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An AHP-based Decision Support Model for Corporate Bond Selection and Investment Analysis

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ABSTRACT

This paper explores the use of an intuitive decision support model for evaluating and selecting corporate bonds. The model is based on the Analytic Hierarchy Process (AHP), which enables an individual investor and a portfolio manager to identify the relative impacts of multiple criteria derived from the assessment of a particular investment environment. It also allows the pairwise comparisons of several corporate bond alternatives with respect to each of the pre-determined criteria. In particular, the evaluation process can capture individual investment behavior and perceptions on different decision criteria and corporate bond alternatives. Therefore, the model can be customized to facilitate corporate bond selection and fixed income investment analysis.

Keywords

Corporate bonds, selection, decision support model, investment analysis.

INTRODUCTION

Investment in financial assets is a dynamic decision-making process influenced by various environmental variables together with individual's behavior. It is not uncommon that an individual investor tends to consider multiple alternatives in order to optimize an expected utility measured by expected return and its variance (Von Neumann and Morgenstern, 1947). However, most traditional literature on utility theory is related to aggregate market behavior, instead of addressing the decision-making process of individual investors (Haugen, 2001). The approach of behavioral finance would be practically appropriate to describe behavioral aspects of investors (e.g. Baker, Hargrove and Haslem, 1977; Statman and Caldwell, 1987). There are various behavioral attributes associated with the process of security evaluation and portfolio selection and the preference of individual investor (e.g. Baker and Haslem, 1974; Lewellen, Lease and Schlarbaum, 1977; Blume and Friend, 1978; Nagy and Obenberger, 1994). For instance, individual behavior might be influenced by lifestyle characteristics, risk attitudes, control orientation and occupation (Barnewell, 1987). Practically, investment criteria might change in a particular environment and at a particular point of time. Moreover, conflicts might arise when there are incompatible expectations such as maximizing the rate of return versus minimizing risk in association with an investment. In general, an investor should rationally consider the tradeoff between risk and return in relation to a particular investment, although it is desirable to achieve a greater rate of return. Therefore, it would be meaningful if a decision support model could enable an investor to balance his/her expected return and attitude towards risks associated with a particular investment. It would also be desirable if it could customize multiple variables and permit intuitive judgments.

The AHP is a powerful vehicle to deal with unstructured decision-making problems involving qualitative measures (Saaty, 1980, 1990). It is able to incorporate multiple criteria and accommodate conflict variables associated with a complicate decision-making process. It also encourages the involvement of individuals when evaluating different alternatives. Therefore, the AHP has been used extensively in various practical decision environments [e.g. Dyer and Forman, 1992; Tullous and Utecht, 1994; Gorgionne, 1999; Min and Melachrinoudis, 1999; Raju and Pillai, 1999; Yahya and Kingsman, 1999; Kengpol and O'Brien, 2001; Crary, Nozick and Whitaker, 2002; Meade and Presley, 2002; Partovi and Corredoira, 2002). This paper attempts to use the AHP to construct a decision support model for corporate bond evaluation and selection. It begins with a description of the AHP-based model for corporate bond evaluation, followed by the pairwise comparisons of selection criteria as well as the pairwise comparisons of bond alternatives, which are facilitated by the *Expert Choice* system.

