworthiness. Portfolios with the highest creditworthiness required substantially fewer issues in order to eliminate unsystematic risk, compared to portfolios containing bonds of lower creditworthiness.

Their findings demonstrate that diversification gains are small if one invests only in the most creditworthy corporate bonds, whereas sizeable diversification gains can be made if one invests in corporate bonds with lower creditworthiness. A portfolio consisting of four of the most creditworthy corporate bonds had only 5.6 per cent higher average variance than a portfolio consisting of all the most creditworthy corporate bonds.

A reasonable assumption is that the diversification gain is even smaller, or simply insignificant, if one invests only in government bonds. This small diversification gain must also be weighed against various costs,

---

**A reasonable assumption is that the diversification gain is even smaller, or simply insignificant, if we invest only in government bonds.**

---

for example transaction costs required to replicate broad indexes. Diversification gains for corporate bonds with the lowest creditworthiness, however, were about the same as diversification gains for equities. One possible explanation is that credit risk, expressed as the interest rate spread to government bonds, is correlated with the stock price. However, many broad market indexes include only government bonds, or bonds with high creditworthiness. In most cases, discussions of market portfolios thus seem fairly misleading.

Reilly, Kao and Wright<sup>8</sup> studied various indexes in the American bond market, which can be used to draw similar parallels. Their study included one index

<sup>6</sup> This method for analysing the yield curve comes from Arbitrage Pricing Theory (APT). See Ross (1976, 1984).

<sup>7</sup> See McEnally and Boardman (1979).

<sup>8</sup> See Reilly, Kao and Wright (1992).

containing only seven of the most recently issued government bonds with maturities exceeding two years, while other indexes included thousands of issues. The former index showed results similar to the other indexes, that is, it had a high correlation with the other indexes. These findings support the argument that diversification gains should not be the main reason for indexing bond portfolios in a large number of different issues, at least not if one is investing largely in government bonds, which the affected index in this study did.

---

**The fact that CAPM has led to widespread use of equity indexes is as logical as it is surprising that broad bond indexes have won such a large following on the same basis.**

---

On the whole, bond indexes – unlike equity indexes – do not result in substantial diversification gains. Portfolio theory, which is mainly based on diversification, is not very relevant when analysing bond portfolios and thus also to justify broad bond indexes as an

optimal market portfolio, at least if much of the portfolio consists of government bonds or other bonds with high creditworthiness. The crucial difference is that bonds with high creditworthiness do not have a large diversifiable risk. The strength of CAPM lies, above all, in its clear division into systematic and unsystematic risks, something that has been easy to communicate and has shown itself to work satisfactorily for the stock market. The fact that this has led to widespread use of equity indexes is as logical as it is surprising that broad bond indexes have won such a large following on the same basis.

## Why, then, should we use bond indexes?

It thus seems difficult – either theoretically or empirically – to justify focusing on *general market indexes* in bond portfolio management. So we must ask what other reasons may underlie the dramatic increase in the use of indexes. “Structured management” is a concept often used in connection with indexing. This means using indexes as comparisons and risk delegation instruments, that is, as a benchmark. This is probably the context in which a bond index has its advantages, not as an approximation of the theoretical market portfolio. Bond indexes ordinarily include a large number of assets, which means that indexes can be used, for example, as a benchmark for how a specific market has developed.

Given the above line of reasoning, however, it should be clear that it is difficult to attach any deep significance to setting up a portfolio with precisely the qualities that characterise broad market indexes. A bond portfolio with the same duration as the whole market will simply react the same way as the market during parallel shifts of the yield curve. Parallel shifts indeed account for a substantial



proportion of risk in a bond portfolio, but the question of whether market duration is a suitable risk level instead has to do with the investor's risk preference. If we think that market duration involves too great an interest rate risk exposure, it makes more sense to design our own indexes with lower duration. In addition, we can adjust the structure and risk exposure of the portfolio by practising active management.

