Risk and Return in the Bond Market: An Empirical Analysis

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I. Introduction

There are three major approaches in the analysis of risk and return relationships in the bond market. One approach is risk structure analysis in which returns on bonds of different qualities are plotted over time and their yield spreads are compared and examined. A second approach is to calculate interest rate equations in which the dependent variable is the interest rate and the independent variables are the risk of the bond, the expected inflation rate and other determinants of the interest rate.

A third approach, which is the purpose of this study, is to apply the capital market theory and the capital asset pricing model to the bond market. That is, according to the capital market theory and the capital asset pricing model, the bond with a greater total risk or systematic risk should have a higher expected return. In this paper, we test the above hypotheses using eleven types of bonds and loans.(1) In section II, the capital market theory and the

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(1) For the first approach, see Melton [14]. For the second approach, there are numerous ar-

capital asset pricing model are stated for the bond market, and the methods of measuring the bond holding period return and its risks are discussed. The inflation systematic risk hypothesis is also explained. In section III, the data and the calculation of the expected return and the market portfolio return are discussed. In section IV, the empirical results are presented. Finally, in section V, a summary and conclusions are presented.

II. The Hypotheses

In most empirical studies, the capital market model and the capital asset pricing model have been tested largely for the stock market.(2) The above two models are usually expressed in the following equations:(3),(4)

For a portfolio,

$$E(R_p)=R_F+\frac{E(R_m)-R_F}{\sigma_m}\sigma_p, \tag{1}$$

$$E(R_p)=R_F+[E(R_m)-R_F]\beta_p; \tag{2}$$

for an individual security,

$$E(R_i)=R_F+\frac{E(R_m)-R_F}{\sigma_m}\sigma_i, \qquad (1)'$$

$$E(R_i)=R_F+[E(R_m)-R_F]\beta_i, \qquad (2)'$$

where

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ticles on the Fisherian equation where the expected inflation rate is included as an independent variable, but few studies include the risk of the bond yield. Roley [19], Roley and Troll [20] include both the variance of the bond yield and the expected inflation rate. They found that both the variance and the expected inflation rate are significant. Levi and Makin [12] and Melvin [15] include the expected inflation rate (the Livingston survey data) and its standard deviation. Levi and Makin found the standard deviation to be statistically significant, but Melvin did not. For theoretical rationale of including the risk variable, see Tobin [28]. For the third approach, see footnote (2).

(2) For the basic literature for the capital market theory and the capital asset pricing model, see Markowitz [13], Sharpe [22, 23]. For a brief survey of empirical results of the CAPM, see Tinic and West [27, pp. 308-321].

(3) In general, Equation (1) represents the capital market line hypothesis, and Equation (2)′ is the security market line hypothesis. Equation (2)′ is derived from Equation (1). See Tinic and West [27, pp. 273-308], and Copeland and Weston [6, pp. 175-200].

(4) In Black [2] model, the risk free rate R_F is replaced by the expected return on the "zero beta" portfolio, $E(R_Z)$:

$$E(R_i)=E(R_Z)+[E(R_m)-E(R_Z)]\beta_i.$$

$$\sigma_i=\sqrt{\frac{\Sigma(R_i-\bar{R}_i)^2}{n-1}},$$

$$\beta_i=\frac{Cov(R_m, R_i)}{V(R_m)},$$

where $E(R_p)$=the expected return on the portfolio p, R_F=the risk free rate, $E(R_m)$=the expected return on the market portfolio m, σ_m=the total risk of the market portfolio m or the standard deviation of the return on the market portfolio, σ_p=the total risk of the portfolio p or the standard deviation of the portfolio return, β_p=the systematic risk of the portfolio p, $E(R_i)$=the expected return on security i, σ_i=the total risk of security i, β_i =the systematic risk of security i.

In general, Equation (1) represents the capital market theory or the capital market line (CML) hypothesis, and Equation (2)′ represents the capital asset pricing model or the security market line (SML) hypothesis. However, in this paper, we assume that the CML and SML hypotheses apply to both a portfolio and an individual security.[5]

In essence, the capital market line hypothesis (Equations (1) and (1)′) states that the expected return is a linear positive function of total risk, and the security market line hypothesis (Equations (2) and (2)′) states that the expected return is a linear positive function of systematic risk. To test the above hypotheses, we need the returns on the market portfolio, returns on individual securities or returns on portfolios. The returns are usually calculated as the holding period returns.

For the stock market, the holding period return is calculated by

(5) The difference between Equations (1)′ and (2)′ can be shown as follows:
The return characteristic equation is given by

$$R_i=\alpha+\beta_i R_m+e. \qquad (a)$$

Then

$$V(R_i)=\beta_i^2 V(R_m)+V(e), \qquad (b)$$

$$\sigma_i=\sqrt{\beta_i^2 V(R_m)+V(e)}. \qquad (c)$$

However, if $V(e)=0$,

$$\sigma_i=\beta_i\sigma_m, \qquad (d)$$

$$\sigma_i/\sigma_m=\beta_i. \qquad (e)$$

Thus, Equation (1)′ reduces to Equation (2)′, if $V(e)=0$.

$$R_t = \frac{D_t + P_t - P_{t-1}}{P_{t-1}}, \tag{3}$$

where D_t = the dividend payment received during period t, P_{t-1} = the stock price at the beginning of the period, P_t = the stock price at the end of the period. The expected holding period return can be calculated by

$$E(R_t) = \frac{E(D_t) + E(P_t) - P_{t-1}}{P_{t-1}}. \tag{4}$$

In most empirical studies, expected values are calculated as the simple average of the past values. For instance, the expected holding period return is given by(6)

$$E(R_t) = \sum_{i=1}^{n} R_{t-i}/n. \tag{5}$$

Similarly, the bond holding period return can be calculated by

$$R_t = \frac{I_t + P_t - P_{t-1}}{P_{t-1}}$$
$$= \frac{I_t}{P_{t-1}} + \frac{P_t - P_{t-1}}{P_{t-1}}, \tag{6}$$

where I_t = the fixed coupon interest payment received during period t, P_{t-1} = the bond price at the beginning of the period, P_t = the bond price at the end of the period, I_t/P_{t-1} = the interest rate return on the bond.

Thus, the expected bond holding period return is given by

$$E(R_t) = \frac{E(I_t)}{P_{t-1}} + \frac{E(P_t) - P_{t-1}}{P_{t-1}}. \tag{7}$$

Where only interest rate data are available, the capital gain return can be calculated by assuming that the bond is a perpetual bond (Consol). In this case, the price of the bond is equal to $P_t = I_t/i_t$. Thus, the rate of change in bond prices can be calculated by(7)

(6) In most empirical studies on the capital asset pricing model, the simple average of the past returns are usually regarded as the expected return. However, for various distributed lag models and expectation models, see Pindyck and Rubinfeld [17] and Lahiri [10].