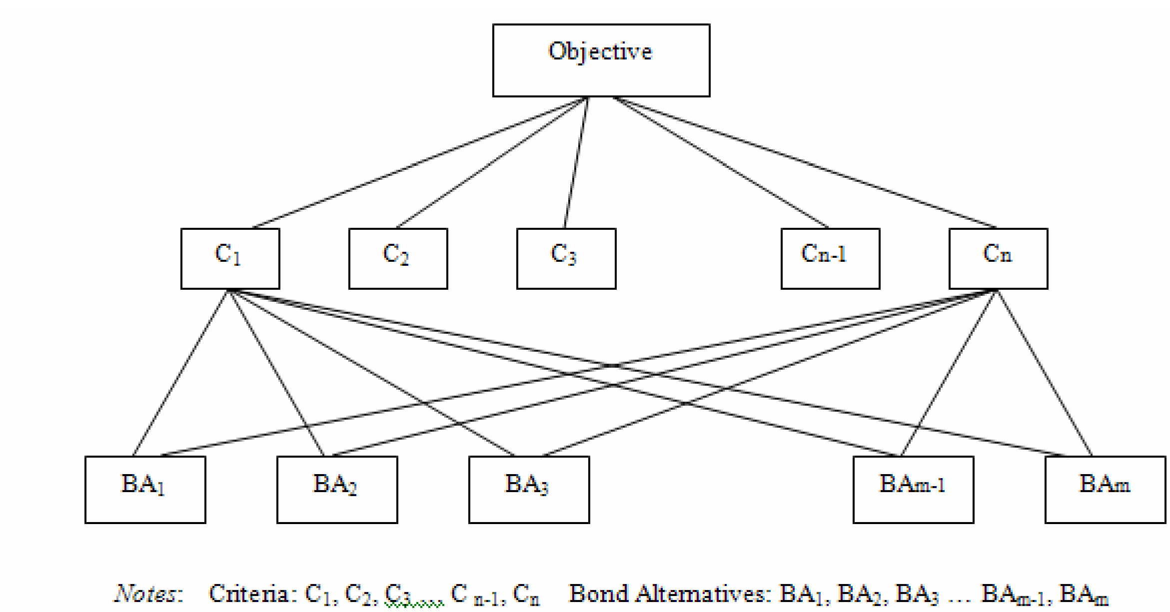
THE EVALUATION MODEL

An assessment model based on the AHP is designed to facilitate the selection of corporate bonds. As depicted in Figure 1, the model includes three levels: Objective, Criteria, and Bond Alternatives. The top of the hierarchy is the objective referring to the selection of a desirable bond or an appropriate bond portfolio. A set of criteria is deployed in the second level, while the bond alternatives being considered are arranged at the third level of the hierarchy.

An individual investor might consider a number of factors in selection of a particular corporate bond, because bond investment involves considerable risks (Bodie, Kane and Marcus, 2001; Fabozzi, 2000; Tuckman, 1996). Firstly, interest rate risk may arise if the price of a typical bond changes in the opposite direction from a change of interest rates. Secondly, credit risk refers to the risk that the issuer of a bond may default or may be unable to make timely principal and interest payments on the issue. Thirdly, inflation risk may arise when there is a variation in the value of cash flows from a security due to inflation. Moreover, liquidity risk depends on the ease with which an issue can be sold at or near its value. Finally, the performance of bond issuer reported and overall economic indicators announced should be assessed to optimise an expected return from investing in a particular bond.

In the present case, the pairwise comparison method is used to evaluate criteria and corporate bonds. In Figure 1, six criteria and five different corporate bonds with a maturity of five years are structured on the second level and third level, respectively. Actually, the six criteria are converted from the above-mentioned considerations for corporate bond evaluation. They are used to demonstrate the AHP-based evaluation process. In addition, the bonds considered should possess a similar maturity period. Although the bonds being considered are rated differently by recognized rating firms such as Moody's Investors Service and Standard & Poor's Corporation, they do not include any provisions such as call provision, put provision and conversion provision. The following process involves both pairwise comparisons of criteria and pairwise comparisons of bond alternatives.

Figure 1 The Evaluation Model



THE SELECTION PROCESS

Pairwise Comparisons of Criteria

The criteria used to evaluate corporate bonds include: (a) Performance of a bond issuer (Performance), (b) Current economic indicators (Indicators), (c) Expected fluctuation of interest rate (Interest Risk), (d) Possible credit changes by rating authorities (Credit Risk), (e) Variation of cash flow from a bond due to inflation (Inflation Risk), and (f) Liquidity risk of individual corporate bond (Liquidity Risk). In the model framework (Figure 1), these criteria are compared in pairs, and the relative importance of one criterion versus another with respect to the objective is judged using a score from 1 to 9. A matrix entry indicates that a row element is: 1 equally, or 3 moderately, or 5 strongly, or 7 very strongly, or 9 extremely more important than a column element. An intermediate value (i.e. 2, or 4, or 6, or 8) between the two adjacent judgments is used when compromise is needed. On the other hand, if a column element is judged more important than a row element, the reciprocal of a number is used. For example, the entry of 5 in the cell of (Performance/Inflation Risk) means that Performance is judged strongly more important than Inflation Risk, with respect to the objective.