It is important to sort out these definitional concepts before going further in implementing an index. A bond index should thus not be synonymous with the market portfolio. An index should instead be viewed as a benchmark, in the sense that it should provide a suitable comparative basis for risk delegation and evaluation of bond management. A properly chosen index means that

---

**It is difficult to attach any deep significance to setting up a portfolio with precisely the qualities that characterise broad market indexes.**

---

---

**A properly chosen index means that the market and the instruments in which we manage our assets are included. The index thus serves as a benchmark that describes developments in the market where a manager and his or her employer operate.**

---

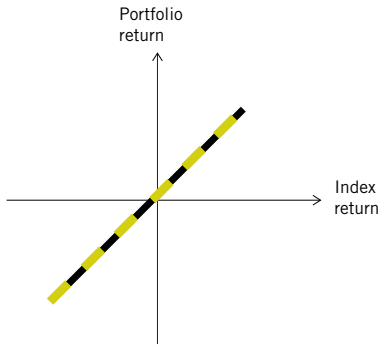
the market and the instruments in which we manage our assets are included. The index thus serves as a benchmark that describes developments in the market where a manager and his or her employer operate. The benchmark chosen should thus reflect the attitude of the employer towards all systematic risk factors, not reflect a market portfolio according to classic portfolio theory.

## Active or passive management?

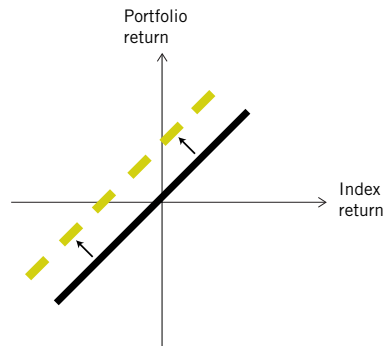
Once some kind of index has been decided upon, the question of passive or active management often comes up. In its purest form, bond indexation means trying to design a portfolio that will achieve the same return as a specific index (Chart 2:1).<sup>9</sup> Thus no management in the traditional sense would be necessary. Instead the indexed portfolio would only need to be managed passively. In other words, the aim of replicating the index would entirely determine the structure of the portfolio. However, it is common for active management to use an index as a reference point and benchmark. By delegating the right to let the portfolio deviate from an index within clearly stated limits, we allow active management. Active management will hopefully achieve better return than passive replication of an index would provide (Chart 2:2). This can be done without affecting the purpose of indexes.

<sup>9</sup> See Galdi (1987).

**Chart 2:1. Passive management with an index as benchmark**



**Chart 2:2. Expected result of active management**



---

**If one choose to actively manage a portfolio and have chosen an index as the basis for management, the index will function as a neutral investment alternative for the manager.**

---

If one choose to actively manage a portfolio and have chosen an index as the basis for management, the index will function as a neutral investment alternative for the manager. The overall risk level is decided by what index is being used for the asset management. Those with greater responsibility than

the portfolio manager decide the level of risk and are thus responsible for the choice. It is important that those who delegate responsibility for financial assets to portfolio managers should understand this. Not until the holdings in the portfolio deviate from the index does a manager take risk of his own and thus has the opportunity to achieve a better expected return. This may be done, for example, by shortening (or lengthening) the duration of the portfolio relative to the index. If the general level of interest rates rise (fall), this means that the return on the portfolio will be relatively higher than that of the index.

---

**Passive management based on an index does not mean that the return over a given time latitude is predetermined or guaranteed.**

---

Passive management based on an index does not, however, mean that the return over a given time latitude is predetermined or guaranteed. If the index according to which we choose to delegate a risk mandate represents a

given market and the actual return in that market after one year is -10 per cent, for example, the responsibility rests with the portfolio manager's superiors, as long as the manager has invested entirely in line with the index. On the other hand, if the manager had deviated from the index and achieved an actual return of -8 per cent with the aid of some kind of particular strategy, the manager's result is +2 per cent.



This method of delegating a risk mandate thus presupposes that not only the portfolio manager, but also employers are familiar with the market and the instruments included in the index.

## Choice of indexes

The choice of indexes should thus be determined by what one wishes to accomplish by portfolio management. On the basis of this goal, one should try to adjust the portfolio in such a way as to achieve the desired level of systematic risk. The risk level chosen will affect the expected return on the portfolio. A portfolio with a longer duration will react differently, compared to a portfolio with a shorter duration, to changes in the level as well as the steepness of the yield curve. Portfolios containing bonds of varying creditworthiness will not react in the same way, either. Since portfolio managers have different preferences, the risk level of external broad indexes will rarely match a given manager's individual risk preference.