(7) This method is used in Roley [19, p. 18] to calculate the bond holding period return. The equation $P = I/i$ is explained in most finance textbooks. The present value of the bond is

$$P_0 = I\left[\frac{1}{(1+i)^1} + \frac{1}{(1+i)^2} + \cdots + \frac{1}{(1+i)^n}\right] + \frac{P_m}{(1+i)^n} \tag{a}$$

where P_0 = the present or the market value of the bond, I = the fixed coupon interest payment, P_m = the fixed maturity price of the bond.

$$\frac{P_t - P_{t-1}}{P_{t-1}} = \frac{I_t/i_t - I_t/i_{t-1}}{I_t/i_{t-1}} = \frac{i_{t-1} - i_t}{i_t}, \tag{8}$$

where i_t=the nominal current interest rate at time t, and $I_t = I$, a constant.

Thus, assuming $I_t = \$1$ and $I_t/P_{t-1} = i_{t-1}$, Equation (6) can be rewritten as

$$R_t = i_{t-1} + \frac{i_{t-1} - i_t}{i_t}. \tag{9}$$

And the expected bond holding period return is

$$E(R_t) = i_{t-1} + \frac{i_{t-1} - E(i_t)}{E(i_t)}. \tag{10}$$

However, most statistical data are provided in the following form as the current yield:

$$I_t/P_t = i_t, \tag{11}$$

where i_t=the nominal interest rate or the current yield, P_t=the current price of bond or the average price of the bond during the period. To comply with this definition, Equation (6) can be rewritten as

$$R_t = \frac{I_t}{P_t} + \frac{P_t - P_{t-1}}{P_t}. \tag{12}$$

Substituting Equation (11) into (12), we obtain

$$R_t = i_t + \frac{i_{t-1} - i_t}{i_{t-1}}. \tag{13}$$

Note that Equation (9) requires that $I = \$1$, or $P_t = 1/i_t$, but Equation (13)

Let $A = \frac{1}{(1+i)^1} + \frac{1}{(1+i)^2} + \cdots + \frac{1}{(1+i)^n}$. (b)

Then $A(1+i) = 1 + \frac{1}{(1+i)^1} + \cdots + \frac{1}{(1+i)^{n-1}}$. (c)

Subtracting (c) from (b),

$$A(-i) = -1 + \frac{1}{(1+i)^n},$$

$$A = \frac{1}{i} - \frac{1}{i(1+i)^n}. \tag{d}$$

As $n \to \infty$, $A \to \frac{1}{i}$ since $\frac{1}{i(1+i)^n} \to 0$. (e)

Also, $\frac{P_m}{(1+i)^n} \to 0$. (f)

Thus, Equation (a) can be rewritten as

$$P_0 = I/i. \tag{g}$$

Let $I = \$1$, and $i = 0.16, 0.14, 0.12, 0.10, ..$ Then the bond price series is \$6.25, 7.143, 8.333, ... If $I = \$2$, then the bond price series is \$12.50, 14.286, 16.667, 20, ... In either series, the rates of change in bond prices are 14.29%, 16.66%, 20.00%, ... except the rounding errors.

requires only the assumption that $P_t = I_t / i_t$.

And the expected holding period return is

$$E(R_t) = E(i_t) + \frac{i_{t-1} - E(i_t)}{i_{t-1}}. \tag{14}$$

In the capital market model and the capital asset pricing model, the total risk is measured by the standard deviation of the return, and the systematic risk is measured by the slope coefficient of the regression equation in which the dependent variable is the holding period return on a security or a portfolio, and the independent variable is the holding period return on the market portfolio. In a similar way, the "inflation systematic risk" can be derived for the bond market.

Assume that the major determinant of the nominal interest rate or the bond holding period return is the expected inflation rate, so that

$$R_i = a + b_i p^* + e, \tag{15}$$

where R_i = the bond holding period return, p^* = the expected inflation rate in goods market, and e = the error term.(8) Then the variance of the bond holding period return is

$$V(R_i) = b_i^2 V(p^*) + V(e). \tag{16}$$

If $V(e) = 0$, then

$$\sigma_i = b_i \sigma_p^*. \tag{17}$$

Since the expected inflation rate is the same for all types of bonds, but b_i can differ between bonds, it can be used as a measure of the inflation risk of a bond. Alternatively, the elasticity of interest rate with respect to the inflation rate can be used as the inflation risk. It can be defined as

$$E_{ip}^* = \frac{\partial i}{\partial p^*} \cdot \frac{p^*}{i}. \tag{18}$$

(8) The Fisher [7] equation assumes that the coefficient b_i should be equal to 1.0 for all types of bonds. However, empirical studies show that the coefficient is generally smaller than 1.0, and varies with bond types. See $\beta_A, \beta_R, \beta_L$ values in Appendix Tables 1-3. For empirical studies on the Fisherian equations, see, for example, Gibson [8, 9], Lahiri [10], Carr [5], Levi and Makin [11, 12], Carlson [4], Melvin [15], Peek [16], and Wilcox [29].

III. Estimation of Return and Risk Variables

In order to test the risk and return relationships, two approaches are possible: the micro approach and the macro approach. In the micro approach, individual security returns are used, while in the macro approach, the group security returns may be used. In this paper, only the macro approach is tested. That is, only Equations (1) and (2) are tested as a pilot study.

For the above purpose, we have selected the following bonds and loans (bond portfolios):

(1) U.S. Treasury bills (3 month, new issues),
(2) U.S. Treasury bills (6 month, new issues),
(3) U.S. Treasury bonds (3 years, constant maturities),
(4) U.S. Treasury bonds (10 years, constant maturities),
(5) Corporate bonds (Moody's AAA),
(6) Corporate bonds (Moody's BBB),
(7) High grade municipal bonds (Standard and Poor's),
(8) Prime commercial paper (4-6 months),
(9) Prime rate charged by banks,
(10) Discount rate (Federal Reserve Bank of New York),
(11) Federal funds rate.