As demonstrated in Table 1, fifteen judgements are required to complete the upper right portion of the matrix because the reciprocal relationship of each pairwise comparison is automatically generated. Once all the judgments are made, a normalized eigenvector of the comparison matrix is calculated. The right-most column of Table 1 shows the normalized eigenvector, which indicates the relative weights for different criteria: Performance (0.337), Indicators (0.086), Interest Risk (0.103), Credit Risk (0.274), Inflation Risk (0.041), and Liquidity Risk (0.159). The consistency ratio (CR: 0.05) which is less than 0.10 suggests that the pairwise comparisons are appropriate and the inconsistency of judgements is not significant.

Table 1 Pairewise Comparisons of Criteria

Criteria	PER	IND	INT	CR	INF	LR	Relative Weights
Performance (PER)		3	3	2	5	3	0.337
Indicators (IND)			1/2	1/3	3	1/2	0.086
Interest Risk (INT)				1/3	3	1/3	0.103
Credit Risk (CR)					6	3	0.274
Inflation Risk (INF)						1/4	0.041
Liquidity Risk (LR)							0.159
							CR: 0.05

Pairwise Comparisons of Bond Alternatives

The selection of corporate bonds and the judgements of pairwise comparisons depend on individual preference. Therefore, the corporate bond alternatives being demonstrated are represented by Bonds 1 to 5, in order to avoid the provision of misleading information about a particular corporate bond. Pairwise comparisons are performed to give the relative preference of one alternative versus another with respect to each of six criteria in the middle level of the model framework. Hence, six matrices (one for each criterion) are illustrated in Table 2. The size of each of the matrices is 5 columns by 5 rows, since five bond alternatives are under consideration.

As shown in Table 2, pairwise comparisons begin with judging the comparative preference of a corporate bond over another with respect to Performance. For example, since Bond 1 is judged as moderately more preferable to Bond 3, a score of 3 is given in the cell of (Bond 1/Bond 3). In addition, because Bond 2 is considered strongly more preferable than Bond 4, a score of 5 is placed in the cell of (Bond 2/Bond 4). This methodology is continued until the upper right half of the matrix is completed. The system can immediately generate a set of relative weights to indicate the degree of preference of five different bonds with respect to Performance by calculating the eigenvector of the judgment matrix. Similarly, pairwise comparisons between bond alternatives with respect to each of the other criteria (Indicators, Interest Risk, Credit Risk, Inflation Risk, and Liquidity Risk) are respectively shown. All consistency ratios are less than 0.10, which indicate that the pairwise comparisons are relatively consistent and appropriate.

Integration of Comparisons

All the relative weights of the corporate bonds against each of the six pre-determined criteria are synthesized with the relative weights of the six criteria to generate a set of normalized composite weights, which indicate the overall relative weights of the five bonds. These composite weights are derived through multiplying the relative weights of corporate bonds by the criteria importance vectors. The resulting synthesized composite weights for Bonds 1, 2, 3, 4, and 5 are 0.287, 0.382, 0.151, 0.074, and 0.106, respectively.

The bond with the highest weight can be listed at the top, which implies that the particular corporate bond is relatively compatible with the pre-determined criteria in comparison with any other bonds. Analogically, a bond with the second highest weight is ranked the second best. In this case, the composite weights also indicate the priority of five alternatives (Bonds 2, 1, 3, 5 and 4). The overall consistency ratio (CR: 0.06) indicates that there is limited inconsistency associated with the pairwise comparisons conducted. Because the resulting composite weights depend on the investor’s intuitive judgements on the criteria and bond alternatives, they reflect the overall intensity of the investor’s evaluation on different alternatives. They also indicate the relative preferences of all alternatives. A bond with the highest score should be the most desirable one among all alternatives that have been considered.

Table 2 Pairewise Comparisons of Bond Alternatives

	Bond 1	Bond 2	Bond 3	Bond 4	Bond 5	Relative Weights
Performance						
Bond 1		1/2	3	3	4	0.294
Bond 2			3	5	3	0.390
Bond 3				3	2	0.147
Bond 4					1/3	0.061
Bond 5						0.108
						CR: 0.06
Indicators						
Bond 1		2	5	3	3	0.380
Bond 2			3	3	5	0.305
Bond 3				1/5	1/3	0.055
Bond 4					2	0.161
Bond 5						0.099
						CR: 0.09
Interest Risk						
Bond 1		1/2	2	3	3	0.249
Bond 2			3	5	3	0.403
Bond 3				3	2	0.167
Bond 4					3	0.104
Bond 5						0.077
						CR: 0.08
Credit Risk						
Bond 1		1/3	2	5	2	0.229
Bond 2			3	5	3	0.423
Bond 3				3	3	0.177
Bond 4					1/4	0.051
Bond 5						0.120
						CR: 0.07
Inflation Risk						
Bond 1		2	2	3	2	0.336
Bond 2			2	2	3	0.266
Bond 3				2	1	0.151
Bond 4					1/3	0.088
Bond 5						0.159
						CR: 0.05
Liquidity Risk						
Bond 1		1/2	3	4	5	0.321
Bond 2			2	5	3	0.366
Bond 3				2	3	0.161
Bond 4					1/2	0.065
Bond 5						0.087
						CR: 0.06