---

**The choice of indexes should be determined by what one wishes to accomplish by portfolio management.**

---

Many of these market indexes try to replicate the configuration of the market. Among other things, this means that average maturity will depend on the issue and debt structure of the country we are investing in. If one instead constructs internal indexes, one can choose for oneself what bonds to include and how to compose them in order to reflect the employer's attitude towards systematic risks. Provided that the requisite expertise and resource are available, internally developed indexes are likely to be preferable.

However, external indexes have advantages that may offset the disadvantage of portfolio management based on a risk exposure not entirely in agreement with our own. This is because the practical task of implementing, testing and maintaining benchmarks developed in-house may be extensive. The benchmarking task may be substantially eased by using external market indexes. An external index also facilitates comparisons with other investors. However, this nevertheless presupposes similar risk preferences in order to use the same benchmarks otherwise the comparison is irrelevant. The fact that the practical task of benchmarking is made easier may thus conceivably offset the disadvantages of implicit risk levels that do not fully reflect the risk attitude of an investor.

---

**External indexes have advantages that may offset the disadvantage of portfolio management based on a risk exposure not entirely in agreement with our own.**

---



## DIFFERENCES BETWEEN EXTERNAL MARKET INDEXES

If we have concluded that a broad market index largely corresponds to our attitude towards all risks, there are numerous indexes to choose from. Reilly, Kao and Wright compared four well-known indexes during the period 1980–1990. First and foremost, they noted a high correlation between the broadest indexes, which include corporate, mortgage and government bonds.<sup>10</sup> They interpreted this as meaning that the general level of interest rates is the most important single factor in explaining the return on bonds, regardless of sectoral classification. In a comparison between indexes that only include government bonds and indexes based on mortgage and corporate bonds, they noted that the former had the lowest standard deviation and return. In addition, the correlation between these indexes was higher than for the broadest indexes.<sup>11</sup>

Finally, they interpreted the high correlation between similar sectoral indexes as meaning that the indexes of the various firms generally measured the same thing. These findings indicate that one need not devote large resources to deciding whose index to choose, when choosing between external indexes, at least not over any longer time latitude. Instead, it is more important to devote resources to finding an index that genuinely agrees with one's own risk preferences and that can thus function as a suitable benchmark.

---

**Portfolio managers' varying goals and restrictions imply an obvious risk that an external market index will not provide a suitable benchmark for measuring their comparative performance or for delegating risk mandates.**

---

By now, it should be fairly apparent that choosing bond indexes is not entirely easy or self-evident. Does an index really represent the attitudes towards risk and expected return? Portfolio managers' varying goals and restrictions imply an obvious risk that an external market index will not provide a suitable benchmark for measuring their comparative

performance or for delegating risk mandates. Critics argue that even if the index chosen reflects the attitude towards risk, indexes are not sufficiently flexible, and investment opportunities would thus be lost. The risk of losing investment opportunities declines, however, if active management is permitted, in which an index is the benchmark used for evaluating and delegating management. In that case, investment alternatives are derived from the organisation's limit structure and not from the index.

<sup>10</sup> The correlation coefficients varied between 0.905 and 0.998.

<sup>11</sup> Usually above 0.98 for the period studied.



## Methods for replicating indexes

Once the range of assets to invest in has been decided, and which will thus be included in the index, as well as the respective weights of these assets, the return on the index will be equivalent to:

$$R_p = \sum_i w(i)r(i)$$

$R_p$  = return on the index  
 $w(i)$  = weight of the issue  
 $r(i)$  = return on the issue

The objective of passive management is for the return on the *portfolio* ( $R_p$ ) to correspond as much as possible to the return on the *index* ( $R_i$ ). In active management, the weights or issues are adjusted to reflect the strategy of the manager, and the return on the portfolio is thus expected to exceed the return on the index. Provided that the index does not contain too many issues and the portfolio is not too small, passive management may be achieved by trying to let the actual weight of issues ( $w(p)$ ) in the portfolio be as similar to the weights in the index ( $w(i)$ ) as possible.<sup>12</sup>

In many major financial markets, however, there are hundreds of different issues to choose from. The Swedish government bond market, with its few and liquid issues, is easier to manage. In Sweden it would not be difficult to let the government bond index and the portfolio contain the same issues, weighted on the size of their respective percentages, if this would result in a risk level consistent with ones preferences.