The sample consists of annual data for the period 1959~81.[9] With the above data, the following variables are calculated:

We have calculated three definitions of the holding period return:

$$R_1 = i_t, \text{ the current interest rate,}$$

$$R_2 = i_{t-1} + \frac{i_{t-1} - i_t}{i_t} \text{[Equation (9)]}, \qquad (19)$$

$$R_3 = i_t + \frac{i_{t-1} - i_t}{i_{t-1}} \text{[Equation (13)]}.$$

The expected return of a bond is assumed to be the average of the holding

(9) The data are obtained from U.S. Council of Economic Advisers, *Econcmic Report of the President*, 1982, p. 310.

period return series of the bond:

$$E(R_1)=\sum^{n} R_1/n,$$
$$E(R_2)=\sum^{n} R_2/n, \quad (20)$$
$$E(R_3)=\sum^{n} R_3/n,$$

where n=the number of observations. In this study, $n=22$.[10]

There are three measures of the bond market portfolio return:

$$R_{b1}=\sum^{k} R_i/k,$$
$$R_{b2}=\sum^{k} R_i/k, \quad (21)$$
$$R_{b3}=\sum^{k} R_i/k,$$

where k=the number of debt securities or the bond and loans. In this study, $k=11$. In other words, the bond market portfolio return is assumed to be a simple average of returns on all types of bonds and loans included in the model.

There are two definitions of the stock market portfolio return:

$$R_s=D_t/P_t+\Delta P_t/P_{t-1},$$
$$R_s{}'=D_t/P_t+\Delta P_t/P_t, \quad (22)$$

where D_t/P_t=the dividend yield, $\Delta P_t/P_{t-1}$=the rate of change in stock price (Standard and Poor's 500 stock price index) where P_{t-1} is the stock price of the preceding period, $\Delta P_t/P_t$=the rate of change in stock price where P_t is the stock price of the current period. Since D_t/P_{t-1} is not available, we have used D_t/P_t for the two definitions. Thus, $R_s{}'$ measure is not consistent because it is calculated by adding two variables with different time dimensions. However, we test the $R_s{}'$ variable only for experimental purposes.

There are three measures of the systematic risk in the bond market:

$$R_1=\alpha+\beta_{b1}R_{b1}+e,$$
$$R_2=\alpha+\beta_{b2}R_{b2}+e, \quad (23)$$
$$R_3=\alpha+\beta_{b3}R_{b3}+e.$$

There are six measures of the systematic risk with respect to the stock

(10) There are 23 observations for the period 1959～81. However, the first observations are lost due to the lagged variables.

market portfolio return:

$$R_1=\alpha+\beta_{s1}R_s+e, \qquad R_1=\alpha+\beta_s{}'_1R_s{}'+e,$$
$$R_2=\alpha+\beta_{s2}R_s+e, \qquad R_2=\alpha+\beta_s{}'_2R_s{}'+e, \tag{24}$$
$$R_3=\alpha+\beta_{s3}R_s+e, \qquad R_3=\alpha+\beta_s{}'_3R_s{}'+e.$$

Also, we have calculated three measures of inflation systematic risk:

$$R_1=\alpha+\beta_{A1}p(A)+e,$$
$$R_2=\alpha+\beta_{R2}p(R)+e, \tag{25}$$
$$R_3=\alpha+\beta_{L3}p(L)+e,$$

where $P(A)$=the actual inflation rate or the expected inflation rate with perfect foresight, $p(R)$=the expected inflation rate predicted by the method of regression equation, $p(L)$=the expected inflation rate predicted by the Livingston survey data which are published twice a year in June and December in the *Philadelphia Inquirer*. The regression equation used for the predicted inflation rate is given below:

$$\underset{}{p(R)_t}=\underset{(2.02)^*}{0.6168}+\underset{(7.20)^*}{1.3284p_{t-1}}-\underset{(-3.84)^*}{1.1183p_{t-2}}+\underset{(3.75)^*}{0.7845p_{t-3}}, \tag{26}$$

$R=0.9334$, $\bar{R}^2=0.8510$, $DW=2.3626$, $S=1.4679$, $F=42.87$, $h=-1.865$,

where P_t=the actual inflation rate during period t. The t ratios are listed in the parentheses below the regression coefficients.

Estimates of the above parameter values are summarized in Appendix Tables 1-3. Table 1 is the results when the holding period return is defined as the current interest rate. Table 2 is the results when the holding period return is defined by Equation (9). Table 3 is the results when the holding period return is defined by Equation (13). For instance, in Table 1, the expected return (average return) of the 3 month Treasury bill is 5.8501% for the period 1960～81, and its standard deviation (total risk) is 2.9435%. Its systematic risk with regard to the bond market portfolio return is 1.0344. However, its systematic risk with regard to the stock market portfolio return (R_s) is -0.0134, and its systematic risk with regard to the stock market portfolio return (R_s') is -0.0134. The last three columns show the systematic risks with regard to the actual inflation rate, the expected inflation rate by the regression method and the expected inflation rate by the Livingston survey data: 0.6915, 0.6985, and 0.9022. [11]

IV. Regression Results

The next step, which is the major purpose of this study, is to calculate the following regression equations to determine whether there are significant relationships between the return and risk variables in the bond market:

$$
\begin{aligned}
E(R_i) &= a + b\sigma_i + e_i,\\
E(R_i) &= a + b\beta_{bi} + e_i,\\
E(R_i) &= a + b\beta_{si} + e_i,\\
E(R_i) &= a + b\beta_s{}'_i + e_i,\\
E(R_i) &= a + b\beta_{Ai} + e_i,\\
E(R_i) &= a + b\beta_{Ri} + e_i,\\
E(R_i) &= a + b\beta_{Li} + e_i,
\end{aligned}
\tag{27}
$$

where $E(R_i)$ = the expected return of the bond (definition i), σ_i = the standard deviation of the holding period return i as a measure of the total risk, β_{bi} = the systematic risk beta with respect to the bond market portfolio return, e_i = the error term, $i = 1, 2, 3$.

Using the data presented in Appendix Tables 1-3, we have calculated regression equations by the OLS regression method, and the results are summarized in Appendix Tables 4-6. We observe the following points:

(a) As to the capital market theory, we note that the standard deviation (total risk) is not significant in Table 1 (Equation 1), but it is significant and has a positive sign in Table 2. However, in Table 3, it is significant and has a negative sign. In effect, the regression results support the capital market line hypothesis only when the holding period return is defined in a conventional way (Equation (9)).

(b) As to the capital asset pricing model, the bond portfolio with a high

(11) The systematic risk beta values are obtained by the OLS regression method. Instead of showing all the regression equations, we show only the slope coefficients in Appendix Tables 1-3.

systematic risk with regard to the bond market portfolio return should have a high expected return. However, the regression results do not support this hypothesis. That is, in Tables 4 and 5 (Equation 2), β_b is not significant, and in Table 6, it is significant but has a negative sign.