DISCUSSION

The AHP-based bond evaluation process is summarized as follows: Firstly, multiple criteria are determined by the assessment of a particular investment environment. Secondly, all criteria and bond alternatives under consideration are structured within the AHP framework. Thirdly, the criteria are compared in pairs with respect to the goal of investment, while all possible alternatives are evaluated in pairs with respect to each of the criteria. An acceptable consistency ratio has to be satisfied in the pairwise evaluation of both criteria and alternatives. The process results in a set of composite weights, which indicate the relative consistencies of different bonds with respect to all pre-determined criteria. Because the composite weights indicate the investor's relative preferences on different bond alternatives, an investment decision can be made based on the composite weights of different alternative bonds being considered.

The model provides an analytical framework for bond investment analysis, in which individual investor can tackle environmental influences in an integrated manner. It encourages individuals to intuitively judge the impact of different environmental variables, and react to any change in a dynamic environment by revising the decision criteria for investment analysis. The use of pairwise comparisons makes it possible to ensure the decision consistency, because the evaluation can be improved by coping with a pre-determined ratio of consistency. The priority of corporate bonds from the use of the model is based on individual assessment of criteria and the various bond alternatives at a particular point of time. Therefore, it can be used to support real-time investment decision-making by adjusting criteria and using different corporate bond alternatives.

The model enables an individual investor and a portfolio manager to compromise conflict intangible criteria through pairwise comparisons. In practice, environmental constraints and investor's expectations are neither mutually exclusive nor independent in many circumstances. Conflict criteria might also involve in the evaluation process. Therefore, the achievement of a balance between different criteria is practically important. With the present model, the relative impacts of different criteria can be identified in the light of an eigenvector resulted from pairwise comparisons with respect to the objective of bond selection.

The pairwise comparisons of bond alternatives against each of the pre-determined criteria lead to the yield of a normalized eigenvector. The normalized eigenvector actually represents the priority of different bond alternatives, because the algorithms for heuristic judgements and reasoning based on the eigenvalue method generate the relative weights for both investment criteria and bond alternatives. In other words, a numerical ranking of alternatives is derived from intuitive comparisons of alternatives. Such resulted priorities of different fixed-income securities facilitate the decision-making of an investment portfolio. If there are a number of bond alternatives under consideration, a desirable portfolio can be determined based on the priority of different bonds. However, it would be appropriate to evaluate a group of corporate bonds with a similar maturity period, because bonds with different maturities would be considerably different in terms of the expected return and risks over different periods. Finally, the composite weights associated with individual bonds suggest the relative preference of different bonds. We might proportionally allocate resources to different bonds to form an investment portfolio based on the relative composite weights. However, investments are usually subject to resource constraints in a planned period. Therefore, the number of bonds to be chosen and the actual amount to be invested should depend on the accumulative investments required and the availability of financial resources.

The present decision support model is useful for fixed-income investment analysis. It can balance different decision criteria and simultaneously evaluate several bond alternatives, even if the selection depends on individual perception and experience. It can also be customized to accommodate a variety of investment variables when evaluating different corporate bond alternatives. Future studies could be carried out to examine the use of the model in facilitating the evaluation of corporate bonds and the management of fixed-income securities in different environments. For instance, the presence of embedded provisions and options makes the valuation of bonds complicate. Therefore, the model can be developed to deal with bonds with specific provisions. It could also be adapted in dealing with the selection of different classes of securities and assets. However, a changing environment and individual's perception on individual corporate bonds might significantly influence bond evaluation and selection. It is practically difficult to standardize investment criteria, because individuals might perceive differently in particular situations. Criteria used together with their impacts are also dependent on an individual investor's experience and judgements. Therefore, it is necessary to assess a particular investment environment in order to formulate the most relevant decision criteria for asset evaluation and selection.

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