---

**In many major financial markets, there are hundreds of different issues to choose from, the quantity implies the need for a number of methods to set up the portfolio.**

---

It is more complicated to put together an indexed portfolio that also covers corporate and mortgage bonds. The same is true if one chooses to invest in major financial markets such as the United States or Japan. In itself, the quantity of issues implies the need for a number of methods to set up the portfolio, provided that one has chosen a broad index. This is true for both bond and equity indexes, but bonds differ in other ways from equities, making it more difficult both to replicate and to maintain bond indexes.

<sup>12</sup> See Nowometsky and Sevilla (1989).

## PROBLEMS OF BOND INDEXES COMPARED TO EQUITY INDEXES

---

**The construction of bonds and the changing supply means that managers are constantly compared with changeable indexes.**

---

One major problem affecting bond indexes is that it must take into account that due to their limited maturities, bonds are directly affected by the time factor, while equities are not. The continuous change in bonds, in turn, affects the weights in the index, which are usually based on market values. The weights are also affected by the changing bond supply, which depends on such factors as the budget situation and debt structure of various countries. This means that portfolio managers are constantly being compared with changeable indexes.

Equity indexes, on the other hand, can be expected to show substantially greater stability. A company's outstanding equity stock ordinarily shows fewer changes than its outstanding bonds, which often consist of more than one issue and also continuously change due to their maturity structure and other features (embedded options are not uncommon). Finally, transparency and liquidity are usually better in the stock market, where a larger proportion of trading occurs in stock exchanges or via electronic trading systems than in the bond market. This may lead to problems in finding reliable bond price quotations, which are also available in real time.

Once an index has been chosen, there are a number of different methods for replicating large indexes, such as the cell, optimisation and minimum variance method.<sup>14</sup> All these methods have the same purpose; to design portfolios that serve as good approximations of an index. The importance of having the managed portfolio agree with the index obviously depends on our purpose for using the index. If one is practising strictly passive management, the need for precision is obviously great, otherwise there is a danger, among other things, that risk exposure will not match the delegated mandate. In case of active management, when using an index as a benchmark, the need for exact replication is substantially smaller, although active management involve the need to know how a risk-neutral portfolio configuration looks.

<sup>14</sup> For mathematical descriptions, see Seix and Akoury (1986).

## Evaluation of bond portfolios using an index norm

Even if a portfolio has been managed passively, a difference in the return on the portfolio and the index may occur. This difference is usually referred to as a tracking error and is defined as follows:

---

**Even if a portfolio has been managed passively, a difference in the return on the portfolio and the index may occur.**

---

$$\text{Tracking error} = \Delta P_{IP} - \Delta P_I$$

$\Delta$  = change

$P_{IP}$  = the total market value of the indexed portfolio

$P_I$  = the value of the index

The error may stem from three different sources: (1) portfolio transaction costs, (2) differences in the prices used in calculating the index and the prices that the manager trades at, and (3) differences in the assets in the index and in the portfolio. To evaluate passive management, it is important to analyse the reasons behind tracking error. This tracking analysis may also be useful when evaluating actively managed portfolios. If active management achieved a result that is worse than the index, this does not necessarily mean that passive management would have achieved better results. If we can prove that the tracking error in passive management would have resulted in an even larger (negative) deviation from the index, active management can still be justified.

If we choose a broad market index that includes a large number of issues, sizeable tracking errors may occur due to transaction costs.<sup>15</sup> The alternative is to include only a limited number of issues. On the other hand, this would imply a risk of poor tracking due to major differences in the composition of the index and the portfolio. In other words, there would be a negative relationship between tracking quality and transaction costs, which is another argument for being careful in choosing an index. Mossavar-Rahmani<sup>16</sup> studied the tracking error for one large market index and calculated an average monthly tracking error of two basis points, with an equally large standard deviation, for a government-guaranteed index. Other investment segments, such as corporate and mortgage bonds, were more difficult to follow and thus resulted in larger deviations.