(c) The bond systematic risk may be calculated with regard to the stock market portfolio return. The systematic risks β_s and β_s' are not significant in Table 4 (Equations 3 and 4), but they are both significant and have positive signs in Table 5. In Table 6, they are also significant, but have negative signs. That is, the regression results support the capital asset pricing model, only when the bond holding period return is calculated by Equation (9), and when the bond systematic risk beta is calculated with regard to the stock market portfolio return.

(d) Regression Equations 5-7 of Tables 4-6 are regression results when the expected bond returns are regressed on three types of inflation rate. In Table 4, the systematic risk with respect to the actual inflation rate (β_A) is not significant, but the other systematic risks β_R and β_L are significant and have positive signs. In Table 5, all the three betas, β_A, β_R and β_L have positive signs and are significant. In Table 6, all the three betas are again significant, but they have all negative signs. In effect, the inflation systematic risk hypothesis is supported when the holding period return is defined as the current interest rate and by Equation (9).

The regression results presented in Appendix Table 5 are mostly consistent with the capital market theory and the capital asset pricing model. However, on this evidence alone, we cannot conclude that the above hypotheses, namely, the capital market theory and the capital asset pricing model are definitely supported. The major reason is that the capital market theory argues that the total risk should be the only significant factor, and the capital asset pricing model argues that the systematic risk should be the only significant factor in explaining the variations in the expected return on risky assets. Thus, if other factors are significant in explaining the variations in the expected return on risky assets, then we will be unable to conclude that the above two hypotheses are supported.(12)

To see if other variables can be significant in explaining the variations in the expected returns on the bond portfolios, the following models are tested:

$$E(R_i)=F(\sigma_i, D_i, T_i, M_i, e_i), \quad (18)$$

$$E(R_i)=F(\beta_i, D_i, T_i, M_i, e_i), \quad (19)$$

where $E(R_i)$=the expected return on bond i or bond portfolio i, σ=the standard deviation as a measure of total risk, β=the systematic risk beta, D=the risk of default index number (The index numbers are assigned in ascending order of default risk, 1 through 11.), T=tax status dummy variable (A number 1 is assigned if the interest income and capital gains are taxable, and a number zero is assigned if they are not taxable.), M=the maturity of the bond or the bond portfolio index number (The index numbers are assigned in ascending order, 1 through 11.), e=the error term.(13)

The index numbers assigned above are arbitrary in the sense that they are based on a subjective judgement, and not on any objective data, though many people may agree with the ranking. Thus, the statistical results should be interpreted as experimental and tentative, and not as conclusive.

The OLS regression results are summarized in Appendix Tables 7-9. We note the following points:

(a) In Table 9 (Equation 1), the total risk (σ) is not significant, but the default risk is significant. In Table 8, the total risk, default risk, and tax

(12) To support the capital asset pricing model, the following criteria should be met by the empirical results: (1) The relationship should be linear in beta. (2) Beta should be the only factor, and other factors such as dividend yield, price-earnings ratio, firm size, beta squared included in regression equations, should have no explanatory power. (3) The expected return on a risky asset should be greater than the risk free rate over a long period of time. See Copeland and Weston [6, p. 207].

(13) The following rank numbers are assigned to the bond portfolios:

Bond Number	1	2	3	4	5	6	7	8	9	10	11
Risk of default	1	2	3	4	10	11	7	8	9	5	6
Maturity	3	5	7	8	10	11	9	4	6	2	1
Tax status	1	1	1	1	1	1	0	1	1	0	1

status are all significant and have positive signs. In Table 9, again the above three variables are significant, but the total risk has a negative sign. These results suggest that the default risk is also a significant variable in explaining the variations in the expected returns on the bond portfolios. Thus, the capital market theory is not supported.(14)

(b) As to the capital asset pricing model, in Equation 2 of Table 7, none of the four independent variables is significant at the 5% level. However, in Equations 3 and 4, all the four independent variables are significant. In Table 8, the systematic risk β_b and the default risk are significant in Equation 2, but none of the four independent variables is significant in Equations 3 and 4. In Table 9, the systematic risks β_b and β_s are significant in Equations 2 and 3, but they have negative signs. Thus, the above regression results do not support the capital asset pricing model that the systematic risk beta should be the only significant factor in explaining the variations in the expected return on the bond portfolios.

(c) As to the inflation systematic risk, in Table 7 (Equations 5, 6, and 7), β_A, β_R, and β_L are all significant and have positive signs, but the other independent variables are not significant. However, in Tables 8 and 9, none of the inflation systematic risks is significant, though tax status and maturity are significant in some equations. Thus, the inflation systematic risk hypothesis is supported only when the bond holding period return is defined as the current interest rate.

In the regression equations presented in Appendix Tables 7-9, there are four independent variables. To see if there exists multicollinearity among the independent variables, simple correlation coefficients are examined. Though there is no significant correlation among the three additional variables, some significant correlations are found between maturity and the total risk, and between maturity and the systematic risk betas. Thus, removing the maturity variable, we

(14) The simple correlation coefficients are 0.00 between default risk and tax status, 0.509 between default risk and maturity, and 0.0745 between tax status and maturity. None of the above correlation coefficients is significant at the 5% level. The critical r is 0.602.

have calculated additional regression equations which are presented in Appendix Tables 10-12. We note the following points:

(a) In Table 10 (Equations 1-4), the total risk and the systematic risks are not significant, but the default risk is significant.

(b) In Table 11 (Equations 1-4), the total risk, the systematic risks, the default risk and the tax status are all significant and have positive signs.

(c) In Table 12 (Equations 1-4), the total risk, the systematic risks, the default risk, and the tax status are all significant, but the total risk and the systematic risks have negative signs.

(d) As to the inflation systematic risk hypothesis, the actual inflation systematic risk β_A is not significant in Tables 10-12, but the other two expected inflation systematic risk are still significant.

In effect, the above regression results are also not consistent with the capital market theory and the capital asset pricing model. What the statistical results show is that the total risk or the systematic risk can be one of the many significant factors in explaining the variations in the expected return on risky assets. In other words, the total risk or the systematic risk does not necessarily reflect the other factors such as the risk of default, maturity structure, and the tax status. Thus, these factors should be regarded as independent factors in portfolio decision making.