<sup>15</sup> See Fabozzi (1996).

<sup>16</sup> See Mossavar-Rahmani (1991).



## Summary

---

**The advantages of indexes are that they provide a good method for achieving a clear structure and improved monitoring of portfolio management.**

---

The use of indexes has become more common in the management of bond portfolios. The advantages of indexes are that they provide a good method for achieving a clear structure and improved monitoring of portfolio management. A properly chosen index means that the market and the instruments in which ones assets are managed are included. The index thus serves as a benchmark that describes developments in the market in which a manager and the employer operate. The use of bond indexes should be justified in this light, not based on classical market portfolio theory.

Such reasoning has mainly been used to analyse the stock market, which has successfully been used as an approximation for all assets. These relationships came into use among investors at an early stage, laying the groundwork for the use of equity indexes. Although an equity index does not necessarily contain “all assets” (approximated by all equities), it usually contains a large number of equities and thus achieves a high degree of covariance with the market as a whole. The fact that equity indexes have an appealing theoretical framework, which has also been proven empirically, has been a decisive factor behind the success of equity indexes as a portfolio management strategy.

---

**A widespread use of equity indexes is as logical as it is surprising that broad bond indexes have won such a large following on the same basis.**

---

The fact that this has led to widespread use of equity indexes is as logical as it is surprising that broad bond indexes have won such a large following on the same basis, that is, as an approximation of the theoretical market portfolio. Although this seems to be the prevailing view of bond indexes, the reason why this reasoning is not viable is surprisingly simple. *Diversifiable or unsystematic risk is insignificant for a substantial proportion of the bond supply.* Taking advantage of the “law of large numbers” thus results in only limited gains. This is especially true of bonds with high creditworthiness. Bonds can and should instead be analysed on the basis of the shape of the yield curve. This means choosing or designing indexes that reflect the attitude of the client to all systematic risk factors, instead of crafting a market portfolio according to classic portfolio theory.

## References

- Akoury, Ravi och Christina Seix, "Bond Indexation: The Optimal Quantitative Approach", *Journal of Portfolio Management*, Spring 1986, pp. 50–53.
- Fabozzi, Frank J., *Bond Markets, Analyses and Strategies*, 1996, pp. 411–425.
- Galdi, Philip H., "Indexing Fixed Income Portfolios", in Frank J. Fabozzi and T. Dessa Garlicki (eds.), *Advances in Bond Analysis and Portfolio Strategies*, 1987, pp. 453–480.
- Lintner, John, "Security Prices, Risk, and Maximal Gains from Diversification", *Journal of Finance*, December 1965, pp. 587–616.
- McEnally, Richard W. and Calvin M. Boardman, "Aspects of Corporate Bond Portfolio Diversification", *Journal of Financial Research*, Spring 1979, pp. 27–36.
- Mossavar-Rahmani, Sharmin, *Bond Index Funds*, 1991, pp. 2–12.
- Mossin, Jan, "Equilibrium in Capital Asset Market", *Econometrica*, Oktober 1966, pp. 76–83.
- Nowometsky, Frederick and Agustin R. Sevilla, "Global Bond Indexation: Concepts, Approaches and Challenges", in Frank J. Fabozzi (ed.), *Fixed-Income Portfolio Strategies*, 1989, pp. 29–52.
- Reilly, Frank K and David J. Wright, "Bond Market Indexes" in Frank J. Fabozzi (ed.), *Handbook of Fixed Income Securities*, 1997, pp. 129–145.
- Reilly, Frank K, G. Wenchi Kao and David J. Wright, "Alternative Bond Market Indexes", *Financial Analysts Journal*, may-june 1992, pp. 44–58.
- Ross, Stephen A., "Modifying Risk and Return in Managing Bond Portfolios", in *The Revolution in Techniques for Managing Bond Portfolios*, CFA: The Institute of Chartered Financial Analysts, 1983, pp. 90–94.
- Ross, Stephen A., "The Arbitrage Theory of Capital Asset Pricing", *Journal of Economic Theory*, December 1976, pp. 341–360.
- Sharpe, William F., "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk", *Journal of Finance*, September 1964, pp. 425–442.