V. Summary and Conclusions

The major objective of this study was to test the capital market theory and the capital asset pricing model in the bond market. According to the capital market theory or the capital market line hypothesis, the expected return on a portfolio should be a linear positive function of the total risk (standard deviation) of the portfolio. According to the capital asset pricing model or the security market line hypothesis, the expected return on a portfolio should be a linear positive function of its systematic risk beta. In other words, the differences in the expected return on the bond portfolio should be explained solely by the differences in the total risk or in the systematic risk of the bond portfolio.

To test the above hypotheses, 11 bond portfolios are selected, and then 3 measures of the holding period return are calculated. Corresponding to each measure, one measure of the total risk, and 3 measures of the systematic risk beta are calculated. Based on these variables, a large number of regression equations are calculated. The regression results show the following:

(a) The total risk and the systematic risk are in general significant variables in explaining the variations in the expected return on the bond portfolio. However, the $\bar{R}^2$ is generally very low in regression equations where the independent variable is only the total risk or the systematic risk. When the default risk and the tax status variables are included in the regression equations, the $\bar{R}^2$ is significantly increased, and these two additional independent variables are found to be also significant (see Appendix Table 11). These results do not support the capital market theory or the capital asset pricing model according to which the total risk or the systematic risk should be the only significant factor in explaining the variations in the expected return on risky assets.[15]

(b) As a supplementary study, we have also tested the inflation systematic risk hypothesis that a bond portfolio with a high inflation systematic risk should have a high expected return. The statistical results show that the actual inflation systematic risk is not significant, but the expected inflation systematic risk is indeed significant.[16]

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(15) The results of this study is consistent with the hypothesis that the market determined risk variables, i.e., the total risk and the systematic risk are inadequate in predicting corporate bankruptcies and bond ratings. See Reilly and Joehnik [18], Brigham and Crum [3], Ahrony, Jones, and Swamy [1], and Shin [24]. The effects of expected inflation on the nominal interest rate are discussed in separate papers, Shin [25, 26].

(16) However, these conclusions may be regarded as tentative and experimental because the sample size was rather small.

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Appendix

Table 1. Expected Return, Total Risk and Systematic Risk (Holding Period Return: R_1)

	$E(R_1)$	σ_1	β_{b1}	β_{s1}	$\beta_s'{}_1$	β_{A1}	β_{R1}	β_{L1}
(1) 3 month Treasury bill	5.8501	2.9435	1.0144	−0.0134	−0.0134	0.6915	0.6985	0.9022
(2) 6 month Treasury bill	6.0047	2.8314	0.9969	−0.0151	−0.0135	0.6700	0.6801	0.8757
(3) 3 year Treasury bond	6.5568	2.7199	0.9627	−0.0010	0.0005	0.6455	0.6892	0.8923
(4) 10 year Treasury bond	6.6859	2.5660	0.8971	0.0090	0.0101	0.6104	0.6647	0.8682
(5) AAA corporate bond	7.2041	2.6095	0.9002	0.0074	0.0065	0.6260	0.6834	0.8878
(6) BBB corporate bond	8.1495	2.9695	1.0123	0.0143	0.0130	0.7072	0.7790	1.0139
(7) High grade municipal	5.3605	3.0916	0.6602	0.0063	0.0057	0.4381	0.4941	0.6424
(8) Prime commercial paper	6.5968	3.0916	1.0774	−0.0379	−0.0377	−0.7332	0.7262	0.9192
(9) Prime rate by banks	7.6355	3.7779	1.3242	−0.0088	−0.0093	0.8829	0.9096	1.1758
(10) Discount rate	7.9000	2.7941	0.9846	0.0019	0.0016	0.6750	0.6895	0.8944
(11) Federal funds rate	6.3573	3.3614	1.1500	−0.0484	−0.0489	0.8165	0.7834	0.9843
Mean	6.7547	2.9779	1.0000	−0.0079	−0.0078	0.6814	0.7089	0.9142
Standard deviation	0.8824	0.3523	0.1651	0.0200	0.0199	0.1145	0.1007	0.1275

Notes: $E(R_1)$=expected return in the portfolio, definition R_1; σ_1=standard deviation of R_1 as a measure of total risk; β_{b1}=systematic risk with regard to the bond market portfolio return; β_{s1}=systematic risk beta with regard to the stock market portfolio return (R_s); $\beta_s'{}_1$=systematic risk beta with regard to the stock market portfolio return (R_s'); β_{A1}=systematic risk beta with regard to the actual inflation rate; β_{R1}=systematic risk beta with regard to the expected inflation rate predicted by the regression equation; β_{L1} =systematic risk beta with regard to the expected inflation rate predicted by the Livingston survey data.

These parameters are calculated using the basic data for the period 1959~81. Since the first year observations are lost to calculate the rates of change, the effective data set is for the period 1960~81, or 22 observations.

During the same period, the average annual rate of change in stock prices (SP 500 stock price indexes), $\Delta P_t/P_{t-1}$ is 4.2986%, and $\Delta P_t/P_t$ is 2.7423%. The average annual dividend yield D_t/P_t is 3.78%. Thus, $E(R_{s1})=E(\Delta P_t/P_{t-1})+E(D_t/P_t)=8.0786\%$, and $E(R_{s2})=E(\Delta P_t/P_t)+E(D_t/P_t)=6.5223\%$. The standard deviations are 10.949% for $\Delta P_t/P_{t-1}$, 11.226% for $\Delta P_t/P_t$, and 0.8822% for D_t/P_t

For definitions of the variables, methods of calculations, and the sources of the basic data, see text.

Table 2. Expected Return, Total Risk and Systematic Risk (Holding Period Return: R_2)

	$E(R_2)$	σ_2	β_{b2}	β_{s2}	$\beta_{s'2}$	β_{A2}	β_{R2}	β_{L2}
(1) 3 month Treasury bill	1.4152	22.2390	1.4441	0.6562	0.5739	−0.7434	0.2593	0.0425
(2) 6 month Treasury bill	1.8499	20.5780	1.3341	0.5877	0.5024	−0.7325	0.0951	−0.0836
(3) 3 year Treasury bond	1.7121	12.7900	0.8017	0.3771	0.3338	−0.9466	−0.6003	−0.6555
(4) 10 year Treasury bond	1.4721	8.5450	0.4770	0.2850	0.2604	−0.8051	−0.5873	−0.6444
(5) AAA corporate bond	1.8553	7.3607	0.3370	0.2476	0.2517	−0.6653	−0.4331	−0.3992
(6) BBB corporate bond	2.9173	8.6099	0.2849	0.2831	0.2821	0.8290	−0.6050	−0.5137
(7) High grade municipal	1.1351	11.9460	0.4346	0.2226	0.2310	−1.5534	−1.4274	−1.5432
(8) Prime commercial paper	3.0150	25.0430	1.6315	0.8718	0.7768	−0.5734	0.6643	0.5481
(9) Prime rate by banks	2.4031	19.3000	1.2183	0.7490	0.6942	−0.9974	0.0172	0.0364
(10) Discount rate	0.5585	15.6900	0.9930	0.5249	0.4942	−0.7241	0.0828	0.0731
(11) Federal funds rate	4.1431	33.4820	2.0431	1.0418	0.9360	−0.2553	1.6438	1.2205
Mean	2.0434	16.871	1.0000	0.5315	0.4851	−0.8023	−0.0810	−0.1745
Standard deviation	1.0089	8.1332	0.5853	0.2765	0.2396	0.3176	0.8032	0.7156

Notes: See Table 1.

Table 3. Expected Return, Total Risk and Systematic Risk (Holding Period Return: R_3)

	$E(R_3)$	σ_3	β_{b3}	β_{s3}	$\beta_{s'3}$	β_{A3}	β_{R3}	β_{L3}
(1) 3 month Treasury bill	−3.3718	23.2320	1.5150	0.6114	0.5129	−0.9284	0.0407	−0.0689
(2) 6 month Treasury bill	−2.1253	20.7830	1.3639	0.5378	0.4403	−0.8226	−0.0689	−0.1569
(3) 3 year Treasury bond	0.2056	12.4280	0.7848	0.3400	0.2972	−0.9604	−0.6601	−0.6973
(4) 10 year Treasury bond	0.8188	8.2937	0.4533	0.2598	0.2381	−0.8513	−0.6529	−0.7181
(5) AAA corporate bond	1.3929	7.5724	0.3145	0.2444	0.2516	−0.7398	−0.5013	−0.4880
(6) BBB corporate bond	2.3235	8.7534	0.2684	0.2750	0.2770	−0.9136	−0.6762	−0.6209
(7) High grade municipal	−0.3462	12.8190	0.4305	0.2119	0.2203	−1.7961	−1.6971	−1.8860
(8) Prime commercial paper	−2.4342	24.2910	1.6018	0.8228	0.7066	−0.9416	0.0993	0.1291
(9) Prime rate by banks	−1.0628	19.4020	1.2432	0.7748	0.7125	−1.4632	−0.4826	−0.4399
(10) Discount rate	−1.9668	16.6900	1.0614	0.5145	0.4812	−0.9832	−0.1796	−0.1823
(11) Federal funds rate	−5.0116	31.5770	1.9632	0.9738	0.8417	−0.4347	1.2047	1.1535
Mean	−1.0525	16.895	1.0000	0.5060	0.4527	−0.9850	−0.3249	−0.3651
Standard deviation	2.1888	7.7176	0.5853	0.2646	0.2199	0.3612	0.7087	0.7299

Notes: See Table 1.

Table 4. Regression Results for Return and Risk (Dependent Variable: $E(R_1)$)

	Intercept			R^2	$\bar{R}^2$	SEE	F	DW	ρ
(1)	6.2548 (2.51)*	0.1679 (0.20)	σ_1	0.0045	−0.1061	0.9280	0.041	1.8792	−0.0056
(2)	4.4515 (2.74)*	2.3032 (1.43)	β_{b1}	0.1857	0.0952	0.8393	2.053	1.6204	0.0767
(3)	6.8693 (23.97)*	14.5400 (1.05)	β_{s1}	0.1084	0.0093	0.8783	1.094	1.8550	0.0227
(4)	6.8601 (23.77)*	13.5780 (0.96)	$\beta_s{}'_1$	0.0934	−0.0073	0.8856	0.928	1.8352	0.0321
(5)	4.3110 (2.75)*	3.5858 (1.58)	β_{A1}	0.2164	0.1294	0.8233	2.486	1.6397	0.0504
(6)	2.9412 (1.78)*	5.3795 (2.33)*	β_{R1}	0.3772	0.3080	0.7340	5.451	1.7774	−0.0330
(7)	2.6339 (1.63)	4.5075 (2.57)*	β_{L1}	0.4240	0.3600	0.7059	6.626	1.803	−0.0439

Notes: The numbers in parentheses are the t ratios. *Significant either at the 5% level or 1% level. Though the DW statistic and the ρ coefficient (first order serial correlation coefficient) are not necessary for the cross section data, we have listed them to observe if there is any serial correlation in the order of the data list. For the basic data, see Table 1.

Table 5. Regression Results for Return and Risk (Dependent Variable: $E(R_2)$)

	Intercept			R^2	$\bar{R}^2$	SEE	F	DW	ρ
(1)	0.8572 (1.36)	0.0703 (2.06)*	σ_2	0.3212	0.2458	0.8762	4.258	2.1202	−0.2243
(2)	1.1892 (2.08)*	0.8541 (1.71)	β_{b2}	0.2455	0.1617	0.9238	2.929	2.1177	−0.2718
(3)	0.8548 (1.50)	2.2362 (2.33)*	β_{s2}	0.3756	0.3062	0.8404	5.413	1.9438	−0.1273
(4)	0.7685 (1.31)	2.6279 (2.40)*	$\beta_s{}'_2$	0.3894	0.3216	0.8310	5.740	1.9785	−0.1344
(5)	3.4885 (4.66)*	1.8012 (2.06)*	β_{A2}	0.3214	0.2460	0.8761	4.263	2.2542	−0.3122
(6)	2.1084 (8.51)*	0.8033 (2.50)*	β_{R2}	0.4090	0.3433	0.8176	6.228	2.0621	−0.1540
(7)	2.2002 (8.63)*	0.8988 (2.43)*	β_{L2}	0.4063	0.3404	0.8194	6.160	2.1000	−0.1875

Notes: See Table 4. For the basic data, see Table 2.

Table 6. Regression Results for Return and Risk (Dependent Variable: $E(R_3)$)

	Intercept			R^2	$\bar{R}^2$	SEE	F	DW	ρ
(1)	3.5407 (7.14)*	−0.2719 (−10.10)*	σ_3	0.9189	0.9099	0.4317	101.978	2.4508	−0.2714
(2)	2.4891 (5.43)*	−3.5416 (−8.84)*	β_{b3}	0.8967	0.8852	0.7415	78.138	2.5381	−0.3451
(3)	2.4715 (2.94)*	−6.9643 (−4.68)*	β_{s3}	0.7087	0.6764	1.2452	21.901	1.8501	−0.0339
(4)	2.5921 (2.66)*	−8.0514 (−4.13)*	$\beta_s{}'_3$	0.6541	0.6157	1.3570	17.019	1.5930	0.0849
(5)	−2.5565 (−1.25)	−1.5269 (−0.78)	β_{A3}	0.0635	−0.0406	2.2382	0.610	0.6701	0.6397
(6)	−1.7977 (−3.48)*	−2.2934 (−3.33)*	β_{R3}	0.5513	0.5015	1.5455	11.059	1.5244	0.1838
(7)	−1.8061 (−3.17)*	−2.0641 (−2.85)*	β_{L3}	0.4737	0.4152	1.6738	8.101	1.4710	0.1926

Notes: See Table 4. For the basic data, see Table 3.

Table 7. Regression Results for Return and Risk (Dependent Variable: $E(R_1)$)

	Intercept			Default risk	Tax status	Maturity	R^2	$\bar{R}^2$	*SEE*	*F*	*DW*	ρ
(1)	8.1072 (2.67)*	−0.7914 (−0.79)	σ_1	0.2273 (1.92)*	0.2428 (0.35)	−0.0931 (−0.79)	0.4124	0.0207	0.8732	1.053	2.1962	−0.1515
(2)	1.6415 (0.39)	4.7315 (1.73)	β_{b1}	0.0550 (0.51)	−0.9603 (−1.09)	0.1396 (1.05)	0.5670	0.2783	0.7496	1.964	2.4413	−0.2386
(3)	6.9251 (16.93)*	68.062 (5.48)*	β_{s1}	0.2953 (6.28)*	1.4094 (3.81)*	−0.4265 (−5.22)*	0.8922	0.8204	0.3740	12.417	2.4317	−0.3779
(4)	6.8720 (17.79)*	69.112 (5.78)*	$\beta_s{'}_1$	0.3179 (6.77)*	1.3830 (3.95)*	−0.4366 (−5.51)*	0.9012	0.8353	0.3581	13.683	2.4447	−0.3765
(5)	0.4713 (0.19)	9.0467 (2.18)*	β_{A1}	−0.0055 (−0.05)	−1.3579 (−1.53)	0.2104 (1.52)	0.6377	0.3961	0.6857	2.640	2.6791	−0.3750
(6)	0.6478 (0.31)	8.9013 (2.59)*	β_{R1}	0.0122 (0.13)	−1.1930 (−1.65)	0.1167 (1.26)	0.6938	0.4896	0.6304	3.3980	2.7675	−0.4169
(7)	0.8641 (0.46)	6.6410 (2.75)*	β_{L1}	0.0282 (0.33)	−1.0863 (−1.64)	0.0899 (1.09)	0.7136	0.5227	0.6096	3.738	2.7890	−0.4244

Notes: See Table 4. The basic data are given in Table 1.

Table 8. Regression Results for Return and Risk (Dependent Variable $E(R_2)$)

	Intercept			Default risk	Tax status	Maturity	R^2	$\bar{R}^2$	*SEE*	*F*	*DW*	ρ
(1)	−2.4065 (−2.27)*	0.1236 (3.01)*	σ_2	0.1323 (2.44)*	0.9176 (2.26)*	0.1366 (1.23)	0.8858	0.8097	0.4402	11.635	1.5790	0.0137
(2)	−2.2505 (−1.44)	1.8335 (1.88)*	β_{b2}	0.1533 (2.29)*	0.7246 (1.16)	0.1579 (0.87)	0.8196	0.6993	0.5533	6.814	1.5449	0.0045
(3)	−2.0837 (−1.24)	3.9642 (1.65)	β_{s2}	0.0709 (0.68)	0.5838 (0.78)	0.1870 (0.84)	0.8025	0.6708	0.5789	6.095	1.4024	0.1179
(4)	−2.1726 (−1.24)	4.5946 (1.62)	$\beta_s{'}_2$	0.0469 (0.40)	0.6552 (0.91)	0.1949 (0.84)	0.8003	0.6671	0.5822	6.010	1.4500	0.0898
(5)	0.4186 (0.31)	−0.1126 (−0.09)	β_{A2}	0.2073 (2.41)*	1.6136 (2.04)*	−0.1716 (−1.45)	0.7137	0.5229	0.6969	3.740	1.7762	−0.1381
(6)	0.2688 (0.48)	1.7873 (1.72)	β_{R2}	0.0320 (0.27)	−0.0058 (−0.57)	0.2887 (1.07)	0.8083	0.6805	0.5703	6.324	2.0872	−0.1228
(7)	0.5929 (0.87)	0.6098 (0.37)	β_{L2}	0.1401 (0.75)	1.0600 (0.73)	−0.0251 (−0.07)	0.7198	0.5330	0.6895	3.853	1.8887	−0.1652

Notes: See Table 4. The basic data are given in Table 2.

Table 9. Regression Results for Return and Risk (Dependent Variable: $E(R_3)$)

	Intercept			Default risk	Tax status	Maturity	R^2	$\bar{R}^2$	SSE	F	DW	ρ
(1)	0.7812 (0.80)	−0.2167 (5.87)*	σ_3	0.0925 (2.04)*	0.6156 (1.86)*	0.1281 (1.35)	0.9823	0.9705	0.3761	83.196	2.443	−0.3075
(2)	1.0718 (0.62)	−3.5565 (−3.42)*	β_{b3}	0.0665 (0.99)	1.2286 (1.97)*	0.0046 (0.02)	0.9594	0.9324	0.5692	35.467	1.9069	−0.1742
(3)	−0.5915 (−0.29)	−6.4488 (−2.05)*	β_{s3}	0.2264 (1.59)	1.2062 (1.30)	0.0762 (0.27)	0.9297	0.8828	0.7494	19.826	1.8621	−0.0713
(4)	−0.9330 (−0.41)	−6.8308 (−1.69)	$\beta_{b'3}$	0.2383 (1.38)	0.8955 (0.96)	0.1350	0.9190	0.8649	0.8044	17.010	1.8565	−0.0446
(5)	−3.4200 (−2.22)*	0.9514 (0.88)	β_{A3}	−0.0134 (−0.13)	−0.7508 (0.82)	0.6665 (5.95)*	0.8941	0.8235	0.9196	12.665	2.0508	−0.1702
(6)	−4.5296 (−4.74)*	0.0303 (0.02)	β_{R3}	−0.0128 (−0.10)	−0.2822 (−0.21)	0.6325 (2.29)*	0.8805	0.8008	0.9769	11.052	2.2108	−0.1993
(7)	−4.3207 (−4.30)*	0.6071 (0.50)	β_{L3}	−0.0584 (−0.41)	−0.8297 (−0.60)	0.7532 (2.73)*	0.8852	0.8087	0.9573	11.570	2.1495	−0.2056

Notes: See Table 4. The basic data are given in Table 3.

Table 10. Regression Results for Return and Risk (Dependent Variable: $E(R_1)$)

	Intercept			Default risk	Tax status	R^2	$\bar{R}^2$	SEE	F	DW	ρ
(1)	6.6452 (2.84)*	−0.3405 (−0.42)	σ_1	0.1645 (1.92)*	0.1666 (0.25)	0.3514	0.0735	0.8494	1.264	2.0380	−0.0298
(2)	3.7477 (2.46)*	2.4930 (1.45)*	β_{b1}	0.1387 (1.91)*	−0.3891 (−0.56)	0.4881	0.2687	0.7546	2.225	2.1399	−0.1573
(3)	5.7438 (7.74)*	12.3240 (0.90)	β_{s1}	0.1393 (1.76)*	0.3325 (0.50)	0.4034	0.1477	0.8147	1.577	1.9208	0.0356
(4)	5.7292 (7.72)*	12.1410 (0.89)	$\beta_{s'1}$	0.1428 (1.82)*	0.3214 (0.48)	0.4021	0.1459	0.8155	1.570	1.9199	0.0364
(5)	3.7448 (2.54)*	3.7670 (1.51)*	β_{A1}	0.1315 (1.81)*	−0.4232 (−0.61)	0.4978	0.2826	0.7474	2.313	2.1104	−0.1803
(6)	2.4548 (1.56)	6.0676 (2.24)*	β_{R1}	0.0974 (1.45)	−0.7162 (−1.11)	0.6130	0.4471	0.6561	3.6950	2.1004	−0.1743
(7)	2.1301 (−1.27)	5.1401 (2.57)*	β_{L1}	0.0918 (1.44)	−0.7639 (−1.27)	0.6572	0.5103	0.6175	4.474	2.1628	−0.1919
(8)	5.8121 (7.21)*	0.1734 (1.84)*	Maturity	0.1768 (0.27)	−0.0405 (−0.43)	0.3519	0.0741	0.8491	1.267	2.2027	−0.1569

Notes: See Table 4. The basic data are given in Table 1 and footnote (13).

Table 11. Regression Results for Return and Risk (Dependent Variable: $E(R_2)$)

	Intercept			Default risk	Tax status	R^2	$\bar{R}^2$	*SEE*	*F*	*DW*	ρ
(1)	−1.2672 (−2.38)*	0.0783 (4.17)*	σ_2	0.1720 (3.81)*	1.1703 (3.22)*	0.8570	0.7957	0.4560	13.984	1.6358	0.0144
(2)	−0.9996 (−1.65)	1.0357 (3.19)*	β_{b2}	0.1845 (3.32)*	1.1002 (2.50)*	0.7969	0.7098	0.5435	9.154	1.6816	−0.0525
(3)	−0.7712 (−1.29)	2.0263 (2.97)*	β_{s2}	0.1434 (2.63)*	1.0717 (2.32)*	0.7792	0.6846	0.5660	8.236	1.6093	−0.0030
(4)	−0.7844 (−1.30)	2.2921 (2.94)*	$\beta_s{'}_2$	0.1334 (2.45)*	1.1192 (2.43)*	0.7766	0.6808	0.5700	8.110	1.6169	−0.0029
(5)	1.5074 (1.27)	1.2564 (1.43)	β_{A2}	0.1284 (1.79)*	0.9458 (1.37)	0.6139	0.4484	0.7494	3.710	1.7276	−0.1091
(6)	0.4610 (0.86)	0.7092 (2.88)*	β_{R2}	0.1438 (2.59)*	0.9499 (1.96)*	0.7717	0.6739	0.5762	7.888	1.9466	−0.1301
(7)	0.6026 (0.98)*	0.7161 (2.34)*	β_{L2}	0.1284 (2.11)*	0.9718 (1.79)*	0.7196	0.5994	0.6386	5.988	1.9024	−0.1691
(8)	0.5228 (0.85)	0.2039 (2.85)*	Maturity	1.5624 (3.08)*	−0.1635 (−2.28)*	0.7134	0.5905	0.6456	5.807	1.8015	−0.1469

Notes: See Table 4. The basic data are given in Table 2 and footnote (13).

Table 12. Regression Results for Return and Risk (Dependent Variable: $E(R_3)$)

	Intercept			Default risk	Tax status	R^2	$\bar{R}^2$	*SEE*	*F*	*DW*	ρ
(1)	1.9417 (3.99)*	−0.2615 (15.16)*	σ_3	0.1267 (3.19)*	0.8111 (2.58)*	0.9769	0.9670	0.3978	98.591	1.9345	−0.0144
(2)	1.1103 (1.85)*	−3.5892 (−11.31*	β_{b3}	0.0673 (1.23)	1.2387 (2.92)*	0.9594	0.9420	0.5270	55.166	1.8968	−0.1687
(3)	−0.0769 (−0.11)	−7.2634 (−8.39)*	β_{s3}	0.2598 (3.89)*	1.3949 (2.46)*	0.9288	0.8983	0.6981	30.439	1.8159	−0.0537
(4)	−0.0001 (−0.0001)	−8.5460 (−7.64)*	$\beta_s{'}_3$	0.3069 (4.25)*	1.1917 (1.96)*	0.9163	0.8804	0.7569	25.546	1.8146	−0.0332
(5)	−5.1419 (−1.40)	−1.6770 (−0.70)	β_{A3}	0.2758 (1.26)	0.9565 (0.45)	0.2688	−0.0446	2.2371	0.858	0.8261	0.6022
(6)	−4.7761 (−3.96)*	−2.6192 (−4.17)*	β_{R3}	0.1936 (1.60)	2.0910 (1.94)*	0.7756	0.6794	1.6840	8.065	1.6480	0.1263
(7)	−5.1308 (−3.85)*	−2.4625 (−3.78)*	β_{L3}	0.2380 (1.86)*	2.1407 (1.83)*	0.7426	0.6323	1.3273	6.731	1.7665	0.0719
(8)	−4.5352 (−5.28)*	−0.0111 (−0.11)	Maturity	−0.2557 (−0.36)	0.6264 (6.23)*	0.8805	0.8293	0.9044	17.190	2.2122	−0.1980

Notes: See Table 4. The basic data are given in Table 3 and footnote (13).